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FOREWORD

I am pleased to put into the hands of readers Volume-5; Issue-5: Sep-Oct 2020 of **"International Journal of Environment, Agriculture and Biotechnology (IJEAB) (ISSN: 2456-1878)",** an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to **Environment, Agriculture and Biotechnology**. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release issue with DOI (Digital Object Identifier) from CrossRef also, now using DOI paper of the author is available to the many libraries. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind.

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Editor-in-Chief
Date: Dec, 2020

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Financing Agricultural Products: A Statistical Approach in sales data inside of a Brazilian State

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***Abstract*—** *The work aims to present statistical data analysis on the sale of financing agricultural products in the regions of Vale do Paraíba, North Coast, and Alto do Tietê in the interior of São Paulo State, Brazil, obtained from agencies located in that regions, to analyze the best-selling products, and to understand the impacts that these regions have on the demand of agricultural producers. The data were collected from agents who participate in the National Rural Credit System through the National Agriculture Strengthening Program (PRONAF). The collected data were organized with the Excel® spreadsheet editor and analyzed using t-test and analysis of variance (ANOVA), to validate the null hypothesis which states that the sales volume was the same independent of the studied region. The results showed variation in sales numbers by region and they were discussed, and recommendations for future works were presented.*

Keywords*—** ***Agribusiness, Agricultural financing, Agricultural products, Analysis of variance, T-test.

I. INTRODUCTION

Gross Domestic Product (GDP) of Brazilian agribusiness, calculated by the Center for Advanced Studies in Applied Economics (Cepea), esalq/USP, in partnership with the Confederation of Agriculture and Livestock of Brazil (CNA), continued to grow in May, completing five successive months of high in 2020. In the month, the expansion was 0.78%, leading to the growth of 4.62% in the period from January to May 2020 (Center for Advanced Studies in Applied Economics - Cepea, 2020). Agribusiness is the most important sector of the Brazilian economy, about 21.4% of Brazil's gross domestic product (GDP) (Instituto Brasileiro de Geografia e Estatística - IBGE, 2020). Due to the characteristics and diversity of climate and soil, which also contains highly fertile and still unexplored agricultural areas, Brazil presents a favorable scenario for the development and growth of agribusiness. When we analyze the increase in global demographics, therefore the demand for more food, we predict that Brazil should reach the level of the world leader in the supply of food and commodities linked to agribusiness, which will imply the solidification of its economy and catapulted its growth (Bacha, 2004). Rural credit in Brazil was systematized by Law No. 4,829/65 and regulated by Decree No. 58,380/66, being restricted to the specific field of financing rural activities. Rural credit finances the cost of normal expenses of production cycles, investment in goods or services, commercialization, and industrialization. Every year, banks have to allocate 30% of cash deposits, 60% of rural savings deposits, and 35% of ACL funding to apply to rural credit operations. The National Monetary Council (CMN) establishes sub directions for each rural segment according to the producer's profile. It aims to increase the productivity of cash resources in the sector and generate income in family farming. The Central Bank (BC) is the body responsible for managing the National Rural Credit System (SNCR), a set of financial institutions that provide rural financing. The SNCR aims at agricultural development in the country (Banco Central do Brasil - BCB, 2020). The National Program for Strengthening Agriculture (PRONAF) was created in 1996, to strengthen family farming, so that they can have more competitiveness with business agriculture, in addition to direct support to family producers, through credit, PRONAF has another line of action aimed at financing joint actions of municipalities and States, to eliminate bottlenecks that are slowing or preventing rural development in areas where the presence of family farmers predominates (Buainain, 1999). The National Program for Strengthening Family Agriculture (Pronaf) is one of the projects funded by the rural credit system. The initiative finances actions that generate income for family farmers and land-reform. Pronaf resources can be made available individually or collectively. The effective interest rates range from 2.5% per year (for the cultivation of rice, beans, cassava, tomato, onion, English potato, and wheat, among

others) to 5.5% per year (for the acquisition of animals intended for breeding and fattening and other crops and creations) (Banco Central do Brasil - BCB, 2020). Ranathunga, Wijemanna, Sathsara, and Gamage (2018), discussed in their work the status of the agriculture in Sri Lanka in a concise manner using the published official data and concluded that the authorities must attempt to achieve the self-sufficiency of each sub-sector to save the foreign exchange on continuous imports. The inclusiveness of the financial services of microfinance banks for inclusive Agricultural development in Anambra State, Nigeria, were analyzed, and data were elicited from three microfinance banks on the number of genders, location, and firms that had access to their financial services by using frequency, tables, mean, and standard deviation, coefficient of variation, t-test and bar chart and showed that there are significant imbalances in the financial services rendered by microfinance banks to gender, location, and firm (Odemero & Obianujunwa, 2016). Similar work was presented by Sroka, Dudek, Wojewodzic, and Król (2019), in which they described spatial variation in generational changes in farms located around large cities (metropolises) in Poland and to assess the factors affecting the scale of such changes, emphasizing the importance of the location of farms relative to large cities.

Another approach in the same research scope had questioned the relationship society's credit structures, describing that the growth of commodity-money relations, the need for cheap low-interest credit to dealers, lawlessness, the need for combining funds for bulk purchases and sales have increased credit cooperation development. As the result, it proposed that the analysis of legal support, the institutionalization of the system of public finance in Russia, has been carried out, as in a special role in crediting innovations in the field of agricultural production and modernization of peasant farms was played by the Moscow People's Bank (Galas & Seleznev, 2019). Durie (2018), had examined financing rural industrialization and employment creation practices and possibilities in Ethiopia, However, attempts were made to see at least the trends in agricultural commercialization, off-farm practices, the government's policy, the financial institution's practices, and above all how other countries approached rural industrialization and financing such industries. Using the descriptive statistics, the correlation analysis and the regression analysis analyses had conducted to understand how far the capital structure affects the profitability of agricultural holdings in the Czech Republic, considering a period of six years from 2008 to 2013(Stekla & Grycova, 2016).

1.1 Statistics tools

Statistical methods are efficient direct approaches that provide objectivity and accuracy and provide tools that formalize and standardize procedures to obtain certain conclusions. The results of statistical analyses are the result of market intelligence services that involve the collection and detailed analysis of business data. There are some different methods and tests within the statistical analysis, the method used should be chosen according to the objective of the project. Variance analysis, also known as ANOVA, is an Inferential Statistics tool used to compare the distribution of three or more groups in independent samples and was the first tool used for our case study. This analysis is also a way of summarizing a linear regression model, by comparison, the sum of squares for each source of variation and, through the use of the F test, test the hypothesis that any source of variation in the model is equal to zero, the null hypothesis in this case. The conclusion of ANOVA is also based on Statistics F, which has Fischer-Snedecor F distribution with (k-1) and (n-k) degrees of freedom, where k is the number of groups and n is the number of observations. In case the F statistic is higher than the f tabled, it is concluded that the result is a much lower value than the calculated one since there is a very large difference between the values of the samples. In the present study, ANOVA was used to compare the sales per month of the agricultural company studied and analyze the influence of different locations on product sales (Garcia-Marques & Azevedo, 1995). ANOVA was also applied in a similar study addressing the development, dissemination, and assessment of a Food Safety System Management (FSSM) curriculum offered to college-aged, agribusiness students in Yerevan, Armenia (Pokharel, Marcy, Neilan & Cutter, 2017). Remenova and Jankelova (2019) in their work monitors the dependence between the decision-making style of agricultural managers and their personal and working parameters to identify the decision-making styles and explain how it can support the agricultural managers gain, and for this issue, a parametric test ANOVA was applied to assess potential differences in the score of decision-making. The parametric test ANOVA had also applied for the prediction of financial distress (default of payment or insolvency) of 250 agriculture business companies in the EU from which 62 companies defaulted in 2014 concerning lag of the user attributes (Klepac & Hampel, 2017). To make a more specific analysis, we chose to use the Student t-distribution comparing means two to two and for the study of the sale of a product for each region. Student's t-test is typically used when the test statistic follows a normal distribution, but the variance of the population is unknown. In this case,

the sample variance is used and, with this adjustment, the test statistic follows a t distribution of Student (Azevedo, 2016). Considering the t-test applied to agribusiness Dlamini and Huang (2020), conducted a study that was considering a gender-based comparative assessment of training needs for beef cattle farmers. Primary data were collected through personal interviews, guided by a reliability-tested questionnaire, from a sample of 397 farmers. The Borich Needs Assessment Model was adopted for data analysis and inferential statistics were employed to evaluate statistically significant differences between the gender groups. This research aims to study the sales of five agricultural products in four regions of the state of São Paulo, Brazil to identify the factors of greatest influence on the numbers of products sold and to facilitate the distribution of sellers in each region at the times of the year studied, reducing costs and increasing the company's profit. For this, it was based on Descriptive Statistics and used two statistical tools, ANOVA and t-test. In the sequence of this work, the Material and Methods that were used are described, detailing the area in São Paulo State, where this research was conducted for the researcher, the period of data acquisition, and how it was treated. Then, the results are presented and discussed. Finalizing the work, the conclusion is presented followed by the recommendations of the author to further researches.

II. MATERIAL AND METHODS

The study was conducted in four regions located inside the São State, Brazil. The four regions consolidated 39 cities, which represents a GDP of more than R$ 60billions and congregated 3 million people. The data was collected by the researcher during one year, by the financing agency companies spread into the four regions, taking into consideration the yearly volume of sales. Sales are related to the number of financing contracts for agricultural products by farmers established in the four regions. The financing contract accounted for were regarded as the financing for five different agricultural products: greenhouses, cattle, pickup truck, tractor, and a photovoltaic panel. The statistical investigation took place in several stages and involves specific and particular aspects reported for each agency. The first step consisted in the formulation of a survey to collect the data at agencies. At this point, it was necessary to consider whether or not the questions are appropriate and have a statistical nature, that is, involve or not variability in the data, classifying the data. The second step evolved was to carry on the data acquisition, until complete one year of information collection, when the appropriate plan for data acquisition had to be designed. Considering the next step, the researcher conducted the data analysis, starting with the choice of the most appropriate representation taking into account the nature of the data and the purposes in view, using Excel®. Finally, the interpretation of the results took account of the proposed question. Then, discussions regarded data was presented, focusing to emphasize what the statistical analyses were confirming or validating (Martins, 2010, p. 09). The analyses as described in the previous topics were made by the statistical ANOVA and t-test tools.

III. RESULTS AND DISCUSSION

Before the presentation of the results, a brief explanation is presented presenting the cities that compound each region. Then, the total sales unities per region were presented considering the main agricultural products requested by them, classified as greenhouses, pickup trucks, tractors, and photovoltaic panels. In the sequence, the total amount of sales per region were presented in Brazilian currency. The statistical tools ANOVA and t-test were applied to validate the null hypothesis considering the period comparing between two months the per studied region. For better classification of the data, the study was shared into four regions where each encompasses the following cities: Region 1: Caçapava, Lagoinha, Natividade da Serra, Pindamonhangaba, Redenção da Serra, São Luís do Paraitinga, Taubaté, Tremembé. Region 2: Arujá, Biritiba-Mirim, Guararema, Mogi das Cruzes, Santa Branca, Salesópolis, Santa Isabel, Suzano. Region 3: Jacareí, Jambeiro, Monteiro Lobato, Paraibuna, São José dos Campos, São Francisco Xavier, Santo Antônio do Pinhal, São Bento do Sapucaí. Region 4: Aparecida, Areias, Bananal, Cachoeira Paulista, Cruzeiro, Guaratinguetá, Lavrinhas, Lorena, Queluz, Piquete, Roseira, Silveiras, São José do Barreiro. Through the graphs generated in Excel®, a macro view of sales by product and region were illustrated in Fig. 1, 2, 3, 4, 5, 6, and 7 were obtained. In the sequence, statistical analysis was conducted, firstly per period, then per region, using ANOVA and t-test, always discussing the results.

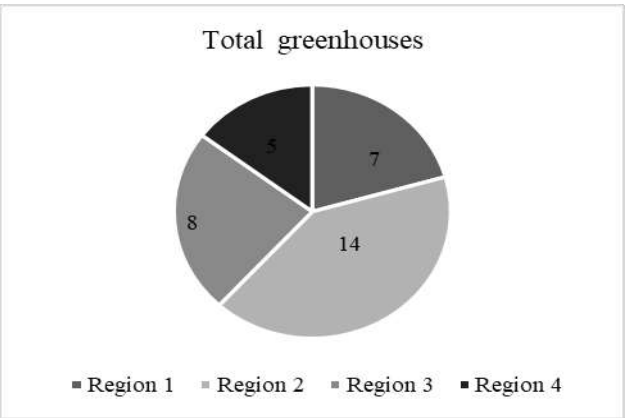

Fig.1: Total greenhouses sold

From Fig. 1 it is clear that Region 2 leads the sales for greenhouses, followed by Region1.

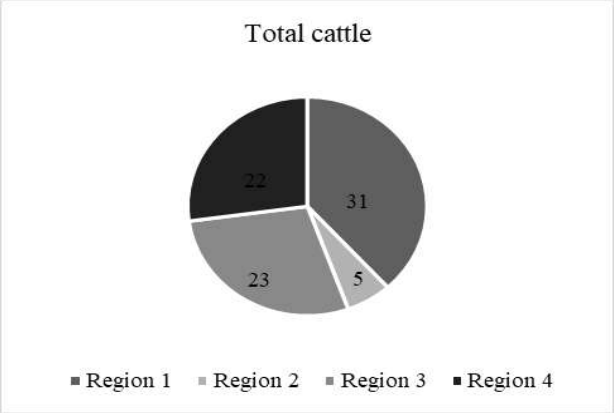

Fig. 2: Total cattle sold

In terms of cattle sales, Region 3 presented the biggest amount, followed by Region 1 and Region 4 with a very closed sales number.

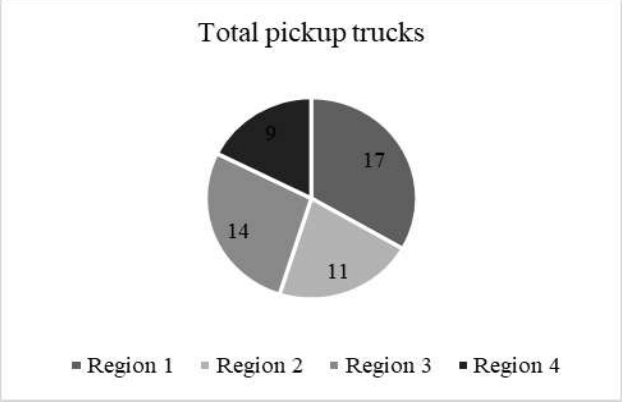

Fig. 3: Total pickup trucks sold

Region 3 presented the highest volume of pickup truck sales, and Region 1 appeared in the second position.

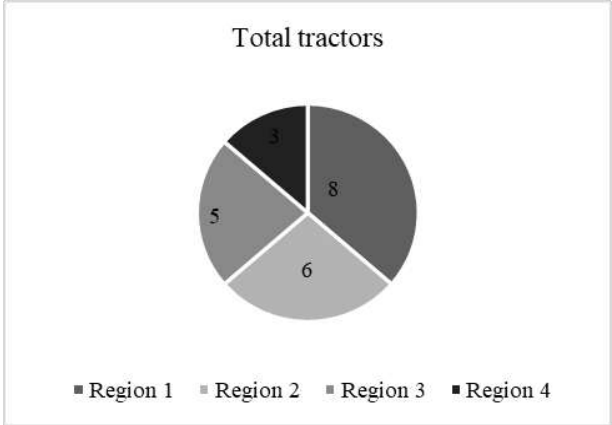

Fig. 4: Total tractors sold

In terms of tractor sold the leader was the Region 3, followed by Region 2.

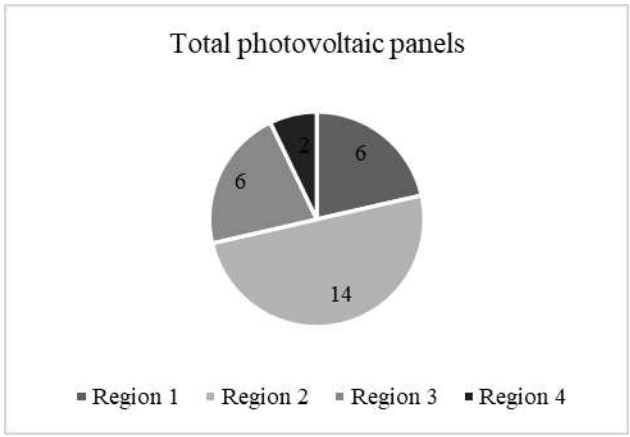

Fig. 5: Total photovoltaic panels sold

Region 2 was the leader in terms of photovoltaic panels sales, presenting alone the total sum of the other Regions.

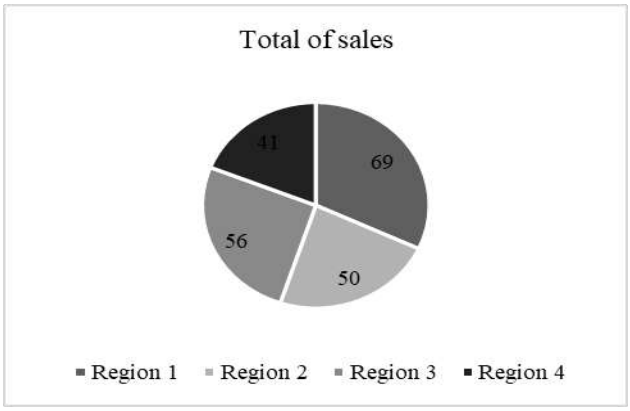

Fig. 6: Total of Sales

In the consolidated numbers, Region 3 is the leader of sold products, followed by Region 1.

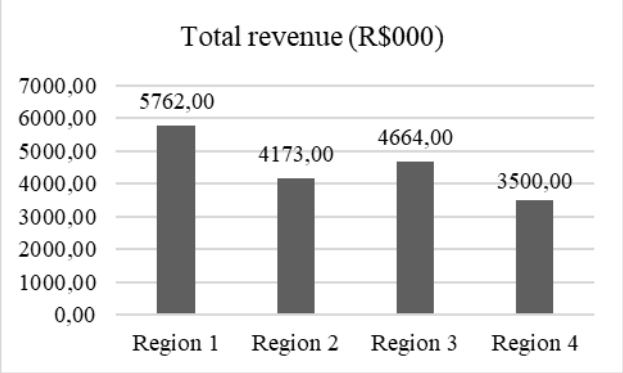

Fig. 7: Total revenue

As can be observed from the Fig. 7, the leader is Region 1, in terms of total revenues per the period under analysis, since its products had more added value.

3.1 Analysis by period

From the collected data, ANOVA was used to compare sales per month. Table 1 presents the results that originated from the calculations performed.

Table 1. ANOVA per period.

Source of variation	**SS**	**DF**	**MS**	**F**
Between groups	934,16	19	49,1663157	3,7177
Residual error	1058	80	13,225	
Total	1992,16	99		
Table value (5%)				1,72

The calculated F value was 3.7177 and comparing with the table value for a significance level of 5%, it was possible to conclude that the null hypothesis should be rejected since the table value is lower. As the values of means are different, it is necessary to perform a more specific analysis to find out which means are different from each other. Therefore, the t-test analysis was conducted to compare the means two by two. Table 2 illustrates the results of this analysis.

Table 2. t-test per period.

	Medium variance	t_0
January-February	3,18	1,75
January-March	4,24	1,55
January-April	2,71	1,78
January-May	2,78	1,58
February-March	2,65	1,59
February-April	3,06	1,40
February-May	3,13	1,57
March-April	3,90	1,88
March-May	3,77	1,56
April-May	3,84	1,72

When comparing the results obtained with the table value (1.6886), also for a significance level of 5%, it is possible to notice in which comparisons the null hypothesis was rejected and in which it was accepted, based on the colors of the legend of Table 3.

Table 3. Hypothesis identification – analysis per period.

Caption
Reject H_0
Accept H_0

The economic scenario is a factor that can explain this difference. There may be an economic crisis or an increase in the price of some component of the analyzed products (such as the agricultural film of the greenhouses), increasing the price of the product in question, and a possible drop in its sales. Geography is another point that can influence product sales. The climate changes in the analyzed period and may change sales.

3.2 Analysis by region

The ANOVA was performed by region to analyze the influence of different locations on product sales. Tables 4, 5, 6 and 7 show the results of the calculations.

Table 4. ANOVA – region 1.

Source of variation	**SS**	**DF**	**MS**	**F**
Between groups	470,24	4	117,56	5,8026
Residual error	479,20	20	23,96	
Total	949,44	24		
Table value (5%)				2,87

Table 5. ANOVA – region 2.

Source of variation	**SS**	**DF**	**MS**	**F**
Between groups	214,80	4	53,70	5,1536
Residual error	208,40	20	10,42	
Total	423,20	24		
Table value (5%)				2,87

Table 6. ANOVA – region 3.

Source of variation	**SS**	**DF**	**MS**	**F**
Between groups	295,44	4	73,86	5,1723
Residual error	285,60	20	14,28	
Total	581,04	24		
Table value (5%)				2,87

Table 7. ANOVA – region 4.

Source of variation	**SS**	**DF**	**MS**	**F**
Between groups	187,84	4	46,96	4,2459
Residual error	221,20	20	11,06	
Total	409,04	24		
Table value (5%)				2,87

When comparing the table F value, to a significance level of 5%, with the calculated value, it was concluded that the null hypothesis was rejected, and a t-test analysis was necessary to obtain more detailed and accurate results. The colors of t_0 show whether the H_0 hypothesis was rejected or accepted as shown in Table 8. These conclusions come from the comparison of the calculated values with the tabulated value (1.86) to a significance level of 5%. For values above the tabled, the null hypothesis is rejected, for values below, it is accepted.

Table 8. Hypothesis identification – analysis per region.

Caption
Reject H_0
Accept H_0

Tables 9, 10, 11, and 12 present data from calculations performed separated by region:

Table 9. t-test for region1.

Region 1		
	Average Variance	t_0
Pick-up trucks and tractors	1,30	2,50
Pickup trucks and greenhouse	1,80	2,78
Pickup trucks and cattle	3,25	2,46
Pickup trucks and photovoltaic panels	1,50	2,84
Tractors and greenhouse	0,80	0,35
Tractors and cattle	2,25	4,85
Tractors and e photovoltaic panels	0,50	0,89
Greenhouse and cattle	2,75	4,58
Greenhouse and photovoltaic panels	1,00	0,32
Cattle and photovoltaic panels	2,45	5,05

Table 10. t-test for region 2.

Region 2		
	Average Variance	t_0
Pick-up trucks and tractors	1,95	1,13
Pickup trucks and greenhouse	1,95	2,26
Pickup trucks and cattle	1,85	1,39
Pickup trucks and photovoltaic panels	2,45	0,61
Tractors and greenhouse	0,70	3,02
Tractors and cattle	0,60	0,41
Tractors and e photovoltaic panels	1,20	2,31
Greenhouse and cattle	0,60	3,67

Greenhouse and photovoltaic panels	1,20	0,00
Cattle and photovoltaic panels	1,10	2,71

Table 11. t-test for region 3.

Region 3		
	Average Variance	t_0
Pick-up trucks and tractors	1,10	2,71
Pickup trucks and greenhouse	1,25	1,70
Pickup trucks and cattle	2,00	2,01
Pickup trucks and photovoltaic panels	1,20	2,31
Tractors and greenhouse	0,65	1,18
Tractors and cattle	1,40	4,81
Tractors and e photovoltaic panels	0,60	0,41
Greenhouse and cattle	1,55	3,81
Greenhouse and photovoltaic panels	0,75	0,73
Cattle and photovoltaic panels	1,50	4,39

Table 12. t-test for region 4.

Region 4		
	Average Variance	t_0
Pick-up trucks and tractors	0,50	2,68
Pickup trucks and greenhouse	0,60	1,63
Pickup trucks and cattle	1,00	4,11
Pickup trucks and photovoltaic panels	0,50	3,13
Tractors and greenhouse	0,40	1,00
Tractors and cattle	0,80	6,72
Tractors and e photovoltaic panels	0,30	0,58
Greenhouse and cattle	0,90	5,67
Greenhouse and photovoltaic panels	0,40	8,50
Cattle and photovoltaic panels	0,80	7,07

In the table of region 1, it is noted that in 7 of the 10 comparisons, there is a rejection of the null hypothesis. In region 2, 5 are rejected. In region 3, 6 are rejected. And in region 4, 7 of the 10 null hypotheses are rejected. Also, it can be observed that the means differ for comparisons of different products in each region. Thus, it is concluded that the factors of each location influence the sale in the regions. Among them, there is the most accomplished agricultural activity in each location, the level of economic development of cities, climate, and relief, which are directly related to the use of photovoltaics and greenhouses, for example. After analyzing the results, It was concluded that sales show a large discrepancy between regions due to the difference between the goods and the needs of each region. The place that stood out most in sales was region 1 and the one with the lowest sales value was region 4, as shown in the total revenue in Fig. 7. There is also little variation in product sales over the months analyzed, which may indicate a slight growth in revenue in the region. Region 2 presented the highest sale of greenhouses and photovoltaic panels, representing greater sustainable development among the four localities, while region 1 showed higher cattle sales, pickup trucks, and tractors, indicating greater development of agriculture and livestock among the regions. Thus, it can be said that the region that presents the most market for the analyzed products is region 1. In the Paraíba Valley region, the largest sale was of tractors and cattle, due to the focus on agriculture, so the sale of products related exclusively to this area appears to be the best investment for the site and possibly generating a higher revenue than other products. In the Alto Tietê region, the most sold product in greenhouses, due to flower and vegetable producers, and the sale of photovoltaic panels, which is associated with largely Japanese producers, who have greater access to knowledge of technology for longer than producers in other regions. Pickup truck sales are relatively high in all regions, as it is a very useful tool in the daily life of any rural producer, regardless of specialization.

IV. CONCLUSION

The work had as a proposal to present statistical data analysis on the sale of financing agricultural products in the regions in the São Paulo State, using these tools in order to analyze the best-selling products, and validate the null hypothesis which states that the sales figures were the same among the regions involved in the research. As presented by the results and discussions made, the null hypothesis was rejected. This paper presented a first approach and a guide to help the understanding the how the financing programs have impacted the sales of the agricultural products in the regions in the São Paulo State, and it can give a direction to explore more data in other regions in the same state or another. Limitations can be observed in this work as a short period collecting data, the number of regions, and the economic profile of each one. The t-test and ANOVA, could be improved by data analytics using algorithms.

V. RECOMMENDATIONS

Based on the results of the research, some recommendations were proposed: a. Amplification of the research for more regions in the São Paulo state. b. Comparison of how the PRONAF program impacts the sales in other Brazilian states. c. Conduct multi-criteria methods as Analytic Hierarchy Process (AHP), in other to understand the choice motivation from the farmers for agricultural products. d. Applied algorithm for data analytics to permit the research takes to account the whole parameters that cause influence on the product sales.

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REFERENCES

[1] Azevedo, P. R. M. (2016). *Introdução à estatística* (3 ed.). https://repositorio.ufrn.br/jspui/handle/123456789/21298
[2] Bacha, C. J. C. (2004). *Economia e Política Agrícola no Brasil*. São Paulo: Atlas, 2004.
[3] Banco Central do Brasil - BCB. (2020, August). *Relatório Anual*.https://www.bcb.gov.br/estabilidadefinanceira/creditorural
[4] Buainain, A. M. (1999). *Trajetória Recente da política Agrícola Brasileira* [Tese de Doutorado], http://www.repositorio.unicamp.br/handle/REPOSIP/285712
[5] Center for Advanced Studies in Applied Economics – Cepea - esalq/USP. *PIB*. (2020, Agust 21). https://www.cepea.esalq.usp.br/upload/kceditor/files/Cepea_PIB_CNA_MAIO_Agosto2020(1).pdf
[6] Dlamini, S. I., & Huang, W. - C. (2020). Towards Intensive Co-operated Agribusiness: A Gender-Based Comparative Borich Needs Assessment Model Analysis of Beef Cattle Farmers in Eswatini. *Agriculture*, 10(96), 1-17, https://doi:10.3390/agriculture10040096
[7] Durie, A. D. (2018). Financing Rural Industrialization and Employment Creation: The Case of Ethiopia. *Independent Journal Of Management & Production (IJM&P)*, 9(4), 1317-1337, https://doi: 10.14807/ijmp.v9i4.803
[8] Galas, M.L., & Seleznev, P. S. (2019). Public Organizations of Russian Solving Socio-Economic Problems of the early of XX century. *Bylye Gody*, 52(9) https://doi: 10.13187/bg.2019.2.766
[9] Garcia-Marques, T., & Azevedo, M. (1995). A inferência estatística múltipla e o problema da inflação do nível de alfa: a ANOVA como exemplo. *Psicologia*, 10(1/2), 195-220, https://doi.org/10.17575/rpsicol.v10i1/2.655
[10] Instituto Brasileiro de Geografia e Estatística - IBGE. (2020, March). *Agência de Notícias IBGE*. https://agenciadenoticias.ibge.gov.br/agencianoticias.pdf.acesso 04/03/2020-march3rd2020
[11] Klepac, V., & Hampel, D. (2017). Predicting financial distress of agriculture companies in EU. *Agricultural Economics – Czech*, 63(8), 347–355, https://doi: 10.17221/374/2015-AGRICECON
[12] Martins, E. (2010). *Contabilidade de custos* (10 ed.). São Paulo, SP: Atlas.
[13] Odemero, A. F., & Obianujunwa, E. P. (2016). Inclusive Financial Services of Microfinance Banks for Inclusive Agricultural Development in Anambra State, Nigeria. *International Journal of Environment, Agriculture and Biotechnology* (ISSN: 2456-1878). 1 (2), 149-154.
[14] Pokharel, S., Marcy, J. E., Neilan, A. M., & Cutter, C. N. (2017). Development, Dissemination, and Assessment of a Food Safety Systems Management Curriculum for Agribusiness Students in Armenia. *Journal of Food Science Education*, 16, 107-117, https://doi: 10.1111/1541-4329.12122
[15] Ranathunga, L.N., Wijemanna, W. M. D. I. S., Sathsara, M. G. S., & Gamage, R.G.B.K. (2018). Agriculture in Sri Lanka: The Current Snapshot. *International Journal of Environment, Agriculture and Biotechnology*, 3(1), 118-125, http://dx.doi.org/10.22161/ijeab/3.1.15
[16] Remenova, K., & Jankelova, N. (2019). Decision-making style of agribusiness managers. *Agricultural Economics – Czech*, 65(7), 322–330, https://doi.org/10.17221/289/2018-AGRICECON
[17] Sroka, W., Dudek, M., Wojewodzic, T. & Król, K. (2019). Generational Changes in Agriculture: The Influence of Farm Characteristics and Socio-Economic Factors. *Agriculture*, 9, 264, https:// doi:10.3390/agriculture9120264
[18] Stekla, J., & Grycova, M. (2016). *Agricultural Economics – Czech*, 62(9), 421–428, https:// doi: 10.17221/232/2015-AGRICECON

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A survey of the damage caused by the *Callosobruchus maculatus* (F.) on different legume seeds sold in Njikoka Local Government Area, Anambra State, Nigeria

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***Abstract*— *Callsobruchus maculatus (F.) commonly called cowpea weevil is a major pest of stored leguminous seeds. The level of damage caused by C. maculatus (F.) on five different legumes on sale in Njikoka L.G.A., Anambra State was studied for a period of six weeks. The legume seeds were Vigna unguiculata var. brown (Brown cowpea) and Vigna unguiculata var. white (White cowpea), Glycine max (Soya beans), Vigna subterranea (Bambara nuts) and Cajanus cajan (Pigeon pea). They were purchased randomly from local traders at Orie-Agu market in Abagana, Anambra State. Clean seeds without infestation were selected for the study. One hundred grammes (100g) of each legume seeds were used. The weevils used for the study were reared in the laboratory. The F1 generation was used to infest the clean legume seeds. The weevils were introduced in different male to female ratios and containers covered with white muslin cloth to allow aeration. The experimental setup was left to stand on the laboratory bench while weight loss and emergence holes were observed at two week intervals for a period of six weeks. The treatments with the higher male to female ratios of weevils showed highest damage to legume seeds (15.08 ± 0.93). V. unguiculata-Cowpea (var. white) was the highest damaged seeds (13.88 ± 1.00), while G. max–soya beans were least damaged (2.24 ± 1.36). The damage done by the weevils on the different legume seeds were statistically significant ($P<0.05$) using Analysis of Variance (ANOVA) and Post Hoc tests. Damaged seeds could lead to serious economic losses for both the farmers and the country. Early harvest, good storage practices and facilities to reduce the attack of these pests on legume seeds is recommended.*

Keywords*— *Legumes, Callobruchus maculatus, weevil, damage, Njikoka.

I. INTRODUCTION

Legumes (Family: Leguminosae) are valuable as a source of dietary proteins, vitamins and minerals. It has been consumed by humans since the earliest practice of agriculture in the developing countries of Africa, Asia and Latin America (Oluwafemi, 2012). It provides protein to rural as well as the urban dwellers as a substitute for the animal protein (Wakili, 2010). They are also a source of calcium, iron, thiamine and riboflavin. The major food legumes cultivated in Nigeria are *Vigna unguiculata* (L.) (Cowpea), *Arachis hypogaea* (L.) (Groundnuts), *Cajanus cajan* (L.) (Pigeon pea), *Glycine max* (L.) (Soya bean), *Vigna subterranean* (L.) (Bambara nuts) and *Sphenostylis stenocarpa* (African yam bean).

Callosobruchus maculatus (F.) (Coleoptera: Bruchidae), also known as the cowpea weevil is a major pest of stored seeds of cowpea, pigeon pea and the African yam bean in tropics and subtropics (Yusuf *et al*., 2019; Ofuya and Lale, 2001). It

is a field-to-store pest and ranked as the principal post-harvest pest of cowpea in the tropics because its attack starts in the field if the legumes are left unharvested especially cowpea. This soon spreads to the store after harvesting and storage (Caswel, 1981). It causes substantial quantitative and qualitative losses manifested by seed perforation and reductions in weight, market value and germination ability of seeds (Oluwafemi, 2012).

The weevil originated in Africa but is now widespread in the tropics and the subtropics. Adults are 2-4mm in length with brownish or black markings. They have a short lifespan of about 12 days and do not feed. Adult females lay about 100 eggs glued to the surface of the pods, and upon eclosion the larvae burrow into the seed where development takes place. There are two identified forms of this species; the active and sedentary forms. The active forms appear during periods of high infestations, they fly readily and are smaller and very active. These active flying forms under normal conditions in the West African Sahel region seem to have increased incidences during the rainy season from June to August due to increased moisture content in the seeds, while the sedentary forms may or may not be able to fly well enough (Ofuya, 2001; Ofuya and Lale, 2001).

Damage and weight loss on stored seeds is caused by the larva and the damage could be direct or indirect. Direct damage refers to the reduction in weight and seed viability while indirect damage refers to the economic loss and loss of goodwill. Factor that influence insect pest attack include climate condition of the store, proximity of source of infestation as well as interspecific and intraspecific competition. Types of storage facilities also play a major role in either protecting or exposing the crops to pest damage. The aim of this study is to ascertain the damage due to *C. maculatus* (F.) on different species of legume seeds sold at Njikoka L.G.A, Anambra State, Nigeria.

II. MATERIALS AND METHODS

Study Area

The study was carried out in Njikoka Local Government Area, Anambra state, Southeastern Nigeria. Njikoka lies within coordinates 6º10´ N and 7º4´ N with an estimated population of 148,394 (NPC/FRN, 2006). They study area experience two seasons in a year - the rainy season which lasts about 7 months (April to October) and the dry season lasting about 5 months (November to March) each year. The area experiences harmattan - a short period of dry and dusty winds which occurs during the dry season. The L.G.A comprises six towns: Enugwu-Agidi, Enuwu-Ukwu, Nawfia, Abagana, Abba and Nimo. These towns all have markets that operate on a daily basis but each town has a specific traditional Igbo market day when the markets experience a very large turnout of both buyers and traders.

Procurement of the experimental seeds

This was a cross-sectional study. The legume seeds for the study were purchased from random sellers at Orie-Agu Abagana. The legume seeds used for the study were *V. unguiculata* var. brown (Brown cowpea) and *V. unguiculata* var. white (White cowpea), *G. max* (Soya beans), *V. subterranean* (Bambara nuts) and *C. cajan* (Pigeon pea). The seeds were properly picked to remove debris and plant remains. Damaged and immature seeds were removed to ensure that the used seeds had no damage or infection before use. The experiment was carried out in the laboratory of the Department of Parasitology and Entomology, Nnamdi Azikiwe University, Awka, Nigeria.

Procurement of insects used for the study

Cowpea seeds infested with *C. maculatus* (F.) were bought from Eke Awka market in Awka South L.G.A., Anambra State. The insects were harvested and cultured in a plastic jar. The jar was covered with white muslin cloth to allow proper aeration and also to prevent insect escape and kept under ambient temperature and relative humidity. The culture was left to develop as many weevils that were enough for the study.

Laboratory experiment

The experiment was carried out using the method described by Onyido *et al*. (2011).

Introduction of insects to the legumes

Two hundred grams (100g) of each of the different legume seeds were weighed into plastic containers. The containers were appropriately labelled with the names of the legumes and the amount of insects introduced. F1 generation weevils were used for the study. The weevils taken from the culture were used to infest the seeds in each container. Three categories of treatments were used in the ratio of 10 males:10 females, 15 males:10 females and 10 males:15 females. The containers were covered with white muslin cloth to enable aeration and prevent insect escape. Then these vials were left to stand on the laboratory bench with the controls. The

samples were observed at 2 weeks intervals for a period of six weeks. Already sterilized seeds without insect infestation were prepared as controls for each type of treatment under study.

Assessing grain damage

The seeds were weighed every two weeks during the experiment and after the experiment the weight losses were recorded. The seeds were also observed and the number of seed holes was determined by observing the emergence holes on individual seeds. Data on the final weight of the seeds (weight loss), nature of damage and the number of seeds with holes were recorded. The weight loss was determined by calculating the difference in the weight before and after the experiment.

Data Analysis

The weights before the experiment were compared with the weights after the experiments and the differences compared with Analysis of Variance (ANOVA) and Post Hoc tests using SPSS package.

III. RESULTS

The multiple comparisons of weight loss according to *C. maculatus* (F.) on the different legumes were calculated (Table 1). The weight loss levels were 15.08 ± 0.93 for *V. unguiculata* (var. white), 13.88 ± 1.00 for *V. unguiculata* (var. brown), 5.73 ± 2.60 for *C. cajan*, 2.24 ± 1.36 for *G. max* and 8.71 ± 4.74 for *V. subterranea*. This highest weight loss was found in *V. unguiculata* (var. white) while the least was observed in *G. max.* This was statistically significant (P<0.05) using Analysis of Variance (ANOVA).

Table 1: Weight loss according to legumes involved.

Legume seeds	Mean total weight loss (%)
V. unguiculata var. white (White cowpea)	21.33
V. unguiculata var. brown(Brown cowpea)	20.33
C. cajan (Pigeon pea)	8.39
G. max (Soya beans)	4.92
V. subterranean (Bambara nuts)	14.64

F = 48.563; df =134; P = 0.000 (P < 0.05)

Comparisons of the damage according to the sex of weevils were 7.56 ± 0.81 for treatments with 10 males:10 females, 10.80 ± 1.03 for treatments with 15 males:10 females and 9.02 ± 00.91 for treatments with 10 males:15 females. Highest weight loss was recorded in treatment with 15 male:10 females and least in treatments with 10 males:10 females which was significant (P<0.05) [Table 2].

Table 2: Weight loss in relation to the ratio of the Weevils used

Legumes seeds	10Males: 10Females	10Males: 15Females	15Males: 10Females
V. unguiculata var. white (White cowpea)	21.08	23.41	20.78
V. unguiculata var. brown (Brown cowpea)	16.75	24.65	21.65
C. cajan (Pigeon pea)	7.17	10.39	8.24
G. max (Soya beans)	3.45	5.78	4.09
V. subterranean (Bambara nuts)	12.92	17.23	15.89

F= 3.094; df=134; P=0.049 (P<0.05)

Multiple comparisons of the emergence holes according to the sex of weevils were 22.30 ± 5.34 for treatments with 10 males:10 females, 29.47 ± 7.04 for treatments with 15 males:10 females and 26.03 ± 6.11 for treatments with 10 males:15 females (Table 3). The damage was highest in treatments with 15 male:10 females and least in treatments with 10 males:10 females, although the result was not significant (P > 0.05).

Table 3: Emergence holes in relation to sex of the weevils involved

Legume seeds	10Males: 10Females	10Males: 15Females	15Males: 10Females
V. unguiculata var. white (White cowpea)	67	103	72
V. unguiculata var. brown (Brown cowpea)	70	91	65

C. cajan (Pigeon pea)	21	59	27
G. max (Soya beans)	5	12	2
V. subterranean (Bambara nuts)	47	74	64

F= 0.034; df= 89; P= 0.717 (P > 0.05)

Comparisons of the damage according to duration of infestation of the weevils showed damage levels of 5.74 ± 0.60 at the second week, 8.39 ± 0.75 at the fourth week and 13.24 ± 1.04 at the sixth week. The damage by weight loss was highest at the sixth week and least at the second week (Table 4). The analysis of variance (ANOVA) was statistically significant (P<0.05).

Table 4: Percentage Weight loss in relation to duration of infestation.

Legume seeds	**Week 2 % weight loss**	**Week 4 % weight loss**	**Week 6 % weight loss**
V. unguiculata var. white (White cowpea)	11.09	15.17	21.33
V. unguiculata var. brown (Brown cowpea)	10.83	14.38	20.33
C. cajan (Pigeon pea)	3.64	5.69	8.39
G. max (Soya beans)	1.70	2.38	4.92
V. subterranea (Bambara nuts)	4.61	7.60	14.47

F= 21.570;df= 134; P= 0.000 (P < 0.05)

IV. DISCUSSION

The findings of this study has shown that *C. maculatus* (F.) is a major pest of stored legumes on sale in markets in the study area. The observation is in agreement with Yusuf *et al*. (2019) who noted that the storage of cowpea seeds over long periods is threatened by bean beetle infestation. In this study, the damage levels were greatest on *V. unguiculata* (var. white) and then on *V. unguiculata* (var. brown) while *G. max* was the least damaged. The observation agrees with the reports of Onyido *et al*. (2011) who also observed similar damages on the legumes by the same pests in their study in Southeastern Nigeria. Also *C. maculatus* (F.) has been reported to attack and damage cowpea seeds exposed to infestation in Northern Nigeria (Musa *et al*., 2013). The observed differences in the level of damage on these legume seeds could be related to the nature of the seeds as those with rough coats attracted more weevils than those with smooth seed coats. Cowpea supported the growth of the weevils because the reduced time for the larval growth facilitated more population growth. *Glycine max* showed reduced infestation due to the hard seed coats. There was a reduced infestation in treatments with *C. cajan* as well. This agreed with Janzen *et al*. (1976), who stated that the seeds are toxic to the bean weevils.

The treatments with higher male to female ratios showed more weight loss and more emergence holes than treatments with lower or equal male to female ratios. This may be as a result of the habit of the female weevils that mate several times with several males and this can lead to deposition of more eggs. The emergence holes increased with increasing duration of infestation and the time of infestation increased with increasing eggs deposition and more weevils were produced which emerged after developing.

V. CONCLUSION

This study has shown the level of damage caused by the cowpea weevil, *C. maculatus* (F.) on different legumes seeds on sale in the study area. The study also revealed that cowpea (*V. unguiculata*, var. white and var. brown) has highest infestation levels. These seeds when damaged caused weight loss and also loss in viability and market value. Damaged seeds could also lead to serious economic losses for both the farmers and the country. Therefore, it is important to maintain good storage practices and facilities to reduce attack of these pests on legume seeds. Also inexpensive, safe and effective pesticides should be employed to destroy already infested legume seeds.

REFERENCES

[1] Caswel, G.H. (1981). Damage to stored cowpea in the northern part of Nigeria. *Samaru J. Agricultural. Research* 5:4–5.
[2] Janzen, D.B., Juster, H.B. & Liener, I.E. (1976). Insecticidal action of the phyto hemagglutinin in black beans on a bruchid beetle. *Science* 192:795-796.

[3] Musa, A.K., Odunayo, A. & Adeyeye, O. E (2013). Effects of Initial Infestation Levels of *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae) on Cowpea and Use of *Nicotiana tabacum* L. Aqueous Extract as Grain Protectant. *Global Journal of Biology, Agriculture & Health Sciences*2(3):209-212

[4] NPC/FRN, (2006). Population Census of Nigeria, Federal Republic of Nigeria. Population distribution in Local Government Areas by Sex and Number of Households. Legal Notices on publication of the details of the breakdown of the National and State Provisional population census totals. *Official Gazette, 94*(24).

[5] Ofuya, T.I. & Lale, N.E.S. (2001). *Pests of stored cereals and pulses in Nigeria*: *biology, ecology and control*. Dave Collins Publications, Akure, Nigeria174 p.

[6] Ofuya, T.I. (2001). Pests of stored cereals and pulses in Nigeria: In Ofuya T.I & Laye N.E.S eds., *Biology, Ecology and Control of Insects Pests of Stored Food Legumes.* Dave Collins Publications, Akure, Nigeria. pp 24-25.

[7] Oluwafemi, A.R. (2012). Comparative effects of three plant powders and pirimiphos-methyl against the infestation of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in cowpea seeds. *SOAJ of Entomological Studies* 1(2):108-117.

[8] Onyido, A. E., Zeibe, C.C., Okonkwo, N.J., Ezubgo-Nwobi, I.K., Egbuche, C.M., Udemezue, O.I. & Eneanya C.I. (2011). Damage caused by the bean bruchid, *Callosobruchus maculatus* (Fabricius) on different legume seeds on sale at Awka and Onitsha markets, Anambra state, South Eastern Nigeria. *African Research Review* 5:116-123

[9] Wakili, A.M (2010). Economic analysis of cowpea production in Nigeria. *Russian Journal of Agricultural and Socio-Economic Sciences*, 1(13) 60-64.

[10] Yusuf, S. Y., Musa, A. K., Adebayo, A. G. & Lawal, M. T (2019). Suppression of damaging effects of *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae) by plant powders. *Agrosearch, 19(1): 1-12*

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Transhumant Goat and Sheep Husbandry Practices in High Hills of Annapurna Conservation Area

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Abstract**—***Small ruminants are the most reliable source of meat in Nepal. However, national production is still insufficient to fulfill their demand. Transhumance pastoralism is a migration system in which farmers graze their animals in mountain pastures in warm seasons and lower altitude forests during colder seasons. Yak, sheep and Goat are reared under this system in Himalayas of Nepal. Farmers travelling through in Madi, Seti, Mardi and Modikhola basin follow transhumance system including Baruwal Sheep and Sinhal goat. A study was conducted to understand small ruminant husbandry system used by transhumant farmers. Farmers of 4 different locations were interviewed and focus group discussion was performed with inhabitants of nearby villages. Additional information were collected from ACAP and VHLSEC. Results revealed that number of transhumant farmers is decreasing. Migration pattern is determined by season (temperature, humidity, rainfall) and fodder availability in the region. This pattern was refined during centuries of practice. Mixed grazing by sheep and goat is beneficial since they feed on different type of pasture. Farmers are slowly adopting veterinary practices. However, treatment depends on value of animal. Animals except newborn lambs are kept open during night and protected by Tibetan mastiff dogs. Availability of better opportunities and decreasing market value of wool are two major constraints faced by farmers. As conclusion, transhumant farming system as present in the study region is an efficient way to exploit seasonally barren landscape to produce meat animals. This way of production can be applied to elevate lifestyle of people living in those landscapes.*

Keywords**—Annapurna Conservation Area, , Husbandry Practices, Small ruminants, Transhumance.**

I. INTRODUCTION

Regular movement of herds between specific locations to use up seasonally available pastures is termed as pastoralism (Blench, 2001). Unlike nomads, movement of transhumant farmers throughout the year, are limited within a short territory. The movement is based on livestock productivity, markets, rangeland conditions and climate change (Aryal et. al, 2014). They normally shift from highland to lowland during the winter months in order to protect from the severe cold and snowfall (Pandey & Chhetri, 2005; Aryal et. al, 2014). This form of pastoralism is one of the ancient ways of livestock farming existing in Tibetan plateau of south west Asia (Ekvall, 1968).

Data from FAO (2017) mentions 1.2 billion sheep and 1.03 billion goats worldwide. Goat has been one of the most accepted and easily available meat-purpose domestic animals in Nepal. Goats are also the most populous animal in the nation, having a population of 11.16 million (DLS, 2018). Every year, 67,706 metric ton goat meat is produced in Nepal (DLS, 2018). However, this amount of goat meat is not sufficient to meet the national demand for goat meat, and therefore more than 60 million Nepali rupees worth of lice goats are imported annually in Nepal. Similarly, sheep is also one of the most accepted meat species. Wool is another valuable product available from sheep. Total sheep population in the nation is 0.8 million. Though this figure seems low as compared to goats and other animals, there is great potential for sheep keeping due to relatively infrequent problems in marketing.

Though transhumant way of pastoralism is as old as domestication of livestock and is the earliest form of livestock husbandry, there is no history of pastoralism

older than 4 centuries in Tibet (Miller, 2007). From Tibet, pastoralism reached Nepal along with migration of Mongol community from Tibet. Chauri, sheep and goats are major livestock species reared under the transhumance system in the region. Normally, yaks are kept free in the high pasturelands whereas goats/sheep are driven out to graze during the day in the pastures and taken back around the tent-house during the night. They normally use horses and guard dogs while shepherding (Pandey & Chhetri, 2005).

Annapurna Conservation Area, Nepal's largest protected area, lies in Annapurna range of the Himalayas. Elevation of the conservation area ranges from 790 meter in the lowest to Annapurna I 8091 meter in the highest point. The conservation area stretches across Manang, Mustang, Kaski, Myagdi, and Lamjung Districts and includes foothills of Himalaya to snowcapped mountains and trans Himalayan steppes. The himalayan foothills comprises the southward part of the conservation area and are considered as valuable ecological as well as cultural hub. These hills are principally populated with Gurung-ethnic communities with intermixed Brahmin, Chhetri and Dalits ethnic communities on lower altitude. Seti, Madi, Mardi and Modikhola are major rivers of the region (ACAP, 2019).

Annapurna Conservation Area is the first protected area conserving natural heritage as well as cultural heritage. This is possible by allowing local resident to live within the boundaries as well as own their private property and maintain their traditional rights and access to the use of natural resources (ACAP, 2019). Livestock is an inseparable part of agriculture in the whole region and is even more important on the high hills where temperature, soil humidity and nutrient content doesn't support crop production. For more than six months every year, snowfall occurs and covers all habitable areas thus making the major parts of the upper region unsuitable for both humans and livestock. For these reasons, farmers have to move towards lower altitude areas in search of warmer lands with plenty of pastures and forests.

Most of the land in high hills and trans himalayan region is not suitable for resident agriculture and livestock rearing. In low producing lands like these, transhumant pastoralism is the most efficient way of land utilization. This way of pastoralism allows growth of lowland pasture during summer which acts as reserve food for animals during winter. Alpine pastures, which grow only during summer are also duly utilized. In this way, pastoralists can get maximum benefit from the system. Although transhumant farmers contribute a great role in ecology of mountainous regions, the methodologies they use for farming and their contribution has yet to be established. Transhumant farmers living high in the Himalayas are away from reach of government supports and services. There is no data on the population of these farmers and their animals. Use of local farming practices used by farmers has yet to be understood. The number of farmers is on a decreasing trend. This main objective of this study is to understand the small ruminant husbandry system used by transhumant farmers in the region and thereby fulfill the existing knowledge gap on the subject.

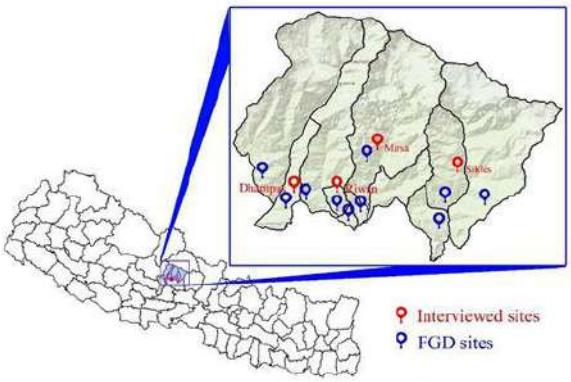
II. MATERIALS AND METHODS

Taking into consideration the common principles of rapid rural appraisal (Chambers, 1994), a three-step procedure was formulated and implemented to collect the information related to transhumant goats and sheep in the high hills of Annapurna Conservation Area.

A. Collection of information of small ruminant herding villages:

On the basis of information provided by Veterinary Hospital and Livestock Service Expert Center, Gandaki Province and Annapurna Conservation Area Project Headquarters located at Pokhara, the goat and sheep herding communities around the ACA were identified in Seti, Madi, Mardi and Modikhola basin. The transhumance sheep herding communities of Mirsa, Sikles, Riwan and Dhampus area were selected for this case study. Four flocks were chosen from the herders, each from Mirsa, Sikles, Riwan and Dhampus villages.

Focus group discussion (FGD):



Upon discussion with Veterinary Hospital and Livestock Service Expert Center and Annapurna Conservation Area Project officials and four key informants each from the villages in the study area, a checklist was prepared to gather information on general details of farm and farmers, management and nutritional practices, reproductive and production parameters, herd health management, migration pattern, and problems faced by the farmers.

Later, a pre-planned and organized discussion was organized with villagers, following the steps of rapid rural appraisal. 4 key informants from different villages, selected on the basis of experience, were interviewed about transhumance migration, animal management, productivity and the current situation of transhumant sheep and goat farming.

The participants in the FGD were the local farmers and former transhumant goat and sheep herders. The FGD was organized in each of the four villages of interest, where at least 10 farmers were present during the session. The discussion was set according to the checklist. Information collected during FGD were further verified with key informants' so as to ensure the reliability of information obtained, when further discussion with the shepherds during field visits who were with the animals on the pasturelands was performed.

B. Field visit

The information collected during FGD and key informants' interviews were further confirmed with the 4 shepherds in the field who were migrating the flocks. Questions in relation to the livelihood and traditional migratory goat and sheep herding were further discussed in depth with the shepherds.

C. Sample Population:

In this study, survey was performed among transhumant farmers on Seti and Madi river basin as well as other transhumant farmers who utilized Mardi and Modikhola basin during winter.

D. Data collection

Data collection was performed by a semi structured questionnaire survey with transhumant farmers. Questions regarding different aspects of farming were asked with farmers and their problems were listened properly. Questions included Migration pattern, General details of farm and farmers, Management of the farm, Nutrition, reproductive and production parameters of the animals, Herd health management, Breeding, and problems faced by the farmers.

Before collection of data, general knowledge on farmers was gained from Veterinary Hospital and Livestock service expert center, Kaski and Annapurna Conservation Area Project Headquarter, Kaski. This was followed by visiting resident farmers of different regions on Seti, Madi, Mardi and Modikhola basin. The information on contemporary location of herd, thus gained, led to individual meeting with herder. After interview with herders, the data was validated by focal group discussion among resident farmers from nearby villages.

E. Data summarization

Knowledge obtained from the interview with farmers was summarized into report. Information from each of the farmers was summarized qualitatively and quantitatively followed by detail study on the matter. Additional information was n gathered from literature review on forage availability of forage and other aspects that were described by farmers in layman term. Altitude of different locations was obtained from Annapurna Conservation Area Project Headquarter.

III. RESULTS AND DISCUSSION

A. History and present context:

Two decades before today, there were many farmers practicing transhumance system in this region. There were more than 10 farming groups each in Lahachok, Ghachok, Tuse, Mirsa, Sikles, Mise, Argui, Tangtin, Dhampus, Chipli and Ghamrung. Among them, most of the farmers have left this practice. Now, there are a few sheep herds based on ghandruk, one each based on Mirsa, Sikles and Tangtin. Interviewed old herders mentioned that there used to be a practice of keeping small sheep herds (around 100) by each farmer and many farmers used to combine their stock to make bigger herd. But this trend is also losing popularity with time, and now a single herd owner keeps big herds with many hired herders working for the herd. this trend is more common in Seti and Madi basin. however, combined herds are also common among farmers who utilize pastureland and forests on Mardi and Modikhola basin during winter.

B. Breeds and breeding:

The breeds of goat and sheep kept by farmers of the region are of local breeds. Breed of the goat is Sinhal and sheep is Baruwal (n=4). These animals are highly adapted to the environment and migration pattern used by farmers. Source of buck/ram is mostly from own farm, selected on the basis of physical parameters and libido.

C. Migration pattern:

The migration system followed by farmers of high hills in Annapurna conservation area, south to Annapurna and Dhaulagiri Range is termed as transhumance since they have definite settled land where they reside like non pastoral society and the route used during migration is fixed. The route of migration depends on season (temperature, humidity, rainfall) and fodder availability in the region and has been refined during hundreds of years of practice. During summer, farmers move their stock up towards the naked hills and the region that are covered with snow whole year. As temperature starts to decline,

their herd start to come downward, through naked hills, towards the land covered by forest and vines.

D. Flock structure and grazing:

All of the interviewed farmers followed mixed practice of keeping both goat and sheep, in the same herd. Keeping both goats and sheep is especially beneficial since they can be grazed at the same time. Among them, goat is a selective feeder and sheep is non selective feeder. When left to graze in the same pasture, goats browse the top nutritious part of the pasture. Sheep flocks graze the whole tiller, even uprooting them. In this way, the hill is left naked at the end of grazing by these two species. In turn, animals defecate and urinate in the pasture, hereby returning some part of nutrients back to soil.

Table.1: Altitude and fodder availability

Altitude (Masl)	**Season(s)**		**Pasture type**
4000-4500	Mid to late summer		Alpine rangeland
3000-4000	Early summer	Late summer	Sub-alpine rangeland
2000-3000	Mid to late spring	Autumn	Forest and temperate rangeland
1200-2000	Winter and early spring		Forest and villages

The pasture above 4000 meters above sea level, are of alpine type, covered by snow during winter. When snow melts on spring, grasses grow very quickly and provide nutritious grass to the herd during summer months. The stocks are maintained in this type of forage for few weeks in summer, depending upon herbage availability and environmental temperature. While descending downward during September and October, herd reaches sub alpine grasslands at elevation of 3000 to 4000 meters. Herd stays few weeks in this type of grasslands and then move to temperate grasslands and forests at 2000 to 3000 meters nearby human settlements. After spending few weeks in forests, herds mostly come to valley and lowland villages during late autumn and winter. In villages, herd feeds on aftermath in the rice-field and also graze on nearby forest. Resident farmers in these villages allow herders to stay and graze large herds on their land. Resident farmers also give food to the herders as well as herding dogs. Once winter is about to over, herd starts to move upwards, following almost same route. During spring and summer, animals graze on newly grown pasture and hence nutritional status of herd is best at this stage. However, there is no system of providing concentrate ration to animals except salt and mustard cake due to remoteness of the grazing lands and unavailability of transportation facility.

Farmers mentioned that 'Toxic plants' is not a common problem among the farmers when the herd is in villages and forests of valley and lowland (n=3). However, on the alpine grassland and naked hills on the base of mountains, farmers are facing problems due to toxic plant marsh marigold (Caltha palustris). According to farmers, they are using traditional practice to face this problem as well. They use lemon concentrate to treat this condition (n=4).

E. Veterinary practice:

Farmers, though being migratory in nature and working in one of the most difficult landscapes in the world, are not away from practice and knowledge from the outside world. They are adopting modern veterinary practices slowly and adapting their way of life accordingly. Practices such as vaccination, deworming, and treatment of some disease are in practice. Government officials and veterinary technicians from Livestock Service Center visits farm in the month of April-May to vaccinate against Peste des Petits Ruminants. Deworming practice is regular on half yearly basis on February-March and September-October among farmers of Mirsa and Sikles. However, deworming is not common among farmers of other regions (n=2). Among ectoparasites, Tick, Mange and Nasal leech are the most common. Ivermectin is used as control measure against mange. Traditional medication is practiced to treat most of the disease and management of physical injury. Major health problems encountered in the region includes Fractures, cold stress and pneumonia. Farmers mentioned that treatment also depends on value of the animal. If an animal is young and productive, it is treated. Treatment is not practiced for old or less productive animals.

F. Housing:

Transhumant animals are highly adapted to harsh climate of the ecological region and can withstand environmental extremes. These animals are kept under the sky whole year irrespective of cold, rain or snowfall occurring in the region. During night, herders stay in the tent made up of polythene in the forest or pastureland and gather animals around the tent. There is a group of trained Tibetan mastiff dogs to take care of this herd and save from predators. According to farmers, most common predators in the region includes Leopard in the forest and snow leopard on the naked hills. However, predation is not a big issue for farmers, as they have trained dogs to guard the flock (n=4).

G. Other managemental aspects:

There is a ram per 50-100 ewes and similar ratio is followed for bucks and does. In case of sheep, mating takes

place on random basis and breeding season starts from the month of May. Peak breeding season is on June to July. After 5 months of gestation, lambing season starts from mid-September and lasts till early January (n=4). even after this season, small number of ewes become pregnant and lambing occurs throughout the year. Newborn lambs are kept on special shed nearby the tent and dam is allowed to graze with the flock. Lambs get mothers milk only twice a day. Once lambs start eating grass, they are mixed to the herd. Weaning happens naturally once Ram starts to chase ewe for mating and it happens around 3-6 months after lambing. Castration of male lambs is done using burdizzo castrator on 5 months to one year of age. There is no special procedure for fattening of lambs before being sold. Main season for selling of livestock is during festivals. Rams and bucks are sold for festivals and rituals of different ethnic groups. Wethers are sold for meat and demand rises during Dashain. Some of the kids and lambs are sold even before castration is done. Among lambs and kids kept for replacement flock, puberty commences at the age of 1.5-2 years in case of ewes and does and 6-8 months in case of bucks and rams. However, young bucks do not get chances to mate due to dominance of older bucks. (n=3)

Shearing is done on half yearly basis, around march and September. Farmers use this hair on traditional way to make clothes such as kambal and bakhkhu. Excess wool is sold to nearby villages and occasionally reach market level.

When reproductive performance of animal decreases below expected level, there is no practice of treatment and management of the conditions. Instead, culling is common practice in this situation. An ewe/doe fails to breed during one season, it is not waited for it to breed during next season. Instead, it is culled (n=4). Normally, ewes and does are kept for ten to twelve parturitions and then culled. Instead, bucks are kept with the herd till their productivity is at peak and then culled. Since animals are culled at higher rate, replacement herd are also made at higher rate.

H. Constraints

There has been a noticeable decline in the number of livestock rearing households and herder population in the past years. There are many problems behind the decline, of which some are listed as follows:

1) Availability of better opportunities

The reason behind this drastic change in culture and unavailability of labor forces, according to farmers, is employment opportunity. Even after working their entire lives, the don't consider themselves able to provide a better life for their children. Due to low income and lack of assurance of profit in this business, there is trend of decreasing attraction to this way of livelihood. This form of pastoralism is also suffering from lack of herders. Similarly, there has been an abrupt decline in people wanting to be herders. In the past, people agreed to be a herder for an exchange of one ram every year. But at present, the rate of payment being practiced in the region is Rs. 15000 on a monthly basis plus food and accommodation on tent. Despite this, it still is not possible to find herders. The livestock owners preferred old herders as compared to new ones since new herders do not have traditional knowledge and practice that was transferred from previous generation.

2) Decreasing market value of wool:

Farmers mentioned that there used to be great market of wool in the past days. But now, this market is drastically reduced. According to farmers, main reason behind this decline is availability of other sources of fiber and already decreasing trend of transhumance pastoralism. There used to be wool traders who come to buy wool at the pasture itself. Since transhumant pattern was already decreasing, it was no more profitable for the traders to travel through Himalayas and collect wool from sparsely distributed farmers. With declining market, price of wool is also decreasing. It used to cost around 80 per kg in the past, which has declined to around Rs. 30 per kg now-days. At present, most of the wool remains unsold and is thrown after shearing.

IV. DISCUSSION

Transhumance based on sheep and goat is one of the most common form of pastoralism in the Himalayan region, other being based on Yaks and Chauri (Ekvall, 1968). The breed used by farmers of the region were Baruwal sheep and Sinhal goat. These breeds are common in the southern part of Himalaya Mountain range (Neupane, 2016; Shrestha, 1997). Decreasing trend of transhumant sheep and goat herding is justified further by Banjade&Paudel (2008). Decreasing national population of sheep also suggests this trend (DLS, 2018). Pattern of upward and downward migration is similar to that mentioned by (Neupane, 2016) The system of forage only ration for most of the animals is adapted by most of the transhumant sheep and goat farmers in the region (Singh et. al., 2006; Tiwari et.al., 2007).

The major constraints mentioned by farmers were Shepherding problem and decreased market value of wool. Shepherding problem was also mentioned by Pandey &Gyawali (2012), in the way similar to mentioned in this article. Problems related to marketing was also mentioned by Tiwari et.al. (2007) and Pandey &Gyawali (2012),

though the problems he mentioned were mainly focused on marketing of other products as well as wool. Surveyed farmers had clearly mentioned that marketing of other products is not a constraint in the region. Other constraints as mentioned in other literatures include poisonous plants (Pandey &Gyawali, 2012), shrinking pastureland (Banjade&Paudel, 2008), Restriction in transboundary movement to Tibet (Tiwari et al, 2007), which were not considered as priority by interviewed farmers.

V. CONCLUSION AND RECOMMENDATION

Transhumance system as present in high hills of Annapurna Conservation Area is developed through centuries in order to maximize utilization of available resources in agriculturally unsuitable zone of the region. This study concludes that the number of farmers involved in transhumant farming is in decreasing order. Most of the ancient routes that have been used in the past are now abandoned. Migration pattern is driven by two factors: temperature and forage availability. Use of mixed herd of goat and sheep has ensured maximum utilization of forage in the pasture. Adaptation in high altitude and low temperature is attributable to local breeds. Farmers are slowly adopting veterinary practice but housing and feeding practices remain unchanged. There is no breeding strategy and it occurs randomly within the herd. Labor force required for transhumant system is slowly migrating in search of better opportunities. As a result, farmers cannot find herders to take care of the herd. Another constraint among the farmers is decreasing value of wool.

Transhumant farmers are most important source of meat for the country and the number of farmers is decreasing. Government should assure farmers that there is a good profit in this business. This can be done by providing loans and subsidies for farmers to start or expand the business. Similarly, availability and cost of veterinary service should be brought to farmers' access. Scientific pasture management can be practiced in the barren lands in order to ensure good nutrition and health of the herd. Experts from government should also support farmers in this purpose. Farmers from two or more villages are found to be clustered in the same location, hereby over utilizing pasture. Farmers can make good contact with each other, and work together to ensure that their herd are not at same location at same time. Annapurna Conservation Area Project can play a role in this. Nutrition status of animals can be improved by using concentrate feed in ration. This will result in increased profitability of the business. Market of wool can be created by providing wool processing and knitting trainings to farmers family. This has to be done by government as well as farmers level.

REFERENCES

[1] Annapurna conservation area project. (2019, April 19). Annapurna conservation area project . Retrieved from National Trust for Nature Conservation: https://ntnc.org.np/project/annapurna-conservation-area-project-acap
[2] Aryal, S., Maraseni, T. N., & Cockfield, G. (2014). Sustainability of transhumance grazing systems under socio economic threats in Langtang, Nepal. Journal of mountain science, 1023-1024.
[3] Banjade, M. R., &Paudel, N. S. (2008). Mobile pastoralism in crisis: Challenges, conflicts and status of pasture tenure in Nepali mountains. Journal of Forest and Livelihood, 49-57.
[4] Blench, R. (2001). Pastoralism in new millinium. Kathmandu: Overseas Devlopment Institute.
[5] Chambers, R. (1994). The origins and practice of participatory rural appraisal. World development, 22(7), 953-969.
[6] Department of livestock Services. (2018). Livestock Statistics fo Nepal. Lalitpur, Nepal: Department of livestock services.
[7] Ekvall, R. B. (1968). Fields on the hoof Nexus of tibetan nomadic pastoralism. New York: Holt, Rinehart and winston.
[8] FAO. (2017). FAOstat. Retrieved 4 2, 2019, from FAO: http://www.fao.org/faostat/
[9] Miller, D. J. (2007). The World of Tibetan Nomads. In D. J. Miller, Nomads of Tibetan Plateu and Himalaya.
[10] Neupane, G. (2016). Effect of altitude, season and pasture quality on blood parameters of range fed baruwal sheep under transhumance system. Chitwan: Agriculture and Forestry University.
[11] Pandey, L. N., &Gyawali, R. (2012). Constraints and potential of goat and sheep production under transhumance management system in the high mountainous regions of nepal. Research and Development Strategies for Goat Enterprises in Nepal. Kathmandu: NARC.
[12] Pandey, M. R., & Chhetri, M. (2005). Nomads and pastoralism: Linkage with biodiversity conservation in upper Mustang, Nepal. Our Nature, 42-49.
[13] Shrestha, N. P. (1997). Productive performance of transhumant sheep and goats at Guphapokhari site. Kathmandu: Pakhribas Agricultural Center, Dhankuta.
[14] Singh, D. R., Kaul, S., &Sivaramane, N. (2006). Migratory Sheep and Goat Production System: The Mainstay of Tribal Hill Economy in Himachal Pradesh. Agricultural economics research review, 387-398.
[15] Tiwari, M. R., Chapagain, P., Basnet, R., & Kusum, N. (2007). Bhyanglung sheep production system in Manang and Mustang district of western Nepal. Proceedings of the 7th national workshop on livestock and fisheries research, 2007 (pp. 157-164). Lumle, Kaski: Regional agriculture research center, lumle, kaski.

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Overview of pond aquaculture in Nepal

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Abstract*— *Pond aquaculture is the foremost contributor to the aquaculture contributing 80.25% (58,433 mt. tonnes) to the total aquaculture production in fiscal year 2017/18. There are 44,722 ponds covering 11895.31 ha area in Nepal with the productivity 4912 kg/ha. Among, the different agro-ecological region, terai region is the main contributor to aquaculture as large number of ponds covering the highest area are located in this region. The highest production of pond aquaculture is from Province-2 followed by province-5. The various challenges faced by the farmers in Nepal are lack of technical knowledge, lack of sustainable fingerling supply system and lack of infrastructure development related to fish farming due to less priority of government in fisheries sector. Hence, the government should develop the plan and policy to disseminate the technical knowledge among fish farmers, management of fingerlings production and supply channel at the community level.

Keywords*— *Aquaculture, pond, Nepal, production.

I. INTRODUCTION

Aquaculture is one of the most promising means of intensifying the utilization of natural water resources and hence improving the conditions in the rural areas of Nepal (Katz, 1987). Being landlocked country, Nepal is deprived of any oceanic resources due to which it depends only on inland aquaculture with finfish farming. The total production of fish in Nepal is 86,544mt.tonnes out of which aquaculture contributes 75.54% (65,544 mt.tonnes) in fiscal year 2017/18 (CFPCC, 2018). Aquaculture is increasing rapidly in Nepal with the average annual growth rate of 4.21% which contributes 1.12% to Gross Domestic Product and 4.18% to Agricultural Gross Domestic Product in fiscal year 2017/18 (CFPCC,2018). Aquaculture practices that contributed to fish productions in Nepal are pond culture, rice cum fish culture, ghol culture, enclosure culture, pen culture, rainbow trout culture and government farm centre. Pond culture is a very popular aquaculture practice with many aquatic species cultured in the pond. Out of all the aquaculture practices, pond culture is the major contributor which alone generated 80.25% (58,433mt.tonnes) of total aquaculture production in Nepal (CFPCC, 2018). Chinese carps and Indian major carps are the dominant species in pond aquaculture which are generally stocked under polyculture. However, the monoculture of Common carp, tilapia and pangasius has also been reported (Mishra,2015). The contribution of various aquaculture practices to total aquaculture production is shown below in the table 1:

Table 1: Contribution of various aquaculture practices to total aquaculture production (CFPCC, 2018)

Aquaculture practices	Production(mt. tonnes)
Pond culture	58,433
Rice cum fish culture	15
Ghol culture	6,390
Enclosure culture	65
Cage	302.28
Rainbow trout	320
Government farm	18.8
Total	65,544

History of aquaculture in Nepal is about 80 years which is considered relatively short compared to other aquaculture developed countries of south and south-east Asia (Shrestha, 2015). Aquaculture in Nepal began in the 1940s with pond culture of Indian major carps. Further development began in the 1950s with the introduction of exotic species common carp (*Cyprinus carpio*) whose breeding success in the 1960s

followed by monoculture practices and gained considerable popularity in private sector (FAO, 2005). More significant progress was seen in the 1970s with the introduction and farming of three exotic Chinese carp species : silver carp (Hypophthalmichthys molitrix), bighead carp (Aristichthys nobilis) and grass crap (Ctenopharyngodon idellus) and their successful breeding in the captivity. Similarly, the induced breeding of three commercial valuable indigenous major carps: rohu (Labeo rohita), mrigal (Cirrhinus mrigala) and catla (Catla catla) were successfully established which was followed by polyculture system of production in the ponds with seven species of fish with different habits (FAO, 2005). Although the aquaculture begin earlier, the aquaculture production was recorded only from 1966 with only 3 mt. tonnes of fish production (Mishra, 2015).

II. CATEGORIZATION OF POND AQUACULTURE

In Nepal, pond aquaculture has been categorized into extensive, semi-intesive and intensive farming (Mishra, 2015). The different farming system are illustrated below (Shrestha and Pandit, 2017):

2.1) Extensive farming

In this farming system, fish are stocked in density of 7000 fish/ha in large ponds measuring 1-5 ha. The fish are reared with no supplemented feed and fertilizer and yield is low i.e. 1-2 ton/ha/yr.

2.2) Semi-intensive farming

In this farming system, fish are stocked in the density of 7000-10000 fish/ha in relatively small ponds 0.2-0.5 ha. Care is taken to develop natural foods by fertilization and feed are supplemented and the yield is moderate i.e. 3-6 ton/ha/yr. It is the most common farming method practiced in Nepal.

2.3) Intensive farming

In this farming, fish are stocked at the density of 10-15 fish/$m^3$of water in small ponds. Complete formulated feed are supplied and the yield is high i.e. 15-100 ton/ha/yr.

III. TRENDS OF POND AQUACULTURE IN NEPAL

Pond culture is the dominant aquaculture practice among various culture practices and is increasing rapidly.

3.1) Expansion of pond area

From the fiscal year 2001/02 to 2017/18, ponds have been constructed in 5,941 ha for aquaculture. From the below figure-1, the pond area in the fiscal year 2008/09 is decreased because of the consequences of natural disasters(flood) that damaged many fish ponds in terai region (Kunwar and Adhikari, 2017). The highest area of pond constructed was achieved in fiscal year 2016/17 (1461.6 ha)

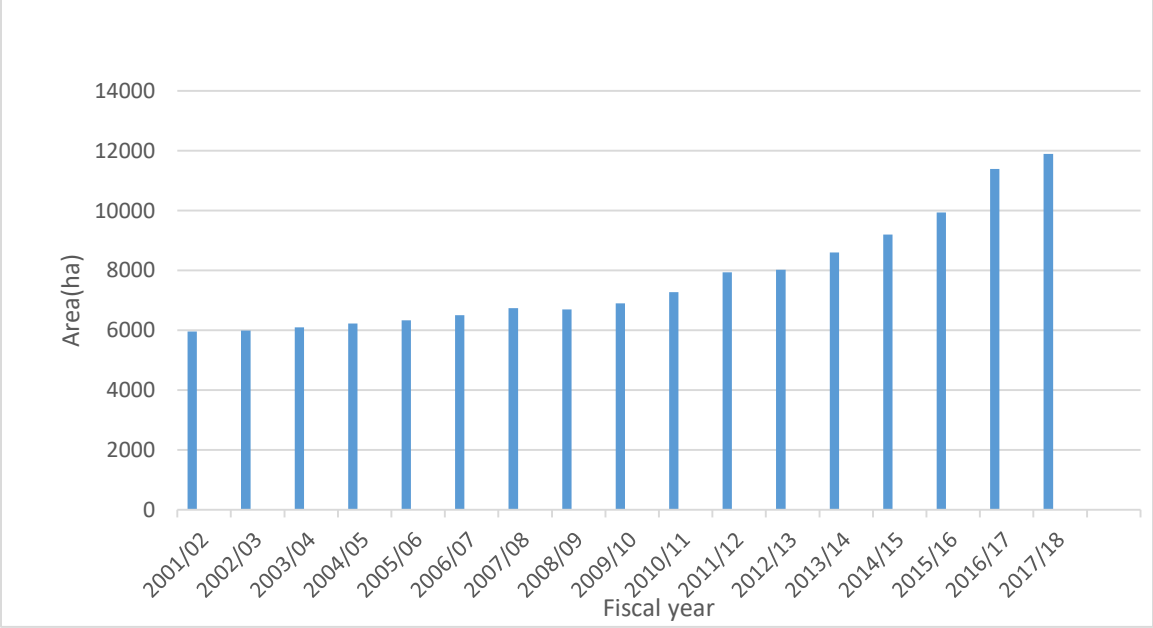

Fig.1: Expansion of pond area (CFPCC, 2018)

3.2) Pond production

From the figure-2, we can conclude that the fish production from the pond increases annually. Significant improvement of fish production was recorded in the fiscal year 2016/17 because in the same fiscal year highest area of pond constryction was achieved. In the last eighteen years, fish production from the pond aquaculture was increased by 47,209 mt. tonnes mainly due to the both horizontal and vertical expansion of pond aquaculture practice and pond productivity.

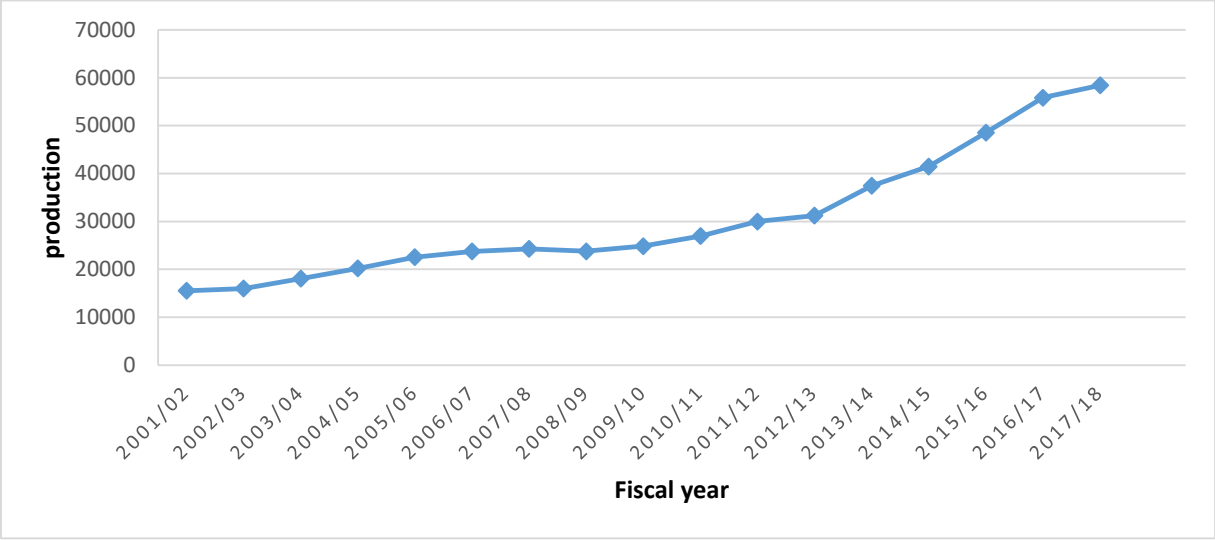

Fig.2: Fish production from pond (CFPCC, 2018)

3.3) Pond productivity

Pond productivity was only 2.61 mt. tonnes/ha in fiscal year 2001/02 which is increased to 4.91 in 2017/18 as shown in the figure-3. This incresed productivity of fish pond has significant impact on national fish production. The reasons for the increased productivity are improvement in technology, mechanization in fish farming system, good management practices and policy of government for the improvement of fish production (Kunwar and Adhikari, 2017).

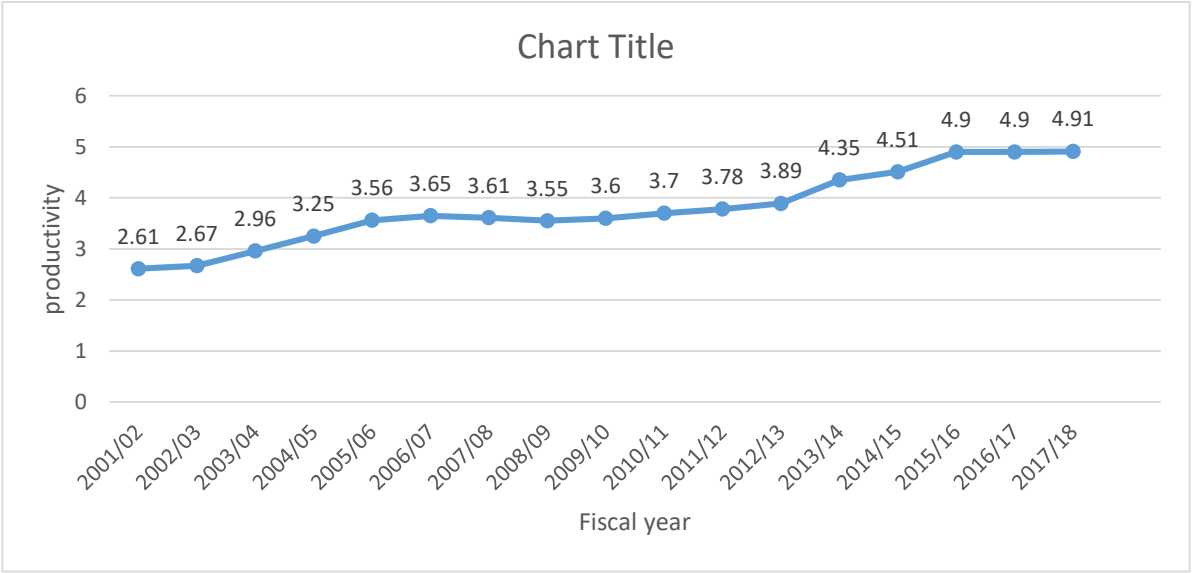

Fig.3: Productivity of fish pond (CFPCC, 2018)

4) Distribution of Pond

Nepal is agro-ecologically divided into three regions i.e. Terai, hilly and himalayan. The pond aquaculture is highest in the terai region which may be due to the suitability of land area and well-developed infrastructure in terai region compared to other. Terai region consists of 80.25% (44,722) of total number of ponds and 88.76% (11895.31 ha) of total area covered by ponds in fiscal year 2017/18 (CFPCC, 2018). Nepal is divided into seven federal provinces by the constitution of Nepal adopted on 20 September, 2015 before that it was divided into five development regions. The province wise distribution of pond, pond production and productivity is listed in the table -2:

Table 2- Province wise distribution of pond in Nepal (CFPCC,2018)

Province	Information on pond			
	Number	Area(ha)	Production(kg)	Productivity(kg/ha)
Province-1	7,751	1,517.6	7,485,029	4,932
Province-2	17,428	6,606.8	33,746,394	5,108
Province-3	3,795	638.26	3,004,765	4,708
Province-4	2,093	273.26	1,167,411	3,989
Province-5	10809	2,483.41	11,604,285	4,673
Province-6	345	32.7	67,238.5	28
Province-7	2501	343.28	1,358,666	3958
Total	44,722	11895.31	58,433,789	4912

IV. CHALLENGES

There are many fish species that would be commercially and economically important but only few species are under culture in Nepal. The reasons behind this are lack of reaserch on the behaviour, propagation, population dynamics and biology of these indigenous species (Gautam, 2015). Furthermore, several challenges are faced by the fish farmers in Nepal. The major problem is the lack of sustainable fingerling supply system (Gurung et al., 2010). The farmers have faced the problem of lack of improved fingerling at stocking time especially in the rural areas that affect the aquaculture production. In addition, lack of marketing infrastructure, lack of cold storage facilities, poor quality fingerlings and fish feed and lack of technical knowledge are the major issues the fish industry is facing (Gautam, 2015). In pond aquaculture, lack of knowldege of proper pond management practice among farmers is also the major problem. Mantaining the water level, oxygen level, pH, avoiding undesirable pollution residues for fish farming in pond aquaculture might also be challenging task for good and hygenic fish production. The natural disasters like flood in terai region and landslides in hilly region are the factors that affect the pond aquaculture production.

V. CONCLUSION

The production of pond aquaculture in Nepal is increasing annually with the growth rate of 4.64% in fiscal year 2017/18 (CFPCC, 2018). People are constructing the ponds for fish farming by replacing the rice field in many parts of Nepal. From the trend of pond construction and production discussed above we can conclude that the pond aquaculture will further flourish in the future. Pond aquaculture is the first contributor to the aquaculture production in Nepal.Terai region of Nepal contributes the highest production to the pond aquaculture due to the suitability of land area, accessibility to developed infrastructures, availability of fingerlings etc. Among the seven provinces, province-2 contributes 57.75% (33,746,394 kg) to the total production from pond aquaculture as there is highest pond number and area.

Among the various system practiced for pond aquaculture in Nepal, semi-intensive farming is the most common. The rearing of fish by enhnacing the growth of natural feed by supplying the fertilizer and additional feed is the most commonly practiced system in Nepal. However, the integration of horticulture crops and livestock rearing with the fish farming in pond is also being practied in Nepal.

Although the aquaculture is gaining popularity among the farmers, several challenges are being faced such as lack of adequate fingerlings, lack of technical knowledge, lack of developed market facilities, natural disasters like flood and landslides that result in the production loss to the farmers etc. To reduces this challenges in the future, the governemnt should make the plan and policy in fisheries sector of Nepal. The training related to the pond management practices should be conducted in community level. The fingerlings

supply system should be managed well. The awareness programme to inform the farmer about the proper site selection to prevent the heavy loss due to natural disasters loke flood and landslides.

REFERENCES

[1] Andrea Katz. "The Role of Aquaculture in Nepal: Towards Sustainable Development." *Ambio*, vol. 16, no. 4, 1987, pp. 222–224. *JSTOR*, www.jstor.org/stable/4313363. Accessed 15 Aug. 2020.

[2] CFPCC. Annual book of fish. Machhapokhari, Balaju, Kathmandu: Government of Nepal; Ministry of Agriculture and Livestock Department, Department of Livestocks. Central Fisheries Promotion and Conservation Centre, 2018.

[3] Gautam, N. "Challenges of Freshwater Fisheries in Nepal: A Short Overview". *International Journal of Applied Sciences and Biotechnology*, Vol. 3, no. 4, Dec. 2015, pp. 579-83, doi:10.3126/ijasbt.v3i4.13524.

[4] Gurung, T. B., Mulmi, R. M., Klayan, K. C., Wagle, G., Pradhan, G. B., &Upadhyaya, K. (2010). Cage fish Culture:An alternative livelihood option for communities display by reservior important in kulekhani, Nepal. *In success stories in Asian Aquaculture*, (pp.85-102) Springer Netherland

[5] Kunwar PS, Adhikari B. Status and development trend of aquaculture and fisheries in Nepal. Nepalese Journal of Aquaculture and Fisheries, 2016 & 2017; volume 3&4, page no.: 1-11

[6] Mishra RM. Status of aquaculture in Nepal. Nepalese Journal of Aquaculture and Fisheries, 2015; volume 2, page no.: 1-12

[7] National Aquaculture Sector Overview, Nepal. National Aquaculture Sector Overview Fact Sheets. Text by Pradhan, G. In: FAO Fisheries Division (ONLINE). Rome. Updated 10 October 2005. http://www.fao.org/fishery/countrysector/naso_nepal/en#:~:text=Aquaculture%20is%20fairly%20a%20new,percent%20of%20total%20aquaculture%20production.

[8] Shrestha MK, Pandit NP. A textbook of Principles of Aquaculture. Aquaculture and Fisheries Program; Agriculture and Forestry University, Rampur, Chitwan, Nepal, 2017.

[9] Shrestha MK. Aquaculture Development in Nepal and Current needs. UddhamSmarika, 2015; Page no. 14-15. http://www.cainepal.org.np/sites/default/files/Aquaculture%20Development%20in%20Nepal%20and%20Current%20Needs_0.pdf

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Evaluation of Heavy Metal Contamination in Green Leafy Vegetables Grown in Allahabad

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Abstract*— *In the following study, we have collected municipal wastewater and have studied heavy metal accumulation and health risk factors in two leafy vegetables i.e in Spinach (Spinacia oleracea) and coriander (Coriandrum sativum). The following heavy metals were analyzed i.e. Cu, Zn and, Cr using Atomic absorption spectrophotometer. Present study explains about the amount of heavy metal contamination that is found in green leafy vegetables. Results showed that spinach plant contain Cu, Zn and Cr at all the study area. Cr was under the secure value limit recommended by FAO/WHO at S1, S2, S5. Cr was detected at S1,S2and S3 areas, but at experimental area S2 Cr in spinach (70.79ppm) and coriander(127.27ppm) was higher than the allowable limit. Soil analysis has not revealed any measurable increase in the concentration of heavy metal according to the fixed standards but the values were higher than control which shows that the abomination was due to pesticides and industrial waste.

***Keywords*— Heavy metals, green leafy vegetables, spinach, coriander, wastewater, soil.**

I. INTRODUCTION

In present times, we can observe that larger part of population have noticeable nutrient deficient syndrome. In day-to-day routine we use variety of leafy vegetables to maintain a balanced diet (116/mg) as they are rich in minerals and vitamins. Heavy metals has caused significant risk to human life and that too in upraised concentration(Gupta& Gupta, 1998).

Vegetable consumption has been identified with heavy metals like cadmium, zinc and copper posing health issues in human being (kachenko& Singh, 2006).Many authorities are advising people to utilize the sewage water but this deserves special attention as it is making our environment unsuitable for human health, animals and plants. Untreated water when used for irrigation increases heavy metals in soil and crops. Roots or foliage are the main source of heavy metals in the plant body. Wastewater irrigation not only pollutes the soil but also results in mineral absorption in edible tissue of the leafy vegetables. Metals play a very vital role in our body for the regular growth and development. Chromium works closely with insulin and regulates blood sugar. . Sewage water is the metro cities are the primary cause of pollution as this is drained into rivers without threshold treatment. Biological Demand of oxygen (BOD), eutrophication and several diseases are the mainly outcome of untreated disposal of sewage water. The source of polluted water is highly because of Domestic households, industrial and agricultural uses. The waste pollutants water from household, industries are treated in water treatment plant. The waste after water treatment system disposed in sea, which affect the surroundings. Mud applications are the main cause to increase the concentration of metals in the soil. The Edible part of crops now contains high value of Cd, Cu, Zn and Ni. These heavy metals are affecting major crop and vegetable production such as wheat, potato, spinach, red beet, cabbage and spinach.

II. MATERIALS AND METHODS

2.1 Details of the research area

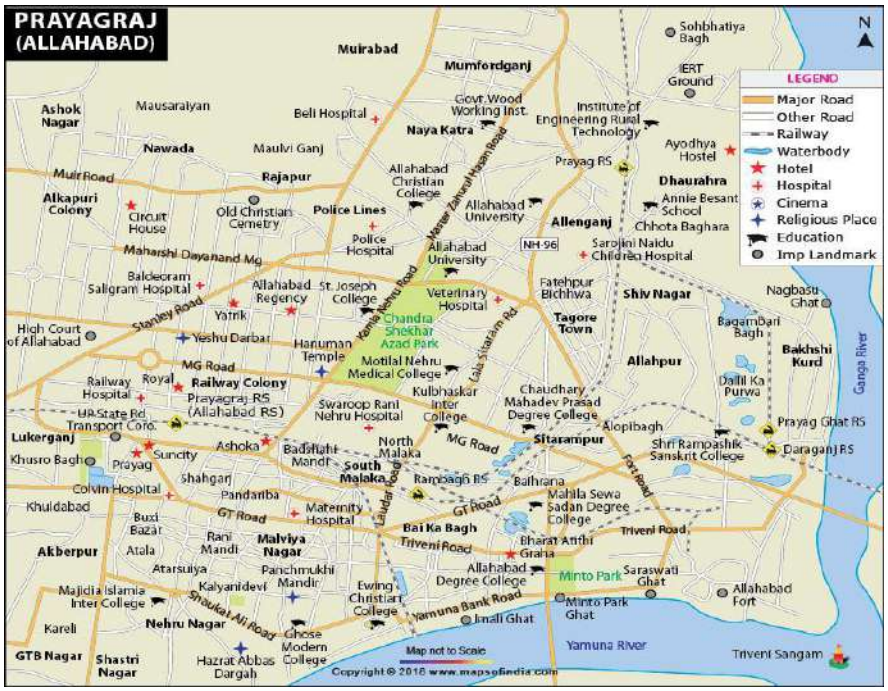

Fig.1: Research areas in Allahabad

Five experimental sites selected for sewage water contamination were Sarasvati ghat (S1),Bai kabagh (S2), Civil lines (S3), Allahapur(S4), Jhalwa(S5)

2.2 Collection AndPreparation Of Water Samples

We have collected the samples from five different areas of Allahabad in precleared 100ml polythene bottles and 2ml of HNO_3 was adjoin as preservative. Water samples that we have collected was kept in insulated field kit containing ice and was brought to laboratory. Further 10ml of water sample was taken in Teflon tubes and 1 ml conc.HNO_3 was added to it. .We have closed the vessel and checked the valve of the tubes. System was pre-programmed using Ethos D control terminal for 5 min of digestion..For control samples were collected from the research areas where normal water is used for agricultural purposes.

2.3 Collection and Preparation of Soil Samples

The soil sample that we have collected from the research area was dried at40°Cfor 48hrs in the hot air oven and was crushed into pieces to pass through 2mm sieve. Extraction of soil with D- acid digestion was done to determine the availability of heavy metals in the soil.The digestion mixture used was a Di- acid mixture. Mixture was made up of conc.HNO3 and HCLO4.5ml of conc. HNO3 was added to 1gm of soil. 12 ml of Di- acid mixture was added and digested in hot water plate in the ratio 3:1 until reddish brown fumes of perchloric acid starts coming out.. Completely dissolved soil samples in the digestion mixture was then evaporated until 2ml was left over in the flask. The digested sample obtained was then transferred and filtered into tubes and were sent for analysis in the Soil Science Lab at Allahabad for Atomic Absorption.

Daily intake of metals.

Average consumption of vegetables and fruits per person per day is 98 and 78 gm respectively. The limit set by FAO/WHO for heavy metal intake for an average adult is 0.01% of 70 kg body weight. Manganese damages the central nervous system. Cobalt and Nickel are carcinogens in nature. More than 5mg of Selenium can be highly toxic to human body. The recommended intake is 0.45 mg which is ten times higher than the daily intake limit. Entry of these metals in our body is due to contamination in water soil and air which becomes concentrated as a result of industrial and human activities.

III. EXPERIMENTAL METHODOLOGY

To analyze heavy metals water samples that were collected from five different research areas i.e (S1-S5) and were sent

to the Soil Science Department for atomic absorption spectrophotometer.

IV. RESULTS AND DISCUSSION

4.1 Copper

From the result obtained we can summaries that copper concentration showed diversion between 7.29ppm(S1) to 34.70ppm(S2). S2(34.70ppm),S4(34.66ppm) and ,S5(34.56)ppm study areas have crossed the acceptable limits i.e 30ppm. In S1,S3 and control study areas Cu concentrations were far below the allowable Indian Standard.

In coriander Cu was at its highest concentration at the study area S2 (60.77ppm). In other areas Cu concentration was far below the crucial level i.e from S5(3.58ppm) to S1(19.29ppm). Result from the control showed 2.19ppm. S2 study area showed binary increase in the copper concentration. (Table 1 and 2). Similar finding was reported by Demirezen and Ahmet (2006) that copper concentration ranged from 22.19 to 76.50 mg/kg in leafy vegetables as compared to non leafy vegetables and the reason was due to the richness of chlorophyll. Further Fytianos *et al.*,(2001) reported that no significant difference in metal engagement in leafy vegetables i.e spinach and coriander from industrial areas were recorded. Present research showed that spinach showed highest Cu concentration as compared to coriander. Control values showed lesser value with soil irrigated with waste water . Results obtained are accordance with the study conducted by Debopam Banerjee *et al.,(*2010).

Table 1 Heavy metal accumulation (ppm) in spinach leaves

Study Area	Copper	Zinc	Chromium
S1	7.28	37.71	0.38
S2	33.70	48.30	70.78
S3	9.61	23.32	28.57
S4	34.61	61.41	13.32
S5	34.55	43.59	BDL
Control	16.28	21.11	BDL
Indian Standard	30.0	50.0	20.0
WHO	40.0	60.0	-

Table 2 Heavy metal accumulation (ppm) in coriander leaves

Study Area	Copper	Zinc	Chromium
S1	19.28	30.82	12.12
S2	60.77	73.71	127.26
S3	9.04	35.21	BDL
S4	14.47	9.97	BDL
S5	3.57	99.55	8.46
Control	2.18	10.22	BDL
Indian Standard	30.0	50.0	20.0
WHO	40.0	60.0	-

4.2 Zinc (Zn)

Zn concentration at S4 was 61.42 ppm and in showed noticeably variation in other selected areas . S4 result showed that the concentrations was exceeding permissible limits of Indian Standard i.e 50ppm. Zn ranged from 24.32ppm to 48.31ppm while control showed 21.11 ppm variation. In coriander Zn concentration overrun the permissible limit i.eS2(73.72ppm) and S5(99.56ppm), whereas S1(30.82ppm), S3(35.23ppm), S4(9.98ppm) and control(10.21ppm) showed lesser value than the permissible limit. (Table 1 and 2).Zn is found throughout our system ,it helps in metabolism function. It plays an important role in wound healing, DNA synthesis and protein production.

4.3 Chromium(Cr)

Chromium was found in spinach in following ranges i.e S3(28.59ppm) and S2(70.79ppm). In samples S5 and control chromium was not detectable. In S1(0.39ppm), and S4(13.31ppm) which is far below the permissible limit. Sample from S2 and S3 overpassed the permissible limit i.e (20ppm). In coriander Chromium was higher in concentration at S2(127.27ppm). At S1 and S5 variations were less as compared to other sites, BDL i.e below detection level **(Table 1 and 2**). Present study showed that chromium in spinach and coriander at specific study area needs urgent evaluation. Chromium shows effects such as skin irritation, headache ,impaired thinking ,blood disorder and other serious health issues.

Chromium exposure occurs through presence of Cr in breathing area, drinking water and eatables. Certain range of Chromium is essential for lipid metabolism but within a certain range (200µg/day). Higher variation in values may lead to accumulation and further cause toxicity in the flora and fauna (Garcia *et al*., 2001).

4.4 Soil

Chromium was not discovered in any of the study areas. Copper was found in the soil and the concentration showed ranges from 7.39ppm to 35.32ppm**(Table 4**). Zinc showed maximum value at S3(32.58ppm) to minimum at (10.31ppm) and control showed value (17.79ppm) and all the values obtained were under the permissible limit.

4.5 Water

Zinc was identified at only S1(<0.05) . No traces of Chromium was observed. Copper concentration showed higher values at all the research areas (**Table 3**) i.e. exceeding the WHO standard . Water pH at S2(7.10) was alkaline as compared to others that showed acidic nature S1(5.24ppm) ,S3(5.16ppm),S4(5.70ppm) and S5(5.39ppm).Physicochemical parameters examined were pH, Electrical conductivity, Total hardness, Calcium ,Magnesium , Total dissolved solid and Dissolved oxygen. showed maximum variation at S2(7.11) and minimum at S3(5.16). Electrical conductivity was maximum found at S3 (1690Mv) to minimum at S2(1214Mv). Total hardness ranged from S1(330mg/l) S2(550mg/l) S3340(mg/l) S4(210(mg/l) S5(370 mg/l). Calcium showed variation from 56 mg/l to 144 mg/l in all the selected area. Magnesium was highest at S2(45.6mg/l) followed by S1(43.2mg/l), S3(36mg/l), S5(28.4mg/l) and S4(16.8mg/l) (**Table 5**).Total dissolved solid ranged maximum from S5(616.30mg/l) to minimum at S4513(mg/l). Dissolved oxygen showed maximum variation from S4(6.2ppm)to minimum at S2(5.5ppm).

Table 3 Heavy metal accumulation (ppm) in waste water

Study Area	Copper	Zinc	Chromium
S1	0.035	BDL	BDL
S2	0.170	BDL	BDL
S3	0.025	BDL	BDL
S4	0.012	BDL	BDL
S5	0.036	BDL	BDL
Control	0.016	BDL	BDL
Indian Standard	0.05	5.0	0.05
WHO	0.20	2.0	0.10

Table 4 Heavy metal accumulation (ppm) in soil

Study Area	Copper	Zinc	Chromium
S1	17.05	29.26	76.88
S2	7.39	10.12	BDL
S3	35.32	32.58	116.93
S4	12.67	15.01	53.03
S5	23.70	18.98	86.98
Control	22.16	17.79	16.77
BIS	135-270	300	-
WHO	-	600	-

Table 5 Physicochemical specification of waste water

Parameters	S1	S2	S3	S4	S5
pH	5.54	7.11	5.15	5.70	5.38
Electrical conductivity	1340Mv	1213Mv	1690Mv	1278Mv	1362Mv
Total Hardness(mg/l)	330	551	341	210	370
Calcium (mg/l)	60	143	75	56	59
Magnesium(mg/l)	43.2	45.4	35	16.8	28.4
Total Dissolved Solids (mg/l)	545.2	904.0	691.3	513.3	616.28
Dissolved oxygen ppm	5.6	5.4	5.5	6.2	5.9

V. CONCLUSIONS

The main source of wastewater contamination are human and animal waste. Presence of phosphorus and nitrogen has also resulted in eutrophication of water resources and also has resulted in high amount of heavy metals in soil and vegetation resulting in potential health hazards. From the present study we conclude that heavy metals in spinach showed higher presence than in coriander. This study may also help other researchers to study more affected areas of Allahabad. Heavy metals showed their presence because of waste water irrigation system practiced in the selected areas. Heavy metals showed their presence could be due to following reasons i.e agricultural practices, geographic position and ability of the plant to absorb heavy metals. Suggested measure may include regular examination of heavy metals in all the food commodities grown in and out.

REFERENCES

[1] ATSDR. (2000), "Toxicological profile for manganese", Atlanta, GA, United States Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

[2] Abida Begum, &Harikrishna, S. (2010), "Pathogens and heavy metal concentration in green leafy vegetables". E-Journal of Chemisty, 7(S1). www. E-Journal.net

[3] Abu Ngozi, E. &Mba, K. C. (2011), "Mutagenic city testing of pharmaceutical effluents on Alliumcepa root tip meristems", J. Toxicology and Environmental Health Sciences, 3(2):44-51.

[4] Al Jassir, M. S., Sarkar, A. &Khaliq, M. A. (2005), "Deposition of heavy metal on green leafy vegetables sold on roadsides of Riyadh city, Saudi Arabia", J. Environ. Contam. Tox., 75:1020-1027.

[5] Anita Singh, Rajesh Kumar Sharma, Madhoolika Agrawal & Fiona M. Marshall. (2010), "Risk assessment of heavy metal toxicity through contaminated vegetables from waste water irrigated area of Varanasi", Indian Tropical Ecology, 51(2):375-387.

[6] Arora, M., Kiran, B., Rani, S., Rani, A., Kaur, B. & Mittal, N. (2008), "Heavy metal accumulation in vegetables irrigated with w ater from different sources", Food Chemistry. 111: 811-815.
[7] Awashthi, S. K. (2000), "Prevention of Food Adulteration Act No. 37 of 1954", Central and State rules as amended for 1999, Ashok Law House, New Delhi.
[8] Bruning, T. &Chronz, C. (1999), "Occurrence of urinary tract tumors in miners highly exposed to Dimtroluene", YOEM, 3:144-149.
[9] Coutate, T. P. (1992), "Food. The Chemistry of its components". 2ndEdn. Cambridge. Royal Society of Chemistry, pp. 265
[10] Cui, Y. J., Zhu, Y. G., Zhai, R., Huang, Y., Qiu, Y. & Liang, J. (2005), "Exposure to metal mixtures and human health impacts in a contaminated area in Nanning, China", Environ. Int., 31:784-790.
[11] Dash, S., Panda, K. K. &Pada, B. B. (1998), "Bio monitoring of low levels of mercurial derivatives in water and soil by Allium micronucleus assay", Mutation Research, 203:11-21.
[12] Debopam Banerjee, Himadri Bairagi, Sibabrata Mukhopadhyay, Anju Pal, Debabrata Bera & Lalitagauri Ray. (2010),
[13] "Heavy metal contamination in fruits and vegetables in two districts of West Bengal, India", EJEAF Che., 9(9):1423-1432.
[14] Demirezen, D. & Ahmet, A. (2006), "Heavy metal levels in vegetables in Turkey are within safe limits for Cu, Zn, Ni and exceeded for Cd and Pb", J. Food Qual., 29:252-265.
[15] Fiskesjo,G.&Levan,A.(1993),"Evaluation of the first ten MEIC chemicals in the Allium test",ATLA,21:139-149.
[16] Fytianos, K., Ktasianis, K., Tziantafyllox, P. &Zacchariadis, G. (2001), "Accumulation of heavy metals in vegetables grown in an industrial area in relation to soil", Bull. Environ. Contam. Toxicol., 67:423-443.
[17] Garcia, E. C., Cabrera, M. L., Lorenzo, Sanchez, J. and Lopez, C. (2001), "Daily dietary intake of chromium in Southern Spain measured with duplicate diet sampling", Br. J. Nutr., 86:391-396.
[18] Gupta, U. C. & Gupta, S. C. (1998), "Trace element toxicity relationships to crop production and livestock and human health: Implication for management", Commun. Soil Sci. Plant Anal., 29:1491-1522.
[19] Habib Mohammad Naser, N., Shil, C. N., Mahmud, U. M., Rashid, H. & Hossain, K. M. (2009), "Lead, cadmium and nickel contents of vegetables grown in industrially polluted and non-polluted areas of Bangladesh", Bangladesh J. Agri. Res., 34(4):545-554.
[20] IOM. (2002), "Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc", Institute of Medicine, Food and Nutrition Board. Washington, DC, National Academy Press, pp. 10-1 to 10-22.
[21] Jackson, A. P. &Alloway, B. J. (1991), "The transfer of cadmium from sewage-sludge amended soils into the edible components of food crops", Water, Air and Soil Pollution, 57-58(1):873-881
[22] Kachenko A. G, Singh B. (2006), "Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia" Water, Air and Soil Pollution, 169:101-123.
[23] Lokeshwari, H. &Chandrappa, G. T. (2006), "Impact of heavy metal contamination of Bellandur lake on soil and cultivated vegetation", Current Science, 91(5):622-627.
[24] Mapanda, F., Mangwayana, E. N., Nyamangara, J. &Giller, K. E. (2005), "The effect of long term irrigation using waste water on heavy metal contents of soil under vegetables in Harare, Zimbabwe", Agric, Ecosys, Environ., 107:151-165.
[25] Muhammad Farooq, Farooq Anwar &Umer Rashid. (2008), "Appraisal of heavy metal contents in different vegetables grown in the vicinity of an industrial area", Pak. J. Bot., 40(5):2009-2016

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Effect of different Modified Atmosphere Packaging on Physico-chemical, Microbiological and Sensorial attributes of Fresh-Cut Muskmelon

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***Abstract*— *In minimal processing, pretreated fresh-cut muskmelon fruit with organic treatment 10% Whey protein concentrate recorded changes in physico-chemical parameters, microbial count and sensorial attributes over the initial values. Pretreated fresh-cut muskmelon was packed in different modified atmosphere conditions. Modified atmosphere packagings with 10% carbon dioxide plus 3% oxygen and 100% nitrogen flushing extended shelf life of fresh-cut muskmelon pretreated with organic and inorganic dipping, up to 18-21 days when stored at 5±1^{0}C. Pretreated fresh-cut muskmelon packaged in perforated packaging (M_4) recorded shelf life up to 12 days only. Decrease in firmness, TSS and sensory parameters while increase in acidity, physiological loss in weight, decay and microbial count was recorded in all MAP conditions. The MAP condition, M_2 (10% CO_2 plus 3% O_2) recorded minimum changes in physico-chemical parameters, restricted microbial growth, maintained quality and enhanced acceptability of pretreated fresh-cut muskmelon up to 21 days under refrigerated storage.*

Keywords*— *fresh-cut muskmelon, 10% WPC, microbial count, shelf life, MAP.

I. INTRODUCTION

Modified Atmosphere Packaging (MAP) is one of the most important techniques used to achieve safety in fresh-cut fruits and/or to prolong their shelf life. Modified atmosphere packaging (MAP) of fresh fruits and vegetables refers to the technique of sealing actively respiring produce in polymeric film packages to modify the O_2 and CO_2 levels within the package atmosphere. Fresh fruit continues to respire, consuming oxygen and producing carbon dioxide and water vapour. It is often desirable to generate an atmosphere low in O_2 and/or high in CO_2 to influence the metabolism of the product being packaged, or the activity of decay-causing organisms to increase shelf life. In addition to atmosphere modification, MAP vastly improves moisture retention, which can have a greater influence on preserving quality than O_2 and CO_2 levels. Furthermore, packaging isolates the product from the external environment and helps to ensure conditions that, if not sterile, at least reduce exposure to pathogens and contaminants.

Muskmelon (*Cucumis melo* L.), a predominant edible fruit belonging to Cucurbitaceae family, is fourth important fruit in the world fresh fruit and fresh-cut market with several varieties and serves as major food sources. It is usually characterized by netted surfaces with shallow vein tracts and flesh is salmon-coloured. Muskmelon is native to North Western parts of India and its primary center of origin is hot valley of Iran and adjacent areas; now growing world-wide in both tropical and temperate regions. In India, muskmelon is grown on an area of 45000 ha with production of 9.35 lakh MT (Anon, 2016). It is common component of fresh cut fruit product and popular for their pleasant odour and sweet taste (Villanueva *et al.*, 2004). The preparation is needed for muskmelon before consumption which makes them suitable to be processed as fresh-cut fruit (Amaro *et al.*, 2012). However, due to rapid deterioration rate and enhanced ethylene productivity, muskmelon has lower shelf life so its market is not widespread. Consumers expect fresh-cut products to be without defects, of optimum maturity, fresh appearance, and have high sensory and nutrient quality (Watada and Qi,

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1999). Hence, high quality of raw product is necessary to achieve high quality fresh-cut product. Final product can only be as good as the incoming raw product. Effective microbial control is essential to restrict high respiration rate which causes spoilage and give unpleasant flavor and odour. The number of processing techniques currently used by the fresh-cut industry is use of low temperature, antioxidants, surfactants, sanitizers and modified atmosphere packaging (MAP).

II. MATERIALS AND METHODS

Sample preparation

The well matured, sound, healthy and fresh fruits of muskmelon (*Cucumis melo* L.) cv. Kundan were collected from Instructional-cum-research farm of Horticulture section, College of Agriculture, Kolhapur. The cubes of 3.5 × 3.5 cm size were prepared and used for research. The defect free, good healthy ripe muskmelon fruits were selected. An overripe and unripe fruits were rejected. The fruits were washed with tap water and disinfected by dipping in sodium hypochlorite solution (100 ppm) for 2 minutes. All tools and equipment were sanitized with sodium hypochlorite solution (150 ppm) prior to fresh-cut processing. Both blossom and pedicel ends including the calyx of each fruit were removed with a sharp knife and then cut longitudinally in to slices. The seeds were removed from the cavity. During the cutting process, fruit with internal defects were discarded. The lids of the jars were modified to enable sampling from the sealed jars. A small hole was drilled using a step- drill bit with regular power drill and an airtight seal was created by inserting a half- hole, bilayer silicon septa into this hole. The fresh-cut muskmelon pretreated with 10% WPC was air dried and packed in glass bottles with different atmosphere modifications. The packagings were carried out in a closed glass chamber with desirable modified atmosphere concentrations.

Physico-chemical determinations

The determination of hardness was done by using a fruit pressure tester (Penetrometer) (make Nieuwlcoop BV Model FT 327) by measuring the maximum penetration force. Weight loss was estimated based on the fresh produce weight and the significant change in physiological weight loss of fresh-cut muskmelon cubes during storage was determined on percentage basis. In all samplings, the fresh weight was measured by an electronic scale of ± 0.01g accuracy and reduction in weight over initial weight in percentage was calculated according to Song *et al.* (2013). The percent decay of fresh-cut muskmelon cubes during storage was calculated based on visual inspection of each fresh-cut cube for infection. Percent decay was calculated according to Gihan (2010) on weight basis. The content of TSS in fresh-cut muskmelon cubes was estimated by using Atago, Tokyo hand refractometer and the values were corrected to 20^0C with the help of temperature correction chart (A.O.A.C., 2005) and expressed in percentage. The titratable acidity of fresh-cut muskmelon cubes was determined by anhydrous citric acid by titrating 10milliliter juice against 0.1N NaOH using phenolphthalein as an indicator as per method advocated by A.O.A.C. (2005).

Microbial analysis

Microbiological growth in fresh-cut muskmelon cubes was observed as total plate count (TPC) and yeast and mould (YM). The method suggested by Luna-Guzman and Barrett (2000) and Silveira *et al.* (2011) was used for microbial analysis.

From each replicate, three random fresh-cut muskmelon cubes of 10g were collected using sterile techniques from a polypropylene container and homogenized with 90 ml of sterile Ringer solution in a sterile stomacher bag for 1 minute. Serial dilutions needed for sample plating were prepared in 9 ml of ringer solution. The pour plate method was performed using the following media and culture conditions: Plate Count Agar for TPC and Potato Dextrose Agar for yeast and mould counts with added 10% tartaric acid to attain PH 3.5. Both the media of the TPC and the yeast and mould count were incubated at 35 ± 1^0C for 48 hours and 25 ± 1^0C for 5 days, respectively. The microbial counts were expressed as log10 (cfu g^{-1}). According to microbial legislation, the maximum tolerated counts is 7 log10 (cfu g^{-1}) for aerobic bacteria and 5 log10 (cfu g^{-1}) and 3 log10 (cfu g^{-1}) the yeast and mould respectively.

Sensorial analysis

Subjective overall acceptability measurements were done on the basis of flavour, colour and appearance, taste and microbial limit tests parameters of samples by a panel of testers based on rating with nine point Hedonic scale suggested by Silvina *et al.* (1998) was considered (Appendix I). A score of 6 was considered the limit of acceptability.

Statistical analysis

The data was reported as an average value of replicates with standard deviation. Analysis of variance (ANOVA) was performed using IBM SPSS statistics 22

(Windows 8.1, Statistical analysis). The level of significance for all the tests was α=0.05. Followed by Duncan's Multiple Range Test (P≤0.05) was carried out to evaluate significant statistical difference of data. For the data expressed as proportions arc sine transformation was applied before analysis.

III. RESULTS AND DISCUSSION

Firmness

Among all the modified atmosphere packagings, M_2 (10% Carbon dioxide plus 3% Oxygen) retained significantly maximum firmness (3.109 kg/cm^2) after 21 days of the storage, while maximum decrease in the firmness was recorded in M_4 packaged fresh-cut muskmelon (2.860 kg/cm^2) after 12 days storage (Fig. 1). This might be due to pretreatment, MAP conditions at low temperatures that maintained cell turgidity, prevented microbiological deterioration, creation of anaerobic condition, restricted availability of free oxygen, slow rate of moisture loss, reduced deterioration rate of bioactive compounds, reduction in respiration rate and ethylene emission as evidenced by Aguayo *et al.* (2007) in fresh cut cantaloupe and Dhumal (2012) in ready to eat fresh arils.

Physiological loss in weight

Minimum physiological loss in weight (2.830%) was recorded in M_2 (10% Carbon dioxide plus 3% Oxygen) followed by M_3 (100% nitrogen flushing) (3.089%) treatment (Fig. 1). Evaporation, transpiration and respiration of fresh-cut muskmelon fruits after harvest and imbalance of vapour pressure in the product tissues and the air inside the package which lead to weight loss over time as reported by Bai *et al.* (2001) in fresh-cut muskmelon.

Per cent decay

At the end of storage period i.e. after 21 day of storage significantly minimum decay (8.993%) was recorded in M_2 (10% Carbon dioxide plus 3% Oxygen) followed by A_3 (100 per cent Nitrogen flushing) (9.252%) with the advancement of time. (Table 1). The established antimicrobial effect of carbon dioxide and less oxygen concentration in package which was responsible for retarding browning and spoilage which delayed of exponential growth phase of microbes and maintained fresh appearance as reported by Bai *et al.* (2001) in fresh cut muskmelon, Oliveria *et al.* (2015) in fresh cut fruits and vegetables, Zhang *et al.* (2013) in fresh cut honey dew muskmelon, Aguayo *et al.* (2007) in fresh cut cantaloupes.

Total Soluble Solids

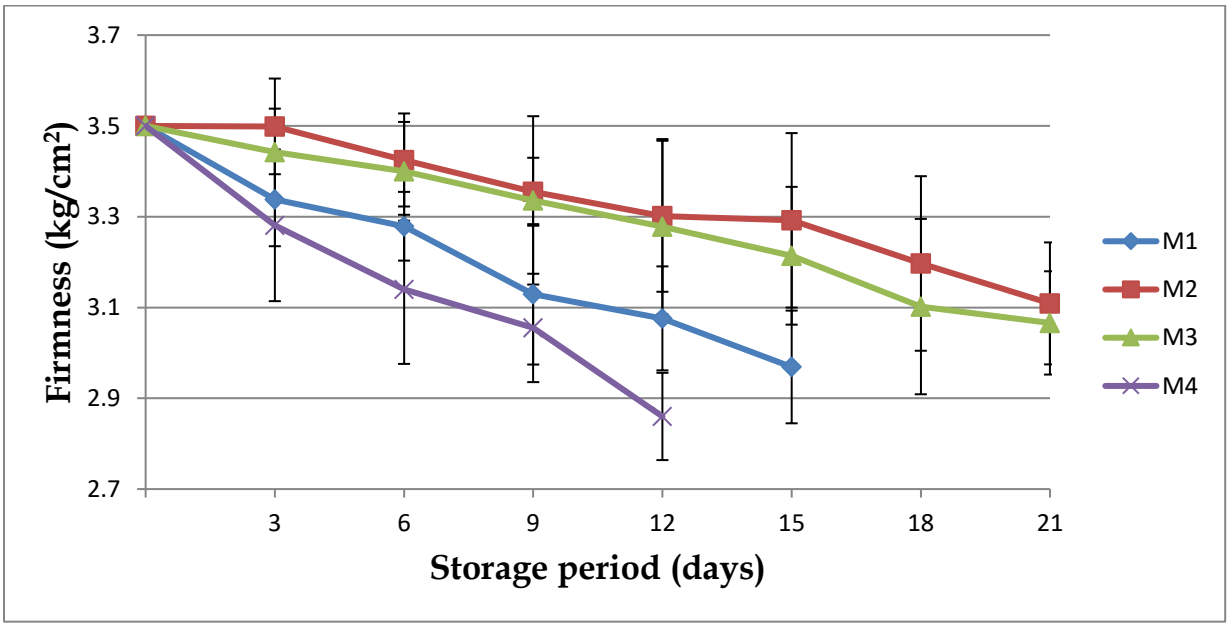
At the end of storage period i.e. after 21 days, packaging treatment M_2 (10 per cent Carbon dioxide plus 3 per cent Oxygen) recorded maximum TSS (7.358 ^{0}Brix) (Fig. 2). This decrease in TSS is might be due to its correlation with decrease of sugar content and could also be due to decrease of fruit respiration rate contributed by refrigerated storage irrespective of packaging condition and treatment tried as reported by Koh *et al.* (2017) in fresh-cut cantaloupe.

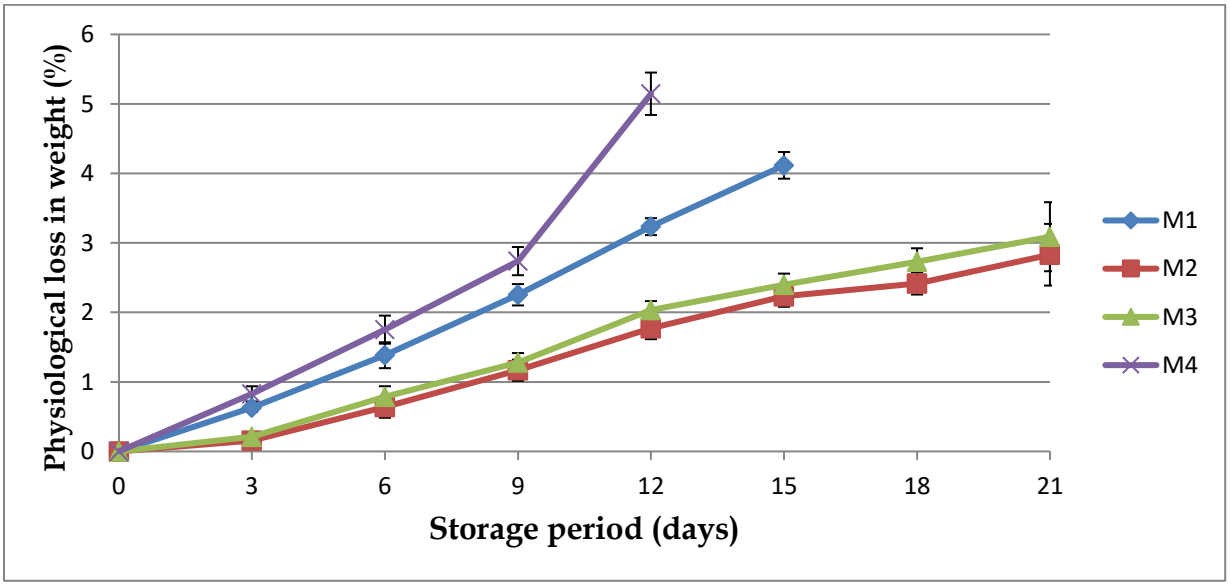
Acidity

During the entire storage period, minimum increase in acidity (0.299%) was recorded in M_2 (10% Carbon dioxide plus 3% Oxygen) (Fig. 2). Numerous studies conducted by Aguayo *et al.* (2007), Koh *et al.* (2017), Aguayo *et al.* (2003) and Lamikanra *et al.* (2000) in fresh cut muskmelon support the findings that low O_2 and/ or high CO_2 atmosphere can retard decomposition of organic acids in plant tissue.

Microbial Limits Test

Initial total aerobic count in fresh-cut muskmelon before dipping in 10% WPC, was 5.249 log cfu per g-1. After dipping, total aerobic count reduced to 4.735 log cfu g-1. At the end of storage period i.e. after 21 days, under MAP conditions, minimum count (4.915 log cfu g^{-1}) was recorded in M_2 (10% Carbon dioxide plus 3% Oxygen) while maximum (6.659 log cfu g^{-1}) was recorded in M_4 (Perforated packaging) after 12th day of storage (Table 2). Before dipping treatment, total yeast and mould count recorded in fresh-cut muskmelon was 4.468 log cfu g^{-1}. After 10% WPC dipping treatment, reduced significantly to 3.980 log cfu g^{-1}. Among all the MAP conditions, M_2 (10% carbon dioxide with 3% oxygen) registered minimum total yeast and mould count (4.010 log cfu g^{-1}) followed by M_3 (4.507 log cfu g^{-1}) at the end of storage period i.e. after 21 days. At the end of 12 days after storage, pretreated fresh-cut muskmelon packaged in perforated packaging (M_4) registered maximum yeast and mould load (5.637 log cfu g^{-1}) (Table 2). Established antimicrobial effect of high CO2 levels and less oxygen concentration in package which was responsible for retarding browning and spoilage which delayed of exponential growth phase of microbes and maintained fresh appearance as reported by Bai *et al.* (2001) in fresh cut muskmelon, Oliveria *et al.* (2015) in fresh cut fruits and vegetables, Zhang *et al.* (2013) in fresh cut honey dew muskmelon, Aguayo *et al.* (2007) in fresh-cut cantaloupes.





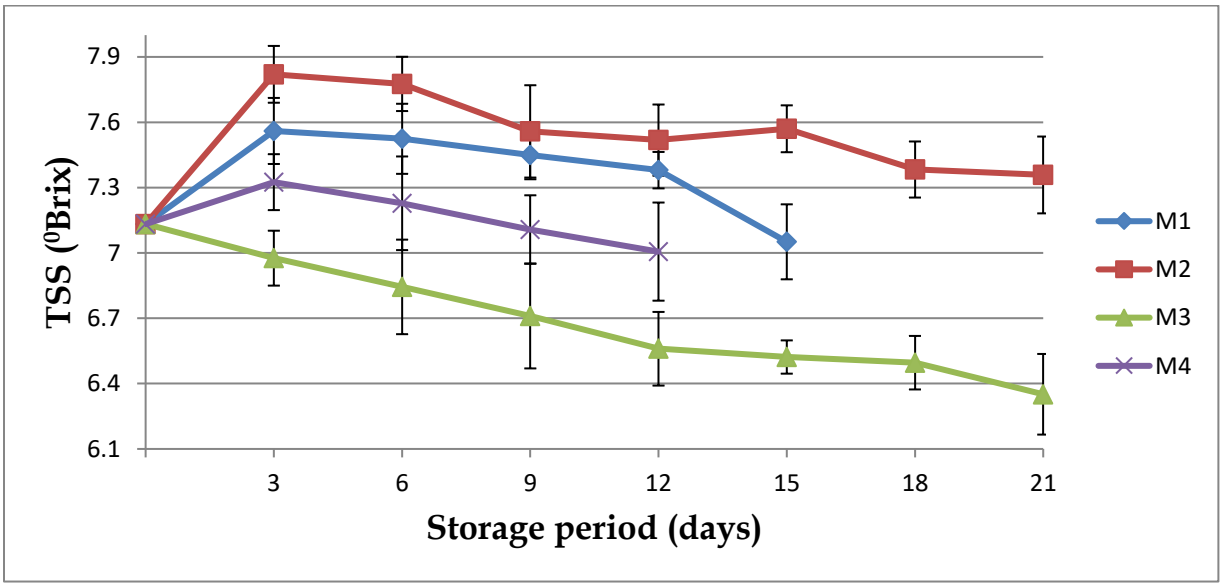
M_1= Air/ passive MAP

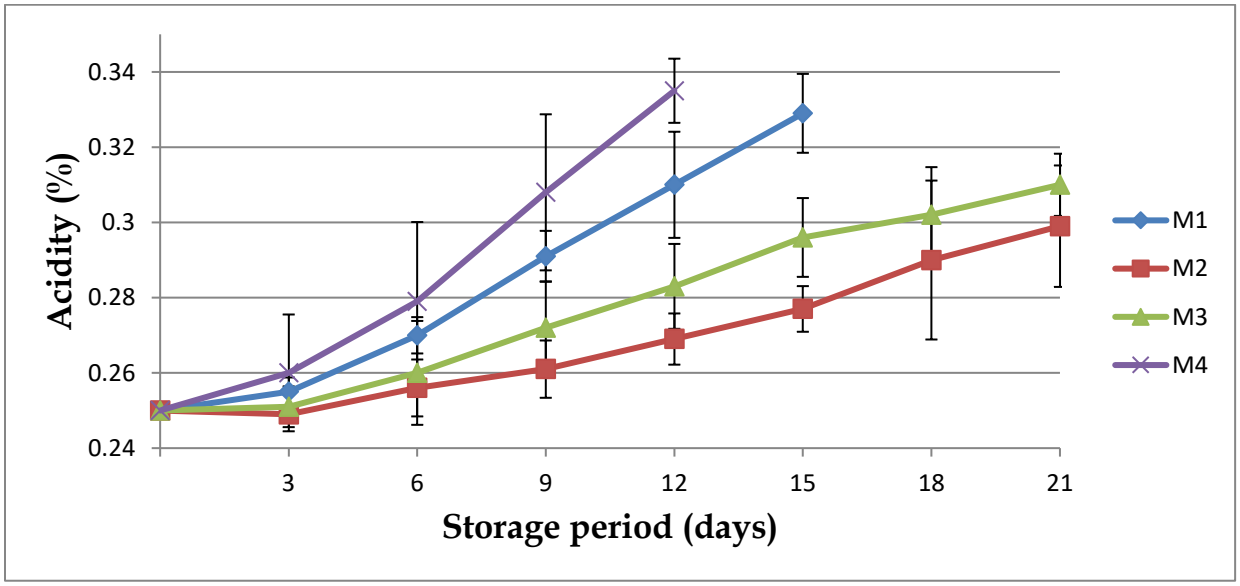
M_2= 10% carbon dioxide + 3% oxygen

M_3= 100% nitrogen flushing

M_4= perforated packaging

Fig.1: Effect of modified atmosphere packaging on the Firmness and Physiological loss in weight of the fresh-cut muskmelon pretreated with 10 per cent WPC and stored at 5±1^{0}C.





M_1= Air/ passive MAP

M_2= 10% carbon dioxide + 3% oxygen

M_3= 100% nitrogen flushing

M_4= perforated packaging

Fig.2: Effect of modified atmosphere packaging on the TSS and Acidity of the fresh-cut muskmelon pretreated with 10 per cent WPC and stored at 5±1⁰C.

Sensorial analysis

Effect of MAP on fresh-cut muskmelon pretreated with organic dipping (Tables 3, 4, 5 and 6) revealed that overall acceptability score in respect of colour and appearance, taste and flavor was highest in M_2 (10% CO_2 + 3% O_2) condition followed by M_3 (100% nitrogen flushing) packaging. However, M_4 conditions noted lowest acceptability for fresh cut muskmelon pretreated with organic

dipping. The maximum overall acceptability in M_2 (10% CO_2 + 3% O_2) might be due to the effectiveness of carbon dioxide enrichment which led to maintain firmness, acidity and TSS, minimum decay and physiological loss in weight. High nitrogen (100%) and CO_2 (10%) in MAP caused reduced respiration rates of fresh cut muskmelon, gave more firmness and slowed down metabolic activities and microbial growth, creation of anaerobic conditions, accumulation of volatiles, off flavour development in product as observed by Falah *et al.* (2015), Silveira *et al.* (2011), Silveira *et al.* (2010), Aguayo *et al.* (2003) in fresh cut muskmelon, Ergun and Ergun (2009) in pomegranate arils cv. Hicaznar and Dhumal (2012) in ready to eat fresh pomegranate arils. Low O_2 combined with high CO_2 provided a better sensory quality to melon pieces then air in minimally processed muskmelon at cold storage conditions.

Table 1. Effect of modified atmosphere packaging on the per cent decay of the fresh-cut muskmelon pretreated with 10 per cent WPC and stored at 5±1^{0}C.

Treatments	Decay (%)				
	Storage period in days				
	9	12	15	18	21
M_1	3.551[a] (11.910)	6.592[b] (14.852)	10.129[c] (18.555)	-	-
M_2	No decay	0.844[a] (5.043)	2.715[a] (9.449)	4.729[a] (12.539)	8.993[a] (17.440)
M_3	No decay	1.007[a] (5.664)	3.552[b] (10.835)	5.237[a] (13.224)	9.252[a] (17.701)
M_4	4.290[a] (10.856)	10.191[c] (18.613)	-	-	-
SE	0.277	0.524	0.301	0.176	0.209
CD at 1%	1.143	2.166	1.244	0.725	0.863

`-' indicates termination of treatments

Figures in parentheses indicates Arcsine value.

Table 2. Effect of modified atmosphere packaging on the total aerobic count (log cfug$^-$1) and total yeast and mould count (log cfug$^-$1) of the fresh-cut muskmelon pretreated with 10 per cent WPC and stored at 5±1^{0}C.

Treatment	Total aerobic count (log cfu g^{-1})			Total yeast and mould count (log cfu g^{-1})		
	Storage period in days			Storage period in days		
	Initial before dipping	Initial after dipping	Final day of storage	Initial before dipping	Initial after dipping	Final day of storage
M_1	5.249	4.735	6.186[c] (15th day)	4.468	3.980	5.098[bc]
M_2	5.249	4.735	4.915[a] (21st day)	4.468	3.980	4.010[a]
M_3	5.249	4.735	5.431[b]	4.468	3.980	4.507[ab]

			(21st day)			
M4	5.249	4.735	6.659d (12th day)	4.468	3.980	5.637c
SE	-	-	0.130	-	-	0.238
CD at 1%	-	-	0.535	-	-	0.985

`-' indicates termination of treatments

M1= Air/ passive MAP **M2=** 10% Carbon dioxide + 3% Oxygen

M3= 100% Nitrogen **M4=** Perforated packaging

Table 3. Effect of modified atmosphere packaging on the colour and appearance (score) and taste (score) of the fresh-cut muskmelon pretreated with 10 per cent WPC and stored at 5±1^{0}C.

Treatments	**Colour and appearance (score)**				**Taste (score)**			
	Storage period in days				**Storage period in days**			
	3	**9**	**15**	**21**	**3**	**9**	**15**	**21**
M1	7.264b	6.000b	4.874c	-	7.873b	6.351b	4.807b	-
M2	7.957a	7.254a	6.595a	6.143a	8.750a	8.113a	7.303a	6.429a
M3	7.735a	7.072a	6.350b	6.007a	8.633a	8.002a	7.169a	6.189b
M4	6.974c	4.839c	-	-	7.487c	5.477c	-	-
SE	0.062	0.066	0.049	0.061	0.077	0.095	0.084	0.054
CD at 1 %	0.258	0.271	0.203	0.254	0.318	0.392	0.346	0.223

`-' indicates termination of treatments

Table 4. Effect of modified atmosphere packaging on the flavour (score) and overall acceptability (score) of the fresh-cut muskmelon pretreated with 10 per cent WPC and stored at 5±1^{0}C.

Treatments	**Flavour (score)**				**Overall acceptability (score)**			
	Storage period in days				**Storage period in days**			
	3	**9**	**15**	**21**	**3**	**9**	**15**	**21**
M1	7.556b	6.116b	4.646b	-	7.564b	6.156b	4.776b	-
M2	8.670a	7.854a	6.659a	6.112a	8.459a	7.740a	6.852a	6.228a
M3	8.453a	7.534a	6.563a	6.045a	8.274a	7.536ab	6.694a	6.080b
M4	7.188c	5.668c	-	-	7.216b	6.328b	-	-
SE	0.076	0.079	0.108	0.069	0.126	0.322	0.093	0.032
CD at 1 %	0.316	0.327	0.446	0.286	0.519	1.328	0.385	0.130

`-' indicates termination of treatments

M1= Air/ passive MAP **M2=** 10% Carbon dioxide + 3% Oxygen

M3= 100% Nitrogen **M4=** Perforated packaging

IV. CONCLUSION

The fresh-cut muskmelon pretreated with organic dipping treatment of 10% WPC and packaged with different modified atmospheres can be stored up to 18-21 days at 5 ± 1^0C. Modified atmosphere packagings with 10% CO_2 plus 3% O_2 flushing or with 100 % nitrogen flushing extended the shelf life of pretreated fresh-cut muskmelon up to 21 days at refrigerated storage (5 ± 1^0C) by controlled decay and microbial growth and enhanced sensorial parameters with minimum changes in physico-chemical attributes.

REFERENCES

[1] O. A. C., 2005. International Official Methods of Analysis. 18th Edn., Association of Official Analytical Chemists, Washington, Dc., U.

[2] Aguayo, E., Allende, A. and Artes, F. 2003. Keeping quality and safety of minimally fresh processed melon. *Eur. Food Res. Technol.* 216: 494-499.

[3] Aguayo, E., Escalona, V. H. and Artes, F. 2007. Quality of minimally processed *Cucumis melo* var. *saccharinus* as improved by controlled atmosphere. *Europ. J. Hort. Sci.* 72: 39-45.

[4] Amaro, A. L., Beaulieu, J. C., Grimm, C. C., Stein, R.E. and Almeida, D. P. F. 2012. Effect of oxygen on aroma .atiles and quality of fresh-cut cantaloupe and honeydew melons. *Food Chem.* 130(1): 49-57.

[5] Anonymous, 2016. Indian Horticulture Database-2015. Pub. National Horticulture Board, Ministry of Agriculture, Govt. of India.

[6] Bai, J. H., Saftner, R. A., Watada, A. E. and Lee, Y. S. 2001. Modified atmosphere maintains quality of fresh-cut cantaloupe (*Cucumis melo* L.). *J. Food Sci.* 66, No. 8.

[7] Dhumal, S. S. 2012. Studies on processing of pomegranate (*Punica granatum* L.) into value added products. A Ph. D. thesis submitted to M. P. K. V., Rahuri.

[8] Ergun, M. and Ergun, N. 2009. Maintaining quality of minimally processed pomegranate arils by honey treatments. *British Food J.* 111(4): 396-406.

[9] Falah, M. A. F., Nadine, M. D. and Suryandono, A. 2015. Effects of storage conditions on quality and shelf-life of fresh-cut melon (*Cucumis melo* L.) and Papaya (*Carica papaya* L.). *Procedia Food Sci.* 3: 313-322. DOI: 10.2016/profoo.2015.01.034.

[10] Gihan, G. A. 2010. Effect of gamma radiation on microbial load and chemical constituents of banana fruits stored under different temperatures. *Res. J. Agril. Biol. Sci*. 6(4): 431-442.

[11] *Lamikanra, O., Chen, J. C., Banks, D. and Hunter, P. A. 2000. Biochemical and microbial changes during the storage of minimally processed cantaloupe. *J. Agric. Food Chem.* 48(12): 5955-5961. DOI: 10.1021/jf0000732.

[12] Silveira, A. C., Aguayo, E., Chisari, M., Artes, F. 2011. Calcium salts and heat treatment for quality retention of fresh-cut 'Galia' melon. *Postharvest Biol. Technol.* 62: 77-84.

[13] Koh, P. C., Noranizan, M. A., Hanani, Z. A. N., Karim, R. and Rosli, S. Z. 2017. Application of edible coatings and repetitive pulsed light for shelf life extension of fresh-cut cantaloupe (*Cucumis melo* L. *reticulatus* cv. Glamour). *Postharvest Biol. Technol.* 129: 64-78.

[14] Song, H. Y., Jo, W. S., Song, N. B., Min, S. C. and Song, K. B. 2013. Quality change of apple slices coated with *Aloe vera* gel during storage. *J. Food Sci.* 78 (6): C817-C822.

[15] Viianueva, M. J., Tenorio, M. D., Esteban, M. A. and Mendoza, M. C. 2004. Composition changes during ripening of 2 cultivars of muskmelon fruits. *Food Chem.* 87: 179-185.

[16] Oliveira, M., Abadias, M., Usall, J., Torres, R., Teixido, N., Vinas, I. 2015. Application of modified atmosphere packaging as a safety approach to fresh-cut fruits and vegetables- A review. *Food Sci. Technol.* 46: 13-26.

[17] Watada, A. E. and Qi, L. 1999. Quality of fresh-cut produce. Postharvest Biol. Technol. 15: 201-205.

[18] Silveira, A. C., Aguayo, E. and Artes, F. 2010. Emerging sanitizers and clean room packaging for improving the microbial quality of fresh-cut 'Galia' melon. *Food Control.* 21(6): 863-871.DOI: https://doi.org/10.1016/j.foodcont.2009.11.017

[19] Zhang, B. Y., Samapundo, S., Pothakos, V., Surengil, G. and Devlieghere, F. 2013. Effect of high oxygen and high carbon dioxide atmosphere packaging on the microbial spoilage and shelf life of fresh-cut honeydew melon. *Int. J. Food Microbiol.* 166(3): 378-390. DOI: 10.1016/j.ijfoodmicro.2013.08.002.

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Effect of different Organic and Inorganic Coatings on Physico-chemical, Microbiological and Sensorial attributes of Fresh-Cut Muskmelon

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***Abstract*— *Eight different organic and inorganic dipping treatments viz., organic coatings- 10% honey, 20% honey, Aloe vera gel, 10% WPC and inorganic coatings- calcium chloride (2.5% at 20^0C), calcium chloride (2.5% at 60^0C), calcium lactate (1%), 0.1% nanosilver stipulated food grade level H_2O_2 along with control were used for pretreatment of fresh-cut muskmelon. The changes in physico-chemical parameters were slow in the fresh-cut muskmelon treated with organic (10% WPC) and inorganic (0.1% nanosilver stipulated food grade level H_2O_2) dipping under refrigerated storage (5±1^0C) up to 18 days. Minimum changes in TSS were recorded in fresh-cut muskmelon pretreated with Aloe vera gel (A_4). The maximum physiological loss in weight and per cent decay was observed in control treatment. The minimum microbial count was observed in fresh-cut muskmelon fruit treated with 0.1% nanosilver stipulated food grade H_2O_2 (A_9) followed by 10% WPC treatment (A_5). Among the different organic and inorganic dipping studied, organic pretreatment of fresh-cut muskmelon with 10% WPC was found best, as regards, inorganic dipping (coatings), 0.1% nanosilver stipulated food grade H_2O_2 was next best. Both the dipping treatments extended shelf life of fresh-cut muskmelon up to 18 days.*

Keywords*— *fresh-cut muskmelon, calcium lactate, WPC, microbial count, shelf life, H_2O_2.

I. INTRODUCTION

Muskmelon (*Cucumis melo* L.), a predominant edible fruit belonging to Cucurbitaceae family, is fourth important fruit in the world fresh fruit and fresh-cut market with several varieties and serves as major food sources. It is usually characterized by netted surfaces with shallow vein tracts and flesh is salmon-coloured. Muskmelon is native to North Western parts of India and its primary center of origin is hot valley of Iran and adjacent areas; now growing world-wide in both tropical and temperate regions. In India, muskmelon is grown on an area of 45000 ha with production of 9.35 lakh MT (Anon, 2016). It is common component of fresh cut fruit product and popular for their pleasant odour and sweet taste (Villanueva *et al.*, 2004). The preparation is needed for muskmelon before consumption which makes them suitable to be processed as fresh-cut fruit (Amaro *et al.*, 2012).

However, due to rapid deterioration rate and enhanced ethylene productivity, muskmelon has lower shelf life so its market is not widespread. Consumers expect fresh-cut products to be without defects, of optimum maturity, fresh appearance, and have high sensory and nutrient quality (Watada and Qi, 1999). Hence, high quality of raw product is necessary to achieve high quality fresh-cut product. Final product can only be as good as the incoming raw product. Effective microbial control is essential to restrict high respiration rate which causes spoilage and give unpleasant flavor and odour. The number of processing techniques currently used by the fresh-cut industry is use of low temperature, antioxidants, surfactants, sanitizers and modified atmosphere packaging (MAP). Applications of edible coating on fruits have the same effect as modified atmosphere packaging (MAP) in modifying the internal gas composition (Park, 1999). The appropriate edible coating formulation may reduce gas exchange rates and water loss as well as represent an excellent way of incorporating

additives to control reactions that are detrimental to quality (Baldwin, Nisperos-Carriedo and Barker, 1995). Edible organic coating can be developed from proteins, polysaccharides, lipids, or from a blend of these groups of material (Kester and Fennema, 1988). The *Aloe vera* gel is used for fresh-cut fruit coating. *Aloe vera* gel provides a barrier to oxygen and water movement, had no effect to the taste (Bernstein, 2005) and also has antimicrobial activity. The numerous chemical and physical preservation strategies retarding cut fruit tissue ripening are used (Reyes, 1996). The use of honey treatments has also been explained in preserving the fresh-like quality of minimally processed fruits and vegetables and to extend their shelf life. Honey has been used since ancient times as a sweetening agent in food and is one of the concentrated natural forms of sugar available worldwide. In addition several inorganic dipping treatments of calcium compound were also used as a firming agent in processing industry.

II. MATERIALS AND METHODS

Plant material

The well matured, sound, healthy and fresh fruits of muskmelon (*Cucumis melo* L.) cv. Kundan were collected from Instructional-cum-research farm of Horticulture section, College of Agriculture, Kolhapur. The cubes of 3.5×3.5 cm size were prepared and used for research.

Sample preparation

The defect free, good healthy ripe muskmelon fruits were selected. An overripe and unripe fruits were rejected. The fruits were washed with tap water and disinfected by dipping in sodium hypochlorite solution (100 ppm) for 2 minutes. All tools and equipment were sanitized with sodium hypochlorite solution (150 ppm) prior to fresh-cut processing. Both blossom and pedicel ends including the calyx of each fruit were removed with a sharp knife and then cut longitudinally in to slices. The seeds were removed from the cavity. The slices were cut into cubes, with approximate dimension of 3.5 × 3.5 cm. During the cutting process, fruit with internal defects were discarded. The healthy and fresh-cut fruit cubes were divided into lots for further treatments of viz. organic coatings- 10% honey, 20% honey, *Aloe vera* gel, 10% WPC and inorganic coatings- calcium chloride (2.5% at 20^0C), calcium chloride (2.5% at 60^0C), calcium lactate (1%), 0.1% nanosilver stipulated food grade level H_2O_2 along with control were used for pretreatment of fresh-cut muskmelon. The treated fresh-cut muskmelon sample weighing 250g were packed in glass pint glass jars and stored in two different environments i.e. in refrigerated storage at 5±10C and at ambient temperature.

Physico-chemical determinations

The determination of hardness was done by using a fruit pressure tester (Penetrometer) (make Nieuwlcoop BV Model FT 327) by measuring the maximum penetration force. Weight loss was estimated based on the fresh produce weight and the significant change in physiological weight loss of fresh-cut muskmelon cubes during storage was determined on percentage basis. In all samplings, the fresh weight was measured by an electronic scale of ± 0.01g accuracy and reduction in weight over initial weight in percentage was calculated according to Song *et al.* (2013). The percent decay of fresh-cut muskmelon cubes during storage was calculated based on visual inspection of each fresh-cut cube for infection. Percent decay was calculated according to Gihan (2010) on weight basis. The content of TSS in fresh-cut muskmelon cubes was estimated by using Atago, Tokyo hand refractometer and the values were corrected to 20^0C with the help of temperature correction chart (A.O.A.C., 2005) and expressed in percentage. The titratable acidity of fresh-cut muskmelon cubes was determined by anhydrous citric acid by titrating 10milliliter juice against 0.1N NaOH using phenolphthalein as an indicator as per method advocated by A.O.A.C. (2005).

Microbial analysis:

Microbiological growth in fresh-cut muskmelon cubes was observed as total plate count (TPC) and yeast and mould (YM). The method suggested by Luna-Guzman and Barrett (2000) and Silveira *et al.* (2011) was used for microbial analysis.

From each replicate, three random fresh-cut muskmelon cubes of 10g were collected using sterile techniques from a polypropylene container and homogenized with 90 ml of sterile Ringer solution in a sterile stomacher bag for 1 minute. Serial dilutions needed for sample plating were prepared in 9 ml of ringer solution. The pour plate method was performed using the following media and culture conditions: Plate Count Agar for TPC and Potato Dextrose Agar for yeast and mould counts with added 10% tartaric acid to attain PH 3.5. Both the media of the TPC and the yeast and mould count were incubated at 35±1^{0}C for 48 hours and 25±1^{0}C for 5 days, respectively. The microbial counts were expressed as log10 (cfu g^{-1}). According to microbial legislation, the maximum tolerated counts is 7

log10 (cfu g^{-1}) for aerobic bacteria and 5 log10 (cfu g^{-1}) and 3 log10 (cfu g^{-1}) the yeast and mould respectively.

Sensorial analysis

Subjective overall acceptability measurements were done on the basis of flavour, colour and appearance, taste and microbial limit tests parameters of samples by a panel of testers based on rating with nine point Hedonic scale suggested by Silvina *et al.* (1998) was considered (Appendix I). A score of 6 was considered the limit of acceptability.

Statistical analysis

The data was reported as an average value of replicates with standard deviation. Analysis of variance (ANOVA) was performed using IBM SPSS statistics 22 (Windows 8.1, Statistical analysis). The level of significance for all the tests was α=0.05. Followed by Duncan's Multiple Range Test ($P \leq 0.05$) was carried out to evaluate significant statistical difference of data. For the data expressed as proportions arc sine transformation was applied before analysis.

III. RESULTS AND DISCUSSION

Firmness

Firmness of fresh-cut muskmelon decreased gradually with the advancement of storage period irrespective of the dipping treatments. Among all the treatments tried, fresh-cut muskmelon fruit pretreated with 1% Calcium Lactate (A_8) (3.267 kg/cm^2) and 10% WPC (A_5) (3.233 kg/cm^2) (Fig. 1) retained significantly maximum total firmness throughout the storage period. This might be due to the cell binding properties of calcium lactate which improved the firmness by maintaining turgor, membrane integrity and inhibit lipase activity in cantaloupe fruits as reported by Syahidah *et al.*, 2015; Lamikanra and Watson, 2004 in fresh-cut cantaloupe. This might be due to the active proteins present in WPC which reduced moisture loss and surface wounding holding the fresh cut tissues firmly as reported by Zsivanovits *et al.* (2012), Silveira *et al.* (2011) in fresh cut muskmelon and Ghavidel *et al.* (2013) in fresh cut apples.

Physiological loss in weight

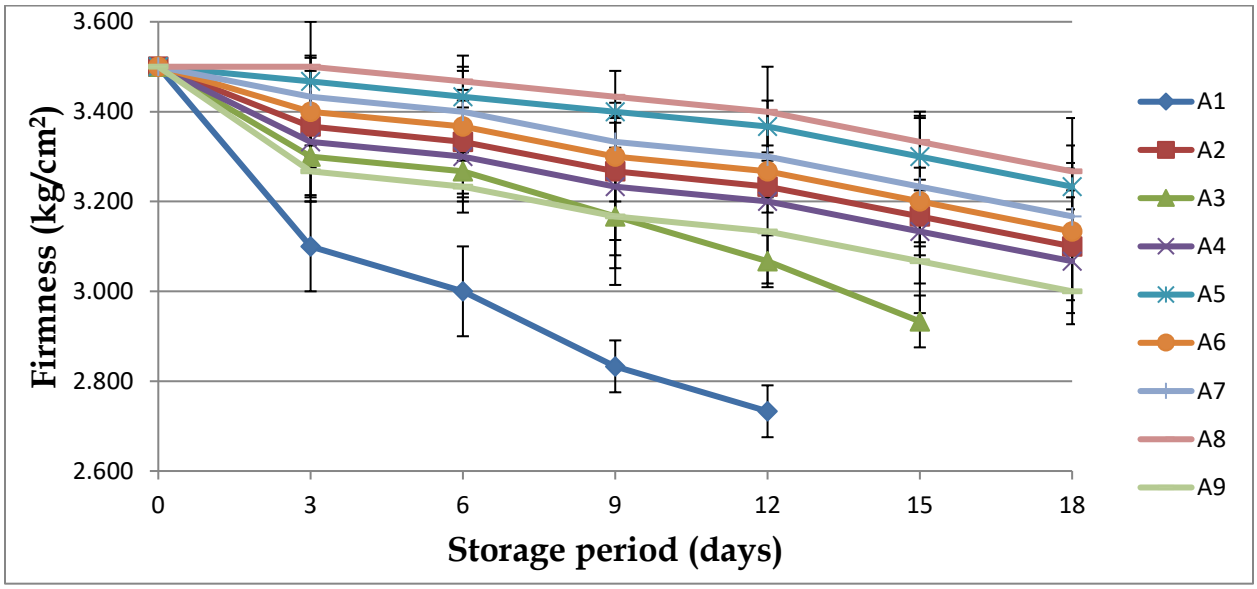
Weight loss is a primary problem in losing weight by reducing moisture content from fruits through rapid ripening and respiration processes which ultimately become the reason of quick transpiration process (Khuram *et al.*, 2015). By decreasing the turgor pressure and firmness of fruit, the weight loss starts to increase which become reason for becoming softer fresh-cut fruits (Beaulieu and Gorny, 2002). Significantly minimum physiological loss in weight (2.367%) (Fig. 1) was recorded in A_5 (10% WPC) followed by A_9 (0.1% nanosilver stipulated food grade hydrogen peroxide) (2.533%) treatment. This might be due to the active proteins and essential amino acids present in WPC and its viscoelastic wax property (Shellhammer and Krochta, 1997) which acts as a barrier for oxygen and moisture because of hydrophobicity due to their high content of long-chain fatty alcohols and alkanes.

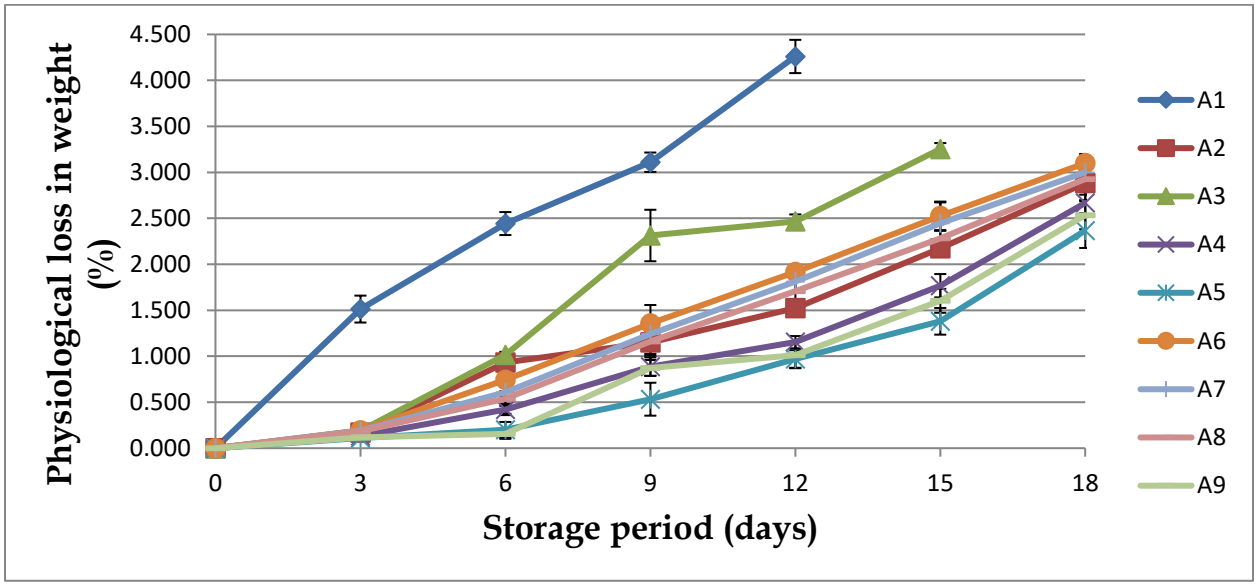
Per cent decay

Minimum per cent decay (6.357%) (Table 1) was recorded in A_9 (0.1% nanosilver stabilized food grade hydrogen peroxide) then followed by A_5 (10% WPC) (6.567%) with the advancement of time. This might be due to sterilization effect of nanosilver antibacterial biofilm coating on fresh cut muskmelon preventing enzymatic browning and discolouration of product. nanosilver stipulated/stabilized food grade hydrogen peroxide is highly effective broad-spectrum disinfectant providing long lasting antimicrobial activity. The slow release of nanosilver stabilized food grade hydrogen peroxide provides mild protective barrier against decay-causing microorganisms as reported by Dhumal (2012) in pomegranate and Mukundan (2007) in fruits, vegetables and fishes. This could be due to the fact of protective firmness, antibrowning effect and antimicrobial effect of 10% whey protein concentrate as reported by Perez-Gago *et al.* (2006) in fresh-cut apples.

Total Soluble Solids (TSS)

In present study, reduction in total soluble solids was reported, which might have correlation with decrease of sugar content as studied by Koh *et al.* (2017). *Aloe vera* gel coating (A_4) recorded the minimum decrease in TSS (5.333 ^{0}Brix) (Fig. 2) up to 18th day of storage followed 10% honey coating (A_2) treatment which registered (5.167 ^{0}Brix) in samples. The minimum reduction in TSS in *Aloe vera* gel treated samples might be due to the decrease in fresh cut fruit respiration rate as contributed by a film providing barrier for oxygen and refrigerated temperature of storage. Similar finding were reported by Koh *et al.* (2017), Yulianingsih *et al.* (2013), Machedo *et al.* (2008) and Lamikanra *et al.* (2000) in fresh cut cantaloupe melon. Honey has been used since ancient times as a sweetening agent in food and is only the concentrated form of sugar available worldwide reported (Dhumal *et al.*, 2014).





Dipping treatments (Coatings):

A_1= Control

A_2= 10% Honey

A_3= 20% Honey

A_4= *Aloe vera* gel

A_5= 10% Whey protein concentrations (WPC)

A_6= Calcium chloride (2.5% at 20 ^{0}C)

A_7= Calcium chloride (2.5% at 60 ^{0}C)

A_8= Calcium lactate (1%)

A_9= 0.1 % Nano silver stipulated Food grade level H_2O_2

Fig.1: Effect of dipping treatments (coatings) on the Firmness and physiological loss in weight of the fresh-cut muskmelon stored at refrigerated storage 5±1^{0}C.

Acidity

Main organic acids muskmelons are malic and citric acids. (Lamikanra *et al.*, 2000). An increase of acidity decreases in fruits and vegetables quality during storage period (Khuram *et al.*, 2015). Minimum acidity (0.266%) (Fig. 2) was recorded in A_2 (10% honey) treated fresh-cut muskmelon. This was due to the pretreatment, packaging condition at low temperature that maintained cell turgidity, prevented microbiological deterioration, creation of anaerobic conditions, restricted availability of oxygen, endogenous enzymatic activities, reduced oxidation of sugars and organic acids, slow rate of moisture loss, reduced rate of bioactive compounds and slow non enzymatic browning as reported by Rolle and Chism in minimally processed fruits and vegetable, Dhumal *et al.* (2014) in pomegranate arils, Ergun and Ergun (2009) in arils of cv. Hicaznar and Gil *et al*. (1996) in cv. Mollar.

Table 1. Effect of dipping treatments (coatings) on the per cent decay of the fresh-cut muskmelon stored at 5±1^{0}C.

Treatments	Decay (%)			
	Storage period in days			
	9	12	15	18
A_1	7.180^c (15.540)	10.267^f (18.687)	-	-
A_2	No decay	2.113^b (8.357)	4.500^b (12.237)	7.803^c (16.223)
A_3	1.900^a (7.920)	5.793^e (13.927)	9.067^e (17.527)	-
A_4	No decay	2.723^c (9.500)	5.383^c (13.417)	7.323^b (15.697)
A_5	No decay	1.817^a (7.747)	3.743^a (11.157)	6.567^a (14.847)
A_6	2.740^b (9.527)	5.637^e (13.733)	8.167^d (16.603)	10.080^d (18.510)
A_7	2.683^b (9.423)	4.750^d (12.587)	7.933^d (16.360)	10.017^d (18.447)
A_8	No decay	2.773^c (9.583)	5.763^c (13.887)	7.867^c (16.287)
A_9	No decay	1.593^a (7.247)	3.590^a (10.923)	6.357^a (14.600)
SE	0.117	0.137	0.183	0.154
CD at 1%	0.475	0.556	0.745	0.628

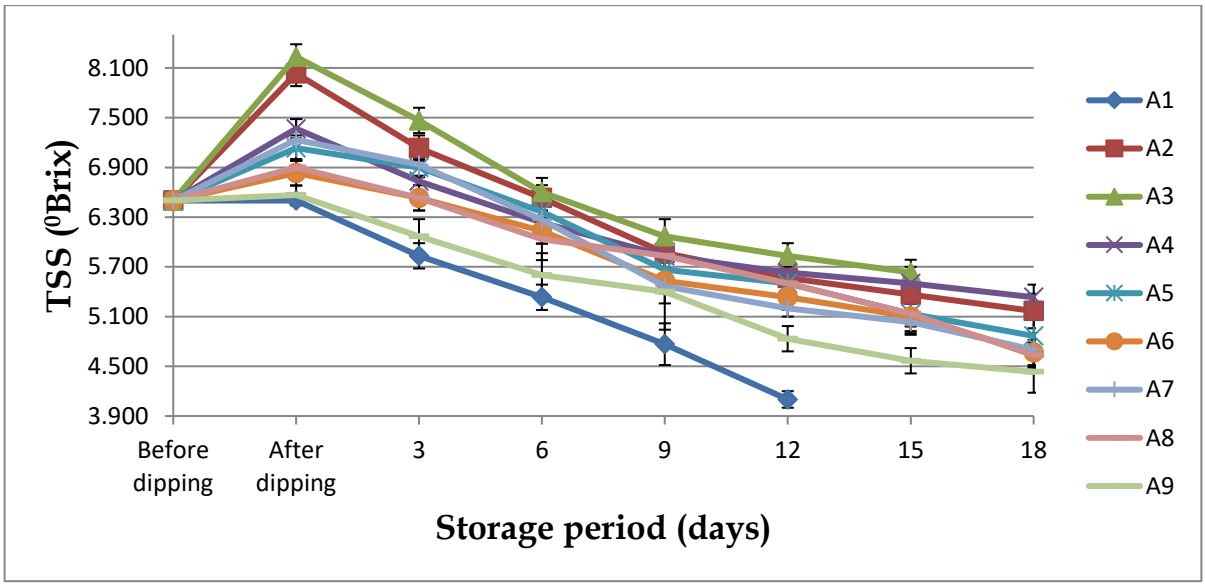
`-' indicates termination of treatments

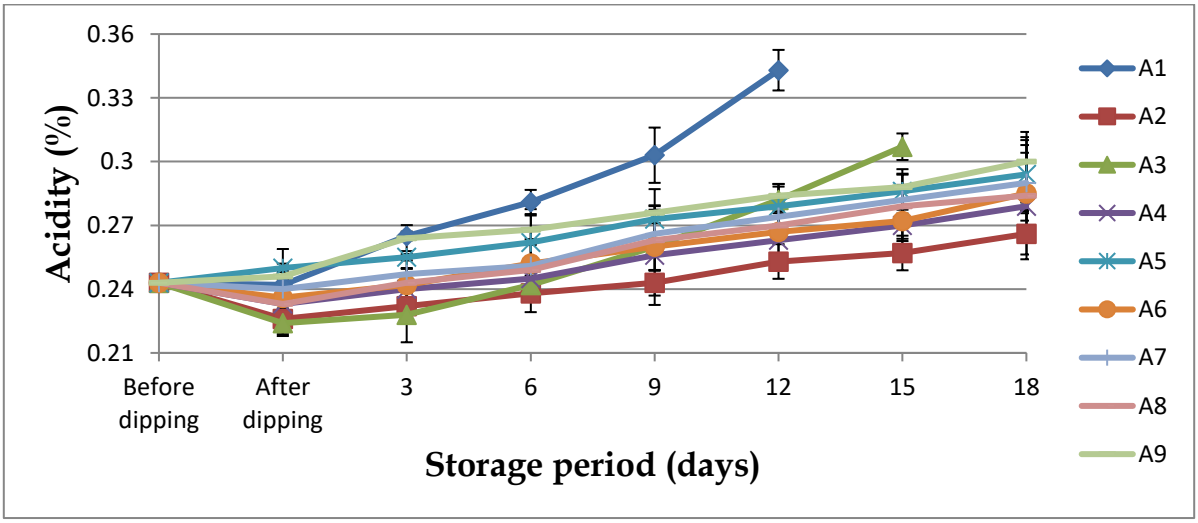
Figures in parentheses indicates Arcsine value.

Dipping treatments (Coatings):

A_1= Control **A_2=** 10% Honey

A_3= 20% Honey
A_4= *Aloe vera* gel
A_5= 10% Whey protein concentrations (WPC)
A_6= Calcium chloride (2.5% at 20 ^{0}C)
A_7= Calcium chloride (2.5% at 60 ^{0}C)
A_8= Calcium lactate (1%)
A_9= 0.1 % Nano silver stipulated Food grade level H_2O_2





Dipping treatments (Coatings):

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A_7= Calcium chloride (2.5% at 60 ^{0}C)
A_8= Calcium lactate (1%)
A_9= 0.1 % Nano silver stipulated Food grade level H_2O_2

Fig.2: Effect of dipping treatments (coatings) on the TSS and Acidity of the fresh-cut muskmelon stored at refrigerated storage 5±1^{0}C.

Microbial Limits Test

The high humidity within a package and the presence of large area of cut surfaces, which provide a rich source of nutrients, create an environment conducive to growth of microorganisms. During storage, the colony growth substantially depends on dippings treatment, experimental material, packaging method and storage time. Initial total aerobic count in fresh-cut muskmelon was 5.373 log cfu g^{-1} while it was reduced to 1.980 log cfu g^{-1} and 3.980 log cfu g^{-1} at final day of storage i.e. 18 days after storage in the fresh-cut muskmelon pretreated with 0.1 per cent nanosilver stipulated food grade hydrogen peroxide (A_9) (Table 2). Significantly minimum total yeast and mold count was observed in 0.1 per cent nanosilver stipulated food grade hydrogen peroxide before dipping treatments, recorded was 4.273 log cfu g^{-1}. After dipping 1.875 log cfu g^{-1} at day 0. At the end of storage period, significantly minimum count (2.801 log cfu g-1). This might be due to sterilization effect of nanosilver and hydrogen peroxide sanitizer antibacterial biofilm coating on the fresh cut muskmelon which prevented enzymatic browning and discolouration of the fresh-cut muskmelon and had suppressing effect on microbes growth. The results of present study are in accordance with those of Mukundan (2007) in vegetables, Dhumal (2012) in pomegranate arils, Ayhan and Chism, (1998) in minimally processed fresh-cut cantaloupe and honeydew melons, Zhang *et al.* (2005) and Allende *et al.* (2009) in fresh-cut muskmelon.

Sensorial analysis

Evaluation of all dipping (coatings) treatments was carried out using 9 point hedonic scale (Portela and Cantwell, 1998). The pre-treatment of fresh-cut muskmelon with 10% whey protein concentrate for 1 minute and packaged in pint glass jar maintained or enhanced colour and appearance, taste, flavor, retained freshness and maintained fresh like quality up to 18 days at 5^0C followed by in 0.1 per cent Nano silver stipulated food grade hydrogen peroxide (Table 3, 4, 5 and table 6). The control treatment showed loss of organoleptic quality throughout the storage period which might be due to increase in lightness, whiteness, discolouration, translucency and texture loss as reported by Haffez *et al.* (2016), Khuram *et al.* (2015), Silveira *et al.* (2011) in melons. Calcium chloride recorded low score (5.966) for flavor and taste (5.706) next to untreated control, which might be the consequences of auto-oxidation of fats, breakdown of proteins having sulphur containing amino acid, both of which give rise to rancid off-flavors and also due to bitterness or off-flavour associated with salt as reported by Luna-Guzman *et al.* (2000). This might be due to the active proteins present in WPC which possess oxygen barrier properties resulting reduced rate of respiration, reduced moisture loss and surface wounding holding the fresh-cut tissues firmly as reported by Ghavidel *et al.* (2013) in fresh-cut apples. Further, WPC coating has anti-browning and antimicrobial properties with antioxidant activity maintaining good colour, appearance and odour of fruit slices.

Table 2. Effect of dipping treatments (coatings) on the total aerobic count (log cfu g^{-1}) and yeast and mould count (log cfu g^{-1}) of the fresh-cut muskmelon stored at 5±1^{0}C.

Treatment	Total aerobic count (log cfu g^{-1})			Yeast and mould count (log cfu g^{-1})		
	Storage period in days			Storage period in days		
	Initial before dipping	Initial after dipping	Final day of storage	Initial before dipping	Initial after dipping	Final day of storage
A_1		5.423^{d}	9.967^{e} (12^{th} day)		4.754^{f}	9.056^{e}
A_2		4.713^{cd}	7.077^{bc} (18^{th} day)		3.494^{cd}	5.901^{b}
A_3		4.330^{c}	6.827^{b} (15^{th} day)		3.252^{bc}	5.801^{b}
A_4		4.697^{c}	7.263^{bc} (18^{th} day)		3.717^{de}	5.869^{b}

A_5	5.373	4.743^{c}	6.670^{b} (18th day)	4.273	3.982^{de}	5.701^{b}
A_6		5.207^{d}	8.830^{de} (18th day)		4.187^{f}	7.936^{d}
A_7		3.903^{b}	8.030^{cd} (18th day)		2.982^{b}	6.987^{c}
A_8		4.380^{c}	7.753^{bc} (18th day)		3.867^{ef}	6.886^{bc}
A_9		1.980^{a}	3.980^{a} (18th day)		1.875^{a}	2.801^{a}
SE	-	0.198	0.374	-	0.163	0.308
CD at 1%	-	0.760	1.440	-	0.627	1.185

`-' indicates termination of treatments

Dipping treatments (Coatings):

A_1= Control
A_2= 10% Honey
A_3= 20% Honey
A_4= *Aloe vera* gel
A_5= 10% Whey protein concentrations (WPC)
A_6= Calcium chloride (2.5% at 20 ^{0}C)
A_7= Calcium chloride (2.5% at 60 ^{0}C)
A_8= Calcium lactate (1%)
A_9= 0.1 % Nano silver stipulated Food grade level H_2O_2

Table 3. Effect of dipping treatments (coatings) on the color and appearance (score) and taste (score) of the fresh-cut muskmelon stored at 5±1^{0}C.

Treatments	**Color and appearance (Score)**				**Taste (Score)**			
	Storage period in days				**Storage period in days**			
	3	**6**	**12**	**18**	**3**	**6**	**12**	**18**
Initial value	**8.00**	**8.00**	**8.00**	**8.00**	**9.00**	**9.00**	**9.00**	**9.00**
A_1	7.333^{c}	6.000^{e}	4.367^{e}	-	7.867^{c}	6.933^{e}	5.500^{f}	-
A_2	7.433^{ab}	7.067^{d}	6.254^{c}	5.998^{bcd}	8.400^{a}	7.967^{bc}	7.000^{abc}	6.107^{ab}
A_3	7.800^{abc}	7.200^{bcd}	5.933^{d}	-	8.333^{ab}	7.833^{cd}	6.500^{e}	-
A_4	7.400^{bc}	7.100^{cd}	6.225^{c}	5.869^{d}	8.467^{b}	8.033^{ab}	7.067^{ab}	6.243^{ab}
A_5	7.967^{a}	7.500^{a}	6.551^{a}	6.209^{a}	8.600^{a}	8.167a	7.167^{a}	6.371^{a}
A_6	7.500^{abc}	7.133^{cd}	6.240^{c}	5.980^{cd}	8.233^{ab}	7.633^{d}	6.667^{de}	5.706^{b}
A_7	7.333^{bc}	7.067^{d}	6.349^{bc}	6.004^{bcd}	8.267^{b}	7.700^{d}	6.700^{de}	5.763^{b}
A_8	7.900^{abc}	7.367^{ab}	6.323^{bc}	6.087^{abc}	8.300^{ab}	7.767^{cd}	6.733^{cde}	5.833^{ab}
A_9	7.600^{abc}	7.300^{abc}	6.424^{ab}	6.153^{ab}	8.100^{ab}	7.767^{cd}	6.833^{bcd}	6.292^{ab}
SE	0.187	0.068	0.053	0.050	0.060	0.063	0.092	0.058
CD at 1%	0.761	0.275	0.214	0.205	0.244	0.256	0.373	0.237

`-' indicates termination of treatments

Table 4. Effect of dipping treatments (coatings) on the flavour (score) and overall acceptability (score) of the fresh-cut muskmelon stored at 5±1^{0}C.

Treatments	Flavour (Score)				Overall acceptability (Score)			
	Storage period in days				Storage period in days			
	3	6	12	18	3	6	12	18
Initial value	**9.00**	**9.00**	**9.00**	**9.00**	**9.00**	**9.00**	**9.00**	**9.00**
A_1	7.900^{d}	7.333^{d}	5.767^{e}	-	7.700^{b}	6.755^{b}	5.211^{b}	-
A_2	8.467^{b}	7.967^{b}	6.933^{b}	6.173^{b}	8.100^{ab}	7.734^{a}	6.785^{a}	6.093^{bcd}
A_3	8.233^{c}	7.667^{c}	6.367^{d}	-	8.122^{ab}	7.567^{ab}	6.267^{a}	-
A_4	8.600^{b}	8.167^{a}	7.167^{a}	6.302^{b}	8.156^{ab}	7.678^{a}	6.742^{a}	6.138^{abc}
A_5	8.733^{a}	8.300^{a}	7.300^{a}	6.454^{a}	8.433^{a}	7.944^{a}	6.973^{a}	6.345^{a}
A_6	8.267^{c}	7.800^{bc}	6.700^{bc}	5.966^{c}	8.000^{ab}	7.567^{ab}	6.558^{a}	5.884^{d}
A_7	8.300^{c}	7.833^{bc}	6.733^{bc}	5.943^{c}	7.989^{ab}	7.533^{ab}	6.594^{a}	5.903^{d}
A_8	8.367^{bc}	7.900^{b}	6.833^{bc}	6.008^{c}	8.033^{ab}	7.633^{a}	6.608^{a}	5.976^{cd}
A_9	8.433^{b}	7.933^{b}	6.900^{bc}	6.257^{b}	8.044^{ab}	7.733^{a}	6.775^{a}	6.234^{ab}
SE	0.043	0.061	0.069	0.045	0.261	0.265	0.238	0.072
CD at 1%	0.175	0.248	0.283	0.183	1.064	1.079	0.967	0.293

`-' indicates termination of treatments

Dipping treatments (Coatings):

A_1= Control

A_2= 10% Honey

A_3= 20% Honey

A_4= *Aloe vera* gel

A_5= 10% Whey protein concentrations (WPC)

A_6= Calcium chloride (2.5% at 20 ^{0}C)

A_7= Calcium chloride (2.5% at 60 ^{0}C)

A_8= Calcium lactate (1%)

A_9= 0.1 % Nano silver stipulated Food grade level H_2O_2

IV. CONCLUSION

The pre-treatment of fresh-cut muskmelon with organic treatment 10% Whey protein concentrate (WPC) packaged in pint glass jar effectively controlled decay, restricted microbial growth with minimum changes in physico-chemical attributes and maintained or enhanced colour, taste, flavor, retained freshness and maintained fresh like quality up to 18 days at 5±1^{0}C. As regards, the inorganic dipping treatments tried, the pretreatments with 0.1 per cent nanosilver stabilized food grade hydrogen peroxide were the recorded minimum decay as well as microbial population in the packaged samples throughout the storage period at 5±1^{0}C.

REFERENCES

[1] A.O.A.C., 2005. International Official Methods of Analysis. 18th Edn., Association of Official Analytical Chemists, Washington, Dc., U.

[2] Allende, A., McEvoy, Tao, Y. and Luo, Y. 2009. Antimicrobial effect of acidified sodium chlorite, sodium chlorite, sodium hypochlorite and citric acid on *Escherichia coli* O157:H7 and natural microflora of fresh-cut cilantro. *Food Control* 20: 230-234.

[3] Amaro, A. L., Beaulieu, J. C., Grimm, C. C., Stein, R.E. and Almeida, D. P. F. 2012. Effect of oxygen on aroma .atiles and quality of fresh-cut cantaloupe and honeydew melons. *Food Chem.* 130(1): 49-57.

[4] Anonymous, 2016. Indian Horticulture Database-2015. Pub. National Horticulture Board, Ministry of Agriculture, Govt. of India.

[5] Ayhan, Z. and Chism, G. W. 1998. The shelf-life of minimally processed fresh-cut melons. *J. Food Quality* 21: 29-40.
[6] Baldwin, E. A., Nisperos-Carriedo, M. O., Baker, R. A. 1995. Use of edible coatings to preserve quality of lightly processed products. Critical Reviews in *Food Sci. and Nutri.* 35: 509-52.
[7] Beaulieu, J. C. and Gorny, J. R. 2002. Fresh cut fruits. http://www.ba.ars.usda.gov/hb66/146freshcutfruits.pdf (accessed 1. 12. 2007).
[8] Bernstein, Michael, 2005. *Aloe vera* coating for fruits and vegetables. Washington DC.
[9] Dhumal, S. S. 2012. Studies on processing of pomegranate (*Punica granatum* L.) into value added products. A Ph. D. thesis submitted to M. P. K. V., Rahuri.
[10] Dhumal, S. S., Karale, A. R., Jadhav, S. B. and Kad, V. P. 2014. Recent advances and the developments in the pomegranate processing and utilization: A Review *J. Agric. and Crop Sci.* 1: 01-17.
[11] Ergun, M. and Ergun, N. 2009. Maintaining quality of minimally processed pomegranate arils by honey treatments. *British Food J.* 111(4): 396-406.
[12] Ghavidel, R. A., Davoodi, M. G., Asl, A. F. A., Tanoori, T., Sheykholeslami, Z. 2013. Effect of selected edible coatings to extend shelf-life of fresh-cut apples. *Int. J. Agric. Crop Sci.* 616: 1171-1178.
[13] Gihan, G. A. 2010. Effect of gamma radiation on microbial load and chemical constituents of banana fruits stored under different temperatures. *Res. J. Agril. Biol. Sci*. 6(4): 431-442.
[14] Gil, M. I., Artes, F. and Tomas-Barberan, F. A. 1996. Minimal processing and modified atmosphere packaging effects on pigmentation of pomegranate seeds. *J. Food Sci.* 61: 161-164.
[15] Haffez, M. M., Ragab, M. E., El-Yazied, A. A. and Emam, M. S. 2016. Effect of chitosan, carboxy methyl cellulose and calcium chloride treatments on quality and storability of fresh-cut cantaloupe. Middle East *J. Applied Sci.* 06: 249-268.
[16] Kester, J. J. and Fennema, O. R. (1988). Edible films and coatings. A review. *Food Technol.* 42: 47-59. CRC Press, Boca Raton, FL.
[17] Khuram, H., Aslam,W., Sakandar, H. A., Asim, M., and Shakeel, A. 2015. Impact of Various biodegradable coatings on shelf life of minimally Processed melon. *J. Glob. Innov. Agric. Soc. Sci*. 3(1):19-24.
[18] Koh, P. C., Noranizan, M. A., Hanani, Z. A. N., Karim, R. and Rosli, S. Z. 2017. Application of edible coatings and repetitive pulsed light for shelf life extension of fresh-cut cantaloupe (*Cucumis melo* L. *reticulatus* cv. Glamour). *Postharvest Biol. Technol.* 129: 64-78.
[19] Lamikanra, O. and Watson, M. A. 2007. Mild heat and calcium treatment effects on fresh-cut cantaloupe melon during storage. *Food Chem.* 102: 1383-1388.
[20] *Lamikanra, O., Chen, J. C., Banks, D. and Hunter, P. A. 2000. Biochemical and microbial changes during the storage of minimally processed cantaloupe. *J. Agric. Food Chem.* 48(12): 5955-5961. DOI: 10.1021/jf0000732.
[21] Luna-Guzman, I., and Barrett, D. M. 2000. Comparison of Calcium chloride and Calcium lactate effectiveness in maintaining shelf stability and quality of fresh-cut cantaloupes. *Postharvest Biol. Technol.* 19: 61-72.
[22] Machado, F. L. C., Alves, R. E., and Figueiredo, R. W. 2008. Application of 1- methylcyclopropene, calcium chloride and calcium amino acid Chelate on fresh-cut cantaloupe muskmelon. *Pesq. agropec. bras., Brasilia.* 43(5): 569-574.
[23] Mukundan, M. K. 2007. A certificate given to Veg. Protect, M/s. Advanced Agro-Tech, Thane by Central Institute of Fisheries Technology, Cochin vide. Certificate No. F.3-2/2007-QAM dated 06.12.2007.
[24] Park, H. J. 1999. Development of advanced edible coatings for fruits. Trends in *Food Sci. Technol*. 10: 254-260.
[25] Perez-Gago, M. B., Serra, M., del Rio, M. A. 2006. Color change of fresh-cut apples coated with whey protein concentrate- based edible coatigs. *Postharvest Biol. Technol.* 39: 84-92.
[26] Portela, S. I. and Cantwell, M. I. 1998. Quality changes of minimally processed honeydew melons stored in air or controlled atmosphere. Postharvest Biol. Technol. 14: 351-357.
[27] Reyes, L. F., Villarreal, J. E. and Zevallos, L. C. 2007. The increase in antioxidant capacity after wounding depends on the type of fruit or vegetable tissue. *Food Chem.* 101: 1254-1262. DOI: 10.1016/j.foodchem.2006.03.032.
[28] Rolle, R. S. and Chism, G. W. 1987. Physiological consequences minimally processed fruits and vegetables. *J. of Food Quality.* 10(3): 157-177. DOI: 10.1111/j.1745-4557.1987.tb00856.x
[29] Shellhammer, T. H. and Krochta, J. M. 1997. Whey protein emulsion film performance: effect of lipid type and amount. *J. Food Sci.* 62: 390-394.
[30] Silveira, A. C., Aguayo, E., Chisari, M., Artes, F. 2011. Calcium salts and heat treatment for quality retention of fresh-cut 'Galia' melon. *Postharvest Biol. Technol.* 62: 77-84.
[31] Song, H. Y., Jo, W. S., Song, N. B., Min, S. C. and Song, K. B. 2013. Quality change of apple slices coated with *Aloe vera* gel during storage. *J. Food Sci.* 78 (6): C817-C822.
[32] Syahidah, K., Rosnah, S., Noranizan, M. A., Zaulia, O. and Anvarjon, A. 2015. Quality changes of fresh-cut cantaloupe (*Cucumis melo* L. var. *reticulatus* cv. Glamour) in different types of polypropylene packaging. *Int. Food Res. J.* 22: 753-760.
[33] Viianueva, M. J., Tenorio, M. D., Esteban, M. A. and Mendoza, M. C. 2004. Composition changes during ripening of 2 cultivars of muskmelon fruits. *Food Chem.* 87: 179-185.
[34] Watada, A. E., Ko, N. P. and Minott, D. A. 1996. Factors affecting quality of fresh-cut horticultural products. *Postharvest Biol. Technol.* 9: 115-125.

[35] Watada, A. E. and Qi, L. 1999. Quality of fresh-cut produce. Postharvest Biol. Technol. 15: 201-205.
[36] Yulianingsih, R., Maharani, D. M., Hawa, L. C., and Sholikhah, L. 2013. Physical quality observation of edible coating made from *Aloe vera* on cantaloupe (*Cucumis melo* L.) minimally processed. Pakistan *J. nutri*. 12(9): 800-805.
[37] Zhang, M., Xiao, G., Peng, J. and Salokhe, V. M. 2005. Effects of single and combined atmosphere packages on preservation of strawberries. *Int. J. of Food Engg.* 1(4).
[38] Zsivanovits, G., Zhelyazkov, S., Brashlyanova, B., Iserliyska, D., Yovkova, D. 2012. Effect of chitosan coating on quality of fresh-cut melon during the shelf-life. Advanced Res. in Scientific Areas, 3: 7.

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Rumen Parameters of West African Dwarf (WAD) Goats Fed Cassava Peels- Poultry Manure Concentrate Supplements

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Abstract— *This experiment was conducted to evaluate the effects of supplementing cassava peels with dried poultry manure on rumen parameters of West African Dwarf (WAD) goats. Twenty growing West African Dwarf bucks aged 5-7 months with an average body weight of 5.05±0.02kg were used in a completely randomized experiment. The goats were randomly assigned to one of the five dietary treatments which consisted of processed cassava peels and dried poultry manure in different ratios of 100:0(diet 1), 50:50(diet 2), 60:40(diet 3), 70:30(diet 4) and 80:20(diet 5). Data collected were subjected to analysis of variance. The result indicated that among all the parameters examined, acetic acid was significantly (P<0.05) influenced by dietary treatments at the start of the experiment and ranged from 20.77mol/100ml to 26.18mol/100ml while pH and acetic acid were significantly (P<0.05) influenced at the end of the trial. There was a significant (P<0.05) increase in value of acetic acid across the treatments at the end of the experiment. The study revealed that supplementing the diets of goats with cassava peels and poultry manure has the potentials of meeting the nutritional needs of the animal without negative effects on the rumen parameters.*

Keywords— ***Cassava Peels, Poultry manure, WAD, Rumen parameters.***

I. INTRODUCTION

Inadequate availability of animal feed in terms of quality and quantity is a major challenge for livestock production, sustainability and profitability (Ajagbe *et al*., 2015, Abo zeid *et al.,* 2017). Natural herbage which used to serve as feed stuffs for ruminant often decline in quality and quantity during dry season. More so, using cereals grains in ruminant diets is considered to be a direct conflicting competition between livestock production and human nutrition (Abo zeid *et al.,* 2017). As a result, livestock producer especially ruminant both at smallholders and commercial production levels have to seek for alternative feed resources without sacrificing quality of feed and productive performance of the animals. As a result of the fore going research efforts have been shifted to use of cheap sources of agro- based industrial by- product and organic waste as supplements in ruminant production. Parts of these feed resources are cassava peel and poultry manure. FAO (2005), stated that productive feeds for the ruminant livestock could be prepared with various components of cassava plant such as tuber, peels, pulp etc as non-structural carbohydrates and fermentable energy source. Dried poultry manure would provide fermentable nitrogen required for optimum utilization of the readily fermentable carbohydrates of the cassava peels in the concentrate diets (Yousuf *et al.,* 2013). Ruminant animals are unique in their feeding status based on the physiology of their rumen. Therefore, adequate feeding to meeting the nutritional need of the rumen microbes plays vital role in ruminant animal nutrition. Mohammed and Chaury, (2008) indicated that rumen fermentation products such as volatile fatty acids are essentials nutrients to meet the demand of rumen microbes and animals body build up. This study was carried out to evaluate rumen parameters of growing West African Dwarf goats fed cassava peel meal and dried poultry manure concentrate supplements.

II. MATERIALS AND METHODS

The experiment was carried out at the Sheep and Goat Unit of Department of Animal Production, Kogi State, University, Anyigba, Kogi State. Anyigba is located in the derived

Savannah of Nigeria on Latitude 7^0 15^1 and 7^0 29^1N of the equator and Longitude 7^0 11^1 and 7^0 32^1 E of the Greenwich meridian (Ifatimehin *et al*., 2006). The wet season spreads over a minimum of seven (7) months and it extends from late April to October with the dry season spanning from November to March with an appropriate of five (5) months. Rainfall here is highly seasonal and September is the rainiest month with short dry season (break) in August with a mean annual rainfall ranging from 150mm to 250mm. The area has a humidity of about 70% on the average and a mean annual temperature of 27^0C (Iji, 2007). The area is characterized by luxuriant growth of many tall grass species like Gambia grass (*Andropogon tectorium*, *Andropogon gayanus*), Elephant grass (*Pennisetum purpuerm*), Guinea grass (*Panicum maximum*) and some short grasses (Ifatimehin *et al*., 2006). Fresh cassava peels, free from stumps were collected and grated before being subjected to hydraulic press for dewatering. The dewatered peels were then pulverized and sieved to obtain the coarse mash, which was then sun-dried for 2-3days before being loaded into bags for feeding animals (Ajagbe *et al.*, 2019). Cassava foliage was harvested fresh and sun dried until the leaves became brittle for milling.

Experimental Procedure

A total of twenty (20) West African Dwarf bucks of about 5-7 months, having an initial weight between 5.00kg to 6.50 kg were obtained from goat producers within Anyigba town for 60 days experiment. Goats were housed semi-intensively in well-ventilated wooden cages in the pens. The cages were built on wooden stands, 40 cm from the floor. Before the goats were brought in, the pen was cleaned, washed and disinfected with izal solution two weeks prior to arrival. The entire goat house was fumigated using strong fumigants (Dimethoate 40% and Action 40%) against fleas. Prophylactic treatments were given to all the goats: they were dewormed and vaccinated against pests des petits ruminantae (PPR). Treatment against ecto-parasites was done with the use of Amitraz solution. Multivitamin was also administered to boost appetite. The goats were randomly distributed to 5 treatments of 4 animals each. A 14 days adjustment period was allowed for the goats before data collection commenced. Concentrate supplements were fed daily on 5% body weight after 5-7 hour grazing. The weighing of the goats was done weekly to determine the weight gain.

The goats were randomly assigned to five treatments with four replicates in a Complete Randomize Design (CRD). 100% treated cassava peel was allotted to T1 as the control diet, 50% untreated cassava peel + 50% cassava foliage was allotted to diet 1, 60% untreated cassava peel + 40% cassava foliage was allotted to diet 2, 70% cassava peel + 40% cassava foliage diet 3 and 80% Cassava peel + 20% cassava foliage allotted to diet 4 respectively. Goats were fed daily supplementary diets on 5% body weight after about 5-6 hours daily grazing.

Rumen Fluid Collection

Rumen liquor samples were collected from two animals per treatment at the start and end of the feeding trial with the use of stomach tube as describe by (Wanapat and Khampa2007) 20ml of the rumen liquor was collected from two replicates per treatment into sample bottles, the rumen pH of each sample was determined immediately after collection using the Jenway pH meter, model 3150 and immediately stored in the freezer at -5° C. until analysis. Rumen fluid sample were strained through four layers of cheese cloth.

Laboratory Analysis

Proximate composition of the experimental diets was analyzed according to the methods of Association of Official Analytical Chemists (AOAC) (2005). Individual volatile fatty acids production was determined using gas chromatography (Mabrahtu and Tenaye, 1997).

Statistical Analysis

Data collected were subjected to one way analysis of variance (ANOVA) SPSS (20).The Mean separations were compared using Duncan's Multiple Ranged Test.

Table 1: Gross Composition of experimental diet (%)

Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**
Cassava Peels	100	50	60	70	80
Cassava Foliage	-	50	40	30	20
Total	100	100	100	100	100

III. RESULTS

Nutrient composition of supplementary diets is shown in Table 2. Dry matter (DM) ranged between 89.16% and 89.90%, diet 2 had higher value than other treatments. Observed value for crude protein ranged between 11.11% and 12.44% with diet 2 having the highest value. Values obtained for crude fibre indicated that diet 2 had higher value while diet 5 had the lowest value**.**Ash contents was higher in diet 2 (3.19%) while diet 1 had higher nitrogen free extract (86.12%).

Table 2: Nutrient Composition of Cassava peel- poultry manure concentrate supplement (%)

Nutrient	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Dry Matter	89.16	89.90	89.76	89.60	89.46
Organic Matter	86.66	82.53	86.71	86.69	86.68
Crude Protein	5.27	12.44	11.94	11.53	11.11
Crude Fibre	4.45	6.34	5.96	4.59	5.20
Ether Extract	0.82	0.74	0.75	0.77	0.79
Ash	2.50	3.19	3.05	2.91	2.78
Nitrogen Free Extract	86.12	72.29	73.30	74.82	75.12

Rumen parameters of West African Dwarf goats fed cassava peels and dried poultry manure concentrate supplements is shown in Table 3. At the start of the experiment, acetic acid and butyric acid were significantly (P<0.05) influenced by dietary supplements while pH, lactic acid and propionic acid were not (P>0.05) significantly different among the treatments. Acetic acid ranged between 20.77mol/100ml and 26.18mol/100lml with diet 3 having higher value. Propionic acid differed (P<0.05) among the treatments ranging from 19.15 to 22.14% following similar trend of higher value in diet 3. The values of pH ranged from 6.48 to 7.14, lactic acid (47.43mol/100ml-48.18mol/100ml).All parameters examined at the end of the trial were not significantly different (P>0.05) among the dietary treatments except pH and acetic acid. Higher value of acetic acid was observed for diet 2 (38.70mol/100ml). Values obtained for diet 1,3,4 and 5 were similar but different from diet 2. Values of pH significantly ranged between 6.64 and 7.11 pH. Lactic acid and propionic acid had higher values for diet 4 (14.62mol/100ml and 20.63mol/100ml) respectively while butyric acid had higher value for diet 2 (22.92mol/100ml).

Table 3: Rumen parameters of WAD goats fed cassava peels-dried poultry concentrate supplements.

	Diets						
Parameters	T1	T2	T3	T4	T5	SEM	LOS
At the start of the experiment							
pH	6.52	6.48	7.14	6.72	6.49	0.12	NS
Lactic acid (mol/100ml)	47.43	48.06	48.12	47.97	47.43	0.34	NS
Acetic Acid (mol/100ml)	24.15^{ab}	25.40^{a}	26.18^{a}	20.77^{b}	25.11^{a}	0.72	*
Propionic Acid (mol/100ml)	20.12	19.50	22.06	20.90	20.33	0.41	NS
Butyric Acid (mol/100ml)	19.46^{ab}	19.39^{ab}	22.14^{a}	18.54^{b}	19.15^{b}	0.48	*
At the end of the Experiment							
pH	6.82^{ab}	6.64^{c}	7.11^{a}	6.72^{c}	7.01^{ab}	0.63	*
Lactic acid (mol/100ml)	14.14	13.83	14.26	14.62	14.30	0.11	NS
Acetic Acid (mol/100ml)	28.17^{b}	38.70^{a}	29.09^{b}	28.22^{b}	29.38^{b}	1.35	*
Propionic Acid (mol/100ml)	20.31	18.82	19.47	20.63	19.43	0.31	NS
Butyric Acid (mol/100ml)	20.59	22.92	19.16	22.17	21.15	0.56	NS

IV. DISCUSSION

Dry matter values of the experimental diets ranged from 89.16%- 89.90%. Crude protein values decreased with decrease ratio of poultry manure supplementation. The dry matter content in this study was higher than 85.00% to 88.50% reported by Yusuf *et al*. (2013). The dry matter content was higher than 83.23-85.60% reported by Ajagbe *et al.* (2020) in their study with West African Dwarf goats fed nitrogen supplemented cassava peel meal. Organic matter content varied between 82.53% and 86.77%. These values are higher than 77.86 -80.53 reported by Ajagbe *et al.* (2020). Crude protein content was lower than 10.00% to16.0% reported by Yusuf *et al.* (2013*)* for their study with young WAD goats fed broiler litter waste and urea based diets. Values of crude fibre content ranged from 6.20% to 9.34%. These values were lower than 5.50% to 25,00% reported by Bello and Tsado (2013). Ether extract content was lower compared to 5.00% to 20.00% reported by Bello and Tsado (2013) for their study on Yankasa rams fed sorghum stover supplemented with graded levels of dried poultry droppings based diets. Ash content values in this study were lower than 10.50% -10.89% reported by Bello (2017) for finger millet straw supplemented with varying levels of dried poultry dropping based diets. Nitrogen free extract in this study was lower than 7.29% -14.56% reported by Ukanwoko and Ibeawuchi (2009). Variation in nutrient composition of experimental diets might be attributed to different feed ingredients, processing methods of feed ingredients, soil condition on which the feed materials used was harvested and other factors such as climatic factors of the location etc.

All the pH values recorded fell within the reported values (6.00-7.20 pH) suitable for the growth and activities of rumen microbes (Jallow and Hsia, 2011). Kamra (2005) stated that a range of 6.0- 6.9 pH can facilitate optimum growth of rumen bacteria. Among the parameters examined at the start of the experiment for volatile fatty acids, acetic acid and butyric acid were significantly ($P<0.05$) influenced by treatment diets. Values of acetic acid for diets 1,2,3 and 5 were similar but different from diets 1. The values of acetic obtained in this study were higher for diet 3. These values were lower compared to the values (52.5-68.9mol/100ml reported by Abo zeid *et al.* (2017). The values were also lower than 42.03mol/100ml- 46.65mol/100ml reported by Okoruwa *et al.* (2016). Butyric acid values were higher than 8.80-12.47mol/100ml reported by Adebayo *et al.* (2017) for their study on rumen fermentation characteristics of West African Dwarf goats fed enzyme supplemented total mixed ration in the dry season. The values were higher than 16.77mol/100ml-18mol/100ml reported by Puga *et al.* (2001) for sheep fed controlled release urea supplements. Variations in the values might be attributed to physical fibrousness, levels of starch content and carbohydrate solubility of the different dietary treatments used in different studies conducted. Aside from lactic acid, values acetic acids obtained indicate that acetic acid predominates the volatile fatty acid production followed by propionic and butyric acid. Values of pH obtained were comparable to 6.47- 6.67 reported by Puga *et al.* (2001) but higher than 5.97-6.17 reported by Oni *et al.* (2017). Lactic acid values obtained at the start of the trial were higher than 5-21mol/1ooml reported by Suarez *et al.* (2006). Values of propionic acid obtained were lower than 21.6mol/100ml -28.8mol/100ml reported by Suarez *et al* (2006) in their study on effects of different levels of roughage- concentrate dietary treatments on rumen fermentation characteristics of sheep. The difference in values obtained by different authors might be attributed to nature of the diets fed to the animals as well as the chemical composition of the test ingredients.

At the end of the study, values of pH obtained were higher than 6.22-7.01 reported by Njidda *et al.* (2016) on rumen fermentation parameters of Red Sokoto goats fed cowpea husk replacing *Daniella oliveri* leaf. The values are comparable to the normal value range of 6.0-7.0 reported by Petrovski (2017). The observed non- significant value of the volatile fatty acids examined indicated that lactic acid and acetic acid reduced across the treatments while propionic acid increased in diet1. Butyric acid values were higher at the end of the study for diet 1, 2, 4 and 5. The increased value of butyric acid might be attributed to levels of carbohydrate degradation of the cellulosic substances present in the feed. Higher values of propionic were observed in diet 3 at the start of the study than at the end of the trial.

V. CONCLUSION

Based on the results obtained in this study, supplementing the diets of grazing growing West African Dwarf goats with cassava peels and dried poultry manure has the potentials of meeting the nutritional needs of the animals without adverse effects on the rumen parameters.

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CONFLICT OF INTEREST

The authors declared that they have no conflicts of interest with the contents of this article.

REFERENCES

[1] Adebayo, K.O, Aderinboye, R.Y, Isah, O.A and Onwuka C.F. I. (2017). Rumen fermentation characteristics of West African Dwarf goats fed enzyme supplemented total mixed ration in the dry season. *Animal Research International* 14(3): 2867 – 2875.

[2] Ajagbe A.D**,** Oyewole, B.O, Aribido, S.O and Oyibo A. (2020). Nutrient Intake of West African Dwarf (WAD) Goats Fed Cassava Peels Supplemented with Nitrogen Sources. *GSC Biological and Pharmaceutical Sciences* 12(1): 189-195.

[3] Ajagbe D.A., Aribido S.O., Oyewole B.O and Egwuje C.O. (2019). Hematology and Serum Biochemistry of Growing West African Dwarf Goats Fed Cassava Peel with Supplemental Nitrogen Sources. *Agricultural Extension Journal*, 3(3).1-6.

[4] Ajagbe, A.D., Kibon, A. and Oyewole B.O (2015). Performance, Milk Yield and Composition of Grazing Sahel does Supplemented with Cottonseed cake-Maize Bran Mixture. *Nsuk Journal of Science and Technology* (NJST) 5 (2): 6-10

[5] Bello A.A. (2017). Feed Intake and Nutrient Digestibility of KonkanKanyal Goats Fed Finger Millet Straw Supplemented with Varying Levels of Dried Poultry Dropping Based Diets. *Asian Journal of Animal Science.*11(5):230-236.

[6] Bello, A.A. and. Tsado, D.N. (2013). Feed intake and nutrient digestibility of growing Yankasa rams fed sorghum stover supplemented with graded levels of dried poultry droppings based diet. *Asian Journal Animal Science* 7: 56-63

[7] FAO (2005).Food and Agricultural Organization. Annual Report, 2005.

[8] Ifatimehin, O.O. Musa, S.D. and Adeyemi, J.O. (2006). Analysis of the changing land use and its impact on the environment of Anyigba Town, Nigeria. *Journal of Sustainable Development in Africa*, 10(4): 45-50.

[9] Iji, M.E. (2007).An assessment of water demand and supply in Anyigba, Kogi State.B.Sc. Research Project submitted to the Department of Gegraphy and Planning Kogi State University,Anyigba, Nigeria.

[10] Jallow, D. B. and Hsia, L .C. (2011). Effect of six feed supplement on ruminal degradation characteristics and amino acid profile of sheep. *International Journal of Animal and Veterinary advances*, 3(5): 367-373

[11] Kamra D. N. (2005). Rumen, Rumen bacteria, Protozoa, Buffaloes, Sheep, Tannins,Goats, Anaerobic bacteria. *Current Science Association* 89, No. 1

[12] Mohammed R. and Chaundry A.S., (2008) Methods to study Degradation of Ruminant Feeds Nutrition, *Res Rev*, 21, 68-81.

[13] Njidda A.A., Alabi O.J. and Olafadehan O.A., (2016).Rumen and Energy Utilization of Red Sokoto Goats fed Cowpea Husk substituting *Daniella Oliverri* Foliage, *Journal of Animal Production and Resources* 28(1), 205-214

[14] Okoruwa, M.I., Bamigboye F. O. and Agbadu, A. (2016) Rumen metabolites and thermo- physiological response of West African dwarf sheep as influenced by ficus foliage with differently processed breadfruit meals. *Global Journal of Agricultural Research* Vol.4, No.5, pp.28-38.

[15] Oni, A.O., Oluwayemisi, A., Adebayo, K.,Sowande, O.S., Ipo su, S., and Onwuka, C.F.I.(2017).

[16] Effects of supplementing cassava peels with cassava leaves and cowpea haulms on therumen environment and blood profile parameters of West African dwarf goats Archivos de Zootecnia, vol. 66, núm. 255, pp. 397-404.

[17] Petrovski K.R (2017). Assessment of the rumen fluid of a bovine patient. *Journal of dairy & veterinary sciences* 2(3) 1-7

[18] Puga, D.C. Galina, H.M. PerezGil R.F Sangine G.L Aguilera., B.A.,Haenlein G.F.W.(2001).Effect of a controlled-release urea supplement on rumenfermentation in sheep fed a diet of sugar cane tops(Saccharum ofÆcinarum), corn stubble (Zea mays) and King grass (Pennisetum purpureum). *Small Ruminant Research* 39: 269±276.

[19] Suárez, B., Van Reenen, C.G., Gerrits, W.J.J., Stockhofe, N., Van Vuuren, A.M. and Dijkstra,J.(2006).Effects of supplementing concentrates differi ng in carbohydrate compos ition in veal calf diets: II. Rumen development. *Journal of Dairy Science.* 89:4376-4386.

[20] Ukanwoko, A.I., And Ibeawuchi, J. A. (2009) Nutrient intake digestibility of West African Dwarf bucks fed poultry waste – cassava peels based diets. *Pakistan Journal of Nutrition*, 8(9) :1461 – 1464.

[21] Wanapat M, Khampa S. (2007). Effect of levels of supplementation of Concentrate containing high levels of cassava chip on rumen ecology, microbial N supply and digestibility of nutrients in beef cattle. *Asian-Australian Journal of Animal Science* 20: 81.

[22] Yusuf, A.O., Ekunseitan, D.A., Bawala, T.O., Ayoola, A.A And Ogunnowo, A.E. (2013). Impact of broiler litter waste and urea based diets on performance of young West African Dwarf goats. *The Pacific Journal of Sceince and Technology* 14(2) 425-432.

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Global Carbon di Oxide Emissions in Hamilton Filter Model

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Abstract*— *The paper examined the cyclical trends, seasonal variation and seasonal adjustment of global CO_2 emission from 1970 to 2018 through the application of Hamilton regression filter model. ARIMA (4,0,0) forecasting model for 2030 has been added with the Hamilton filter model and observed that the new model is stable, stationary and significant in which volatility is being minimised and the heteroscedasticity problem is totally disappeared.

Keywords*— *CO_2 emission, Hamilton filter, seasonal adjustment, cyclical trend, ARIMA forecasting.

JEL Classification codes-C13,C22,C50,O13,O40,Q54

I. INTRODUCTION

A series contains both the cyclical and seasonal behaviours. A seasonal behaviour is very strictly regular, meaning there is a precise amount of time between the peaks and troughs of the data. Cyclical behaviour on the other hand can drift over time because the time between periods isn't precise. A series with strong seasonality will show clear peaks in the partial auto-correlation function as well as the auto-correlation function, whereas a cyclical series will only have the strong peaks in the auto-correlation function. Patterns of peaks and troughs occur in both cyclical and seasonal analysis wherein seasonal trends the period between successive peaks (or troughs) is constant. But in cyclical trends the distance between successive peaks is irregular.

The decomposition of macroeconomic time series with trend and cyclical components is crucial to many macroeconomic concepts such as potential output, natural interest rate, share prices and inflation rate and so on. Econometric analysis requires filtering techniques which cater data sequences having short and strong trends. Filter can be used to decompose a time series into trend, seasonal and irregular components.

H.P.Filter (1997) has been used as a low pass smoothing filter in a numerous macroeconomic investigation setting smoothing parameter to certain arbitrary conventional values. It can decompose trend and cycles of the time series data to produce new time series such as potential GDP and output gap that are useful in macroeconomic discussion and in some recent public debate. It also used ARMA forecasting technique that deliver the required forecasted values that are needed in H.P. algorithm. The cyclical component obtained by H.P.Filter is unpredictable which indicates that we cannot do any investigation into the cyclical component because they are independent.

Many business cycles analysis, volatility of stock price indices and unemployment trends and cyclical patterns have been being studied through Baxter and King (1999) and Christiano and Fitzgerald (2003) models of decomposition of trends and cycles through filter till now.

Therefore, the author endeavours to examine the patterns of trends and seasonal and cyclical fluctuations of global CO_2 emission during 1970-2018 by applying the methodology of Hamilton Filter model(2018).The paper also finds the projected rise of global CO_2 emission in 2050 and examined the forecasting ARIMA(p,d,q) model incorporating in the Hamilton regression filter model up to 2030.

II. SOME IMPORTANT STUDIES

Bhowmik(2018) studied that global CO_2 emission has been rising at the rate of 2.19% per year and global per capita CO_2 emission has been catapulting at the rate of 0.58% per annum during 1960-2015.Global CO_2 emission contains four upward structural breaks in 1968,1976,1988 and 2004 and per capita emission has two upward structural breaks in 1969 and 2004 respectively. World CO_2 emission is positively related with global GDP and GDP per capita significantly during the specified period.There is no cointegration between world GDP and world CO_2 emission during 1960-2015.

Hamilton filter (2018) claims that H.P.Filter (1997) creates spurious dynamic relation, fails to eliminate spurious predictability,produces values for the smoothing parameter vastly at odds with common practice. It is not also a sensible approach for a random walk. Therefore, author uses regression variable at date t+h on the four most recent values as of date t which is a better alternative to detrend and to extract cyclical components. Hamilton also assumes random walk, then cyclical component is estimated as $y_{t+h} - y_t$ which is predictable and perform much better than the H.P.Filter model.

Ciais et al.(2018) examined that since the beginning of the Industrial Era, fossil fuel extraction from geological reservoirs, and their combustion, has resulted in the transfer of significant amount of fossil carbon from the slow domain into the fast domain, thus causing an unprecedented, major human-induced perturbation in the carbon cycle during 2000-2009 which was observed a major change over preindustrial period. Emission of carbon from fossil fuel reserves, and additionally from land use change is now rapidly increasing atmospheric CO_2 content.

Schuler (2018) applied Hamilton filter in the credit to GDP gap in USA taking data of GDP from Fred during 1947Q1-2017Q1 and data of credit GDP ratio from BIS during 1952Q1-2016Q4 which produced more robust cycle estimates than H.P. filter.

Bhowmik(2020) examined the growth rate of GDP in India during 2011Q4 -2019Q4 using quarterly data in explaining the trend,seasonal patterns and cycles in context of Hamilton regression filter model.The paper concludes that the TRAMO/SEATS of Hamilton filter produce clear seasonal variation showing v shaped volatility and cycles confirmed two peaks. ACF and PACF of Hamilton residual series verified the nature of seasonality. Residuals suffer from heteroscedasticity. ARIMA(1,0,0) process of Hamilton filter for forecasting 2030 converges to stable and stationary processes.

Even,Hodrick(2020) applied ARIMA model in Hamilton regression filter in decomposing cyclical components of US GDP during 1947Q1-2019Q1 using simulation technique and found that coefficient of AR(1) is greater than one and coefficients of AR(2) and MA(1)and MA(2) are less than one and the estimated equation is significant.

Oliver and Peter(2020) stated that global co_2 emission has increased by 1.6% per year during 1970-2003 which accelerated to 3.2% per year during 2003-2011 using the data set of EDGAR V4.2FT2010.

EDGAR(2020) stated that 2015 was the hottest year among the 16th warmest year during 1998-2015 but there was a structural break since annual growth rate of co_2 from 2012-2015 decreased especially in China, USA, EU, Canada and there was increased decoupling of CO_2 emission and GDP.

Lindsey(2020) reported that during 1750-2019,the atmospheric concentration of CO_2 in ppm has been steadily increasing but the CO_2 emission has been catapulting along with small cycles.Author mentioned that CO_2 concentration was never exceeded over 300ppm until preindustrial revolution, but in 1958 it reached to 315 and in 2015 it accelerated to 400ppm.If global energy demand continues to grow,the CO_2 emission is projected to exceed 900ppm by this century(2100).

III. METHODOLOGY AND SOURCE OF DATA

Semi-log regression model is applied to find linear trend which is given by,

$\text{Log}(x_i)=a+bt+u_i$

Where x_i= variable to be estimated, a and b are constant,t =time,u_i=random error and i=1,2,……..n.

Then Cochrane and Orcutt(1949) model was applied to find the projection of global CO_2 emission for 2030.

Hamilton (2018) regression filter model has been calculated in the following manner to find the decomposition of cyclical trends, cycles and seasonal variations.

$y_{t+8}=\alpha_0+\alpha_1 y_t+\alpha_2 y_{t-1+}\alpha_3 y_{t-2}+\alpha_4 y_{t-3}+v_{t+8}$

Or, $v_{t+8=}y_{t+8}+\acute{\alpha}_0+\acute{\alpha}_1 y_t+\acute{\alpha}_2 y_{t-1}+\acute{\alpha}_3 y_{t-2}+\acute{\alpha}_4 y_{t-3}$

So, $y_t=\alpha_0+ \alpha_1 y_{t-8}+\alpha_2 y_{t-9+}\alpha_3 y_{t-10}+\alpha_4 y_{t-11}+v_t$

Therefore,$v_t= y_t-(\acute{\alpha}_0+\acute{\alpha}_1 y_{t-8}+\acute{\alpha}_2 y_{t-9}+\acute{\alpha}_3 y_{t-10}+\acute{\alpha}_4 y_{t-11})$ where $\acute{\alpha}_i$ are estimated and y is the variable to be estimated.

$v_{t+h}=y_{t+h} -y_t$ is the difference i.e. how the series changes over h periods. For h=8, the filter $1-L^h$ wipes out any cycle with frequencies exactly one year and thus taking out both long run trend as well as any strictly seasonal components.

It also applies random walk: $y_t=y_{t-1}-\varepsilon_t$ where d=1 and $\omega_t^h=\varepsilon_{t+h}+\varepsilon_{t+h-1}+\ldots\ldots\ldots\ldots+\varepsilon_{t+1}$

Regression filter reduces to a difference filter when applied to a random walk. Hamilton suggested h=8 for business cycles and h=20 for studies in financial cycles. Regression v_t converges in large samples to $\alpha_1=1$ and all other α_j =0.Thus, the forecast error is $v_{t+h}=y_{t+h} -y_t$.

The equation v_t can be decomposed into trend, cycle and seasonally adjusted through SEATS/TRAMO or STL or census X-13 packages. The Box and Jenkins(1976) model The forecasting of ARIMA(p,d,q) has been applied in the Hamilton regression filter model for prediction in 2030.

of ARIMA(p,d,q) can be estimated as below.

$v_t=\alpha+\beta_{0i}v_{t-i}+\varepsilon_t+\beta_i\varepsilon_{t-i}+\grave{e}_t$

where v_t=Hamilton regression filter residual, α is constant, β_{0i} and$\beta_i$are the coefficients of AR and MA. AR terms and MA terms are $V_{t-i}$and ε_{t-i}respectively where i=1,2…….n ,and$\grave{e}_t$= random error/residuals. For convergence criteria, β_{0i} and$\beta_i$should be less than one and the values of AR and MA roots must be less than one for stability and stationary condition.

Data of global CO_2 emission in Giga Ton from 1970 to 2018 were collected from the World Bank.

IV. OBSERVATIONS FROM THE MODELS

Global CO_2 emission has been catapulting at the rate of 1.74% per annum significantly during 1970-2018 which is estimated by the trend line given below.

$Log(x_1)=2.741+0.0174t+u_i$

(43.94)*(9.90)*

R^2=0.99,DW=1.31,AIC=-235.31,SC=-231.56,x_1=global CO_2 emission in giga ton,*=significant at 5% level.,u_i=residual.

In 2018,the global CO_2 emission was 36.10gigaton which is projected to rise 63.503Gigaton in 2050 which is depicted in Figure 1 below.

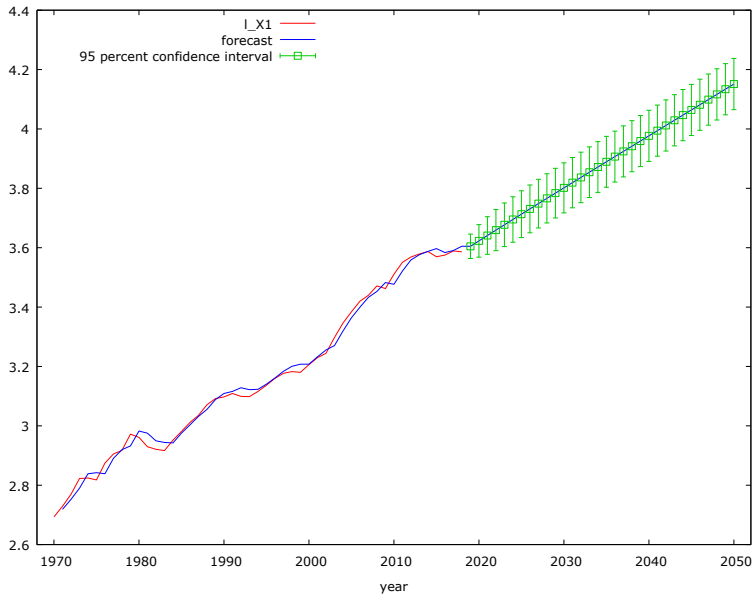


Fig.1: Global CO_2 emission projection

Source: Plotted by author

Actually, the global CO_2 emission fulfils the quadratic function properties which indicated that the trend line is non-linear and the estimated equation is given below.

$Log(x_1)=2.748+0.013t+0.000105t^2+u_i$

(159.11)* (8.31)* (3.41)*

R^2=0.98,F=1129.95*,DW=0.314,*=significant at 5% level, u_i=residual.

This non-linear trend is significant at 5% level having autocorrelation problem.

The global CO_2 emission has the property of having five structural breaks in its path from 1970 to 2018 in 1977,1987,1996,2003 and 2010 all of which are significant at 5% level and all showed upward rising. It is depicted in Figure 2 below.

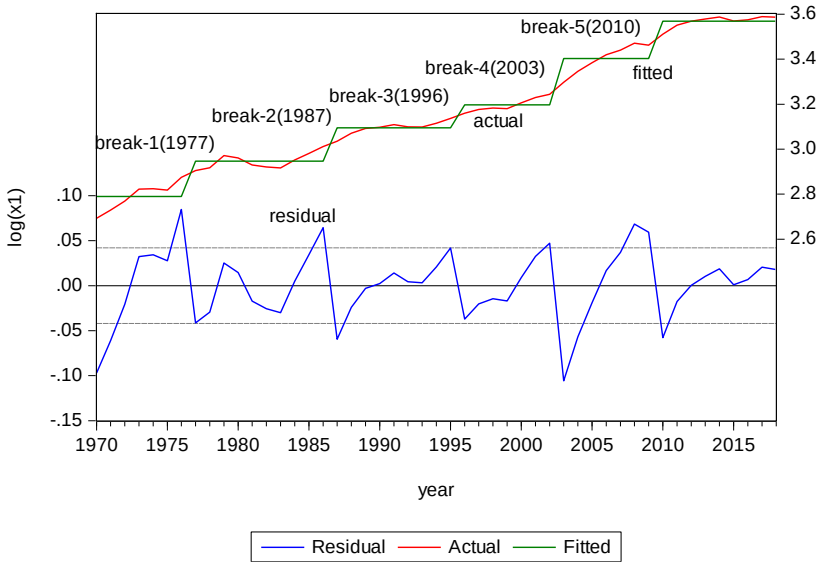


Fig.2: Structural breaks of global CO_2 emission

Source: Plotted by author

Hamilton regression filter model of global CO_2 emission during 1970-2018 is estimated below where the adjusted sample has fallen during 1981-2018 where total observations are 38 after adjustment.

$Log(x_1)_t$=-0.2489+0.6954$log(x_1)_{t-8}$+0.2872$log(x_1)_{t-9}$

(-1.59) (1.50) (0.38)

-0.5741$log(x_1)_{t-10}$+0.7263$log(x_1)_{t-11}$+v_t

(-0.72) (1.48)

R^2=0.94,F=129.50*,DW=0.283,AIC=-2.71,SC=-2.49

The Hamilton regression filter is found as a good fit with high R^2 and significant F values with low AIC and SC respectively and all the coefficients are less than one.The residual v_t is calculated as

$v_t=log(x_1)$ –[-0.2489+0.6954$log(x_1)_{t-8}$+0.2872$log(x_1)_{t-9}$-0.5741$log(x_1)_{t-10}$+0.7263$log(x_1)_{t-11}$]

This equation can be treated as Hamilton filter model of global CO_2 emission.

The estimated Hamilton regression filter equation is plotted in Figure 3 where fitted and actual lines are shown as upward rising and the residual consists of 7 peaks and troughs respectively whose cyclical trend is diverging away from equilibrium with rising volatility.

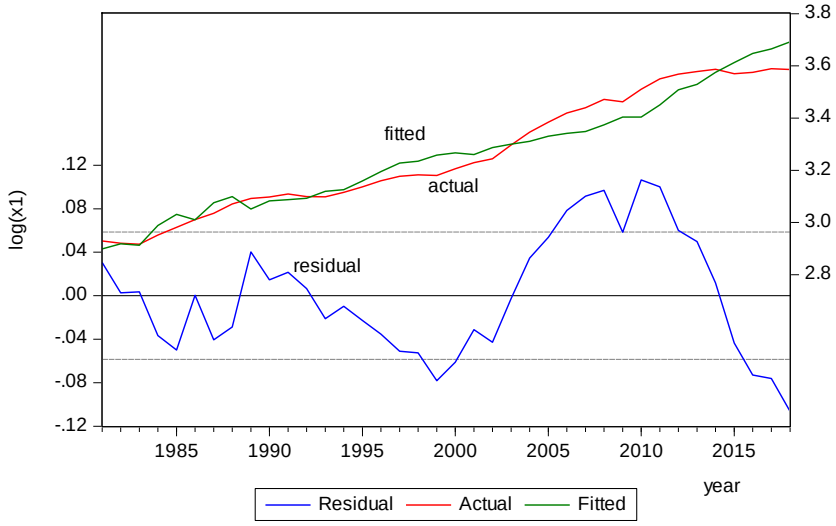


Fig.3: Hamilton regression filter

Source-Plotted by author

Hamilton filter residual of global CO_2 emission during 1970-2018 has been decomposed into trend, cycle, seasonal variation, remainder, seasonally adjusted cycle respectively in a panel of diagrams in Figure 4 below. In panel1,the Hamilton filter residual is shown as a cyclical pattern having seven peaks and troughs. In panel 2,the smooth cyclical trend is plotted which minimises cycles showing two peaks and troughs where amplitude is widening. In panel 3,the seasonal variation is shown where its patterns are v shaped. In panel 4,the remainder is presented which is fluctuating and in panel 5,the seasonally adjusted cycle is visible which looks as like as residual line.

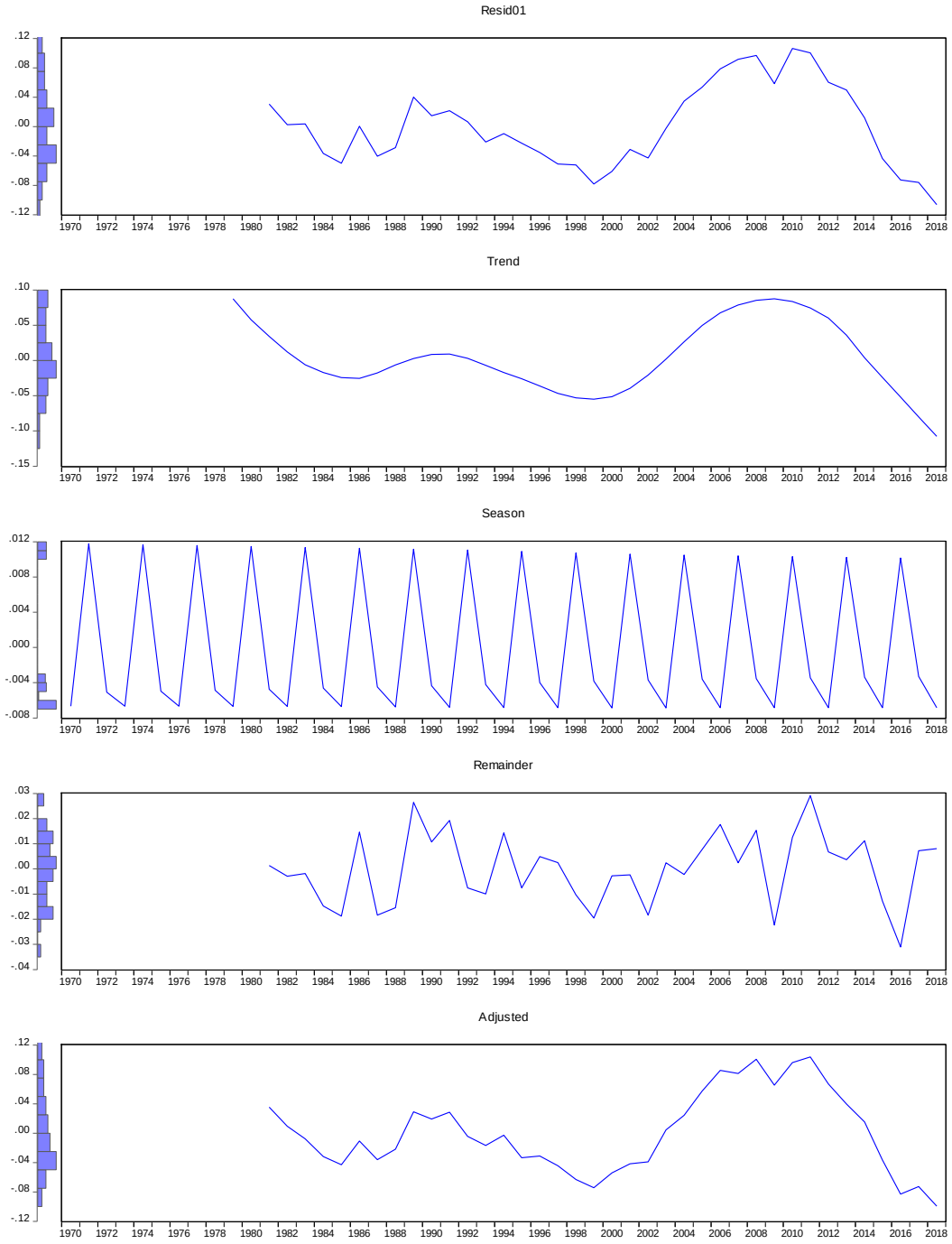


Fig.4: Decomposition of Hamilton regression filter of global CO_2

Source-Plotted by author

In the Figure 5, the Hamilton filter of global CO_2 emission, its cycle, trend and seasonal adjustment is plotted in the composite figure. The Hamilton filter trend line exemplified with two peaks and troughs which are diverging with bigger

amplitude. There is no wide difference between seasonally adjusted and the actual residual of the filter of global CO_2, although both of which are cyclical with upswings and downswing phases.

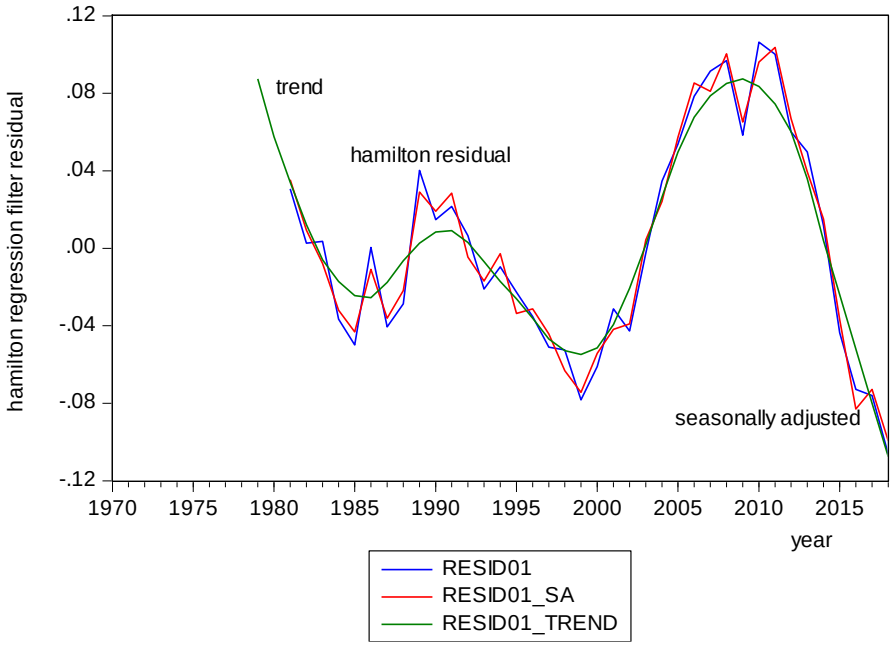
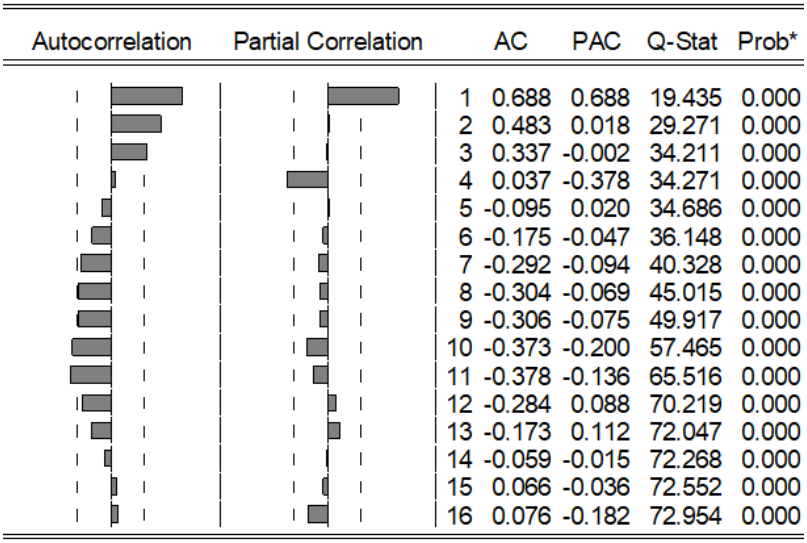


Fig.5: Cycle, trend and seasonal adjustment

Source-Plotted by author

The seasonal fluctuation can be confirmed by the application of finding auto correlation functions and partial autocorrelation functions of the Hamilton regression filter residual series of the global CO_2 emission from 1970 to 2018.The ACF have been declining up to lag 4 and then it reached negative which are increasing up to lag 11and started to diminish up to lag 14 and then it moved up towards positive values from lag 15.Similarly PACF declined up to lag 2 and then turned to negative up to lag 4 and from lag 6 the negative values increased up to lag 10 and reached positive values up to lag 13 and then fell negative. The patterns of ACF and PACF indicate that the seasonal fluctuation of global CO_2 emission is confirmed since the probabilities of Q stat are significant. In Figure 6,it proves clearly.



	AC	PAC	Q-Stat	Prob*
1	0.688	0.688	19.435	0.000
2	0.483	0.018	29.271	0.000
3	0.337	-0.002	34.211	0.000
4	0.037	-0.378	34.271	0.000
5	-0.095	0.020	34.686	0.000
6	-0.175	-0.047	36.148	0.000
7	-0.292	-0.094	40.328	0.000
8	-0.304	-0.069	45.015	0.000
9	-0.306	-0.075	49.917	0.000
10	-0.373	-0.200	57.465	0.000
11	-0.378	-0.136	65.516	0.000
12	-0.284	0.088	70.219	0.000
13	-0.173	0.112	72.047	0.000
14	-0.059	-0.015	72.268	0.000
15	0.066	-0.036	72.552	0.000
16	0.076	-0.182	72.954	0.000

Fig.6: AC and PAC of Hamilton filter residual

Source-Plotted and calculated by author

Among the best 20 models of automatic forecasting of Autoregressive Integrated Moving Average of Hamilton regression filter models of global CO_2 emission,the ARIMA(4,0,0) model is selected for forecasting for

2030.By applying ARMA maximum likelihood method after adjusting sample during 1981-2018,the estimated equation is observed as below.

$v_t=0.00221+0.8635v_{t-1}+0.0452v_{t-2}+0.4387v_{t-3}$

(0.127) (4.98)* (0.18) (2.17)*

$-0.6406v_{t-4}+0.000453\sigma^2_t$

(-4.85)* (4.11)*

$R^2=0.84$,F=35.65*,DW=2.084,AIC=-4.44,SC=-4.18,AR roots=0.89±0.32i,MA roots=-0.46±0.70i

The ARIMA(4,0,0) forecasting model of Hamilton residual is highly significant showing minimum volatility where the coefficient of σ^2 is minimum and significant along with other three coefficients.Even,R^2 is high,F is significant,AIC is minimum and the roots of AR and MA are less than one which revealed that the both AR and MA processes are convergent,stable and stationary.

In Figure 7,the forecast ARIMA(4,0,0) is depicted neatly where the forecast value for 2030 is (0.044088) in comparison with the value of (-0.0950) at 2018 and forecast line is moving upward up to 2027 and then it is declining although its amplitudes were increasing up till 2010.

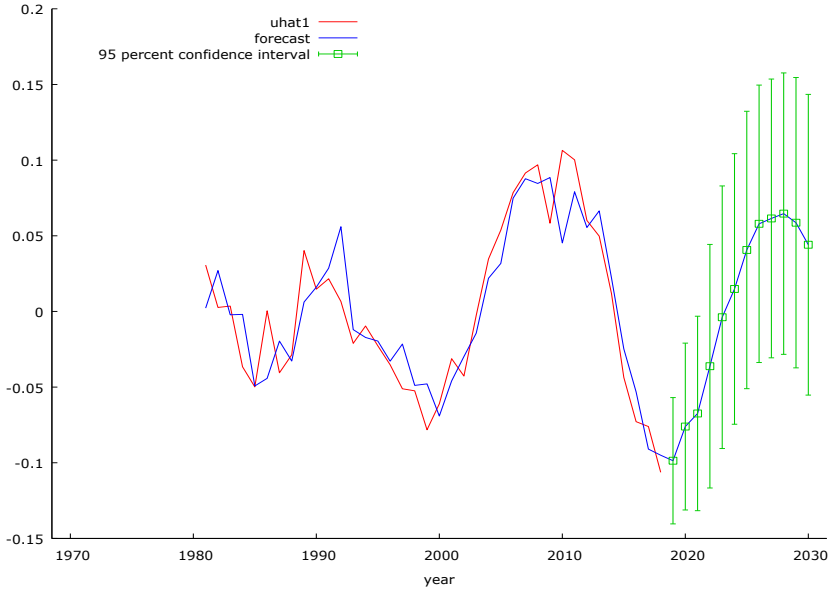


Fig.7: ARIMA forecast in Hamilton filter model

Source- Plotted by author

The heteroscedasticity test for residual of ARIMA(4,0,0) by applying ARCH(4) revealed that $nR^2=3.0166$ because $n=34,R^2=0.088872$ which is accepted by Chi-square(4) test whose probability is found as 0.55 (where F=0.7058 whose probability is 0.59) after adjusting the sample during 1985-2018 which implied that no heteroscedasticity is accepted at null hypothesis.

V. LIMITATIONS AND SCOPE FOR FUTURE STUDIES

The paper did not compare the observations of decompositions of Hamilton regression filter model with the Hodrick-Prescott Filter model.If the quarterly or monthly data of co_2 emission were taken then the observations from Hamilton filter will be more perfect and analytic. The details of autocorrelation and partial autocorrelation functions are not shown step by step of all lags.Application of Hamilton filter through ARIMA(p,d,q) forecast model may produce many debates. The clarifications of explaining amplitudes were not included in this analysis.Even,the explanation of volatility through appropriate GARCH model is also absent here.Therefore,there is enough scope of future research in the context of this paper.

VI. MODEL DEMANDS POLICIES

Based on Business as Usual trend,global CO_2 emission is projected to increase some 43.08 billion metric ton in 2050 in comparison to 35.3 billion metric ton in 2018.By 2100,CO_2 concentration will reach between 540-970ppm as compared to 368ppm in 2000.(https://www.acer-acre.ca/resources/climate-change-in-context/introduction-

2/global/scientific-projections/projections-for-carbon-dioxide).By 2100,cumulative global CO_2 emission will exceed 1 trillion tons of carbons (3.67 trillion of CO_2) threshold which according to IPCC will raise the earth's surface temperature to 2°C above the pre-industrial minimum and trigger dangerous interference. (http://euanmearns.com/global-co2-emissions-forecast-to-2100/).

Paris Climate Agreement targets to limit temperature rise with in 1.5°C that might increase global GDP by 60-65% by 2030.The agreement claims to reduce CO_2 emission by 20% along with 20% increase in renewable energy and energy efficiency respectively. As a whole, GHG emissions intensity must be reduced by 33-35% below 2005 level within 2030. So, to limit global temperature rise to 1.5°C,emissions must be below 25gigatons by 2030.As on 2020,February,194 states with EU agreed the Paris Agreement where 188 countries plus EU represent more than 87% of GHGs. China had committed to cut GHGs by 26-28% by 2025 and USA assured to cut through Clear Power Plan. India is also committed to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 levels. India's emission intensity has reduced by 21% over the period 2005-2014. By 2030, India's emission intensity is projected to be even lower—in the range of 35 to 50 percent. (https://www.nrdc.org/experts/anjali-jaiswal/road-paris-indias-advancement-its-climate-pled).

VII. CONCLUSIONS

The paper concludes that the global CO_2 emission has been catapulting at the rate of 1.74% per annum significantly during 1970-2018 and its projected value of 2050 is 63.503gigaton in comparison to 36.10 gigaton in 2018.Hamilton regression filter showed that global CO_2 is cyclical in patterns having 7 peaks and troughs but the smooth cyclical trend consists of two distinct peaks and troughs which are widening in the amplitude and the seasonal variation is v shaped when it is decomposed by STL method. The seasonal variation is confirmed by the patterns of ACF and PACF whose Q stat are significant at 5% level. Automatic forecasting ARIMA(4,0,0) model for 2030 is incorporated with Hamilton filter and the result is appeared as convergent, stable and stationary with minimum volatility. This model is free from heteroscedasticity problem.

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REFERENCES

[1] Baxter, M., & King, R. G. (1999). Measuring business cycles: Approximate band-pass filters for economic Time Series. Review of Economics and Statistics,81(4),575-593. https://EconPapers.repec.org/RePEc:tpr:restat:v:81:y:1999:i:4:p:575-593.

[2] Bhowmik,Debesh.(2018). Linkage between global CO2 emission and world GDP.In Doifode,Shamal.K & Matani,Ashoke G.(Eds.),Renewable Energy Sources & Environment Protection(pp 93-120),Delhi:International Research Publication House.

[3] Bhowmik,Debesh.(2020). Cyclical and seasonal patterns of India's GDP growth rate through the eyes of Hamilton and Hodrick-Prescott Filter models.(In Press).

[4] Box, George.,& Jenkins,Gwilym.(1976).Time Series Analysis, Forecasting,and Control. San Francisco: Holden Day.Retrieved from http://garfield.library.upenn.edu/classics1989/A1989AV48500001.pdf.

[5]Christiano, L.J., & Fitzgerald, T. J. (2003). The band pass filter. International Economic Review,44(2),435-465. https://EconPapers.repec.org/RePEc:ier:iecrev:v:44:y:2003:i:2:p:435-465

[6]Ciais, Philippe et al.(2018).Carbon and other Biogeochemical Cycles. In Chapter 06 of WG1ARS of IPCC (pp.465-570). https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter06_FINAL.pdf

[7]Cochrane,D.,& Orcutt,G.H.(1949).Application of Least Squares Regression to Relationships Containing Auto-Correlated Error Terms.Journal of the American Statistical Association,44(245),32-61.Retrieved from https://doi.org/10.1080/01621459.1949.10483290

[8]EDGAR.(2020).Trends in Global CO2 emissions:2016Report.Retrieved from https://edgar.jrc.ec.europa.eu/news_docs/jrc-2016-trends-in-global-co2-emissions-2016-report-103425.pdf

[9]Hamilton, J. D. (2018). Why you should never use the Hodrick-Prescott Filter. Review of Economics and Statistics,100(5),831-843. Retrieved from https://econweb.ucsd.edu/~jhamilto/hp.pdf.

[10]Hodrick, R.J., & Prescott, E.C.(1997,February).Post-war US Business Cycles :An Empirical Investigation. Journal of Money, Credit and Banking,29(1),1-16.Retrieved from https://www0.gsb.columbia.edu/faculty/rhodrick/prescott-hodrick1997.pdf.

[11]Hodrick,R.J.(2020,February).An explanation of trend-cycle decomposition methodologies in simulated data. (NBER Working Paper 26750).Retrieved from http:www.nber.org/paper/w26750.pdf

[12]Lindsey, Rebecca. (2020, August 14). Climate Change: Atmospheric Carbon Dioxide. Retrieved from https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

[13]Oliver,J.G.J.,&Peter,J.A.H.W.(2020,May).Trends in Global CO2 and Total Green House Gas Emission:2019 Report.PBL Netherland Environmental Assessment Agency. Retrieved from https://www.pbl.nl/sites/default/files/downloads/pbl-2020-trends-in-global-co2-and-total-greenhouse-gas-emissions-2019-report_4068.pdf

[14]Schuler, Y.S. (2018).On the Cyclical properties of Hamilton's regression filter. Discussion Paper-03,Deutsche Bundesbank.Retrieved from https://ideas.repec.org/p/zbw/bubdps/032018.html

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Using the Kostiakov – Lewis Infiltration function to evaluate a furrow irrigated field at Mhlume, a region in the north-eastern Lowveld of Eswatini (Southern Africa)

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Abstract— *The Eswatini sugar industry grows fully irrigated sugarcane on 57 420 hectares of land producing 6 197 753 tonnes of cane and 871 301 tonnes of sucrose annually (ESA-Integrated Report, 2019). Poor and inefficient furrow irrigation is still practiced by many growers in particular the poor small holder farmers in the industry. The two treatments were; in-row irrigated furrows and interrow irrigated furrows. A total of ten advance-recession measures were conducted, five were conducted on each treatment. The furrows were of length of 240 m and gradient along the furrows was 1:250. Two Washington State flumes were used to measure flow. One was used to measure inlow at the beginning of the furrow, and another one was used to measure runoff (outflow) at the end of the fourrow. The time water was allowed into the furrow was recorded. Other measurements included the time water reached the furrow end, the time to the middle of the furrow, the wetted perimeter at each point, the depth of flow and the top width of the water level. These measurements were required for the calculation of the Kostiakov exponent "a" and the coefficient "k".*

The results showed that the distribution uniformity (84%), application efficiency (88%) and deep percolation ratio (11%) were better in interrow irrigation than in in-row irrigation. However, runoff was higher with interrow irrigation at 6% compared to 2% with in-row irrigation.

Keywords— ***Evaluation, infiltration, application efficiency, deep percolation, run-off, Kostiakov-Lewis function.***

I. INTRODUCTION

Furrow irrigation is probably the oldest and most widely used method for applying irrigation water to many field crops and vegetables worldwide (Walker and Skogerboe, 1989; Nie et al., 2018). At Mhlume the irrigation of sugarcane using furrow irrigation covers 6 072 hectares which is 66% of the area under sugarcane. This method uses the furrow for the control of water after it leaves the head – ditch or step-canal. On land that has not been properly leveled or graded relatively smaller streams of water should be used in the furrow to prevent erosion and loss of water by runoff at the end of the rows. Where the land has been leveled and well prepared, larger streams can be used without fear of erosion or loss of water at the end of rows. Balancing the inflow, the application uniformity, deep percolation losses and tailwater runoff are the many challenges of using furrow irrigation to most farmers.

Measured furrow flow rates at Mhlume ranged from 1.0 litres per second to a maximum of 7.0 litres per second depending on the method of head control, soil type and furrow length. Under certain conditions of tillage where the water flow velocity in the furrow is retarded by cloddiness or vegetation (trash, weeds etc.), larger amounts of water per furrow can be used without damage to the crop or causing excessive erosion in the furrow.

If the individual furrow streams are too small, too much time will be required for the advancing water front to reach the end of the furrow and the soil near the head ditch or stepcanal (to approximately 50% of the furrow length) will be over – irrigated before the lower end has been wetted

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sufficiently. In furrow irrigation, the most important criteria therefore are to adequately select furrow irrigation variables (furrow length, time of cut-off, and discharge), improve irrigation scheduling, and improve water management of the field which will also potentially reduce over-irrigation and deep percolation of applied water (Holzapfel et al., 2010).

The factors that affect the performance of an irrigation method are; rate of infiltration of water into the soil; inflow rate of the water; slope of the field; time of irrigation; time of recession of water from the soil surface; soil moisture prior to irrigation; spatial variability of the soil; climatic conditions; and furrow shape (Walker, 2003; Walker and Skogerboe, 1987 ; Hsiao et al., 2007)..

The field evaluation of a surface irrigation system helped to identify modifications that enhanced the hydraulic performance. Besides the easily identified problems of applying too much or too little water onto the soil, the distribution of infiltrated water over the field may vary considerably, tail water runoff may be excessive, or significant deep percolation losses may occur. Solutions to these problems are numerous. In fact, the optimal solution is usually a combination of several remedies (Walker, 2003). When discussing changes in discharge, time of cut off, slope and length of run, any alteration in one of these parameters will affect one, or more of the other parameters. Methods of evaluation differ depending on the available resources and the experience of the researcher.

The Kostiakov – Lewis equation below is one of the simplest used for furrow evaluation (Walker and Skoggerboe (1987), (Xanthoulis and Wallender (1991); Childs et al., (1993)).

$$Z = k\,T^{a} + f_o\,T \qquad (1)$$

where;

Z = infiltrated volume per unit length (m^3/m),

T = opportunity time (min),

a = Kostiakov exponent,

k = Kostiakov coefficient and

f_o = the steady or basic infiltration rate ($m^3/m/min$).

The advantage of the Kostiakov – Lewis function is that it makes use of the volume balance approach, meaning that all the parameters are measured in the field and secondly predictions could be made as to the effect of changing some of the parameters on the performance of irrigation.

II. MATERIALS AND METHODS

A total of ten advance-recession measurements were conducted, five were on in-row irrigated furrows and the other five were on interrow irrigated furrows. Furrows were parabolic in shape with a standard spacing of 1.5 m. The gradient along the furrow was 1:250. Each furrow had an approximate top width ranging from 0.6 m – 0.8 m and a water flow depth of 0.08 m to 0.15 m. The soils were relatively of moderate infiltration.

The advance – recession set up consisted of two Washington State flumes (WSC), one placed five metres from the stepcanal used for measuring inflow and the other placed at the end of the furrow, used for measuring runoff (outflow). Water was introduced into the furrows and the advance distances and time of reaching each stake were measured (Issaka et al., 2015; Walker, 2003). It was essential to ensure that inflow did not vary with time. The type of field selected for the measurement was one with a neyrpic gate and a stepcaral that is fitted with duckbill weirs.

Wooden stacks were placed 30 m apart (figure 1) along the entire furrow. The time water was allowed into the furrow was noted. The movement of the advance was noted by recording the time water arrive at each woodstack (station). This was done until the water had reached 80% of the furrow length as per estate practice before cutting – off the inflow from the stepcanal. Recession (time) was taken as the time when the tail of water passed a woodstack. A degree of subjective judgement is required for recession, but errors are small in magnitude when compared to the contact time.

Other measurements included the time water reached the furrow end T_L, the time to the middle of the furrow $T_{1/2L}$, the wetted perimeter at each point (wp), the depth of flow (y) and the top width of the water level (T) at each station along the furrow. These measurements were required for the calculation of the Kostiakov exponent "a" and the coefficient *"k"* as described by Walker and Skoggerboe (1987).

The steady or basic infiltration rate f_o was measured on another set of furrows by using the inflow –outflow method. Figure 1 below shows the position of the measuring points in relation to the stepcaral.

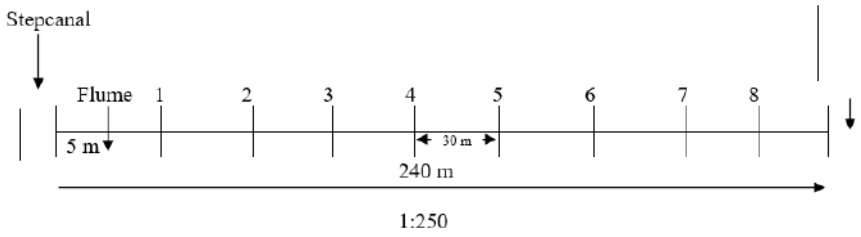

Fig.1: Schematic diagram showing the position of the WSC flume and measuring points along the furrow.

III. RESULTS AND DISCUSSION

The field measurement techniques provided the means for defining the following six important elements in the evaluation; the inflow discharge, the advance and recession of the water over the field surface, the tail water discharge, the soil moisture after the irrigation, the volume of water on the soil surface at various times, and an indication of the subsurface infiltration characteristics of water on the soil.

Inflow-outflow hydrographs

Figure 2 and figure 3 show the inflow – runoff hydrograph for the inter-row irrigation event and the in-row irrigation events respectively. The area under each graph gives the total volume of water applied and the total volume of runoff. The volume of water applied in the in-row situation was 37.6 m^3 compared to 24.2 m^3 in the inter-row event which was 55% higher. The total volume which occurred as runoff was however, higher in the inter-row situation 5.5% than in the in-row situation which was 2.3%.

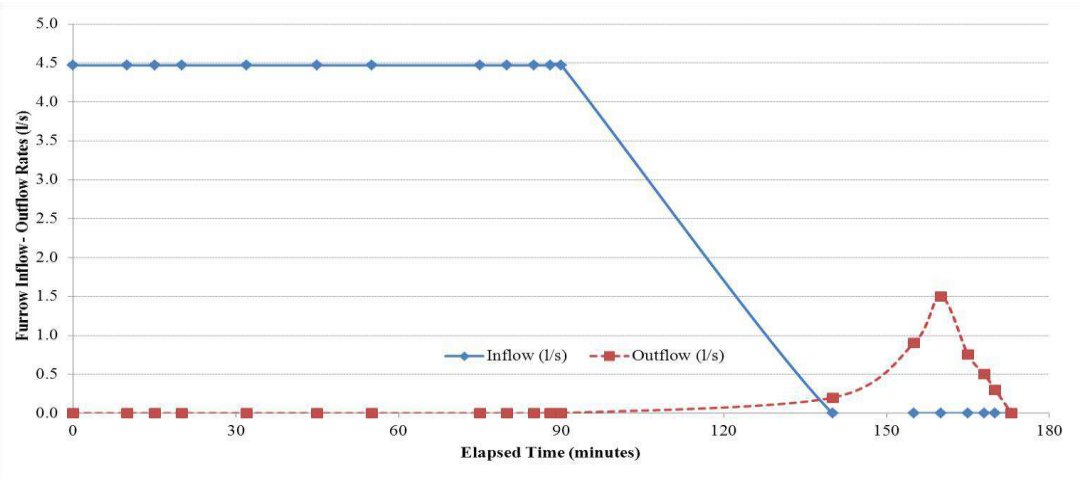

Fig.2: The graph showing the inflow-runoff hydrograph for the inter-row irrigation events.

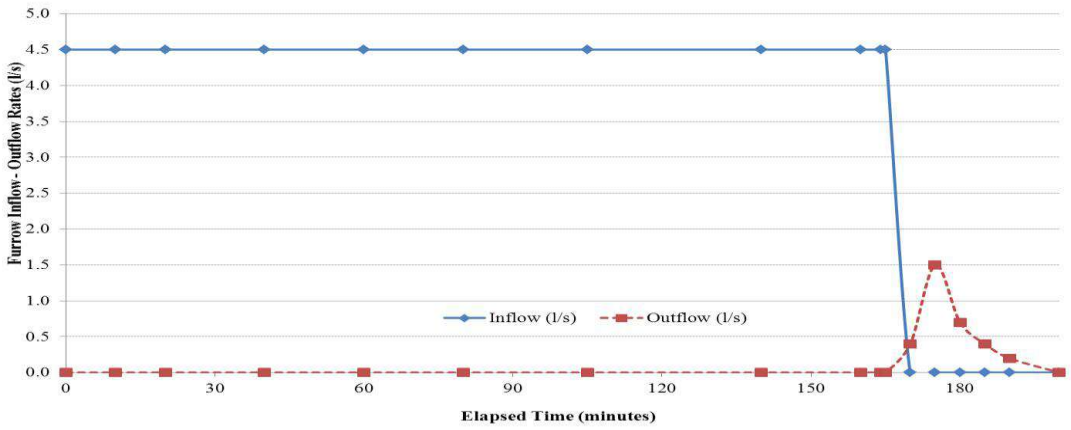

Fig.3: The graph showing the inflow-runoff hydrograph for the in-row irrigation events

Water reached the cutoff point in about 90 minutes in the inter-row irrigation compared to about 160 minutes in the in-row irrigation event. The sugarcane growing along the furrow in the case of the in-row irrigation event provided resistance to the advancing front.

Subsurface distribution of water along the furrows

The subsurface distribution of water along the furrow is shown in figure 4. The depth of water applied in the in-row irrigation event was greater than that applied in the inter-row irrigation case. This was due to the resistance to water flow by the cane resulting in a higher opportunity time per unit length of furrow in the in-row event. Water flow was faster in inter-row irrigation resulting in less opportunity time.

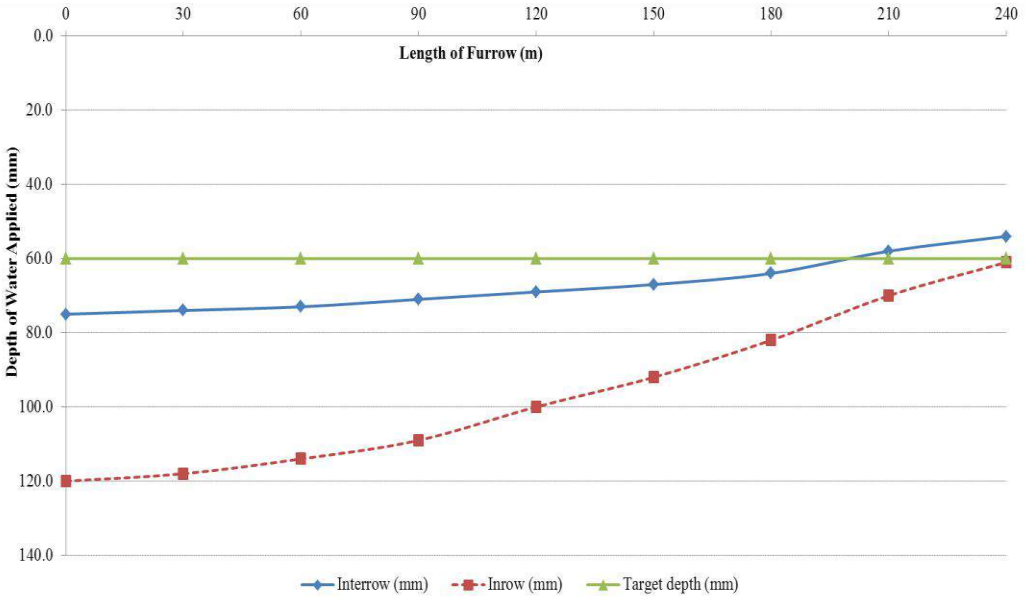

Fig.4: The subsurface distribution of water along the measured furrows.

The results showed that the target amount of 60 mm per furrow was highly exceeded in the inrow irrigation event compared to the interrow irrigation event, with the later under applying the last 30 m of the furrow.

The analysis of the field data allowed for the quantitative definition of the irrigation system performance. Such performance reflects, of course, not only the physical features of the system but its management as well. Occasionally, the inflow is cut off shortly after completion of the advance phase, and the application at some point in the field is inadequate to meet the requirements. At other times, the requirements are met with the least watered areas just receiving the required amount of water. Finally, and most often, the applied depths exceed the requirement at all locations. Because of the large differences in economic, physical, social and operational conditions that occurred in surface irrigation, it is impossible to place quantitative judgement on any of these cases.

The measures for the irrigation performance for the inrow and interrow irrigations are summarized in table 1.

Table 1. Measures of Irrigation performance for Interrow and In-row irrigation

	INTERROW IRRIGATION	IN-ROW IRRIGATION
Distribution uniformity	84%	67%
Application Efficiency (Ea).	88%	48%
Deep Percolation Ratio (DPR)	11%	27%
Run off (%)	6%	2%

The application efficiency for in-row irrigation was low at 48.1% and had a high deep percolation ratio of 26.8%. This indicated that 27% of the water applied on the furrow was lost due to deep percolation. The deep percolation was being measured against the targeted application depth. In furrow irrigation, deep percolation losses are usually unknown by most managers and because they are hidden, irrigators tend to be praised for no-runoff yet deep percolation is enormous.

IV. DISCUSSION

The challenge in furrow irrigation is to predict the required opportunity time to enable the irrigator to apply the correct amount of water. The Newton – Raphson method was used to predict the required opportunity time to apply the target 60 mm for each irrigation event. The assumption was that no change was to be made on the furrow length, width (shape) and inflow volume. This resulted in the following times (Table 2).

Table 2: Comparison of the actual times and the calculated times for each irrigation event

	INTERROW		IN-ROW	
	Actual	Calculated	Actual	Calculated
Opportunity time (range)	51 < x < 91	62.8 min	53 < x < 166	50.9 min
Time of Advance (T_L)	91 min	94.5 min	166 min	174.2 min
Time of Advance ($T_{1/2L}$)	33 min	33.7 min	61 min	62.7 min

Where: T_L – time (minutes) of advance to the full length of furrow.

$T_{1/2L}$ – time (minutes) of advance to the middle of the furrow.

The implication of these results is that the water must spend 36% of the time from the inlet to the middle of the furrow and the rest 64% to the end of the line in order to minimise deep percolation and runoff while ensuring uniform application.

Application of the results for management decisions

The outcome of the evaluations had the following design implications; since both the distance (length of the furrow) and the time (required opportunity time to apply a certain depth of water) are known, then the water flow velocity can be calculated. Using Manning's equation $V = k\ R^{2/3}\ S^{1/2}$, where $k = {}^{1}/_{n}$, and R the hydraulic radius measured for a given furrow, the slope S can be calculated for maximum efficiency. This resulted in the adoption of the use of compound slopes which is now a practice at Mhlume.

Where in many cases the slope is limiting, one has to vary the water inflow into the furrow. A simple relationship (Equation 2) was developed based on the above analysis, which states that the furrow inflow q is proportional to the depth of water to apply per unit time and the total furrow area, i.e.

$$q = k*C*A. \quad (2)$$

where;

k - is a proportionality constant incorporating time(s) = (2.78×10^{-4}).

C - gross depth of water applied (mm)

A - is the furrow area defined as length by spacing (m^2)

For example, for a 50 mm depth, the derived q and L values are summarized in table 3:

Table 3: Derived furrow inflow (l/s) for a given furrow length (m)

Furrow length (m)	Furrow inflow (*l/s*)
50	1.04
100	2.09
150	3.13
200	4.17
250	5.21
300	6.26

V. CONCLUSION

The Kostiakov – Lewis function was successfully used for the evaluation of two types of furrow irrigation system performances at Mhlume. It has the advantage of providing analytical solutions to the flow equations which could easily be solved. The fact that all the parameters used in the equations were based on actual measurements

on the field being evaluated, the results and predictions could be trusted and considered accurate. The measurement of advance rates, hydraulic cross-sections, and tailwater volumes provided the basis for any furrow irrigation evaluation.

It is clear that in-row irrigation cannot be favoured where the length of the furrow is more than 100 m. Deep percolation losses are higher in in-row irrigation than in interrow irrigation. The effect of water losses by surface runoff is not as serious as compared to deep percolation provided sound management practices such as cutback, reuse and the quarter time rule are practiced.

A simple relationship of inflow and furrow length was developed to guide engineers and managers on the approximate flow rate for a given length of furrow. Such measurements are field specific as they are dependent on the soil type.

Multitude furrow slopes would help reduce deep percolation and improve water application efficiency in furrow irrigated fields.

REFERENCES

[1] Bautista, E. and Wallender, W.W. (1985). Spatial variability of infiltration in furrows. Trans. ASAE **1985**, 28, 1846–1851.
[2] Childs, J.L., Wallender, W.W., Hopman, J.W., 1993. Spatial and seasonal variation of furrow infiltration. J Irrig. Drainage Eng. ASCE 119 (1), 74-90.
[3] ESA-Integrated Report. (2019). Integrated Annual Report 2018/19. Pages: 1 - 52
[4] Eduardo A. Holzapfel1, Carlos Leiva1, Miguel A. Mariño2, Jerónimo Paredes1, José L. Arumí1, and Max Billib3 (2010). Furrow Irrigation Management and Design Criteria Using Efficiency Parameters and Simulation Models. CHIL. J. AGRIC. RES. 70(2):287-296
[5] Hsiao, T., P. Steduto, and E. Fereres. (2007). A systematic and quantitative approach to improve water use efficiency in agriculture. Irrig. Sci. 25:209-231.
[6] Issaka, R. Z., Ibrahim. H., Issah, M.H. (2015). Performance Evaluation of Furrow Lengths And Field Application Techniques. International Journal of Scientific & Technology Research Volume 4, Issue 10, October 2015, 278 – 281. ISSN 2277-8616.
[7] Izadi, B., King, B., Ashraf, M.S., Evaluation of the portable furrow infiltrometer. Agricultural water management (34), 1977, 207-205.
[8] Nie, Wei-Bo, Yi-Bo Li, Fan Zhang, Shu-Xin Dong, Heng Wang and Xiao-Yi Ma, (2018). A Method for Determining the Discharge of Closed-End Furrow Irrigation Based on the Representative Value of Manning's Roughness and Field Mean Infiltration Parameters Estimated Using the PTF at Regional Scale. Water 2018, 10, 1825; doi:10.3390/w10121825
[9] Walker, W.R., 1989. Guidelines for designing and evaluating surface irrigation systems. FAO Irrigation and Drainage paper (45)
[10] Walker, W.R., Skogerboe, G.V., 1987. Surface irrigation theory and practice. Prentice – Hall, Englewood Cliffs. NJ.

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Impact of Cement Production on soil Heavy Metals and Nutrients Uptake of Elephant Grass (*Pennisetum Purpureum*) Grown within 2km Radius of cement Factory in South West Nigeria

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***Abstract*— *The study investigated the impact of cement production around cement factory at Ewekoro, South West Nigeria within two kilometer radius to the factory on nutrients uptake by Elephant grass. Elephant grass was sampled at 500, 1000, 1500 and 2000 m. Sampling was carried out in wet and dry seasons for two years (2015 and 2016). Samples were subjected to Laboratory analysis. The parameters determined in the plant samples were Ca, Mg, Na, K, total N, Cu, Zn, Fe, Mn, Pb, Ni, Cr, and Cd. Generally, there was a decrease in all the nutrients uptake by the grass as the distance from the factory increased during the dry season. Mg in the plant tissue initially decreased to a distance of 1500m and was later observed to increase 2000m from the factory. Calcium and Zn concentration was found to be highest in Pennisetum purpureum. Mean composition of micro-nutrients revealed higher concentration of Zinc ranged from 6.31±0.36 to 42.04±2.71 mg/kg and lower concentration from 6.42±0.78 to 10.44±3.39 mg/kg respectively. Results of heavy metal concentration revealed a range from 2.67±0.24 to 6.11±0.77 mg/kg for Lead while the mean values obtained ranged from 0.04±0.01 to 5.5mg/kg. Results obtained from analysis of Pennisetum purpureum showed Calcium to be the most abundant micronutrients with a mean concentration ranged from 2.99% to 5.13% while the mean value recorded at Ewekoro showed a range between 0.19% and 0.36%. Mean Nitrogen content ranged between 1.26 and 2.47% at Ewekoro.*

Keyword*— *nutrient uptake, heavy metals, micronutrients, pollution.

I. INTRODUCTION

Pollution is the introduction of contaminants into a natural setting to cause instability, disorder, harm or discomfort to the ecosystem (Blacksmith Institute, 2007). Soil, water and air can be polluted by metals. Plants growing in a polluted environment are known to accumulate the toxic substances that can cause sicknesses to human body (Alloway, 1995). Plants normally absorb whatever soil nutrient that is available to them. Even the specks of dust that contaminate soils are absorbed by the plants and later hinder the normal functioning of the leaves, which ultimately results in crop low yield (Alloway, 1995). A reasonable amount of heavy metals are absorbed by the plants from the contaminated soil which are later absorbed by animals and man through the consumption of the plant products by livestock and man.

Accumulation of heavy metals by plant roots, stems and leaves grown in polluted soils have been reported by Okoronkwo *et al*. (2005). Elephant grass (*Pennisetum purpureum* Schumach). is a dominant tall tropical grass (CABI, 2014) with high yield and can tolerate a range of climatic conditions. It is also a valuable forage crop (CABI, 2014; FAO, 2015). Cattle and buffaloes cherish the plant. Elephant grass can be grazed, provided it is often kept at the lush vegetative stage. Meanwhile,livestock tend to feed only

on the younger leaves (FAO, 2015). Elephant grass is a multipurpose plant. Apart from being animal feeds, its culms can also be used to build fences and thatches. Therefore, this study aims to assess the impact of cement particulate contamination on nutrient uptake and yield of Elephant grass *(Pennisetum purpureum)*within 2 km radius cement factory

II. MATERIALS AND METHOD

Elephant grass was the pre-dominant plant that animal feeds on in the study area. It was randomly collected at 500, 1000, 1500 and 2000m interval. The four treatments were replicated three times i.e. from each location three plants were bulked in three places. Collection was carried out in wet and dry seasons for two years (2015 and 2016). Samples collected were subjected to Laboratory analysis using standard procedure. Determination of the composition of micronutrients such as Ca, Mg, Na, K, N, Cu, Zn, Fe,and Mn in the plant samples were carried out while the soil samples were analyzed to determine the level of the presence of heavy metals such as Pb, Ni, Cr, and Cd.

The soil samples were collected at different places, dried and 2mm sieved. The leaf samples were oven-dried and digested with Nitric/Perchloric acid mixture (2:1). The cations, (Ca, Mg, Na, K), were analyzed by Atomic Absorption Spectrophotometer (AAS) through flame ionization method (Chapman and Pratt, 1961), total Nitrogen in the plants was determined by Kjeldahl digestion and the Nitrogen determined colourimetrically (Bremner, 1996). Total P was determined colourimetrically by the Vanado-molybdenum yellow procedure (Murphy and Riley, 1962). Micro-nutrients (Cu, Zn, Fe and Mn) and heavy metals (Pb, Ni, Cr, and Cd) were also determined with AAS from the digest above.

Statistical Analysis

Statistical analysis of the data collected was carried out using the SAS software 2014 version. Parameters evaluated are mean values of data generated from the field using Duncan Multiple range Test at 5% significant level.

The chemical composition of cement is shown in table 1 below.

III. RESULT

Table 1: Chemical components of Cement.

Components	Producer L (%)	Producer H (%)	Producer T (%)
Na_2O	0.11	0.11	0.11
MgO	1.60	2.10	3.82
Al_2O_3	4.19	4.31	4.29
SiO_2	18.59	19.84	19.31
P_2O_5	0.58	0.09	0.09
SO_3	3.31	2.96	3.26
Cl	0.04	0.05	0.02
K_2O	1.16	0.59	0.53
CaO	55.62	62.05	56.62
TiO_2	0.21	0.26	0.21
MnO	0.03	0.17	0.38
Fe_2O_3	2.66	3.01	3.30

Source: Lviv Polytechnic National University Institutional Repository http://ena.lp.edu.ua

Table 2 showed the level of Cr, Pb, Ni and Cd in the soil from 0 – 100m depth in Ewekoro North east. Compared with 0 – 20cm away from the cement factory at Ewekoro North East during dry and seasons, Cr and Pb contents in the soil were significantly reduced while there were no significance differences in the amount of Ni and Cd up to

120cm depth. It was noticed that Cr, Pb, Ni and Cd decreased as the soil depth increased. In Ewekoro the major difference in heavy metals status was that the data recorded in the wet season were higher than the data obtained in the dry season.

Also, table 1 showed the effect of cement particulateon properties of heavy metals in Ewekoro north east direction during dry and wet seasons. Compare with 500cm distance away from the cement factory, the Cr content was significantly different from 1000, 1500 and 2000 m away from the factory while Pb , Ni and Cd were significantly reduced except 1000m away from the factory during the dry season. During the wet season, Cr, Pb and Ni were significantly increased except 2000m away from the factory. The Cd level was undetected. The Pb, Ni, Cr and Cd concentration in the oil did not follow the same pattern.

In Ewekoro south west, during the dry and wet seasons, there were no much significant difference s between Cr and Pb from 0 – 20 cm to 100 -120 cm depth. During the dry season, Ni and Cd were not detected. Cadmium was not detected in Ewekoro south west during the wet season.

Compared with 500m distance away from the factory, there was increase in Cr content as the distance increased from 1000 to 2000m distance. Pb (except 500m), Ni and Cd were not detected during the dry season. During the wet season, compared with Cr, Pb and Ni at 500m distance away from the factory, the Cr, Pb and Ni increased as the distance increased except the Cr and Pb content at 1000m away from the factory. The Cr, Pb and Ni contents in wet season were higher than the Cr, Pb and Ni during the dry season. Cadmium content was not detected.

Table 2: Impact of Cement Production on soil Chromium, lead, Nickel and Cadmium at Ewekoro cement factory within 2km radius

EWEKORO NORTH-EAST(Dry)

Depth	Cr	Pb	Ni	Cd
0-20	1.4275^{a}	1.74^{a}	0.15875^{a}	0.03^{a}
20-40	1.335^{a}	1.4913^{ab}	0.12375^{a}	0.03125^{a}
40-60	1.20875^{b}	1.4238^{ab}	0.12375^{a}	0.025^{a}
60-80	1.2125^{b}	1.3263^{b}	0.11125^{a}	0.03625^{a}
80-100	1.11125^{b}	1.3063^{b}	0.11875^{a}	0.02125^{a}
100-120	1.10125^{b}	1.1375^{b}	0.075^{a}	0.0175^{a}

EWEKORO NORTH-EAST(Wet)

Depth	Cr	Pb	Ni	Cd
0-20	1.63125^{a}	1.07375^{a}	0.15625^{a}	0^{a}
20-40	1.58125^{b}	$1.05a^{b}$	0.15625^{a}	0^{a}
40-60	1.54375^{bc}	1.01375^{b}	0.1425^{a}	0^{a}
60-80	1.55375^{bc}	0.94375^{c}	0.14125^{a}	0^{a}
80-100	1.57625^{b}	0.9225^{c}	0.11625^{b}	0^{a}
100-120	1.525^{c}	0.87^{d}	0.05^{c}	0^{a}

Distance	Cr	Pb	Ni	Cd
500	1.33^{b}	2.2658^{a}	0.18^{a}	0.05417^{a}
1000	1.6375^{a}	2.0608^{a}	0.24417^{a}	0.04833^{a}
1500	0.84167^{d}	0.3125^{c}	0^{b}	0^{b}
2000	1.12167^{c}	0.9775^{b}	0.05^{b}	0.0005^{b}

Distance	Cr	Pb	Ni	Cd
500	1.44917^{c}	0.93333^{b}	0.105833^{c}	0^{a}
1000	2.1^{a}	1.29917^{a}	0.124167^{b}	0^{a}
1500	1.49167^{b}	0.78833^{c}	0.095^{c}	0^{a}
2000	1.23333^{d}	0.895^{b}	0.183333^{a}	0^{a}

EWEKORO SOUTH-WEST(Dry)

Depth	Cr	Pb	Ni	Cd
0-20	0.19^{a}	0.01^{ab}	0^{a}	0^{a}
20-40	0.2025^{a}	0.01^{ab}	0^{a}	0^{a}
40-60	0.1925^{a}	0.0125^{a}	0^{a}	0^{a}
60-80	0.18875^{a}	0.00375^{ab}	0^{a}	0^{a}
80-100	0.18^{a}	0.0025^{ab}	0^{a}	0^{a}

EWEKORO SOUTH-WEST(Wet)

Depth	Cr	Pb	Ni	Cd
0-20	2.885^{a}	7.035^{a}	0.20375^{a}	0^{a}
20-40	2.6638^{ab}	6.065^{a}	0.16^{b}	0^{a}
40-60	2.3775^{b}	5.713^{a}	0.11375^{c}	0^{a}
60-80	2.4788^{ab}	5.674^{a}	0.0925^{cd}	0^{a}
80-100	2.7088^{ab}	7.119^{a}	0.07^{d}	0^{a}

100-120	0.22875[a]	0[b]	0[a]	0[a]	100-120	2.6038[ab]	5.529[a]	0.07625[d]	0[a]

Distance	Cr	Pb	Ni	Cd	Distance	Cr	Pb	Ni	Cd
500	0.11083[b]	0.025833[a]	0[a]	0[a]	500	1.4[c]	4.0125[b]	0.20417[a]	0[a]
1000	0.27083[a]	0[b]	0[a]	0[a]	1000	0.9425[d]	3.35[b]	0.16167[b]	0[a]
1500	0.14417[b]	0[b]	0[a]	0[a]	1500	5.13[a]	8.6892[a]	0.05417[c]	0[a]
2000	0.2625[a]	0[b]	0[a]	0[a]	2000	3.0058[b]	8.7042[a]	0.0575[c]	0[a]

Means with the same letter in the same column are not significantly different at 5% level using Duncan multiple range test

Effect of cement particulate on the nutrients status of the elephant grass (*Pennisetum purpureum*) at the vicinity of Ewekoro cement factory

Tables 3 -6 showed the nutrients uptake of elephant grass (*Pennisetum purpureum*) in the vicinity of Ewekoro factory in the wet and dry seasons. The N, P, Ca, Mg, Na, Cu and Zn concentration in *Pennisetum purpureum* harvested at the south west direction of Ewekoro cement factory during the wet season is shown in Table 3. Generally, it was observed that all the nutrients were reduced in concentration as the distance from the factory increased. Phosphorus (P), K, Ca, Mg and Na (except 2000 m away) significantly increased as the distance from the factory reduced when compared with 2000 m away from the factory while there were no significant differences among N, Cu and Zn when the distances were compared. The nutrients were adequate for optimum growth of *Pennisetum purpureum*. The nutrients composition of *Pennisetum purpurem* in the dry season followed the same trend as that of the wet season except that the concentrations were much lower in the dry season than the wet season (Table 4)

Table 3: Nutrients assessment of Pennisetum purpureum at the South-West direction of Ewekoro in the wet season

Distance (Km)	%	----------mg/kg----------						
	N	P	K	Ca	Mg	Na	Cu	Zn
500	2.47[a]	919.14[a]	16310.26[a]	45976.50[b]	6321.38[a]	1915.73[a]	24.50[a]	107.94[a]
1000	2.14[a]	781.85[b]	15391.23[a]	46265.70[a]	5880.14[b]	1816.27[b]	20.80[a]	105.04[a]
1500	1.92[a]	707.00[c]	14983.07[b]	42960.20[c]	5669.50[c]	1793.22[c]	20.15[a]	100.60[a]
2000	1.52[a]	673.79[d]	14085.72[c]	40526.70[d]	4524.00[d]	1757.62[c]	18.91[a]	94.28[a]

Means with the same letter in the same column are not significantly different at 5% level using Duncan multiple range test

Table 4: Nutrients assessment of Pennisetum purpureum at the South-West direction of Ewekoro in the dry season

Distance	N	P	K	Ca	Mg	Na	Cu	Zn

(m)	%	mg/kg	_____ mg/kg _____				mg/kg	
	%	mg/kg		mg/kg			mg/kg	
500	1.91[a]	561.48[a]	14353.5[a]	39947.6[a]	4557.85[a]	1677.9[a]	17.63[a]	85.08[a]
1000	1.71[a]	566.07[a]	14180.4[a]	38201.5[b]	4093.5[c]	1665.2[a]	17.31[a]	79.76[a]
1500	1.40[a]	519.39[b]	13209.9[b]	35537.6[c]	3596.67[b]	1517.7[b]	12.77[a]	70.45[a]
2000	1.44[a]	509.63[c]	10128.0[c]	29935.2[d]	3898.97[b]	1412.8[c]	13.12[a]	62.00[a]

Means with the same letter in the same column are not significantly different at 5% level using Duncan multiple range test

Compared with 2000m away from the factory, the N, P, K, Ca and Mg contents of the leaves of Purpureum were significantly increased at 1500, 1000 and 500m distance away from the factory from the North east direction (Table 5). The N, P, K, Ca, Mg Na, Cu and Zn were reduced as the distance from the factory increased. The total N, K, Ca and Mg were adequate for proper growth of elephant grass up to 2000m away from the factory (Tables 5 and 6). The available P was very low at any distance from the factory. All the nutrients contents in the plants sampled during the dry season were generally higher than the plants analyzed during the wet season (Table 6). There were no significant differences in N content of the sampled elephant grass at any distance from the factory.

Table 5: Nutrients assessment of Pennisetum purpureum at the North-East of Ewekoro in the wet season

Distance (m)	%		_____mg/kg _____					
	N%	P	K	Ca	Mg	Na	Cu	Zn
500	1.39[b]	516[a]	9613[a]	38239[a]	3301[a]	1699[a]	20[a]	73[a]
1000	1.31[b]	494[a]	9490[b]	35439[b]	3205[b]	1617[b]	17[a]	72[a]
1500	1.67[a]	441[b]	9225[c]	34964[c]	3100[c]	1608[c]	12[b]	65[b]
2000	1.43[ab]	382[c]	8984[d]	34090[d]	3027[d]	1555[d]	12[b]	60[b]

Means with the same letter in the same column are not significantly different at 5% level using Duncan multiple range test

Table 6: Nutrients assessment of Pennisetum purpureum at the North East direction of Ewekoro in the dry season

Distance	N%	------	----------(mg/kg)----------					
(m)		P	K	Ca	Mg	Na	Cu	Zn
500	1.43[a]	1133[a]	13412[b]	51288[a]	4878[a]	2444[a]	34[a]	129[a]
1000	1.31[a]	1097[b]	12716[a]	49521[b]	4600[b]	2404[b]	29[b]	118[b]
1500	1.26[a]	1050[c]	12339[b]	48205[c]	4173[c]	2212[c]	25[b]	104[c]
2000	1.36[a]	992[d]	10623[c]	44895[d]	3576[d]	2107[d]	25[b]	104[c]

Means with the same letter in the same column are not significantly different at 5% level using Duncan multiple range test

Compared the nutrient contents of the sampled in the west direction to the east direction, the N, K, Ca and Mg contents of the plants in west direction was higher than the north east direction. The P, Na, Cu and Zn contents in the north east direction was higher than the west direction.

IV. DISCUSSION

The heavy metal Nickel (Ni) in the sampled soils was low, going by MAFF (1992) recommendation of 50 mg/kg for Ni as its critical level while Lead (Pb) concentration in the soil was above 0.01mg/L recommended by WHO (1984). At present, Ni might not pose negative effect on crops grown in the area while the concentration of Pb needs to be put in check. Alloway (1995) observed that the crop grown in polluted area can absorb heavy metals in excess that are likely to pose risk to human health. This work is in line with Adejumo *et al.*, (1994); Schuhmacher *et al.*, (2004); Al-Khashman and Shawabkeh, (2006); Isikli *et al.*, (2006) who stated that cement production emits heavy metals such as Cd, Cr, Cu, Pb and Zn. Lepedus *et al.*, (2003) emphasized that cement dust during cement processing can reduce chlorophyll and carotenoid content. Studies on the effect of cement dust on biosynthetic processes in the plant by Oyedele *et al*. (1995) also revealed a reduction in chlorophyll and carotenoid content, impair Carbon IV Oxide exchange and reduction in plant photosynthesis rate. Also, Oyedele *et al.*, 1995; Schuhmacher *et al.*, 2004; Al–Khashman and Shawabkeh, 2006; Isikli *et al.*, 2006 buttressed that Cement production emits heavy metals such as Cd, Cr, Cu, Pb and Zn which are deposited into the soil and thereafter absorbed by plants . Achternbosch *et al.* (2003) reported that conventional cement raw materials contain 25 mg/kg of Cr, 21 mg/kg of Cu, 20 mg/kg of Pb and 53 mg/kg of Zn and about 50% of the total, Cd, Cu and Zn load in cement ranked highest. This might be the reason why the soils around the cement factory in Ewekoro are high in Fe, Zn, Pb and Cr. Josephine *et al*, (2017) were of the opinion that majority of the emitted heavy metals are known to be toxic to humans and plants, even at low concentrations. Murugesan *et al.*, 2004 observed that cement kiln exhaust of the cement factory deposits on vegetables could be absorbed by plants and have adverse effect on human health when the plants are consumed. The Ca and Mg contents in the elephant grass were found to be high. This is in agreement with the assertion of Farmer (1993), that, the alkaline cement dust and their ash in the pollution complex lead to increase in soil alkalinity.

The high N content obtained in the elephant grass in this work in the dry season was higher than that reported for N in the dry season. This might be as a result of moisture that enhanced N nitrification. High rates of Ca is known to be inversely related to the phosphorus content in soil and it is even known to inhibit the absorption and utilization of P and other nutrient elements in the soil.

Also Cu and Zn in both locations and both seasons exceeded the World Health Organization (WHO) recommended value limit of 10 and 50 $mgkg^{-1}$ in plants. This is likely to have negative impact on animals that feed on them. There was no particular trend observed in the nutrient content of elephant grass with regard to the distance to the cement manufacturing factory for N, P, K, Ca, Mg, Na, Cu and Zn contents. . Accumulation of heavy metals by plants' roots, stems and leaves grown in polluted soils have been reported severally. Okoronkwo *et al*. (2005) said that it had been the interest of the public to know whether vegetables, fruits and other food crops cultivated in polluted soils are safe for human consumption especially now that the environmental quality of food production is of significant concern (Chiroma *et al*., 2003). The understanding of the behaviour of contaminants especially heavy metal in the soil-plant system seems to be particularly significant. For instance, consumption of Pb is believed to cause mental retardation in many children, while mild consumption causes anaemia (Bladwin and Marshall (1999).). Toxic elements are taken in through air, food and water. Out of these three, the air intake is the most readily assimilated into the body (Rai *et al*, 2010).

V. CONCLUSION

The study investigated the impact of cement production on physicochemical properties of soils and Elephant grass grown around Ewekoro cement factory. in Ogun state, SW Nigeria within two-kilometer radius to the factories between 2015 and 2016

The research presented in this work revealed that the cement industry is one of the polluting industries. Controlling the spread of dust and other emissions should be given top priority to maintain the ecosystem around the vicinity of the factory.

REFERENCES

[1] Achternbosch M, Bra¨utigam KR, Hartlieb N, Kupsch C,Richers U, Stemmermann P (2003). Heavy metals in cement and concrete resulting from the co-incineration of wastes in cement kilns with regard to the legitimacy of waste utilisation. Karlsruhe: Forschungszentrum Karlsruhe GmbH

[2] A.O.A.C. (1970). *Official methods of analysis* 11th ed. Association of Official Analytical Chemist, Washington DC.

[3] Al- Khashman, O.A. and Shawabkeh, R. A. (2006). Metals Distribution in Soils Around the Cement Factory in Southern Jordan. *Environment Pollution* 140: 387.
[4] Alloway, B. J. (1995). *Heavy metals in soils* 2nd Ed. Blakie Academic and Professionals, London. UK. p.190.
[5] Bladwin, D. R. and Marshall, W. J. (1999). Heavy metal poisoning and its laboratory investigation. *Journal of Clinical Biochemistry* 36 (3): 267- 300.
[6] Blacksmith Institute (2007). The world's most polluted places. Blacksmith Institute.
[7] Bremmer (1996). Comparison of Total Nitrogen Methods Applied for Histosols and Soil Horizons with High organic Matter Content. *In Communications in Soil and Plant Analysis.* 37: 939-943
[8] CABI (2014). Invasive species compendium datasheets of Elephant grass (*Pennisetum purpureum*). Wallingford (UK): CAB International.
[9] Chapman, D. and Kimstach, V. (1996). Selection of Water Quality Variables. In Water Quality Assessments – A Guide to Use of Biota, Sediments and Water in Environmental Monitoring. Ed. Deborah Chapman. 2nd Edition. UNESCO/WHO/UNEP. Pp 74–89
[10] Chapman, D. and Pratt (1961). Direct and residual effects of plant growth retardants, on cotton seed. In *Agricultural Sciences*. 4 (12A)
[11] Chiroma T.M, Ebewele, R.O and Hymore F.K..(2012). Levels of Heavy Metals (Cu, Zn, Pb, Fe and Cr) in Bushgreen and Roselle Irrigated with Treated and Untreated Urban Sewage Water. *International Research Journal of Environmental Sciences*. 1(4): 50-55.
[12] FAO, (2015). Grazing management and tussock distribution in elephant grass: In *Grass and Forage Science.* 70 (3): 214-215
[13] Farmers, (1993). Effects of Riyadh cement industry pollutions on some physiological and morphological. In Saudi Journal of Biological Sciences.
[14] FMANR, (1990). Literature review on soil fertility investigations in Nigeria. Federal Ministry of Agriculture and Natural Resources, Lagos, pp: 32-45.
[15] Isikli *et al.*, (2006). Distribution and variation of Heavy metals and soil properties around mega a cement factory in Gboko, Benue state, Nigeria. *International Journal of Science and Technology*. 4 (7): 2 – 17
[16] Josephine Adekola, Moira Fischbacher-Smith, Denis Fischbacher and Olalekan Adekola. (2017): Health Risks from Environmental Degradation in the Niger Delta, Nigeria. *Environmental and Planning*. 35 (2): 334-354
[17] Larcher (1995). Physiological Plant Ecology 3rd Edition.Published by Berlin Heidelberg New York.springer-Verlag, 1995. (1995). ISBN 10:0387581162/ISBN 13:9780387581163
[18] Lepedus, H., Cesar, V and Suver, M. (2003). The annual changes or chloroplast pigment content in current and previous year needles or Norway spruce (*Picea abies* L. Karst) exposed to cement dust pollution. *ACTA Botanica Croatica* 62: 27 – 35.
[19] MAFF, 1992. Code of Good Agricultural Practice for the Protection of Air. MAFF, London, UK., pp: 87-153
[20] Murphy J. and Piley J.P., (1962). A modified single solution methods for the determinants of phosphate in natural waters. *Analytical Chem. Acta* 27: 31-6, 1962.
[21] Murugesan, M., A. Sivakumar, N. Jayanthi and K. Manonmani (2004). Effect of cement dust pollution on physiological and biochemical activities of certain plants. *Pollution Research.* 23(2): 375-378.
[22] Okoronkwo, N.E. Igwe J. C. & Onwuchekwa E.C. (2005). Risk and health implications of polluted soils for crop production: *African Journal of Biotechnology*. 4:1521-1524.
[23] Oyedele, D. J., Obioh, I. B., Adejumo, J. A., Oluwole, A. F., Aina, P. O & Asubiojo, O. I. (1995). Lead contamination of soils and the vegetation in the vicinity of lead smatter in Nigeria. *The Science of the total Envir,lfyioubbvnuycuctyuconment.* 172 (2-3): 189-195.
[24] Samal A. &Santra, M. (2002). Particulate matter effect on biometric and biochemical attributes of fruiting plants. *Global Journal of Environmental Science and Management*.
[25] Schuhmacher, M., Domingo J. L. & Garreta J. (2004). Pollutants emitted by a cement plant: Health risks for the population living in the neighbourhood. In *Environmental Research* 95(2) 198 – 206.
[26] Rai, A. Kulshreshtha, K. Srivastava, P.K & Mohanty, C.S (2010): Leaf surface structure alterations due to particulate pollution in some common plants. *Environmentalist.* 30, 18-23.
[27] WHO (IPCS) (1983) Environmental Health Criteria 27: Guidelines on Studies in Environmental Epidemiology. WHO, Geneva. Pp. 351

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Perception of an adaptation to climate change by the maize farmers of Baitadi District, Nepal

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Abstract— *A survey research was conducted in Dilasaini and Dogadakedar rural municipalities of Baitadi district, Nepal to study the perception of and adaption to climate change by the maize farmers. Thirty households from each local levels were selected randomly. Primary data was collected through household survey with pre-tested interview schedule, direct observation and focus group discussion. Descriptive statistics along with binary logistic regression model were used for analysis of the data. The total population was dominated by brahmin and chhetri (89.67%) followed by occupational caste (10%) community with economically active population 61.68 percent. The major occupation was agriculture (65%). Farmers were gradually diverted towards other livelihood options like remittance, off farm activities, beside agriculture. 68.33 percent of total households were dominated by male while only 31.67 percent were female dominated. Majority of farmers (91%) perceived changes in climatic affected the maize production. Most of the farmers reported frequent drought followed by off seasonal rain. Almost 78.3 percent households preferred radio for the information related to climate change. Age and agriculture as the major source of income were found significantly affecting the knowledge on climate change negatively. Individuals with agriculture as the major income possess comparatively less knowledge on climate change as compared to their younger counterfeit. The existing climate change coping strategies depends heavily on the traditional knowledge. Promoting the minors with precise information, skills and knowledge, garnered through site-specific researches along with holistic mitigating approaches and scaling up traditional knowledge on climate change impacts and adaptation strategy is sure to pave a way forward to climate resilience community.*

Keywords— ***Adaptation strategies, Climate change, Maize production, Perception, Vulnerability.***

I. INTRODUCTION

Agriculture continues to be extremely important business in case of Nepal which contributes 32.6% to national GDP and provides employment to 65.6% of population (MoAD, 2015). The stat shows the overall development of the national is impossible without development of this very sector. Agriculture is not only the source of bread and butter but a major source of raw materials to the agro-based industries in Nepal. Agriculture sector contributes more than 60% to the total national export (CBS, 2014). Among the harvests of staple crops; maize is one of the most important crop for mid hill farmers. Climate change is hitting on agriculture mostly developing country like Nepal.

The air temperature near earth surface rose by 0.74^0C from 1906 to 2005 and scientists estimated it could be increased as much as 6.4^0C on average during the 21st century (IPCC, 2007). Nepal's temperature has been reported to be rising at a rate of 0.06 ^{0}c per year as a result of climate change (Dahal, 2006). This could affect crop production as each plant species are most productive or can survive/tolerate only within a certain range of temperature. Climate change has also been linked to changes in precipitation patterns in the country, particularly, the monsoon season. The monsoon season has been shortened with decline in total annual precipitation, and increase in frequency of heavy/intense storms (often leading to flooding) in rainy season as well as droughts in winter season (Pokhrel & Pandey, 2011). Approximately 64% of the cultivated areas in Nepal are heavily dependent on monsoon rainfall and changes in the time and duration of this monsoon rainfall could adversely affect the agricultural production significantly (Lohani, 2007). Maize is produced on nearly 100 million hectares in developing countries, with almost

70 % of the total maize production in the developing world coming from low and lower middle income countries (FAOSTAT, 2010). Pant (2012) on the other hand has reported that climate change affected rice and barley production negatively in the country thus, increased food insecurity. Furthermore, increase in disease and pest infestation in crops due to changes in seasonal patterns have been linked with not just decline in production but even extinction of some local crop varieties and natural vegetation (Malla, 2008). Using crop production and meteorological records, Thomson et al., (1966) showed that a 6 °C increase in temperature during the grain filling period resulted in a 10% yield loss in the US Corn Belt. A later study in the same region showed maize yields to be negatively correlated with accumulated degrees of daily maximum temperatures above 32 °C during the grain filling period (Dale, 1983).

Far-western Nepal is one of the most vulnerable to vagaries of the climate change. Persistent food crises in the region are the reminders of the continuing vulnerability of the region to the effect of climate conditions. This is in large measure due to weak institutional capacity, low paying capacity of the farmers, limited engagement in environmental and adaption issues, and a lack of priority to the sector. This region is quite virgin incase of research study and findings. Those working in the sector of climate change are just providing their service based upon some assumption and eyed seen symptoms. This research tried to drag out the perception and knowledge of the local maize farmers about climate and climate change and measured adapted by them to cope with the problem.

Nepal has various types of agriculture zones in which agricultural sectors damaged in Terai and more in hills and mountain due to increase in temperature (Malla, 2008). Increased concentration of CO_2 causes vigorous growth of the crops which ultimately lead to reduce level of organic carbon from soil, soil micronutrients and enhanced activity of micro-organisms (Malla, 2003). Some of the farmers are happy with the changes; for example, Farmers of Manang and Mustang districts have noticed improved apple sizes in recent years (Dahal, 2005). There will be gains in some crops in some regions of the world; the overall impacts of climate change on agriculture are expected to be negative, threatening global food security (IFPRI, 2009).

Adaption to climate change may include many measures, one of these is policy reform to adjust/ adapt to climate change. Individuals, households, government or any stakeholders can implement effective adaption strategies to adjust the climate variations and uncertainties based on the resources availability and economic and social conditions. Nepal gradually adopting new cropping system and changed the cropping system from rice-wheat-maize to fruits and plantation crop like banana which is less sensitive to climate change (Gurung, 2008). Promotion of rain water harvesting in mountainous region can be adoptive strategy for existing as well as projected impacts of drought (MOPE, 2004). Sloping Agriculture Land Technology and eco-friendly vegetable production in Jugedi khola watershed, kabilash helped to cope with impacts change in that area (Ghimire, 2008). Economics diversification can also be an important adaption strategy for the developing countries to reduce dependence on climate sensitive resources (UNFCC, 2007). Zero tillage is an emerging coping for climate change that reduces 27% green house gases emission (AEU, 2010 and 2011).

The study outcomes helped to streamline approaches for achieving Millennium Development Goals (MDGs) specially the poverty eradication, environmental sustainability goals, provides strategy to cope climate change, etc. Climate change induced flood, landslide, soil erosion, erratic rainfall, drought, etc resulting increased risk and uncertainty, however the alteration in the cropping pattern, loss of the local and indigenous variety and use of the hybrid and resistant variety of maize are some of the local strategies in coping the climate change. Thus, this study aimed to estimate the impact of climate change on Maize production in the Baitadi. This study will contribute toward existing knowledge gap and help researchers and policy makers to respond to climate change by adjusting agricultural and environmental policies and practices as needed. This study explores the perception of Farmer's on climate change and its adaption strategies and reducing the vulnerability of the climate change impacts

II. MATERIALS AND METHODS

The study was conducted in June-July, 2018 on Baitadi district of Nepal. Dilasiani and Dogadakedar rural municipalities were purposively selected in consultation with community level, district level organization and DADO where maize has been the major staple cereal crops. Pre-testing of interview schedule was done before the field survey by administering the designed interview schedule to the 8 respondents nearby the study area to assure the research design and preliminary information regarding socio-cultural, topographical, and institutional features. Altogether 60 households, farmers with at least 10 years of settlement, thirty from each rural municipality (representing all the wards possible) were selected randomly assuring the availability of relevant information regarding the past trends of climate hazards. Interview

schedule was used to collect the primary information. Additionally, 5 focus group discussion and 5 key informant interviews were conducted to generate the general status and distribution of maize production, and effect of climate change on maize production. The major variables included in interview schedule were socio-economic characteristics, farm characteristics, livelihood options, farmers' perception, their adaption strategies, and crop production trends. The study concentrated on both primary and secondary data. Climatic data related to rainfall, temperature, RH and other required parameters were collected from the meteorological station situated at Baitadi in addition to data from various published journals, research articles, proceeding of various NGOs and INGOs, reports of Distrct Agriculture, Development Office (DADO), District Development Committee (DDC), National Agriculture Research Council (NARC), Central Bureau of Statistics (CBS), local leaders and working agencies were the sources of secondary information. The available 10 year climatic data was analyzed to determine the climatic suitability and hazard for maize production in the study area.

a. Methods and techniques of data analysis

Data entry and analysis were done by using Statistical Package for Social Science (*SPSS V.16*) and Microsoft Excel. The local units of measurements were corrected into scientific one. Both descriptive and analytical methods were used to analyze the data. Both qualitative and quantitative analyses were done with regards to the objectives.

i. Qualitative analysis

Qualitative data were analyzed by using the both descriptive and analytical statistics. Qualitative information from the survey questionnaire was quantified with the appropriate scaling method. Farmer's perception was mapped using multiple ranking matrix and likert scale.

Quantitative analysis

Socio-economic and farm characteristics of the respondents like family size, age, occupational pattern, change in size of holding, size of the irrigated holding, distribution of economically active population were described by using simple descriptive statics like frequency, percentage, mean and standard deviation. Impacts and perception of Farmers on the change of climate variables over the time and their adaption strategies were studied by estimating frequency, frequency, percentage, charts and diagram.

Analytical statistics

Changes in the trend of area allocation over the time and productivity changes obtained from both primary and secondary sources were analyzed using trend line estimation in Microsoft Excel.

Climate change impact analysis

The log linear regression analysis was done to study the effect of precipitation and temperature on productivity of Maize.

$$lnP_t = a + b_1 lnA_t + b_2 lnAM_X T_t + b_3 lnAMnT_t + b_4 lnSRF_t$$

Equation 1

Where,

P_t = productivity of Maize (tonha^{-1}) in tth year

A_t = area under Maize in tth year

$AM_X T_t$ = seasonal average of maximum temperature for Maize in tth year

$AMnT_t$ = seasonal average of minimum temperature for Maize in tth year

SRF_t = seasonal rainfall for Maize in tth year.

III. RESULTS AND DISCUSSION

i. General characteristics of study area

The study district, Baitadi, covered an area of 1,519 Sqr. km and had total population of 250,898 (CBS, 2011). The Baitadi districts entail 4 municipalities and 6 Rural Municipalities. Baitadi falls into the farthest western regional districts of Nepal touching Jhulaghat, India, to its boarder. Table 1 illustrates that the majority of the household head were male (31.67%) which is in line with the national status. Similarly, overall average age of the household head were 44 years with minimum of 21 years and maximum of 70 years. Majority of the household head were under economically active age group. Overall sample had a higher literacy rate (75%) while, illiteracy being just 25%. The average year of schooling was 8.05 and the maximum year of schooling was 18 and minimum was zero. Joint type of family was dominating in both the rural municipality and was followed by nuclear one.

The members of age group 15-60 was maximum (68%) followed by members of age group below the 15 years i.e. 32.84% and members of age group above 60 years i.e. 5.4%. In the both Rural Municipality the maximum average family size was 19 while minimum family size was 3 and the average family size was 7.91. The major

occupations of family members were agriculture contributing 65% in both the rural municipality, followed by the trade/business (25%), service (5%), wage (3.33%) and remittance (1.67%) respectively.

The total land holding area was 15.33 ropani[1]. Average owned land was 14.2 ropani which was higher in comparison to the average land rented-out i.e. 0.73 ropani and rented-in i.e. 0.67 ropani respectively. The maximum land holding was 80 ropani while minimum land was 1 ropani and the average of total land was 15.53 ropani. The maximum cultivated land of both the Rural municipality of total land was 50 ropani and minimum cultivated land was 1 ropani. The average maize cultivated land over 60 households was 5.81 ropani. Among them maximum total maize cultivated land was 30 ropani and minimum 1 ropani land.

The average income from agriculture was NRs 40541.67 while average income from maize was NRs 18991.67.The maximum and minimum income from agriculture was NRs 150000 and NRs 1500 respectively. Similarly, the maximum and minimum income from maize only was NRs 90000 and 1000 respectively.

Table 1 Socio-economic characteristics

Socio-economic characteristics	**Overall average**	**Maximum**	**Minimum**	**SE**
Gender of HHH				
Male	41 (68.33)			
Female	19(31.67)	-	-	-
Age of household head	43.48	70	21	1.52
Ethnicity				
Brahmin	17(28.33)	-	-	-
Chhetri	37(61.67)	-	-	-
Janjati	0(0.0)	-	-	-
Dalit	6(10.00)	-	-	-
Education status				
Total illiterate[2]	15(25.00)	-	-	-
Total literate[3]	45(75.00)	-	-	-
Average year of schooling	8.05	18	0	0.55
Type of family				
Nuclear	19(31.67)	-	-	-
Joint	41(68.33)	-	-	-
Members below 15 years	156(32.84)	-	-	-
Members between 15-60	293(61.68)	-	-	-
Members above 60	26(5.40)	-	-	-
Average family size	7.91	19	3	0.46
Major occupation				
Agriculture	39(65.00)	-	-	-
Wage/Labour	2(3.33)	-	-	-
Trade/Business	15(25.00)	-	-	-
Service	3(5.00)	-	-	-
Remittance	1(1.67)	-	-	-
Land holding				
Owned Land (Ropani)	14.20	-	-	-
Rented-in (Ropani)	0.67	-	-	-
Rented-out (Ropani)	0.73	-	-	-
Total land (Ropani)	15.53	80	1	1.79
Total cultivated land (Ropani)	11.96	50	1	1.19
Total maize cultivated land (Ropani)	5.81	30	1	0.66
Income	40541.67	150000	1500	3855.3

[1] 1 Hectare = 20 Ropani

[2] Individuals who cannot read and write

[3] Individuals who can read and write

from Agriculture				3
Income from maize	18991.67	90000	1000	2225.25

Note: Figures in the parenthesis represent the percentage

ii. Mostly affected parameters by climate change

The most rated effect of climate change was reduced quality (3.67) followed by yield loss (3.48), diseases (3.27) and pest (3.13) as shown in Table 2. Climate change is deteriorating the quality of the product which can be attributed to the shift in flowering time and immature maturity or early maturity. In spite of rainfall during harvesting, hailstorm deteriorate the quality of the produce which ultimately results yield loss.

Table 2 Mostly affected parameters by climate change

Parameters	**Values**	**Rankings**
Reduced quality	3.67	I
Yield loss	3.48	II
More diseases	3.27	III
More pests	3.13	IV

iii. Major factors affecting Maize production and productivity

iv. The major factor affected by climate change were more frequent droughts (4.02) followed by more severe drought (2.83), more frequent storms (2.65), unseasonal rains (2.22), and more intense storms (1.93) respectively as shown in table 3. Western hills are receiving more frequent droughts at present context. These frequent droughts are affecting the maize production and productivity. Some of those droughts are quite severe.

Table 3 Majors factors affecting maize production and productivity

Parameters	Value	Ranking
More frequent droughts	4.02	I
More severe droughts	2.83	II
More frequent storms	2.65	III
Unseasonal rains	2.22	IV
More intense storms	1.93	V

v. Farmers response to climate change

vi. The majority of the farmers do little or nothing to cope with the effects of climate change as shown in Table 4. Some farmers' intensified routine activities like pruning, fertilizing and pest control activities to cope with the negative consequences of climate change on their maize crops. Much of the farmers still have not gone for crop diversification to cope with the climate change.

Table 4 Farmers response to climate change

Parameter	**Values**	**Rankings**
Do little or nothing	2.67	I
Intensify routine activities (pruning, fertilizing, pest control etc.)	2.23	II
Specific adaptations (irrigation, improved drainage, etc.)	2.08	III
Diversify to other crops	2.07	IV

vii. Sources of information on climate change

The most of farmers obtained the information on climate change through radio (78.3%) followed by TV (13.3%), internet (5%), Newspaper (1.7%) and educational institutions nearby (1.7%).

Table 5 Source of information on climate change

Sources	**Overall Average**
Radio	47(78.3)
TV	8(13.3)
Internet	3(5)
Newspaper	1(1.7)
Education Institution	1(1.7)

(Figures in the parenthesis represent the percentage**)**

Farmer's trust on different information sources

The relatively greater number of the farmers trusted on the media (4.93) followed by scientists, government sources, family member or friends, World Wide Fund, supplier and environmental organization respectively.

Table 6 Farmers' trust on different information sources

Sources	**Values**	**Ranking**
Trust the media	4.93	I
Trust scientist	4.77	II

Trust government	4.55	III
Trust family member or a friend	4.28	IV
Trust on World Wildlife fund	3.28	V
Trust supplier	3.05	VI
an environment Trust	2.83	VII

Required government interventions to combat climate change

To cope with the effects of climate change first of all government needs to disseminate awareness about climate change using the most effective possible mediums. In addition to this government need to provide trainings on strategic planning at management level to cope with the climate change so that their capacity to cope with climate change will be strengthened. Training for trainers was rated least by the households.

Table 7 Need of different government effort cope with climate change.

Parameters	Values	Ranking
Information about adaptation methods, tools etc.	4.23	I
Training for strategic planning at management level	4.03	II
Training on project development and execution (adaptive research)	3.65	III
Training of trainers	3.53	IV

Farmers experience about different climatic parameters.

The figure 1 revealed that majority of the farmers (93.3%) have experienced changes in temperature over the years. 91.7 percent individuals have experienced change in rainfall pattern and 86.7 percent have experienced changes in production over the years. The result revealed that only 36.7 percent of the individuals have tried the maize varieties recommended for Terai region in their land.

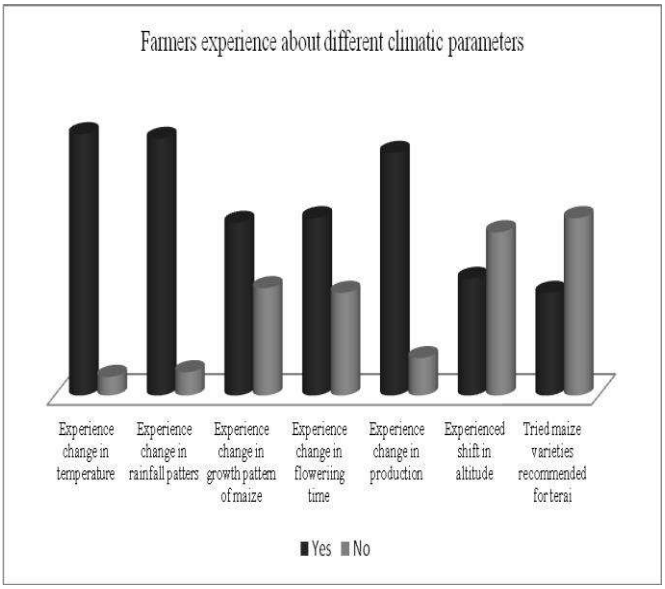

Fig.1: Farmers experience about different climatic parameters

Efforts carried out by the government and non-government organizations to cope with climate change

Table 8 reveals that government and non-governmental organizations have carried our surveys in those areas to cope with the climate change. Still other follow of activities are missing to carry on in those areas. Surveys are followed up by awareness/training events which are followed up by climate/meteorological studies. Widespread adaptation efforts have not been carried out in significant amount to cope with climate change.

Table 8 Different efforts carried out by different stakeholders

Parameters	Values	Ranking
Surveys	2.1	I
Climate/meteorological studies	1.6	III
Awareness/training events	1.9	II
Adaptation pilot projects	1.2	IV
Widespread adaptation efforts	1.0	V

Factors affecting the knowledge on climate change

Table 9 provides the result of binary logistic regression model to determine the most critical factors that influence the knowledge on climate change. The model's $\chi 2$ value of 23.45 and log likelihood ratio of -19.8703 indicate that all the variables in the model significantly influence the knowledge on climate change at 1%. The Pseudo R^2 =0.3904 means that 39.04 percentage of the knowledge on

climate change is governed by the tabulated 4 explanatory variables i.e. the model fits 39.04 percent to the given data.

Table 9 Factors determining knowledge on climate change

Know about climate change	**Coefficient**	**Standard error**
Gender of HHHs	-0.321	0.898
Age of HHHs	-0.190*	0.061
Year of schooling	0.038	0.116
Agriculture as major income source	-1.434***	0.881
Constant	12.966	4.290
Number of Observation	60	
Chi-Square Value ($\chi 2$)	23.45	
log likelihood ratio	-19.870	
R^2	39.04	

Note: * and *** denotes the level of significance at 10% and 1% respectively

The result revealed that age of HHH and Agriculture as a major income source were negatively significant at 10 percent level and 1 percent level respectively with negative sign. The result signifies that with the increase in age, the knowledge on climate change is decreasing as compared to the young people. Similarly individuals having agriculture as a major source of income have comparatively less knowledge on climate change as compared to the individuals with non-agriculture as major source of income. Khanal et al. (2017) stated that younger individuals and farmers having non-agriculture as major source of income are expected to have more knowledge and information about climate change and agronomic practices that they can use in response.

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IV. CONCLUSION

Climate change poses an increasing threat to the sustainability of agricultural production and livelihood strategies of poor and rural people worldwide. Agriculture is the primary source of food and is greatly dependent on weather and nature. It is primary mainstay of the majority of population and source of livelihood for most of the agriculture are heavily affected by the climate change and its implication in agriculture. Agriculture was the major occupation for the people of both rural municipalities. Farmers were gradually diverting towards other livelihood options like remittance, off farm activities, beside agriculture. Majority of farmers perceived changes in climate variability affected in maize production in recent years. Most of the farmer reported that there has been frequent drought and unseasonal rains. Frequent drought being the major problem possesses detrimental effect on the quality of maize. Farmers were deprived of modern technology and they mainly relied on radio, amongst others, for information about climate change. Change in temperature and rainfall pattern was experienced by majority of the farmers over the years. Minimal farmers' intensified routine activities like pruning, fertilizing and pest control practices to cope the discomforting consequences of climate change on maize crops. Government and non-governmental organizations carried surveys to analyze its' effect. Widespread adaptation efforts and their effective implement, at local and national levels, lags way behind the surging climate change. Empowering communities with information, technological skills, education and employment is the best way to address vulnerability. A location wise action-research is therefore necessary to identify and document climate change impacts and adaptation strategy. The local observations described above provide a clear direction for future research and for development planning and adaptation management programs in different ecological regions. Policy and program should be formulating holistic approach to mitigate climate change and improve livelihood of the local communities.

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REFERENCES

[1] CBS. (2014). Statistical Information on Nepalese Agriculture. Central Bureau of Statistics, Kathmandu, Nepal.
[2] Dahal, N. (2006). Implications of climate change in Nepal: Some observations and opportunities. Paper presented at 23rd Warden Seminar, November 2006 held in Pokhara, Nepal.
[3] Dale, R. F. (1983). Temperature perturbations in the Midwestern and South--eastern United States Raper and P. J. Kramer, Eds.) Pp.21-32. west view Press, Colorado, USA.
[4] FAOSTAT. (2010) Food and Agricultural Organization of the United Nations (FAO), FAO Statistical.

[5] IPCC. (2007) Summary for policymakers. In: M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. Linden and C. E. Hanson (Eds.). Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, UK. pp. 7-22.
[6] IPPC, (2007). Intergovernmental Panel on Climate Change. 4th Assessment Report: Climate Change
[7] Khanal, K. S, Dhungana. and S, Khanal. (2017). Perspective Response of Climate Change Impacts on Agricultural Crops in Sauraha-Pharsatikar VDC, Rupandehi District, Nepal. Int. J.Appl.Sci.Biotechnol. Vol 5(3): 345-355. DOI: http://dx.doi.org/10.3126/ijasbt.v5i3.18291.
[8] Lohani, S. N. (2007). Climate change in Nepal shall we wait until bitter consequences?. T he Journal of Agricultural Economics. 8(1).3845.
[9] Malla, G. (2008). Climate change and its impact on Nepalese agriculture. The Journal of Agriculture and Environment. Government of Nepal, Ministry of Agriculture and Cooperatives 9: 62-70.
[10] Malla, G. (2008). Climate change and its impact on Nepalese agriculture. The Journal of Agriculture and Environment. Government of Nepal, Ministry of Agriculture and Cooperatives 9: 62-70.
[11] MOAD. (2012). Selected indicators of Nepalese agriculture and population. Government of Nepal, Ministry of Agriculture Development, Agribusiness and Statistics Division, Kathmandu, Nepal. 2p.
[12] MoAD (2015). Statistical information on Nepalese agriculture (2014/2015). Agribusiness promotion and Statistics Division, Singh Durbar, Kathmandu, Nepal
[13] Pant, K.P. (2012). Climate Change and Food Security in Nepal. The Journal of Agriculture and Environment. 13. 919.
[14] Pokhrel, D.M. and B. Pandey. (2011). Climate Change Adaptation: Strategic Vision in Agriculture. The Journal of Agriculture and Environment. 12. 10412.
[15] Thomson, L. M. (1966). Weather variability, climate change and grain production. Science 188, 535-541.

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Prospects of Crop Insurance as a Risk management tool among the Banana Farmers of Kanchanpur District, Nepal

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***Abstract*—** *Out of 60 household literacy percentage of study area was found to be 80% which is above the national average. Major occupation of sampled household was agriculture (63.33%) which is nearly equal to the national scenario. Nearly 50% of total land was covered by banana cultivation. Between selected site of study, Punarbas municipal farmers were more likely to adopt insurance than Krishnapur municipal. Almost all insured farmer were aware about insurance before adopting crop insurance but only 3/4th of non insured farmer were aware about insurance and government policy related to insurance. Insured farmer motivation towards adoption of insurance was due to awareness provided by the insurance company and capacity to paying premium while some farmers were reluctant to adopt insurance due to untimely payment of claim and no faith in insurance company. The 80% of total insured farmers were reimbursed after bearing loss. While taking about continuity insurance if the government reduce the subsidy scheme, more than 90% insured farmers were willing to continue crop insurance but less than 1/4th of insured farmers were ready to continue insurance after complete withdrawal of subsidy scheme. About 60% of banana farmers will read to pay 3% premium rate if the government reduce the subsidy or without subsidy support. Adoption of insurance (100%) and price setting before harvesting (56.67%) were the main strategy to recover the loss by insurer farmers whereas crop diversification, crop management practices and price setting before harvest were the main strategy to minimize the loss by the non insurer farmers.*

Keywords*— *crop insurance, government subsidy, insurance premium, non-insured farmer, willingness to pay.

I. INTRODUCTION

Agriculture continues to be extremely important business which contributes more than 60% to the total national export (CBS, 2014). The Nepalese agriculture sector is based on the production of basic staple food grains. Very few farmers, who have stepped towards the HVC and other commercial crops, are not confident about the future because of the lack of credit, appropriate infrastructure and weather vagaries. Among the harvests of business significance, banana is a standout amongst the most critical natural product usually developed in sub-tropical and tropical part of the country. It is being developed since time immemorial in home yards for home utilization in Nepal (Gautam & Dhakal, 1994). Banana positioned third in production and fifth in territory among fruit crops in Nepal (CBS, 2014). Banana has great potential for income generation, enterprise development and job creation for the people.

Agriculture is directly exposed to the natural climate and weather. Banana having a weak fleshy pseudo stem and more weight at the top of plant is more prone to weather problems. Banana farmers in Nepal are facing many risks in their farming activities, the major being the windstorm. Banana farmers in Nepal are facing many risks in their farming activities, the major being the windstorm. The frequency of recurring windstorm is creating fear, anxiety and loss of production in banana farmers. To solve the issue to some extent National crop insurance directive was promulgated in 2013, but it's appropriate implementation and regulation has not been practiced intensively till date. The indigenous coping strategies such as crop diversification, irrigation maintenance and off-farm

strategies are not found effective anymore in this changed scenario. Due to low level of participation of farmers in the crop insurance, the future of this scheme is totally uncertain and no one is in the stage to say it by now.

In these situations this research helps to identify the perception of farmers toward crop insurance particularly in banana and determine their willingness to join and pay for it identifying the principle factors affecting the adoption of insurance schemes and would be helpful in policy recommendations to increase the farmers' participation in crop insurance schemes in near future.

There is great need to work in this sector and develop the future road map of the insurance scheme and banana farmers in Nepal. This research tries to identify the motivational factors for the farmers to adopt banana insurance.

Till today no any study has been carried out to drag the actual cause behind low level of participation and the factors influencing the decision for crop insurance. In this aspect crop insurance becomes most essential in our contest. To solve the issue to some extent National crop insurance directive was promulgated in 2013, but it's appropriate implementation and regulation has not been practiced intensively till date.

The National crop insurance policy also doesn't have much research base to proceed further effectively. To reduce this gap research is designed to achieve the following specific objectives; identify the risk involved in banana production in Nepalese context; evaluate the most important factors that influence farmer's decision for crop insurance and willingness to pay as crop insurance premium; assessing farmer's perception on crop insurance; assess farmer's willingness to adopt crop insurance as a risk management tool. This research would be quite helpful in policy recommendations to increase the farmers' participation in crop insurance schemes in near future.

II. MATERIALS AND METHODOLOGY

2.1. Study area

The study was conducted in Kanchanpur districts of far western of Nepal as it is one of the main banana producing districts. Punarbas and Krishnapur Municipality were purposively selected for the study with the consultation of the community level and district level organizations. These settlements are occupied by Brahmin, Chhetri, Dalit, Tharu, Janajati & others.

Kanchanpur District in the Mahakali Zone is Nepal's most western district in the Terai and shares its southern and western borders with India. The latitude and longitude of the region is 280 32″- 290 8″ and 800 3″- 800 33″ respectively. The maximum & minimum temperature of this area is 30.50 0C and 17.50 0C respectively and the annual rainfall is 1422.71 ml. The headquarters of this district is Mahendranagar, covers an area of 1610 km2 and has a population of 451,248 according to census 2011. The predominant language of this area is Nepali, Tharu, Rana Tharu, Doteli and Tamang.

2.2. Sampling size, sampling procedure and selection of the respondent

All the farmers from these two settlements were the target population for this study. During the selection of the respondents, only age of above 30 years and at least 15 years of settlements within locales were included in the sample, with the hope to make available of the valuable and useful information regarding the past trends of crop insurance in banana. Careful attention was paid to make the sample more inclusive. All together 60 households (30 insured & 30 non-insured) were selected purposively for the study from both Municipality.

2.3. Research instrument

Research instrument includes the semi-structured questionnaire which was pre-tested to nullify the errors present in the questionnaire. The research period lasts from 3rd march- 15th of April 2017. the housleholds selected for pre-testing were not selected during survey. Key informant interview was conducted and one focus group discussion to triangulate the information collected and also to aware farmers about the pros and cons of insurance and further recommendations and strategy.

2.4. Data collection

Both the primary and secondary informations were collected. Primary information was collected from the field survey and secondary informations were collected from the past literetures and most relavant study. For the collection of secondary information national and intersnational journal articles were used, ministry reports, websites and various national conferences papers were traced.

2.5. Data analysis

Both the descriptive and inferential statistics were used for analyzing data. Data analysis was done by using Ms- excel 2010 and IBM SPSS V.16. ranking was done by using the index of importance. This indexing technique was used to calculate the constraints associated with potato production in the Terai region (Subedi et al. 2019a) and wheat production (Subedi et al. 2019b). Similarly, Joshi and Kalauni (2020) and Shrestha and Shrestha (Shrestha & Shrestha, 2017) used this technique for ranking of

marketing problems in large cardamom and seed production & marketing constraints in maize respectively.

The index of importance was computed by using the formula:

$$\text{Iimp} = \sum \frac{Sifi}{N}$$

Iimp = index of importance

∑ = summation

Si = Ith scale value

Fi = frequency of ith importance given by the respondents

N = total number of respondents

III. RESULTS AND DISCUSSIONS

3.1. Characteristics of banana growers

In case of families adapting banana insurance, 51.67 percent were male and 48.33 percent were female with 86.67 percent of household were headed by male and remaining 13.33 percent were headed by female members. While in case of families not adapting banana insurance, 51.63 percent were male and 48.37 percent were female with 93.33 percent of household were headed by male and remaining 6.67 percent were headed by female members. From the descriptive statistics, age distribution of the banana farmers with insurance in the study area ranged from 22 years to 55 years with active population (15-60) representing 64.31 percent and mean age was 37.87 years. Similarly, the age distribution of the non-insurers ranges from 24 years to 46 years with active population (15-60) representing 64.63 percent and mean age was 34.17 years (table 1).

The average land holding of insurers was 8.513 ha among this banana had been cultivated in 4.163 ha. But in case of non-insurer the average land holding was 5.93 ha in which banana had been cultivated in 2.73 ha. Out of total cultivated land area 1.46 ha mean (60.58%) land was owned and 0.95 ha mean (39.42%) was taken in leased-in, among this mean land for banana cultivation was 1.15 (47.72%).

Table1. Characteristics of banana growers in the study area

Parameters	Insurers	Non-insurers
Gender		
Male	51.67	51.63
female	48.33	48.37
Head of family		
Male	86.67	93.33
female	13.33	6.67
Education		
Illiterate	20	20
Literate	45	45
Below SLC	16.67	16.67
PCL	16.67	16.67
University	1.67	1.67
Occupation		
Agriculture	63.33	63.33
Wage/Labor	41.67	41.67
Business	23.33	23.33
Service	16.67	16.67
Remittance	20	20
Average land holding		5.93
Own land	4.83	2.73
Lease land	3.68	1.15
Banana cultivated area	4.16	

3.2. Banana Insurance

3.2.1. Status of banana insurance

Table.2. Status of insurance by place of residence

Place of residence	NON –INSURED	INSURED
PUNARBAS	11(47.80)	12(52.2)
KRISHNAPUR	19(51.4)	18(48.6)
Total	30	30

Source: Field Survey (2017)

In case of families adopting banana insurance, 52.2 percent of banana farmers of Punarbas area were found to

be engaged in insurance but in case of Krishnapur area 48.6% banana farmers were adopting insurance which is minimum than Punarbas area (Table 2). It might be there were more access of Insurance Company & I/NGOs from both side (from Kailali and Kanchanpur) and also the farmers of Punarbas were most actively involved on commercial farming. Many I/NGOs might also focus on that region than Krishnapur. Similarly 47.80 % farmers of Punarbas and 51.4 % farmers of Krishnapur were not adopting insurance. Similar to our study half of the un-insured farmers were selected for the willingness to pay in chitwan district (Pant, Dutta, Kattel, & Dhungana, 2019). Since the insurance of agricultural commodity is newly introduced in Nepal and with reference to far-west region still many are unaware about it. (Budhathoki, Lassa, Pun, & Zander, 2019) reported that most of the farmers were positive regarding their crops in future to receive premium returns under losses.

3.2.2. Awareness about Insurance

Table 3. Awareness about insurance of banana by type of farmers

	Insured farmers		Non-insured farmer	
Awareness	F	Percentage	F	Percentage
About insurance	30	100	23	76.67
Insurance subsidy provided by government	30	100	23	76.67

Source Field Survey (2017)

All Insurers farmers were awared about the insurance and insurance subsidy scheme before adoption of crop insurance which was provided by government. More than 2/4th of non-insurers farmers 76.67 percent (23 out of 30) were awared about both of the scheme even they do not adopt insurance (Table 3).

3.3.3 Source of Information about Insurance Scheme

Table 4. Source of information on scheme by type of farmers

	Insured farmers		Non-insured farmer	
Source	F	Percentage	F	Percentage
Insurance company or agent	15	50.00	9	39.13
DADO	7	23.33	13	56.52
Media	0	0.00	1	4.35
Cooperatives and I/NGOs	8	26.67	0	0.00

Source: Field Survey (2017)

The source of information on insurance scheme by insurer farmers was Insurance Company i.e. 50 percent then followed by Co-operatives and I/NGOs (26.67%), and DADO (23.33%). No any farmers among insurers do not get information from media (Table 4). Similarly in case of non-insurer farmers' maximum percentage i.e. 56.52 percent of information were obtained from DADO then followed by Insurance Company or agent (39.13%) and Media (4.35%). But non-insurers farmers do not get information from NGOs & INGOs or Cooperatives. Farmers group and DADO was the main source of information regarding crop insuance (Ghimire et al., 2016).

3.2.4. Reason for not adopting crop Insurance

Table 5. Reason for no adoption of insurance by non-insured farmer-

Reasons	INDEX VAULE	RANK
Awareness of INS	0.73	IV
Capacity of paying premium	0.56	VI
Documentation difficulty	0.74	III
Faith in INS company	0.90	II
Timely payment of claim	0.93	I
Access of INS Companies	0.70	V

Source: Field Survey (2017)

Among the major hindrances for not adopting crop insurance by the farmers; not timely payment of the claim ranked first followed by lack of faith in insurance company then Documentation difficulty, awareness of insurance, access of insurance companies and capacity of paying premium ranked lastly. The ranking scale for reason for no adoption of insurance by non-insurer farmers is ranges from 1 to 4 in which 1 denotes the higher ranking and 4 denotes lower ranking for no adoption of insurance (Table 5). In case of non-insurer farmers if the index value is high then it's ranking as first but it is reverse in case of insurer farmers.

3.3.5. Motivation factors towards Insurance

Table 6. Motivation factors toward insurance to insured farmers

Factors	INDEX VAULE	RANK
Awareness of INS	0.26	I
Capacity of paying premium	0.27	II
Documentation	0.93	VI
Faith in INS company	0.53	III
Timely payment of claim	0.71	V
Access of INS Companies	0.69	IV

Source: Field Survey (2017)

Similarly as in non-insurer farmers the ranking scale ranges from 1 to 4 but if the index value is lower it prioritize as ranking first and for higher value of index it is ranked as last. Here in the above table 6, among the major motivational factors towards insurance by the farmers; Awareness of Insurance ranked first followed by capacity of paying premium, faith in insurance company, access of insurance companies, timely payment of claim and documentation ranked last. Insured farmers have to good access to pay for the premium needed to pay after premium and were also found to pay more than 75% average (Budhathoki et al., 2019).

3.2.6. Reimbursement of claim loss

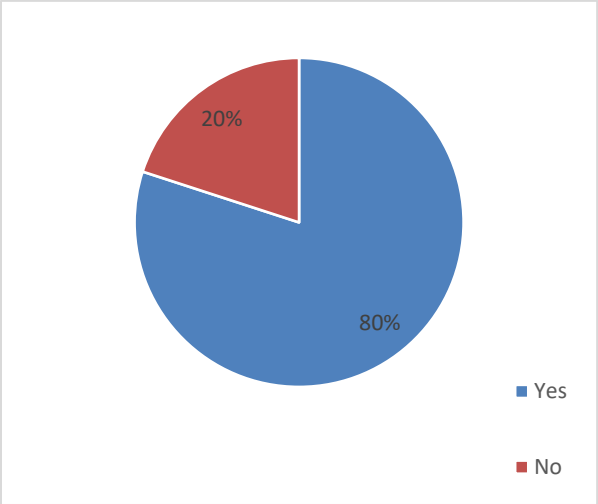

Fig.1: Reimbursement of claim loss

Among the total claimed of crop loss by banana farmers about 80 percent insurer farmers get reimbursement within 3 months to 10 months and only 20 percent farmers will not get reimbursement of claim (fig. 1.

3.2.7. Continuity of Insurance

Table 7. Continuity of insurance in study area

	Reduce subsidy		Withdrawal subsidy	
Continuity	F	%	F	%
Continue	28	93.33	7	23.33
Discontinue	2	6.67	23	76.67

Source: Field Survey (2017)

If the government reduce the subsidy provided to farmers for insurance, maximum number of farmers about 28 (93.33%) out of 30 were ready to adopt insurance and only 2 (6.67%) were discontinue the insurance. But if the government completely withdrawl the subsidy provision almost 76.67 percent of farmers were discontinue the insurance and only 23.33 percent farmers were ready to continue insurance (Table 7). The main reason regarding discontinuation of insurance is due to the insufficient amount of subsidy and even unfair policy regarding the payment for damaged crop and area.

3.2.8. Willingness to pay

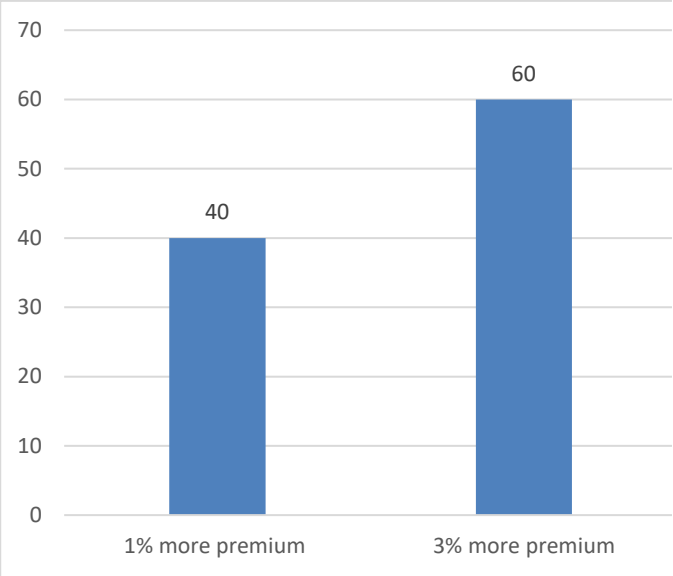

Fig.2: Willingness to pay premium rate

The 40 percent insurer farmers were ready to pay maximum extent rate at the rate 1% more if the government reduce the subsidy or without subsidy support and about 60 percent insurer farmers were ready to pay 3% more premium rate with reduce subsidy or without subsidy support (fig 2). Similar to our findings was reported by(Pant et al., 2019).

3.2.9 Strategy to recover loss

Table 8 Means to recover loss (Strategy to recover losses)

	Insured farmer		Non-insured farmers	
Strategy	F	Percentage	F	Percentage
Adoption of insurance	30	100.00	NA	
Do nothing	NA		8	26.67
Crop management practice	8	26.67	13	43.33
Price setting before harvest	17	56.67	11	36.67
Change the variety	2	6.67	5	16.67
Crop diversification	11	36.67	21	70.00

Source: Field Survey (2017)

To recover the crop losses multiple activities were found which was done by the farmers adopting insurance and not adopting insurance. For recover the loss from banana farming, farmers adopt insurance (100%), Price setting before harvest ranked first (56.67%) followed by Crop diversification (36.67%), crop management practice (26.67%), and change the variety (6.67%) ranked as last (Table 8). The amount of premium paid for the insurance of crops was determined by the nature of crop (Budhathoki et al., 2019) and even in some conditions change of firm under losses was adopted.

3.3.10 Stage of Insurance in banana

Most of the farmers insured the banana at early stage of growing and few numbers of farmers insured the banana before fruiting. The damaging stage of banana crops is before fruiting, early stage of fruiting and during harvesting. So farmers should insure their banana in early stage of growing.

3.3.11 Basis for Evaluation

Evaluation should be carried out by plant per hectare basis and premium per hectare basis. The amount of premium paid by banana farmers was higher than that of reported by (Budhathoki et al., 2019), this might be due to the premium payment under different crops. Basis on evaluation 5% premium should be paid, out total premium paid 75% premium was paid by government and only 25% premium was paid by the banana insurer farmers. The premium rate per plant was calculated by following ways:

Premium paid = Premium rate per plant * plant per hectare

= 2.5*2700

= Rs. 6075

Frequent re-evaluation will also be conducted by insurance company or agent.

3.3.12 Risky stage of banana production

The risky stage of banana cultivation was found to be during fruiting stage and before harvesting stage or fully matured stage.

3.3.13 Reason for insuring banana

- Banana more risky than other crops.
- Start Commercial farming only in banana.
- Newly started business
- If crop loss, destruction percentage will be more than other crops.

3.3.14 Reason of not insuring for the total crop area

- Remaining area shouldn't be used for banana cultivation.
- Done for trial purpose only.
- Due to less faith in insuring company.
- Due to unavailability of money during insuring time.

3.3.15 Basis for valuation of claim settlement

Field visit by DADO agent, ASC, insurance company agent, Police (Anju, 2018).

3.3.16 Improvement needed in the existing valuation and premium payment provisions for banana insurance.

The valuation should be done on the field during destruction and percentage of reimbursement of claim should also announced at that time.

- If increase in premium rate, there should be provision of full payment on time.
- The loss percentage should be fully recovered.
- Made easy assessment of claim settlement.
- Timely and easy access of documentation and service delivery.
- No need to increase the government subsidy but made the claim procedure easy, timely provision of payment, full recovery of loss, etc.

3.3.17 Reason for not going other crops and livestock insurance

- Not done in a commercial way.
- No assess of insurance company.
- Less chance of losses than banana crops.
- Lack of awareness.
- Lack of premium paying capacity.
- Complex Documentation.
- No faith in the scheme/agency.

3.3.18 Benefits of having Insurance agent in the community

- Easy in Documentation.
- Timely provision of reimbursement of the claim for the crop losses.
- Easy in claim payment.
- Easy in premium payment.
- Easy in claim procedure and valuation.

3.3.19 Difficulties of not having Insurance agent in the community

- Take long time for loss settlement.
- Difficulty in claim procedure.
- Low assess of insurance service provider to the farmer's field.
- Difficulty in documentation.
- Difficulty in searching the insurance agent.
- Loss of claim payment due to unavailability of insurance agent during destruction.
- Difficulty in valuation process.

3.3.20 Condition for insuring banana crop

- If easy access of claim procedure.
- If timely reimbursement of claim.
- If valuation method made easy.
- If easy in documentation.
- If easy access of Insurance agent, DADO agent.
- If provision of full payment of claim according to losses.
- If claim payment is sure and easy in claiming.
- If easy access of government subsidy during loss condition.

3.3.21 Suggestions of improving Agricultural insurance

Government should pay full attention on insurance service provider.

- Access of insurance agent in their V.D.C.
- Provision of losses in time.

Provision of full payment of loss should be given to the farmers.

- Documentation process should be made easy.
- Direct supervision should be made by Government agency.
- Valuation should be done in the field by government agency during loss occurs.

- Exact valuation of loss should be done in time and made valuation easy.
- Equally treated to all farmers i.e. no biasness in between farmers.

IV. CONCLUSION

Female household heads were more likely to adopt insurance. Access of source of information as more influences factors for adopting insurance if government provided premium subsidies. Timely payment of claim, faith of Insurance Company and documentation of insurance had negative attitude towards crop insurance among farmers even they incurred loss. Different INGOs and NGOs, Insurance Company should have collaboration with government agency will increase the adoption of crop insurance.

REFERENCES

[1] Anju, T. P. and A. (2018). Importance , Scope and Status of Agriculture Insurance in Nepal. *Journal of Agricultural Economics and Rural Development*, *4*(1), 365–371.

[2] Budhathoki, N. K., Lassa, J. A., Pun, S., & Zander, K. K. (2019). Farmers' interest and willingness-to-pay for index-based crop insurance in the lowlands of Nepal. *Land Use Policy*, *85*(October 2018), 1–10. https://doi.org/10.1016/j.landusepol.2019.03.029.

[3] CBS. (2014). Statistical Information on Nepalese Agriculture. Central Bureau of Statistics, Kathmandu, Nepal.

[4] Gautam, A. K., &Pokhrel, S. (2010, February). Climate change effects on agricultural crops in Nepal and adaptation measures. In *Thematic Working Group (agriculture and food security) meeting*.

[5] Ghimire, Y. N., Timsina, K., Kandel, G., Thapa Magar, D. B., Gautam, S., & Sharma, B. (2016). *Agriculture Insurance in Nepal: Case of Banana and Livestock Insurance*. (July), 1–12. https://doi.org/10.13140/RG.2.1.4767.6403.

[6] Kalauni, D., & Joshi, A. (2020). Value chain analysis of Large Cardamom (Amomum subulatum Roxburg) in Bhojpur, Nepal. *Journal of Agriculture and Natural Resources*, *3*(1), 95–116. https://doi.org/10.3126/janr.v3i1.27102.

[7] Pant, P., Dutta, J., Kattel, R., & Dhungana, S. (2019). farmers willingness to pay for crop insurance in chitwan nepal. *The Journal of Agriculture and Environment*, *20*(2).

[8] Shrestha, A., & Shrestha, J. (2017). Production, Problems and Decision Making Aspects of Maize Seed Producers in Banke District, Nepal. *Azarian Journal of Agriculture*, (February 2018).

[9] Subedi, S., Ghimire, Y. N., Adhikari, S. P., Devkota, D., Shrestha, J., Poudel, H. K., & Sapkota, B. K. (2019a). Adoption of certain improved varieties of wheat (Triticum aestivum L.) in seven different provinces of Nepal. *Archives of Agriculture and Environmental Science*,*4*(4),404–409. https://doi.org/10.26832/24566632.2019.040406

[10] Subedi, S., Ghimire, Y. N., Gautam, S., Poudel, H. K., & Shrestha, J. (2019b). Economics of potato (Solanum tuberosum L.) production in terai region of Nepal. *Archives of Agriculture and Environmental Science*, *4*(1), 57–62. https://doi.org/10.26832/24566632.2019.040109.

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Mini-seedling budding of *Hevea brasiliensis*: forty years of efforts in China

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Abstract*— *Good varieties are the basis for long-term high, stable and efficient production of rubber trees. Mini-seedling buddings have the characteristics of short nursery period, low labor intensity, large number of seedlings per unit area, easy transportation and planting, well-developed taproot and intact root system, high survival rate after planting, fast growth, strong tolerance to drought, wind and cold, and early tapping. The application of rubber mini-seedling buddings and its related research were summarized. Finally, the outlook for ongoing research on mini-seedling buddings was prospected.

Keywords*— *Hevea brasiliensis, mini-seedling budding, propagation, application.

I. INTRODUCTION

Mini-seedling budding of *Hevea brasiliensis* is a new propagation technique of elite clone on the basis of traditional budding method, which was developed by Rubber Research Institute, Chinese Academy of Tropical Agricultural Sciences [1-3], and was listed by the Agriculture Ministry of China as the first batch of main push varieties and technology of south subtropical crops during the 11th Five Year Plan period. Mini-seedling budding technique use 2-week-old seedlings, which are pulled out of the germination bed with seeds (nutrient provider for budding and further growing), with about 20cm plant height and leaf phenology between elongating stage to leaf-unfolding stage[4-5], as rootstock and green bud- patches as scion[6-14]. The budding operation process is done at indoor, which reduce labor intensity comparison with traditional budding in the field. After budding the budded seedlings are directly transferred into nursery bags or pre-planted on sand bed or nursery trays with some shade. After budding successfully, two compound leaflets are kept on the seedling stocks when topping to avoid dieback [15-16], rootstock bud are picked[17-18], scion bud sprouting [19-23], and the buddings are raised up to 2-3 leaf whorls during 5-8 months with above 0.4cm shoot diameter[24-27]. Raising polybag-budding by mini-seedling budding technique are 3-12 months less than those by traditional propagation, which reduce propagation costs and labor intensity and increase nursery productivity per unit area (Table 1). Mini-seedling budding shorten rootstock growth time by using small rootstocks for budding. The weight of polybag buddings raised by mini-seedling budding is twice lighter than those raised by compared with the traditional method for raising budded stumps, resulting in lower cost and less labor intensity as well as higher productivity of the nursery per unit area. Mini-seedling buddings with good taproot and intact roots is easy to transport and transplant. In addition, mini-seedling buddings are characterized by high survival rate of field transplanting, fast growth after transplanting, wind tolerance [28], cold resistance [29], and drought resistance [30], early tapping (nearly one year shorter than traditional buddings). Taken together, in contrast to traditional buddings, mini-seedling budding can save cost and increase income by 0.5-1.0 yuan per plant [3, 31]. The cost of rubber plantation raised by mini-seedling buddings at nursery period and immature period is 6450 yuan per hectare less than that raised by traditional buddings, showing good economic benefits [32].

Table.1:Comparison on nursery time of buddings at 1-3 leaf whorls by different propagation

Nursery types	rootstock diameter(cm) at budding	nursery time(month)
polybag budded stumps	1.50-3.00	≤20
Green budding	0.60-1.40	≤12
Young budding	0.40-0.50	≤10
Mini-seedling budding	0.30-0.40	≤8

Note：nursery time is from sowing seeds to transfer budded plants out of the nursery.

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II. RESEARCH AND DEVELOPMENT HISTORY

Mini-seedling budding of *Hevea brasiliensis* was begun research in 1980 and begun to take shape in 1983-1984. Reform of scientific research institutions in China was begun in 1986, which meant researchers had to fund their own research. In 1987, Huang Shoufeng group applied for a research loan (3000 yuan) from Rubber Research Institute to multiply mini-seedling buddings, sold them and repaid the loan. Meanwhile, mini-seedling buddings were transplanted in the field. After that, the research of mini-seedling budding stagnated without funding. Mini-seedling buddings were raised again in 1996 and prepared for the assessment of scientific and technological achievement in 1998. After appraisal, the research of mini-seedling budding stalled again without funding. Popularization of large-scale trial planting mini-seedling buddings was supported by the earmarked fund for China Agriculture Research System (CARS-34-YZ4) since 2005-2006.

III. POPULARIZATION OF LARGE-SCALE TRIAL PLANTING

Mini-seedling budding was introduced and outreached in Hainan Province [33], Yunnan Province [34-36] and Guangdong Province [37-42], respectively. Since its popularization in Yunnan Province in 2003, it has been rapidly recognized by the majority of seedling raising farms and planting farmers. In 2019, the number of rubber mini-seedling buddings promoted by the rubber tree seedling breeding base of Yunnan Institute of Tropical Crop Science had exceeded 1.2 million, covering an area of over 2666.67 hm2. In 2005, Jinghong Farm of Yunnan Agricultural Reclamation introduced mini-seedling budding and conducted three training sessions on mini-seedling budding training, with a cumulative total of 310 training persons. From 2005 to 2011, 304,848 plants were transferred out of the nursery, with a survival rate of 46% and a nursery rate of 95.8% [36]. Jinghong branch of Yunnan Natural Rubber Industry Co., Ltd. could produce 50,000 mini-seedling buddings in 2007. In 2008, Xishuangbanna successfully introduced mini-seedling budding, and extended to production, and 22,200 mini-seedling buddings were raised in private breeding farms and planted in 50 hm2 to rubber farmers [34]. The industrialization and large-scale production of mini-seedling budding has been realized in state farms of Guangdong Agricultural Reclamation Tropical Crop Research Institute. The annual production capacity of rubber mini-seedling budding has exceeded 1 million plants [37]. The problem is that the technical team of mini-seedling budding is unstable, which affects the industrialization and large-scale production of mini-seedling budding. Therefore, it is necessary to train a group of skilled mini-seedling budding workers before the beginning of budding production every year, the new and old mini-seedling budding workers should be trained to be as skilled workers as possible before taking up the job[37]. Furthermore, there are 4 standards related to the study of seedling bud grafting, including one national industry standard [43], one national standard [44], and two local standards [45-46].

According to the above-mentioned production and promotion of mini-seedling budding, the survival rate of bud grafting needs to be further improved, and the increased demand for skilled workers for bud grafting during the season of bud grafting needs to be solved.

IV. THE OUTLOOK FOR ONGOING RESEARCH AND DEVELOPMENT

Breakthrough on technology and mechanism of rubber seed storage Rubber seeds are moderately recalcitrant seeds that can tolerate moderate dehydration and slightly higher temperatures[47], with a critical moisture content of 13% [48], and germination decreased by about 40% when seeds are stored indoors for half a month after falling from the tree. However, rubber seed has a short viability period when exposed to direct light (Table 2).

Table.2: Germination percentage of rubber seed exposed to sunlight

Time of exposure to sunlight(day)	Germination percentage(%)
1	95
2	68
3	9
4	1
5	0

Source: Prang Besar Research Station (PBRS)

Therefore, seeds must be collected daily or alternate daily and set for germination immediately. If rubber seeds are not sown in 10-15 days, they lose viability on storage as a result of the production of hydrocyanic acid (HCN), but over 90% of the cyanogenic material is consumed to form non-cyanogenic compounds during seedling development, and the cyanogenic glucosides are believed to be transported and metabolized in the young growing tissues[49].

Taken together, the initial seed quality, seed moisture content and preservation environment are the three major factors affecting the longevity of seeds. Due to the wide variation in maturity and development stages of rubber seeds, the initial quality of the seeds during storage is not consistent, which affects the stability and repeatability of different storage methods (Table 3). The seed storage technology of *Hevea brasiliensis* can not only be used in seedling raising, but also can be used for rootstock screening. The breakthrough of this technology and mechanism will greatly improve the technical level of rubber tree seedling nursery.

Table.3: Different storage methods of rubber seeds

Core of storage	Storage time
-7-7℃ [50]	About a year
Germination and storage in cold storage at 12-13 ℃ [51]	more than three months
River sand and compound for seed [52]	short and medium term
Paraffin embedding [53]	About a year
polyethylene glycol 1500[49]	Six months
7℃-10℃ [54]	three months
Sawdust and 10℃/22℃/27℃[55]	three months
Pick seeds from the rubber tree [55]	92-100 days
Water storage [56]	one month

Mechanism on budwood quality control of mini-seedling budding Budwood quality mainly include diameter and rejuvenation of bud patches. The older the bud stick, the lower budding survival rate and bud breakout rate, the more sensitive to disease of leaf and root, resulting in rubber clone degradation and the decline of growth and yield. The increase rate of rejuvenated rubber buddings in yield was more than that in stem growth [57]. Therefore, rejuvenation of bud stick plays a very important role in improving quality of rubber buddings. Bud sticks rejuvenation is required in rubber tree seedlings (NY_1686-2009), which is regenerated by the method of repeated budding with healthy and strong rootstock and renewed every 5 years. In the technical regulation of rubber tree seedling propagation (NY_1686-2018), rejuvenation of bud stick is required once every 4-5 years by cutting stock and re-budding or re-planting and bud stick is from bud wood resource nursery. The diameter of rootstock used for seed seedling bud grafting is small (about 0.4cm). The survival rate of s mini-seedling budding can be improved by selecting the bud strips with the same diameter as the rootstock. At present, the methods of bud proliferation used in mini-seedling budding are as follows: the green cluster buds in the outdoor by repeatedly cutting off and re-sprouting [44], and the young bud stick in the outdoor bud wood nursery (not lignified, 5-8cm in the length and 0.3-0.5cm in diameter) [58], the proliferation buddings with more than 3 whorls in green house[53], and the micropropagation of anther tissue culture [51]. As mentioned above, bud stick propagation mainly focused on the diameter, but there is little systematic study on the effect and mechanism of bud stick rejuvenation (such as rejuvenation times), on the quality of bud stick and budding. The juvenility characteristics of bud stick can be recovered by rejuvenation (repeated budding of the old bud stick on the new seedling stock or by tissue culture) , and the survival rate of mini-seedling budding can be significantly increased by juvenile bud stick, and the budding trees from juvenile buds showed fast growth and high yield in the field. The higher yield of juvenile clones of *Hevea brasiliensis* was demonstrated by the differential expression of some genes [58-63] , transcriptome level [64] , proteome level [65] and epigenetic level [66](Table 4) , and these results can provide inspirations for the quality control of min-seedling budding propagation, and further more consistent material for early yield screening [67].

Improvement of sprouting uniformity of mini-seedling budding After cutting back, mini-seedling buddings take different days to sprout, and lead to unsynchronized growth of leaf phenology, which increased intensity of grading buddings before taking out of nursery and production cost. Therefore, to reduce nursery intensity, sound preparation for budding like rejuvenation of bud patches, enough and strong bud patches, vigorous rootstock with strong stem and healthy taproot, pre-planting in trays after budding (Table 5) and cutting back at the same time [68] to sprout and grow evenly.

Table.5: Effect of pre-planting on dieback rate of mini-seedling budding after transplanting in 6 months

Pre-planting	dieback rate（%）
Trays with coir	9.31±4.79bB
Sand bed	13.95±4.01aA

Note: For trays, 63 repeats, each repeat contains 240 plants. For sand bed, 36 repeats, each repeat contains 231 plants.

Table. 4: Genetic, transcriptomic, proteomic, and epigenetic differences between juvenile and mature clones of rubber trees.

Clones	Tissue	Differential expression
Unknown	Leaf, flower, bud, latex, bark	*HbCMT1* transcripts accumulated in various examined tissues, with high expression levels in the leaf and low levels in the latex. *HbCMT1* transcript expressed at different levels with the lower in self-rooting juvenile clones than in their donor clones [58]. *Hb14-3-3a* and *Hb14-3-3b* were differentially expressed in flower, leaves, barks and latex of *Hevea brasiliensis*. *Hb14-3-3*a transcripts accumulated at relatively high levels in the barks, while *Hb14-3-3b* transcripts accumulated at relatively high levels in the leaves [59]. *HbHDT1* was differentially expressed in the flower, callus, embryos, leaf, bud and latex, and was not induced in the latex by jasmone acid and ethylene [60]. A translationally controlled tumor protein (*TCTP*) was constitutively expressed in the latex, leaves and barks, and induced by ethylene [61].
Haiken 2[62]	latex	Suppression subtractive hybridization method showed that comparison with DCs, 95 genes were upregulated and 81 downregulated in self-rooting JCs, respectively. Systematic analyses of the differentially expressed genes between self-rooting JCs and DCs suggest that rubber biosynthesis, production, and scavenging of reactive oxygen species may have significant functions in high-yielding self-rooting JCs.
CATAS7-33-97, Haiken2[63]	Flower, somatic embryo, leaf, callus, latex	*HbTRX1* was constitutively expressed in all tested tissues. *HbTRX1* transcripts accumulated at relatively low levels in the flower, somatic embryo, and leaves, while HbTRX1 transcripts accumulated at relatively high levels in the callus and latex. The HbTRX1 transcript was expressed at different levels, with higher levels in self-rooting juvenile clones than in their donor clones.
CATAS 7-33-97, Haiken 2[64]	latex	Comparative transcript profiling indicated that 1716 genes were identified as differentially expressed between self-rooting JCs and DCs. Functional analysis showed that the genes related to the mass of categories were differentially enriched between the two clones. Several genes involved in carbohydrate metabolism, hormone metabolism and reactive oxygen species scavenging were up regulated in self-rooting JCs.
Haiken 2[65]	latex	The proteomic approach showed that comparison with donor clones, 13 proteins were upregulated, 11 proteins were downregulated in self-rooting juvenile clones. These proteins were classified as carbohydrate and energy metabolism, secondary metabolism, signal translocation, transcriptional regulation-related, protein synthesis and degradation, transport, nucleoside acid process, lipid metabolism.
CATAS 8-79[66]	leaf at bronze stage	The genomic DNA methylation showed that the juvenile clones was 33.2% and the mature clones was 22.9%, and different expressed fragments were related with metabolism and cell growth.

Container of mini-seedling budding and mechanized seedling nursing Different container mini-seedling buddings can be grown depending on the environment in which they are planted, e.g., mini-seedling buddings raised in small root-tubes with 2-3 leaf whorls are suitable for remote mountainous areas, mini-seedling buddings raised in large container with 4-6 leaf whorls are suitable for flat and of high value for intercropping. Currently, sales of rubber buddings are also severely affected due to the ongoing downturn in rubber prices, and the exploration of mechanized seedling nursery in container of mini-seedling budding seedling is still lagging.

V. CONCLUSION

Mini-seedling buddings are widely raised in China rubber plantation for the characteristics of short nursery period, low labor intensity, large number of seedlings per unit area, easy transportation and planting, well-developed taproot and intact root system, high survival rate after planting, fast growth, strong tolerance to drought, wind and cold, and early tapping. However, there are several scientific problems such as seed storage, budwood quality, sprouting uniformity and mechanized container nursing to be solved in the future.

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REFERENCES

[1] Huang S (1988) Mini-seedling rootstock budding technology research bulletin. Tropical Crops Research, (2):60.
[2] Huang SF (1989) A new method of rubber asexual propagation ——Mini-seedling budding of *Hevea brasiliensis*. Chinese Journal of Tropical crops (01):25-31.Puangbut, D., S. Jogloy, and N. Vorasoot, 2017: Association of photosynthetic traits with water use efficiency and SPAD chlorophyll meter reading of Jerusalem artichoke under drought conditions. Agricultural Water Manage 188, 29-35.
[3] Lin WF, Huang SF, Xie GS, Cai MD, Chen JM (1998) Mini-seedling budding of *Hevea brasiliensis*. Chinese Journal of Tropical crops (03):8-15.
[4] Wang BZ, Dong JH, Sun MZ (1992) Fundamental physiology of budding success of mini-seedling budding of *Hevea brasiliensis*. Chinese Journal of Tropical Crops (02):9-14.
[5] Wang BZ, Dong JH, Pan XX, Huang JW, Pan HY, Hu MY (1993) Physiological parameters of roots in relation to budding success of mini-seedling budding. Chinese Journal of Tropical Crops (01):9-14.
[6] Chen XT (2008) In vitro Rapid Propagation on min-type bud patches and its application in mini-seedling budding of *Hevea brasiliensis*. World Tropical Agriculture Information (11):28.
[7] Chen XT, Zhang XJ, Wang Y, Wu KX (2008) A method of mini-seedling budding of *Hevea brasiliensis* by raising micro-type budwood., p 7.
[8] Gui MC, Liang GP, Duan AA, Xiao SY (2011) The effect of temperature on in vitro mini-type budding stick of *Hevea brasiliensis*. Tropical Agricultural Science and Technology 34 (03):5-7.
[9] Huang Z, Wang LQ, Liang FY, Chen HJ, Zhou GM, Zhou JZ, Zhang N, Ni YM, Zhang QQ (2012) A method of multiplying green and small budwood in mass production., p 5.
[10] Zhang N, Huang Z, Liang QL, Liang FY (2012) Research on multiplication technology of green and small budsticks of *Hevea brasiliensis*. Chinese Journal of Tropical Crops 33 (05):881-885.
[11] Liang GP, Sun XL, Ning LY, Gui MC, Tian H, Huang FX, Guan Y, Li L (2014) A method of mini-seedling budding of *Hevea brasiliensis* by raising young budwood and budding., p 5.
[12] Yu JJ, Tang M, Tian H, Li L, Guan Y, Liang GP, Li XQ, Gui MC (2018) The effect of different lignified scions on the growth of grafted mini-seedling of *Hevea brasiliensis*. Tropical Agricultural Science & Technology 41 (02):5-8.
[13] Sun XL, Tian H, GUI MC, Tang M, Liang GP (2019) Experiment of mini-seedling grafting with different buds from different budwoods of rubber trees. Tropical Agricultural Science and Technology 42 (4):1-3, 8.
[14] Tang M, Tian H, Liang GP, Li XQ, Gui MC (2019) The differences of leaf morphology of grafted mini--seedling from mature and juvenile types of *Hevea brasiliensis* clones. Tropical Agricultural Science and Technology 42 (01):21-24.
[15] Zhou J, Wang J, Lin WF, Cai MD, Zhang RQ (2013) Rootstock Treatments on the Growth of Three Kinds of Budding of Rubber Tree. Chinese Agricultural Science Bulletin 29 (16):29-31.
[16] Zhou J, Lin WF, Wang J, Cai MD, Zhou LJ (2014) Effect of Different Truncated Rootstock Treatments on Growth. Guizhou Agricultural Sciences 42 (11):119-122.
[17] Chen JM, Cao JH, An F, Cai XQ, Zou JX, Wang J (2009) A needling method to pick bud for mini-seedling budding of *Hevea brasiliensis*., p 5.
[18] Zhou J, Lin WF, Cai MD, Wang J, Zhou LJ, Chen XH, Zhang XC, Zeng XH (2014) A method of bud-picking of mini-seedling budding of *Hevea brasiliensis*., p 6.
[19] Huang SF, Lin WF, Wang BZ (1994) Continuation research on mini-seedling rootstock budding of *Hevea brasiliensis* - techniques for promoting the sprouting. Tropical crops research (02):8-14.
[20] Chen HJ, Xie GS, Cai MD (2006) Promotion of scion bud in mini-seedling rootstock budding of *Hevea brasiliensis* using different combinations of phytohormones. Chinese Journal of Tropical Crops (02):1-5.
[21] Zhang N, Liang QL, Huang CH, Huang Z, Liang FY, Zhou SX, Huang MC (2012) A method of promoting sprout of mini-seedling budding of *Hevea brasiliensis*., p 5.
[22] Chen XH, Lin WF, Zhou J, Wang J, Cai MD, Yao XC (2014) A method of improving consistency on sprout and growth of mini-seedling budding of *Hevea brasiliensis*., p 7.
[23] Wang JK, Wang LF, An F, Xie GS (2015) Plant growth regulator stimulation on sprout and growth of mini-seedling rootstock budding of *Hevea brasiliensis*. Chinese Journal of Tropical Agriculture 35 (04):4-10.
[24] Zhang N, Huang Z, Pan Y, Li PY (2011) Factors Influencing Iron Deficiency Chlorosis of Container Rubber Seedlings and Correction Technique. Chinese Journal of Tropical Agriculture 31 (05):4-8.
[25] Chen Q, Zhou J, Wang J, Lin WF, Li LP (2018) Effects of different water and fertilizer drip irrigation treatments on growth of rubber mini-seedling polybag-raised buddings. Journal of Southern Agriculture 49 (03):525-529.
[26] Zhou J, Chen Q, Wang J, Lin WF (2018) Effect of different mediums on the growth of rubber small polytube-raised buddings. Journal of Agricultural Science and Technology 20 (02):33-38.
[27] Zhou J, Wang J, Lin WF, Cai MD (2013) Effect of different mediums on the growth of rubber container buddings. China Tropical Agriculture (05):57-59.
[28] Lin WF, Xie GS, Huang SF, Cai MD, Chen JM (1999) Multi-spot experiment and primary demonstration of mini-

seedling budding of *Hevea brasiliensis*. Chinese Journal of Tropical Agriculture (03):39-43.
[29] Zhang YY, Wang JK, Yang C, Xie GS (2013) Effect of chilling stress on physiological characteristics of two kinds of rubber seedlings. Southwest China Journal of Agricultural Sciences 26 (02):559-564.
[30] Hu JL, He XY, Chen K, Zhang YN (2015) Comparison on drought-tolerance of three planting materials of *Hevea brasiliensis*. Modern Agriculture Technology (21):157-158.
[31] Liu ZL, Lin BJ (2011) Introduction and extension of mini-seedling rootstock budding of *Hevea brasiliensis* in Yunnan Province. Tropical Agricultural Science and Technology 34 (01):7-9.
[32] Mini-seedling budding of *Hevea brasiliensis* (2018). http://www.catas.cn/xjs/contents/572/126277.html.
[33] Lin WF, Xie GS, Huang SF, Cai MD, Chen JM (1999) Multi-spot experiment and primary demonstration of mini-seedling budding of *Hevea brasiliensis*. Chinese Journal of Tropical Agriculture (03):39-43.
[34] Liu ZL, Lin BJ (2011) Introduction and extension of mini-seedling rootstock budding of *Hevea brasiliensis* in Yunnan Province. Tropical Agricultural Science and Technology 34 (01):7-9.
[35] Sun XL, Liang GP, Gui MC, Ning LY, Tian H, Huang Q (2017) A method of rapid nursery for mini-seedling budding of *Hevea brasiliensis*., p 6.
[36] Ding C, Li B, Wang QB, Guo FX (2012) The introduction and application of mini-seedling rootstock budding of *Hevea brasiliensis*. Bulletin of agricultural science and technology (05):223-225.
[37] Chen HJ, Huang Z, Wang LQ, Liang FY (2011) Familiarization and application promotion of mini-seedling rootstock budding of *Hevea brasiliensis*. China Tropical Agriculture (04):50-51.
[38] Liao JX, Chen DJ, Yao LY, Zheng QK (2018) Analysis of familiarization and application promotion of mini-seedling rootstock budding of *Hevea brasiliensis.* Peasant Family Technology (11):13.
[39] Ni YM, Huang Z, Wang LQ, Liang FY, Zhou JZ, Zhang QQ, Jiang ZH (2012) Factory propagation of rubber seedling budding technology. Tropical Agricultural Engineering 36 (06):18-21.
[40] Wang SS, Hu NS, LI QY, Chen W (2012) Exploration and practice of mini-seedling rootstock budding of *Hevea brasiliensis*. Modern Horticulture (14):6.
[41] Chen W, Li QY, Liu JR, Wang SS, Hu NS (2010) Production trials of mini-seedling rootstock budding of *Hevea brasiliensis*. Tropical Agricultural Engineering 34 (01):45-48.
[42] Huang Z (2011) Optimization and improvement of mini-seedling rootstock budding of *Hevea brasiliensis*. Tropical Agricultural Engineering 35 (04):28-32.
[43] Technical Committee for Standardization of Tropical Crops and Products of Ministry of Agriculture and Rural Development (2009) rubber tree seedlings. GBT17822.2-2009.
[44] Technical Committee for Standardization of Tropical Crops and Products of Ministry of Agriculture and Rural Development (2018) The technical regulation of rubber tree seedling propagation. NYT 1686-2018.
[45] General Bureau of Agricultural Reclamation of Yunnan Province (2019) The technical regulation of mini-seedling budding production of *Hevea brasiliensis*. DB5328/T 10-2019.
[46] Market supervision and Administration Bureau of Xishuangbanna Dai Autonomous Prefecture (2016) The technical regulation of mini-seedling budding production of *Hevea brasiliensis*. DB5328T10-2016.
[47] Tian XM, Li HL, He Y, Hong QM, Hu WB, Li Q (2014) Research progress on recalcitrant seeds storage of tropical crops. Chinese Journal of Tropical Agriculture (8):52-58.
[48] Zhou LJ, Lin WF, An F, Zhou J, Wang J. Chen XH, Zhang XC, Zeng XH, Zou JX (2013) A storage method of rubber seeds., p 6.
[49] Priyadarshan, P.M. (2011) Biology of *Hevea* Rubber. Wallingford, UK: CABI, 24.
[50] Xie GS, Huang YF, Lin WF, Chen JM, An F, Tao ZL, Wu ZX, Cao JH, Wang J, Zou JX, Cai MD, Zeng XH, Zhang XC (2008) Low temperature storage of rubber seeds., p 6.
[51] Chen XT (2008) Storage technology of rubber seeds., p 4.
[52] Zhou LJ, Lin WF, An F, Zhou J, Wang J. Chen XH, Zhang XC, Zeng XH, Zou JX (2013) A storage method of rubber seeds., p 6.
[53] Lin WF, Wang J, Wei HQ, Cao JH, An F, Xie GS (2008) A storage method of rubber seeds., p 6.
[54] Rubber plantation and processing technologies (2009). Kuala Lumpur, Malaysia: Malaysian Rubber Board, 49.
[55] Feng GS (1996) Experiment on rubber seeds sown in spring and stored in winter. Journal of Yunnan Tropical Crops Science & Technology 19 (4):33-34.
[56] Fu JR (1991) Recalcitrant seed. Plant Physiology Communications 27 (6):402-406.
[57] Carron MP, Tian L (2010) Field trials network emphasizes the improvement of growth and yield through micropropagation in rubber tree (*Hevea brasiliensis*, Muëll. Arg.). World Tropical Agriculture Information (6):1-6.
[58] Li HL, Wang H, Yang ZP, Guo D, Peng SQ (2015) Cloning and Expression Analysis of *HbCMT1* in *Hevea brasiliensis*. Journal of Plant Genetic Resources 16 (4):842-847.
[59] Li HL, Guo D, Peng SQ (2010) Cloning and expression of 14-3-3 protein genes from *Hevea brasiliensis*. Chinese Journal of Tropical Crops 31 (09):1452-1457.
[60] Lu HZ, Li HL, Guo D, Peng SQ (2010) Cloning and Expression Analysis of *HbHDT1* in *Hevea brasiliensis*. Chinese Journal of Tropical Crops 31 (1):59-64.
[61] Liang XL, Li HL, Peng SQ (2009) Cloning and Expression of *HbTCTP* in *Hevea brasiliensis*. Molecular Plant Breeding 7 (1):188-193.
[62] Li H, Guo D, Peng S (2014) Differential gene expression profiles in latex from *Hevea brasiliensis* between self-rooting juvenile and donor clones. Plant Growth Regulation:65-71.

[63] Li H, Lu H, Guo D, Tian W, Peng S (2011) Molecular characterization of a thioredoxin h gene (*HbTRX1*) from *Hevea brasiliensis* showing differential expression in latex between self-rooting juvenile clones and donor clones. Mol Biol Rep 38 (3):1989-1994.
[64] Li H, Guo D, Zhu J, Wang Y, Chen X, Peng S (2016) Comparative Transcriptome analysis of latex reveals molecular mechanisms underlying increased rubber yield in *Hevea brasiliensis* self-rooting juvenile clones. Front Plant Sci 7.
[65] Li H, Guo D, Lan F, Tian W, Peng S (2011) Protein differential expression in the latex from *Hevea brasiliensis* between self-rooting juvenile clones and donor clones. Acta Physiol Plant 33 (5):1853-1859.
[66] LI HL, Li WG, Yang ZQ (2014) MSAP Analysis of Juvenile Clones and Mature Clones of *Hevea brasiliensis*. Chinese Journal of Tropical Crops 35 (4):617-621.
[67] Bao J, Zhang SX, Shi MJ, Tian WM (2014) Consistency analysis of latex production capacity in rubber tree clones. Chinese Journal of Tropical Crops 35 (11):2173-2178.
[68] Chen XH, Lin WF, Zhou J, Wang J, Cai MD, Yao XC (2014) A method of improving consistency on sprout and growth of mini-seedling budding of *Hevea brasiliensis*., p 7.

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A Dutch Christian Communicator, Desiderius Erasmus Roterodamus

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Abstract— *This is a short paper exhibiting the Christian Communication contributor of a historical well-known figure. Desiderius Erasmus Roterodamus was a notable Christian scholar, teacher, preacher and philosopher that reigned during the Northern Renaissance. The influence upon this research study was due to a popular, huge, zone high school located in Flatbush, Brooklyn at the intersections, of Flatbush and Church Avenues. Erasmus Hall Educational Campus comprise five Gothic-style high schools founded in 1786 by the Flatbush Dutch Reformed Church.*

Keywords— ***Erasmus, Dutch, Northern Renaissance, Christianity, Philosopher, Humanist, Theologian.***

I. INTRODUCTION

Desiderius *Erasmus* Roterodamus was a Dutch Philosopher and Christian Humanist that scholarly studied and translated a lot of work during the Northern Renaissance. The Northern Renaissance was a 300-year golden age of enlightenment, which was known during the 15th century, as an artistic movement. This Renaissance was a European artistic movement occurring north of the Alps, where they were involved with the use of oil painting, from the Italian Renaissance.

As a Christian Humanist, Desiderius *Erasmus* worked as a scholarly theologian that translated biblical scriptures, and added content to the New Testament in Greek. This doctrine was published in 1516 during the Renaissance movement, along with the combination of Christian faith, and a strong interest in the nature of humanity. The New Testament was created to redeem humanity with principles of human dignity, individual freedom, and happiness teachings to one another. “The fluidity of religious identities in the early years of the Reformation stemmed in part from the complex and ambiguous relationship between humanism and reform, which almost always featured a shared enthusiasm for biblical revival.” (Wooding, L., 2017) It is the philosophy of Jesus Christ, where God is most satisfied, and when humans are glorified.

However, Desiderius *Erasmus* Roterodamus was the first and most famous Dutch Philosopher known to mankind. Desiderius *Erasmus* studied, and shared the proper human behavior in order to live, a good long life from a Dutchman’s perspective. Erasmus urge for wisdom led to his studies of mankind, through the Bible, ancient literature, and fine arts to gain a better understanding of social and moral values of a Christian. In addition, Erasmus was a translator that taught humanism by deciphering some of the most controversial, early Renaissance figures that influenced their society. “Using his humanist touch, he penned several editions of the New Testament in Latin and Greek, which in turn led to the Protestant Reformation and Catholic-Counter Reformation.” (Who was Desiderius Erasmus?) These translations of the Bible, along with his knowledge of Christ, lead believers to follow, and convert to Christianity.

The Life of Desiderius Erasmus Roterodamus

Desiderius was born, Gerrit Gerritszoon, and estimated to be birthed on October 28, 1466 in Rotterdam, Burgundian Netherlands (Holland) *Holy Empire*. Desiderius Erasmus Roterdamus was birth in wedlock, between the union of Roger Gerald and Margaret Rogerius, where Gerrit Gerritszoon is the indication of Gerald Geraldson in Dutch. Gerald Geraldson was christened the named "Erasmus" meaning “beloved” after Saint Erasmus of Formia, who Roger Gerald personally favored, while Desiderius meant “desired one”. Saint Erasmus of Formia had great respect as a patron of sailors and expert in pain relief of the abdominal, during the Eastern Roman Emperor Diocletian in the third

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century. Roger Gerald was a curate and Catholic Priest in Gouda, while Margaret Rogerius was the daughter of a physician from Zevenbergen, who became a monk. There is very little information known about Erasmus' mother, but she was believed to be a housekeeper of Roger. However, Erasmus lived in Rotterdam for four years, and eventually moved to Gouda with his older brother Peter, where he started school at age 4. At age 9, Erasmus along with Peter were sent to a prestigious Latin grammar school in Deventer, owned and operated by the charter clergy of the Lebuinuskerk (St. Lebuin's Church). "He advanced as far as the third-highest class at the chapter school of St. Lebuin in Deventer. One of his teachers, Jan Synthen, was a humanist, as was the headmaster, Alexander Hegius. The schoolboy Erasmus was clever enough to write classical Latin verse that impresses a modern reader as cosmopolitan." (Tracy, J. D., n.d.) Erasmus and Peter were in the care of their parents until the plague of 1483, which took them away from Erasmus and this world. The Plague, also known as The Great Plague, Black Plague or Black Death, was an epidemic of the Yersinia pestis disease that claimed the lives of 75 to 200 million humans in Eurasia. "Yet some twenty five years later, there is still relatively little scholarly discussion of plague outbreaks after 1348 or of the cumulative psychological effect of recurring epidemics." (Marshall, L., 1994) This plague peaked in Europe between 1347 and 1351 with several outbreaks, which led to a second, and third term of the plague's pandemic. The Great Plague killed 30% to 60% of Europe's population, and consequently, it took 200 years for the world's population to recover.

After the deaths of Roger Gerald and Margaret Rogeris, Erasmus and Peter lived with their appointed guardians for two years before being sent to Monastery School of Hertogenbosch, to become monks. Their education was provided by the Brethren of the Common Life, who fostered monastic vocations. The loss of Erasmus' parents and the mistreatment of his guardians, forced Desiderius Erasmus into priesthood, to avoid poverty with a strong educational background in monastery. Erasmus entered a consecrated lifestyle in St. Augustine, located in Stein, South Holland, where he studied pure classical usage and manifesto. Desiderus paraphrased Lorenzo Valla's Elegantiae, which led to the outrage of some "barbarians" that disliked his work; however, Erasmus' monastic superiors became barbaric to defend him from those of discouragement during his studies. In April 1492, Desiderius Erasmus was ordained into priesthood and accepted a trip to Italy, as the Latin Secretary to Henry of Bergen. At the age of 25, Erasmus then assisted the Bishop of Cambrai, who was impressed with his skill of writing letters in Latin to work in Italy. Bishop Henry then invited Erasmus to travel to Paris, France to study classical literature, along with the Latin culture aboard. During this business trip to Paris, Erasmus was able to introduce the Renaissance Humanism culture to Western Europe with respect to the ascetic Jan Standonck.

Over the following 10 years, Erasmus traveled between France, the Netherlands, and England, as one of the world's most notable Christian scholar lecturers. He produced some of his best writings while studying at the University of Paris in the College de Montaigu. Erasmas became the Chief in the Institution of Scholasticism, where his influence transitioned the organization into the School of Renaissance Humanism. As a lecturer, Erasmus worked with Henry while attending school in Paris, where he began reading Origen and Saint Paul to digest the teachings of moral concerns from Christ in Greek. These works influenced the 1503 publishing, *Enchiridion militis Christiani* (*Handbook of a Christian Knight*), where Erasmus gave readers the spiritual interpretation of the meditated scriptures along with the teachings of Christ. Desiderius Erasmus continued to study the Greek language knowing he would gain a deep understanding of theology through his research. Desiderius then discovered the manuscript of Valla's *Adnotationes* on the Greek New Testament that he published in 1505, and sought more information to support his findings. Erasmus then sailed to England in search for references on the Greek New Testament, but landed the perfect opportunity in the promiseland of Northern Humanism - Italy, as the new tutor for the family of Henry VII. Desiderius Erasmus spent the rest of his life in Italy, after becoming the Doctor of Divinity at Turin University. He then polished his knowledge of Greek literature, and became an English Professor of Divinity for Lady Margaret at the University of Cambridge. Although it was well-known that Desiderius Erasmus Roterodamus hated English wine and their local weather, he stayed on-campus in Queens College – Cambridge between the years of 1510 and 1515 occupying rooms located along the "I" staircase. In 1516, the Greek translation of the New Testament, *Novum Instrumentum omne*, was published from Latin Vulgate by Erasmus. After Martin Luther's *Ninety-five Theses* was published in 1517, the Protestant Reformation erupted as Erasmus attended debates regarding human nature, free will, and religion. He followed-up by expressing his views against

Martin Luther in his 1523 publishing, *De libero arbitrio,* before he became ill. Desiderius suffered from poor health and complained about Queens College's harsh wine supply, as it was the primary remedy for gallstone in the Renaissance Era. On July 12, 1536, Desiderius Erasmus Roterodamus fell ill and died of a dysentery attack, during his move back to the Netherlands. With all respect to Christ, Desiderius Erasmus Roterodamus didn't receive his last rites as a priest, although Erasmus exhibited a direct relationship with God to his believers.

Desiderius Erasmus Roterodamus was an excellent preacher, scholar, and theologian of the Northern Renaissance, where he made a difference in mankind. Erasmus served as an editor translating works from Latin to Greek by *St. Jerome*, *St. Hilary* and *St. Augustine* during his studies. Desiderius wrote about the legendary freedom fighter and rebel *Pier Gerlofs Donia*, who was known for his enormous size and strength, through his journey to become a Doctor of Divinity. Pier Gerlofs Sonia, also known as Grutte Pier, or Big Pier, was a Frisian rebel leader and pirate that led the Frisian Rebellion from 1515 to 1519 against a very violent military force called The Black Band. Erasmus also padded biographies on *Irenaeus*, *Origen*, and *Chrysostom* due to their contributions to Christianity. Below, I highlighted a few attributes of Christian contributions that Desiderius Erasmus Roterodamus embarked upon.

• ***Irenaeus*** was a Greek Bishop of Lugdunum (Lyons, France) known for guiding and expanding Christian communities throughout Lugdunum. Irenaeus was taught theology by Bishop Polycarp, who became a disciple of the Apostle John, and saved Christians from an authorized mass slaughtering in Lyons by Marcus Aurelius. He wrote various works on myths and the structure of Valentians' Gnosticism, including the creator *God*, supreme *God*, and other *Gods* in the world.

• ***Origen***, *real name* Oregenes Adamantius - also known as Origen of Alexandria, was a known early Christian theologian and scholar of the early Greek Church. Origen lived in Alexandria, Egypt in the first century working as a grammar teacher to support his mother, and six younger brothers, due to his father's martyrdom for execution. Oregenes Adamantius wrote over 200 treatises on various topics regarding theology with his most notable work being *Hexapla*. Hexapla was Origen's synopsis of the six versions of the Bible's Old Testament. "Origen's purpose in the Hexapla was merely by the aid of 'the Hebrew and of the later translations which squared with it to demonstrate the unsatisfactory character of the current text of the church Bible, and the object was accomplished by leaving well enough alone, the parallel arrangement in columns sufficing to bring out its incongruities from the point of view of the Hebrew, which was the standard and the truth." (Margolis, M. L., 1916)

• ***Chrysostom***, also known as Saint John Chrysostom, was a Doctor of the Roman Catholic Antioch Church, who denounced the abuse of authority. He was a well-known preacher and public speaker born in the Antioch of Syria, in 349. Chrysostom was known as the greatest preacher ever heard in the Christian Pulpit, where he earned the name Chrysostom for golden-mouthed (in Greek). Saint John Chrysostom was also considered one of the greatest leaders in the Greek Church. He was honored as a Saint in the Oriental Orthodox, Eastern Orthodox, Catholic, Anglican, and Lutheran churches due to his involvement within Christianity. Chrysostom was then appointed Archbishop of Constantinople from being a deacon in Saint Meletius of Antioch.

Desiderius Erasmus Roterodamus was a great scholar that managed to communicate and express his views of Christianity through literature. He influenced the masses to follow Christianity by teaching the history of Christ, the Apostles, and heroes of Christianity. Although he wrote about various topics, here are some notable works of Desiderius Erasmus' publishings that contributed to Roman Catholic Church and its biblical truths.

• **Manual of the Christian Knight** (also known as, the *Handbook of the Christian Soldier* or *Enchiridion Militis Christiani*) (1503) was compromised during a trip to France with Bishop Henry. As followers witnessed, Erasmus was told by Jean Viorier that monastery life was pointless and silly. This debate with the very fiercest preacher, Viorier, influenced the writing of a Handbook for Christian Knights in 1501 by Erasmus. The lost of Viorier's discipline who faced death in a calm, peaceful manner trusting in God without characterizing deep sincerity triggered this work. At a later meeting, Jean Viorier lent Erasmus the works of Oregenes Adamantius for future

reference. Oregenes was an early Greek theologian and biblical scholar, who pronounced the promotions of moral and spiritual order through pictures and poems embedded in a storyline. This methodology led to the crafting of the 1516 publishing, *Institutio principis Christiani (Education of a Christian Prince). The Manual of the Christian Knight* provides a vivid explanation of approaching the modern attitude and philosophy of the second century. It exhibited the basic sermons regarding the written law of Christ for Christians to follow their path of righteous. This small book was translated into vernacular languages to influence the atheists, independent intellectual thinkers, and the anti-Christians of moral and social powers of life.

• **The Praise of Folly** (written in 1509, published in 1511) "was written for Sir Thomas More with whom Erasmus had made friends on his trip to England. It is a spoof, in which Folly demands praise for all of the ways of the world. It is under Folly's influence that people behave as they do and that institutions are organized with an upside-down logic. Erasmus was particularly scathing in his description of the state of religion and of the Catholic Church. Historians are fond of saying that Erasmus laid the egg that Luther hatched." (Erasmus, D., n. d.)

• **Sileni Alcibiadis** (1515) is the most direct essay assessed in regards to church reform of the Northern Renaissance. Erasmus criticized the Priests and people in power of abusing their wealth and dictating the poor as servants. He also believed the Priest should be pure, but sprayed away without being condemned. This work suggests the upper class should be important and guide those in need. Erasmus believed the Roman Catholic Church's purpose to assist those in living a pure Christian life, according to the Gospel.

• **Institutio principis Christiani (Education of a Christian Prince)** (1516) was Erasmus' written advice on the characteristics of the "Good Christian Prince" dedicated to a young king Charles of Spain, who later became the Habsburg Emperor Charles V. "It was written at around the same time as Machiavelli's famous work The Prince (written 1513, published 1532), but provides very different advice. Instead of advocating ruthlessness and cruelty as effective governing techniques, Erasmus recommends education, humility, and policies of peace." (Desiderius Erasmus' Institutio Principis Christiani, 1516, 2017, March 3). The Education of a Christian Prince (1516**)** was published three years after Niccolo Machiavelli's *The Prince* was written; it served as a document to show love to Prince Charles rather than filling him with fear. The Education of a Christian Prince also described The Prince as a modest warm hearted individual with great energy.

• **Spongia adversus aspergines Hutteni (The Sponge of Erasmus against the Aspersions of Hutten)** (1523) is a 12-page pamphlet where Erasmus exhibits his skills in semantics to answer a misinterpretation to Ulrich von Hutten (a German Protestant scholar who followed Martin Luther). Martin Luther accused the Roman Catholic Church of corruption and called Erasmus a coward for not addressing the issue accordingly. This led to a mature expression of moral concerns and freedom of will for mankind written in Latin, because it was the primary language at that time.

• **Ciceronianus** (1528) is a treatise criticizing the Latin style of writing during the early 16th century which attempted to imitate the works of Roman Philosopher, Marcus Tullius Cicero. Pigman, G. W. (1980) explained, *Ciceronianus* believed "treatises on imitation are a logical place to look for discussions of the relationship of past to present because they are concerned with using the writings of the ancients as models for contemporary composition. And since they are usually concerned with the stylistic possibilities of Latin, they almost always have to confront an inescapable fact of historical difference." It discussed the significance of education, interest of a student, and methods of teaching through the translations of holy text, which some were in a symbol system.

• **Ecclesiastes (Gospel Preacher)** (1536) was Erasmus' latest major publishing before his death that consist of four sections. They are composed in metaphorical interpretation of effective preaching and the attributes of a Christian Educator. A theological treatise, an outline textbook on hermeneutics, and a list of sermon developed topics were made clear in Erasmus' written product on the

art of preaching. *Ecclesiastes* discussed the values of the office of the priest, rhetorical devices that influence a preacher's repertoire, and the subjective worth of sermons and scriptural references.

II. CONCLUSION

Desiderius Erasmus Roterodamus was a very attentive and knowledgeable individual that reigned during the late 1400s, early 1500s. He lived to be 69 years of age, while residing and traveling throughout Europe. Erasmus studied monetary and theology throughout his life, as he progressed to be a Doctor of Divinity. He studied Greek theology to practice and share the proper moral concerns of God from ancient history. Ong, W. J. (2002) clarified that scholars of the Middle Age and Erasmus Age simply translated early documents of Greek literature, from oral traditions of illiterate societies to literate cultures. Erasmus specialized in translating Greek literature with a strong following of believers during the Northern Renaissance period. Desiderius Erasmus Roterodamus wrote countless works, but only a few were published with other works expressed during his public speeches and debates. He was a Catholic and Protestant Humanist that pronounced human rights and free will through his position in the Roman Catholic Church. Erasmus also argued and defended the Bible in *Novum instrumentum* during the incline of the Protestant Renaissance. After Erasmus' ideas and works were stolen during the Protestant inclination, it seemed like the Roman Catholic Church were competing when evangelizing during masses. "Catholics throughout Europe would feel, in hindsight, that the writings of Erasmus had spurred Luther on, or, as they put it, that Erasmus had laid the egg which Luther hatched. For years they would be hell-bent on demonstrating that the humanist was in large part responsible for the outbreak of the Lutheran heresy." (Wegman, R. C., 2011)

Desiderius Erasmus Roterodamus was a very witty and brilliant individual that transcribed certain literatures that were orally spoken in Greek or English into Latin, so it could not be revised. Gilman, W. E. (2003) clarified, "*De copia* had more than 150 'editions' before the end of the sixteenth century, the translators had many difficult textual problems to resolve." He also invented Latin words within his native tongue to gain the support of those that need the message given, or assistance with conveying the same message. Desiderius Erasmus Roterodamus had a tremendous influence upon the Northern Renaissance of Europe, where he expressed his views upon the Roman Catholic Church to correct their actions. Erasmus was consistent with his biblical studies, which influenced Protestant believers when their movement emerged. Most importantly, anyone can learn how to live a good successful life with moral and social concerns through *Desiderius Erasmus Roterodamus'* works. Blessings.

REFERENCES

[1] Erasmus, D. (n.d.). In Praise of Folly (1509 C.E.). *Desiderius Erasmus: In Praise of Folly*, 353–356. Retrieved from https://www.olma.org/ourpages/auto/2014/9/4/51647061/erasmus reading.pdf
[2] Desiderius Erasmus' Institutio Principis Christiani, or The Education of A Christian Prince 1516. (2017, March 3). Retrieved October 5, 2019, from https://www.bl.uk/collection-items/desiderius-erasmus-institutio-principis-christiani-or-the-education-of-a-christian-prince-1516.
[3] Gilman, W. E. (2003). New Books. *EBSCO Publishing*.
[4] Margolis, M. L. (1916). Hexapla and Hexaplaric. *The American Journal of Semitic Languages and Literatures*, *32*(2), 126–140. doi: 10.1086/369791
[5] Marshall, L. (1994). Manipulating the Sacred: Image and Plague in Renaissance Italy*. *Renaissance Quarterly*, *47*(3), 485–532. doi: 10.2307/2863019
[6] Ong, W. J. (2002). *Orality and literacy: the technologizing of the word* (3rd ed.). London: Routledge.
[7] Pigman, G. W. (1980). Imitation and the Renaissance sense of the past: The reception of Erasmus' Ciceronianus. *The Journal of Medieval and Renaissance Studies*, 1–46.
[8] Smoluk, M. (2007). Lublin Studies in Modern Languages and Literature. *Royal Education in the Tudor Age*, *31*, 194–210.
[9] Tracy, J. D. (n.d.). Erasmus. Retrieved October 4, 2019, from https://www.britannica.com/biography/Erasmus-Dutch-humanist.
[10] Wegman, R. C. (2011). Obrecht and Erasmus. *Journal of the Alamire Foundation*, *3*(1), 109– 123. doi: 10.1484/j.jaf.1.102195
[11] Wooding, L. (2017). Erasmus and the Politics of Translation in Tudor England. *Studies in Church History*, *53*, 132–145. doi: 10.1017/stc.2016.9

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A Qualitative test of Primary and Secondary Metabolites of *Bintaro* Plant as a Rat (*Rattus argentiventer*) Pest Repellent

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***Abstract*— *Bintaro is a mangrove plant that grows on the coast and is often used as a shade tree in megacities. The toxic content of the Bintaro plant is found in all parts of the plant. The toxic content of cardiac glycoside compounds contained in the Bintaro plant can be used as a rat repellent. Rat pests are important pests in crops, especially in rice plants which are difficult to control in mechanically and chemically, thus rice production always decreases. Therefore, it is necessary to search for effective, efficient, and environmental-friendly control technology, namely by using fruit extracts. The plant-based rodenticides made from Bintaro fruit extracts are effective for overcoming rat pests. The purpose of the study was to determine the qualitative levels of primary and secondary metabolites from Bintaro plants which act as antifeedants for rat pests (Ratus argiventer). The method used in this research was qualitative testing using phenol method to test the content of primary and secondary metabolites in the leaves and stems of Bintaro plants. From the results of the research conducted, it was found that the qualitative levels of primary metabolites from Bintaro leaves and stems contained protein content. Fat and carbohydrate content of secondary metabolites found in the stems and leaves of the Bintaro plants were Alkaloids, Saponins, Flavonoids and Polyphenols in Bintaro leaves and on its stems contained Flavonoids, Saponins, Tannins and alkaloids.*

Keywords*— *Bintaro, rat pests, primary and secondary metabolites content.

I. INTRODUCTION

Bintaro is a mangrove plant that grows a lot on the coast and is often used as a shade tree in megacities. This Bintaro plant is known for its high toxic content, where the poison from the Bintaro plant has been used for various uses since the early 15th century. The toxic content in the Bintaro plant is found in all parts of the plant, ,especially its fruit, which has the highest toxic content.

In Asian society, especially Indonesia, Bintaro fruit is widely used as a rat pest repellent. So far, the handling of rat pests has been carried out using commercially-available rodenticides. Considering of many dangers posed by rodents which have anticoagulant-based ingredients, alternative ways of controlling rat pests were developed. One of the alternative ways to control rat pests is to utilize the content of one of the characteristics of Bintaro fruit. The toxic content of cardiac glycoside compounds contained in Bintaro fruit seeds can be used as a rat repellent.

In general, there are two kinds of metabolism, namely primary metabolism and secondary metabolism. Primary metabolism produces primary metabolites, while secondary metabolism produces secondary metabolites. Primary metabolism is present in all organisms with almost the same processes and pathways, whereas secondary metabolism has specific and unique pathways and products for each organism. Primary metabolism is directly involved in growth, whereas secondary metabolism is not involved (Anurag et al., 2015).

Primary metabolites modify and synthesize carbohydrates, fats, proteins and nucleic acids, while

secondary metabolites produce secondary metabolites of relatively small size, generally with a molecular weight of less than 3000 Da. Primary metabolites play a role in the processes of photosynthesis and respiration, while secondary metabolites play a more important defensive role in plants (Anurag et al., 2015).

In plants, secondary metabolite compounds have several functions, including as attractants (attracting other organisms), defense against pathogens, protection and adaptation to environmental stress, protection against ultraviolet rays, as growth regulators and to compete with other plants (allelopathy). Secondary metabolites are also suspected as waste or plant detoxification products, however, most of the function of secondary metabolites is still unknown (Dewick, 2009; Kabera et al., 2014). Research on secondary metabolites is still one of the largest areas of research field to determine the function and pharmacological properties of each secondary metabolite (Kabera et al., 2014).

This research was conducted to determine the qualitative levels of primary and secondary metabolites from Bintaro which can function as a biorodenticide.

II. RESEARCH METHODOLOGY

The research was conducted in the laboratory of the Faculty of Agriculture, Muhammadiyah University of North Sumatra, Medan.

The materials used in this study were Bintaro plants (leaves and stems), alcohol, methanol, aquades, and others that support the research.

The tools used in this study were beaker glass, test tube, spatula, Erlenmeyer flask, stopwatch, calculator, writing instruments and others that support this research.

Qualitative test of primary metabolites

Sample Preparation

The samples used in this study were the leaves and stems of Bintaro. A total of 100 grams were cut into small pieces. Then dried using an oven at 60^{o}C for 6 hours.

Preparation of standard glucose solution

A total of 0.1 g of glucose powder was weighed and then put into a 100 mL flask. A total of 10 mL of glucose stock solution was taken using a pipette then put into a 100 mL measuring flask and diluted to the limit mark. The glucose standard solution was made with the concentrations of 0, 10, 20, 30, 40, 50 ppm by piping out the glucose standard solution as much as 0, 5, 10, 15, 20 mL then put into a 50 mL measuring flask and diluted to the marking area. The next step was measuring the absorbance with a spectrophotometer at a wavelength of 490 nm, then making its linear equation as standard curve (Bintang, 2010).

Determination of carbohydrates (Phenol Method)

10 grams of Bintaro plant samples (stems and leaves) were weighed, then furnaced for 5 hours. 1 gram of sample ash was taken and dissolved in 10 mL concentrated HNO3, then filtered in a 10 mL measuring flask. Then, the filtrate diluted with distilled water to mark the boundaries. Furthermore, 1 mL was taken and then added 1 mL of phenol 1% and 6 mL of sulfuric acid and 2 mL of distilled water. The mixture was allowed to stand at room temperature and then its absorption was measured at a wavelength of 490 nm. The treatment was repeated twice (*duplo*)

Determination of Protein (Kjeldhal Method)

A total of 1 gram sample was weighed, then put into a kjeldahl flask, added 1 tablet kjeldhal. Then 10 mL of concentrated sulfuric acid solution was added and all the ingredients were digested (heated) in the Kjeldahl flask until it boiled and dissolved and the liquid turned clear. 75 mL of distilled water was diluted and cooled to room temperature. 10 mL of the filtrate was taken to determine the total nitrogen content and determined using a spectrodirect at a wavelength of 410 nm. The treatment was repeated twice (*duplo*).

Qualitative test of secondary metabolites

The leaves and stems of fresh Bintaro are cleaned and then cut into small pieces. Furthermore, the cut-offs were dried for 7 days (1 week). After drying, then mashed the sample using a blender until smooth. After that, the leaves, stems and smooth Bintaro fruit were ready to be extracted. The manufacture of Bintaro plant extract began by weighing 10 grams of Bintaro powder (leaves and stems). After that, the sample was put into an Erlenmeyer flask and added with 100 mL of aquades. Then closed the Erlenmeyer flask using aluminum foil and soaked for 3 x 24 hours (48 hours) and shook it using an orbital shaker. After 72 hours the extract was filtered using a filter and the filtrate obtained was used in testing for secondary metabolites. The steps were the same for the extraction treatment with ethanol solvents.

Test of Secondary Metabolite Compounds from Bintaro Plant Extracts Extracted with Water and Ethanol Solvents
Alkaloid Test

The test was carried out by taking 2 mL of each sample (leaves and stems) of Bintaro which had been extracted with

water and ethanol solvents into 2 different test tubes. After that each extract was added with 5 drops of Dragendroff reagent. If each solution forms an orange precipitate, it is positive that it contains alkaloids. Furthermore, for Alkaoid testing using mayer reagent was carried out by taking 2 mL of each sample (leaves, stems and fruit) Bintaro which had been extracted with water and ethanol solvents into 2 different test tubes. After that each extract was added with 3 drops of concentrated hydrochloric acid and 5 drops of Mayer's reagent. If each solution forms a white precipitate, then the sample is positive that it contains alkaloids (Mustikasari & Ariyani, 2010).

Flavonoid Test

The test was carried out by taking 2 mL of each sample (leaves and stems) of Bintaro which had been extracted with water and ethanol solvents, then heated for about 5 minutes. After being heated, each added 0.1 gram of Mg metal and 5 drops of concentrated HCl. If each solution forms a yellow orange to red color, then it is positive that it contains flavonoids (Mustikasari & Ariyani, 2010).

Saponin Test

The test was carried out by taking 2 mL of each sample (leaves and stems) of Bintaro which had been extracted with water and ethanol solvents. The sample was put into a test tube, added 10 ml of hot water, cooled and then shook vigorously for 10 minutes). The reaction is positive if foam is formed which is steady for not less than 10 minutes, 1 cm to 10 cm high. With the addition of 1 drop of 2 N hydrochloric acid, the foam does not disappear (Arif et al, 2015).

Polyphenol Test

The test was carried out by taking 2 mL of each sample (leaves and stems) of Bintaro which had been extracted with water and ethanol solvents. Then it was reacted with 1% FeCl3 solution, if it forms green, red, purple, dark blue, blackish blue or greenish black, it indicates the presence of phenolic compounds (Kurratul et al., 2014).

Tannin Test

The test was carried out by taking 2 mL of each sample (leaves and stems) of Bintaro which had been extracted with water and ethanol solvents, then heated for about 5 minutes. After heating, each of them added a few drops of 1% FeCl3. If each solution forms a greenish brown or blue-black color, it is positive for tannins (Marlinda et al, 2012).

III. RESULTS AND DISCUSSION

1 Primary Metabolites

From the research that has been done, it was found that the primary metabolite contents in Bintaro plants can be seen in table 1 below

Table 1. Primary Metabolites Content

No	Sample	Fats	Protein	Carbohydrates
1	Bintaro Leaves	14.60 %	0.024 %	3.21 %
2	Bintaro Stems	12.80 %	0.013%	3.54 %

From table 1, it can be seen that the highest content of primary metabolites in fat content is in Bintaro leaves, namely 14.60%, while the highest is carbohydrate content, which is 3.54%. Primary Metabolites are usually used to synthesize glucose through the process of photosynthesis to produce energy for plants.

2 Secondary Metabolites

From the results of the research that has been done, it was found that the content of secondary metabolites in Bintaro plants can be seen in table 2 below:

No	Secondary Metabolites	Leaves	Stems
1	Flavanoid	+	+
2	Saponin	+	+
3	Tanin	-	+
4	Polifenol	+	-
5	Alkaloid	+	+

From table 2 above, it can be seen that the leaves contain secondary compounds, namely flavonoids, saponins, polyphenols, and alkaloids, while the stems contain flavonoids, saponins, tannins, and alkaloids.

The stems contain tannin compounds which are insect repellents. Insects that consume a suitable food source will grow and develop well. On the other hand, insects that consume food sources that have inadequate nutrients will experience inhibition in their growth and development. Likewise, insects whose food contains certain chemical compounds will be inhibited growth and development. Such compounds are found in plants (Dadang and Priyono, 2008)

Alkaloids contain in the stems and leaves of the Bintaro plant are toxic, as food inhibitors and insecticides for insects. According to Cahyadi (2009) alkaloid and flavonoid compounds can act as stomach poisons. Therefore, if the alkaloid and flavonoid compounds enter the insect's body, their digestive organs will be disturbed.

Flavonoids found in the stems and leaves of Bintaro are chemical compounds that have insecticidal properties. Flavonoids attack several nerve organs in several vital organs of insects, resulting on nerves weakening, such as breathing and death. Flavonoids work as respiratory inhibitors. Inhibitors are substances that inhibit or decrease the rate of chemical reactions, flavonoids also affect the energy mechanism in the mitochondria by inhibiting the electron transport system (Roqib and Kristanti, 2015).

Saponins found in the stems and leaves of the Bintaro plant can affect the absorption of minerals and vitamins. Southon et al. (1988) stated that saponins reduce iron absorption in tested mice. The decrease in absorption is more due to the influence of the disturbance of Fe transport through mucosal cells compared to the bonds formed between Fe and saponins.

REFERENCES

[1] Apriantono, A., Dedi, F., Puspitasari, N., Sedarmawati & Slamet, B. (1988). *Analisis pangan.* Bandung: ITB.

[2] Arif, R., Sri,W dan Ike Y, W. 2015. Isolasi dan Identifikasi Senyawa Saponin Ekstrak Metanol Daun Binahong (A*nredera cordifolia* (ten.) steenis). Jurnal Online Mahasiswa (JOM) Bidang Farmasi. Vol.1 No. 1.

[3] Cahyadi, R. (2009). Uji Toksisitas Akut Ekstrak Etanol Buah Pare (Momordica charantia L.) Terhadap Larva Artemia salina Leach Dengan Metode Brine Shrimp Lethality Test (BST). Skripsi. Semarang: Universitas Diponegoro.

[4] Handoko, T. Suhandiaya, G. Mulyana,H. 2012. Hidrolisis Serat Selulosa Dalam Buah Bintaro Sebagai Sumber Bahan Baku Bioetanol. Jurnal Teknik Kimia Indonesia, Volume 11 No 1 (2012), halaman 26-33. Universitas Parahiyangan. Bandung

[5] Harborne, J. B. (1987). Metode fitokimia penentuan cara modern menganalisis tumbuhan. Bandung: ITB.

[6] Hariyatimi. (2004). Kemampuan vitamin e sebagai antioksidan terhadap radikal bebas pada lanjut usia. *Jurnal MIPA*, *14*, 52-60.

[7] Hermiati, Rusli, Manalu, N. Y., & Sinaga, M. S. (2013). Ekstrak daun sirih hijau dan merah sebagai antioksidan pada minyak kelapa. Departemen Teknik Kimia, Fakultas Teknik, Universitas Sumatera Utara, 2(1).

[8] Hertiani, T., Pramono, S., & A.M, S. (2000). Uji daya antioksidan senyawa flavonoid daun (Plantago major L.). *Majalah Farmasi Indonesia*, *11*(4), 234.

[9] Juniaty Towaha dan Gusti Indriati. 2011. Potensi Tanaman Bintaro (Cerbera Manghas) Sebagai Alternatif Sumber Bahan Bakar Nabati. Warta Penelitian Dan Pengembangan Tanaman Industri. Volume 17 Nomor 1, April 2011. ISSN 0853-8204

[10] Kurratul A, Betty L dan Balqis. 2014. Skrining Fitokimia dan Penentuan Aktivitas Antioksidan Serta Kandungan Total Fenol Ekstrak Buah Labu Siam (*Sechium edule* (jacq.) Sw.). Diploma Thesis, Universitas Negeri Malang.

[11] Prayuda, Y.E. 2014. Efikasi Ekstrak Biji Bintaro (Cerbera manghas) Sebagai Larvasida pada Larva Aedes aegypti LInstar III/ IV. Program Studi PendidikanDokter Fakultas Kedokteran dan Ilmu Kesehatan UIN Syarif Hidayatullah Jakarta.

[12] Rahayu, Pakki.T, Sukmawati. 2014. Preferensi dan Kemampuan Makan Tikus Rumah (Rattus diardii) pada Beberapa Varietas Beras (Oryza sativa) di Penyimpanan. Jurnal Agroteknos 4(1):66-70Sa'adah, L. (2010). Isolasi dan identifikasi senyawa tanin dari daun belimbing wuluh (Averrhoa bilimbi l.). Universitas Islam Negeri (UIN) Maulana Malik Ibrahim, Malang.

[13] Roqib, M dan Kristanti, I. P. 2015. Pengaruh Ekstrak Daun Beluntas (*Pluchea indica*) terhadap Mortalitas dan Perkembangan Larva *Spodoptera litura* F. Jurnal Sains Dan Seni Its Vol. 4, No.2

[14] Septyaningsih, D. (2010). Isolasi dan identifikasi komponen utama ekstrak biji buah merah (Pandanus conoideus lamk). Universitas Sebelas Maret, Surakarta

[15] Southon, S., A.J.A. Wright, K.R. Price, S.J. Fairweather–Tait, & G.R. Fenwick. 1988. The effect of three types of saponin on iron and zinc absorption from a single meal in the rat. British Journal of Nutrition. 59: 389–3

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Development potential of Beef Cattle under the Coconut Trees in east Bolangitang district Regency of North Bolaang Mongondow

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***Abstract*— *Farmers in East Bolangitang District, Indonesia were trying to increase beef cattle population as a source of their income, but the problem was the lack of feed caused by cattle being cultivated on agricultural land. The purpose of this study was to determine the potential for land development under coconut trees for forage. The research method used was a survey method, with the determination of the location was by purposive sampling, namely three villages that have the largest cattle population. The data collected was primary and secondary data with the type of data was cross section and time series. Respondents were determined by purposive sampling, namely 40 farmers who use land under coconut. Analysis of the data used descriptive analysis. Coconut area was 0.2-2 Ha or the average was 0.94 Ha. 35 percent ownership status by farmers and 65 percent farmers as tenants. Beef cattle ownership was 148 or 2-6 cattle per farmer. Feed consumption per head per day consisted of 6.21 kg of grass, 10.40 kg of corn waste and 6.26 kg of rice waste. Forage production for 0.94 Ha can be utilized by 8.83 ST. In conclusion, coconut land in the study area has the potential to be used as a forage development. Need for socialization for farmers to introduce quality forage.*

Keywords*— *beef cattle, land, coconut, potential.

I. INTRODUCTION

The phenomenon of achieving self-sufficiency in beef, which is difficult to achieve, was influenced by various factors, including the insufficient population of beef cattle. The production of beef in the regions, maintained traditionally, is expected to sustain national demand for meat. This includes local cattle raised by small farmers in rural areas (Rusdiana, 2019).

However, the required beef production is closely related to the availability of feed both in quantity and quality. The availability of forage for both quantity and quality depends on the land potential of each area.In addition, quantity and quality of forage in the tropics, fluctuatesespecially during the dry season resulting in a decrease in the level of productivity of beef cattle (Osak, et al, 2020).

Several studies conducted indicate that beef cattle farmers face various constrains related to feed. Their land use cause less land to be used for the development of feed. Transfer of land functions was a problem faced by various areas of beef cattle development (Mulyani et al, 2016; Elly et al, 2018[b]; Elly et al, 2019[a]).

Cattle farmers and the government were trying to solve the forage problem in the development of beef cattle. Beef cattle must be encouraged considering the need for beef every year has increased. Beef cattle as ruminants have the largest contribution as a meat producer. This contribution really supports the fulfillment of food needs, especially animal protein. In addition, beef cattle has a role in income distribution and has a significant market potential (Rusdiana and Talib, 2019).

Beef cattle farmers in East Bolangitang District were trying to increase the beef cattle population as their source of income. Increasing the productivity of beef cattle farming as an effort to increase economic growth in rural areas is aimed at increasing the added value and income of farmers (Romjali, 2018).On the other hand, the development of beef cattle is regionally intended to supply the shortage of beef availability. This means that beef cattle in the regions have the opportunity to support beef demand, where the demand continues to increase from year to year.

The need for national beef consumption has not been fulfilled, even beef tends to be in deficit until 2018 (Sodiq et al, 2018). Beef cattle farming is developed so that the population achieved is balanced with the need for food consumption from animal origin (Rusdiana and Praharani, 2018).In an effort to develop beef cattle in a region, it is necessary to analyze the potential of the area and density of beef cattle for the development of livestock farming in a development areaincluding in the coconut land area (Osak et al, 2019).

The problem was that the productivity of beef cattle in this area was low due to many constrains. Lack of feed because cattle were grazed on agricultural land was one of constrainsfaced by farmers. Whereas in this area the land under thecoconut trees has not been optimally utilized.Other farmers grow food crops under coconut trees and the waste was used as feed. However, the quality of food crop waste was considered low, especially dry waste. The problem was the extent to which the land under coconut trees can be used for forage development. Based on the background and thinking above, a study has been carried out related to the use of land under coconut trees. The purpose of this study was to determine the potential for land development under coconut trees through the introduction of forage.

II. RESEARCH METHODS

The research method used was a survey method of farmers through interviews using a questionnaire. The research location was determined by purposive sampling, namely three villages (Bohabak, Binjeta and Nunukan). The sample villages were determined based on the consideration that they had the largest cattle population. The data collected are primary and secondary data with the type of data is cross section and time series data. Respondents were determined by purposive sampling, namely 40 farmers who use the land under coconut trees. Data analysis using descriptive analysis.

III. RESULTS AND DISCUSSION

Farmers develop beef cattle as a side business. This condition was supported by various studies related to rural beef cattle farming. The main occupation of the respondents was as a farmer (100 percent). This condition was supported by the potential of research areas in agricultural development, such as the availability of dry land and rice fields. Potential areas that were managed optimally will support the successful development of the livestock subsector (Yulia et al, 2015).

Most of the farmers in the research locations developed food crop farming, both in open land and under coconut trees. The area of coconut land used by farmers was 0.2-2 Ha or an average of 0.94 Ha. The results showed that the status of coconut land, 35 percent belonged to farmers and 65 percent of farmers were cultivators. The land under coconut trees was used for grazing cattle. The number of cattle ownership was 148 head or 2-6 head per farmer. Various attempts were made to increase the scale of the business, including the government in this case facilitating the increase in business scale ([Kementerian Pertanian, 2017). Cattle in the research area were grazed during the day and transferred from one coconut field to another.

Farmers have not built stables so cattle were left on the farm. The respondent's cattle consume grass that grows wild under coconut trees. Corn and rice waste was also used as cattle feed in the research area. The consumption of cattle feed at the research location can be seen in Table 1.

Table 1. Consumption of Feed by Beef Cattlein Research Location

No.	Feed Consumption	Total (Kg/Cattle/Day)	%
1.	Grass	6,21	27,16
2.	Corn Waste	10,40	45,47
3.	Rice Waste	6,26	27,37
	T o t a l	22,87	100,00

Data Table 1 shows that the amount of corn waste was the largest consumption of beef cattle (45.47 percent). Then followed by the amount of rice waste by 27.37 percent and grass 27.16 percent. Agricultural waste of food crops in the area can be relied on as cattle feed. Beef cattle farming was generally integrated with food crops (Susanti et al, 2014). A waste management strategy was needed to support the development of beef cattle.

The problem was that the quality of dry food crop waste is low. The indication is the need for the introduction of technology to improve the quality of the food crop waste. This is because the feed given to cattles must contain good nutritional value (Saputra et al, 2016). The land under coconut trees and other idle land can be used for forage development. This condition shows that the land for forage development in the research area is not an obstacle. However, the importance of land cannot be ignored even though its role is small (Nur et al, 2018). The grass that was developed by some farmers in North Bolaang Mongondow Regency was dwarft grass. The

results showed that forage production for 0.94 Ha could be utilized by 8.83 AU. 1 Ha of coconut land, if the contents were calculated to be 0.8 Ha, it requires 16,000 cuttings of dwarft grass. The grass was planted with 1m X 0.5 m, and the grass production obtained was 4 kg per m2. The grass under the coconut tree can be cut 9 times per year, which means that it produces 288 tons per year per Ha. The amount produced was 288 tons equivalent to 22.5 Animal Units / year (Salendu and Elly, 2012). Types of dwarft grass that can be developed in the study area can be seen in Figure 1.

Fig.1: Dwarft grass developed under coconut trees

Figure 1 shows that the land under the coconut can be used by farmers to support feed needs in the study area. The introduction of this grass was carried out in other areas and responded well by the farming community. The grass has been given to cattle developed with cage systems (Elly et al, 2018 a andElly et al, 2019 b).

IV. CONCLUSIONS

Basedonthe research results, coconut land in the study area has the potential to be used as a forage development. Need for socialization for farmers to introduce quality forage.

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REFERENCES

[1] Elly, F.H., A.H.S. Salendu, Ch. L. Kaunang, Indriana, R. Pomolango, and Syarifuddin. 2018 (b). Forage Introduction to Support Development of Cattle in Sangkub District. International Journal of Environment, Agriculture and Biotechnology3(5):1718-1720.

[2] Elly, F.H., A. Lomboan, C. L. Kaunang and R. Pomolango. 2019 (a). Benefits of Integrated Farming System for Cattle Crops in North BolaangMongondow Regency North Sulawesi Province, Indonesia. International Journal of Agriculture, Environment and Bioresearch 4(4):1-5.

[3] Elly, F.H., A.H. Salendu., Ch. L. Kaunang., Indriana., Syarifuddin and R. Pomolango. 2018[(a)]. Empowerment of Farmers in Efforts to Develop Sustainable Cattle Farming in Sangkub District Regency of North BolaangMongondow, North Sulawesi Province, Indonesia. Proceeding The Fourth International Seminar on Animal Industry. IPB International Convention Centre,Bogor Indonesia, August, 28-30 2018.

[4] Elly, F.H., A. Lomboan., Ch. L. Kaunang., M. Rundengan and Syarifuddin. 2019[(b)]. Development Potential of Integrated Farming System (Local Cattle-Food Crops). J. Animal Production. 21(3):143-147.

[5] Ministry of Agriculture. 2017. Government Policy in Developing Beef Cattle Farms in Indonesia. Directorate General of Animal Husbandry and Animal Health, Ministry of Agriculture, Jakarta.

[6] Mulyani, A., D. Kuncoro, D. Nursyamsi, and F. Agus. 2016. Paddy Field Conversion Analysis: Use of High-Resolution Spatial Data Shows Alarming Conversion Rates. Journal of Soil and Climate 40(2):121-133.

[7] Nur, T.M., C. Fadli, and H. Satriawan. 2018. Analysis of Potential Integration of Cattle Oil Palm in Bireuen Regency, Aceh Province. Journal of Agribusiness and Rural Develpoment Research. 4(2):69-80.

[8] Osak,R.E.M.F., Anis, S.D. and Rumambi, A., 2020. Replacement of Napier grass with legume tree foliage in the coconut-beef cattle integrated farming system (Coco-Beef

IFS). Livestock Research for Rural Development 32(1)Retrieved September 30, 2020, from http://www.lrrd.org/lrrd32/ 1/richa32014.html

[9] Osak, R.E.M.F., Lumy, T. D. F., andOroh, F. N., 2019.Cattle Density Analysis for Development of Cattle Farming in Coconut Land Area in South Minahasa Regency, Indonesia. International Journal of Environment, Agriculture and Biotechnology 4(2):370-373.

[10] Romjali, E. 2018.Beef Cattle Innovation Development through Field Laboratory Approach.Journal of WARTAZOA 28(2):69-80.

[11] Rusdiana, S. 2019. The phenomenon of the need for food sourced from meat can be fulfilled by increasing beef cattle business in farmers. SOCA Journal 13(1): 61-83.

[12] Rusdiana, S and C. Talib. 2019. Government Policy Supports Increasing Beef Cattle Farmers' Business. SOCA: Journal of Agricultural Socio-Economics13(3):380–395.

[13] Rusdiana, S and L. Praharani, 2018. Beef Cattle Development: Beef Self-Sufficiency Policy and Livestock Business Feasibility. Journal of AgroEconomic Research Forum 36(2):97-116.

[14] Salendu, A.H.S.and F.H. Elly. 2012. Utilization of Land Under Coconut Trees for Cattle Feed in North Sulawesi. Pastura Journal 2(1):21-25.

[15] Saputra, J.I., Limanand Y. Wid. 2016. Analysis of Potential Development of Beef Cattle Farms in PesawaranRegency. Integrated Animal Husbandry Scientific Journal 4(2):115-123.

[16] Sodiq, A., P. Yuwono, Y. N. Wakhidati, A. H. Sidhi, M. Rayhanand A. Maulianto. 2018. Beef Cattle Development through Cluster Programs: Program and Activity Description. Journal of Agripet 18(2):103-109.

[17] Susanti, Y., D. S. Priyarsonoand S. Mulatsih. 2014. Beef Cattle Farm Development for Economic Improvement of Central Java Province: A Regional Planning Approach. Journal of Indonesian Agribusiness 2(2):177-190.

[18] Yulia, L.M., Bagaand N. Tinaprilla. 2015. The Role and Development Strategy of the Animal Husbandry Subsector in the Development of Agam Regency, West Sumatra. Journal of Indonesian Agribusiness 3(2):159-176.

International Journal of Environment, Agriculture and Biotechnology, 5(5)
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Analysis of the Capacity of Radar Time Series Data for Crop Mapping in the Context of the Sahel: Case of Groundnut, Millet and Maize in Senegal

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Abstract— *Monitoring agricultural areas, using remote sensing, has been a major issue in the Sahel region, due to the small size of farm plot compared to satellite spatial resolution. The main goal is to develop a methodology based on radar data for mapping crops in Senegal. Training plots were used to analyse temporal dynamics of radar signals. The result shows that the possibility to separate agricultural area from other land cover at the beginning of the rainy season. The radar signal of the three crops are confused at the beginning but we note a strong difference at the end of the growing season, where peanut crops signal is marked by a sharp fall. Variance analysis allowed to select images which are able to discriminate these cultures.*

The Classification And Regression Trees (CART) model used is able to identify peanut plots with more than 82% of accuracy, but confuse maize crop (accuracy less than 70%). This result means the resulting inability to separate the two types of maize crops (one which is sown early and harvested in mid-season, another sown in mid-season and harvested at the end of the season). So, in this area, the use of radar permit to improve crop mapping considering agricultural practice of cereals.

Keywords— ***Remote Sensing, Synthetic Aperture Radar, Sentinel-1, Agricultural monitoring areas, Senegal, Nioro.***

I. INTRODUCTION

The use of earth observation data for vegetation monitoring and agriculture has been the subject of many research projects in the past [1]. More recently many scientists have demonstrated the potential of remote sensing as a robust method for monitoring agriculture [2, 3, 4, 5, 6], and for better dealing with the impact of climate change in this vital sector of the nation's economy.

In the Sahel region, where agriculture is still highly dependent on rainfall (for example, less than 5% is irrigate in Senegal for example), which make it very vulnerable, particularly in the context of climate change. This situation has serious food security, economic and social impacts. In addition, reliable data and information is not always readily available to help better anticipate sound practices that could improve agricultural productivity. Thus, it is urgent to build tools and methods that could improve the accuracy of agricultural data and statistics, for better management of this sector and thus, contribute to fight against food insecurity in this region. However, remote sensing applications in the Sahel region can be very challenging, as the agriculture system is often dominated by small plots of lands (generally less than 2 hectares) with mixed crops,

making difficult to differentiate unambiguously and map the different crops; and thus, estimate routinely yield from a remote sensing approach.

The objective of this study is to exploit the potential Radar Sentinel-1 times series data for mapping agricultural area in Sahel context.

These studies have shown strong correlation between the spectral reflectance of crops at certain wavelengths and their physical and biological characteristics, thus demonstrating the possibility of using satellite images as a tool for monitoring the state of crops. However, in the Sahelian context, the differentiation of crops with remote sensing has not been easy because of the small size of plots (typically 2 ha) compared to the spatial resolution of the sensors. However, the advent of new generations of optical and radar remote sensing images with better resolutions (high spatial, spectral and temporal resolution) provides new options for mapping agricultural production.

In this study, we used the temporal variability of Sentinel-1 radar signals (C-band, VV and VH polarisation) during the agricultural season to try to discriminate millet, maize, and peanut crops at the scale of the plot. The use of radar imaging is preferred as optical data are sensitive to cloud cover during the rainy season in Senegal (July to October).

Analysing the temporal variation of the signals of different crops in VV and VH polarisation can be useful in distinguishing between them as these crops do not have the same phenological cycles [7, 8, 9]. Hence this analysis seeks to identify the periods when the greatest differences between crop signals is noted. It is also possible to use the signals of different types of land use to create a mask map of non-agricultural areas.

Several authors [10, 11, 12, 13, 14, 15, 16, 17, 18] have demonstrated that the monitoring and mapping of herbaceous vegetation by radar methods is difficult due to the sensitivity of the radar signal to various surface parameters (soil roughness, soil moisture and vegetation). However, with some vegetation covers, the contribution of the soil varies with time and becomes minimal compared to that of vegetation and so temporal monitoring throughout the agricultural season suggest that it is possible to overcome this limit.

II. MATERIALS AND METHODS

Study area

The study area is located in the "peanut basin" which covers a large part of central Senegal. Annual rainfall ranges between 700 and 1100mm, and agriculture is mostly made of millet, maize and peanut which is the main source of income for the population [19].

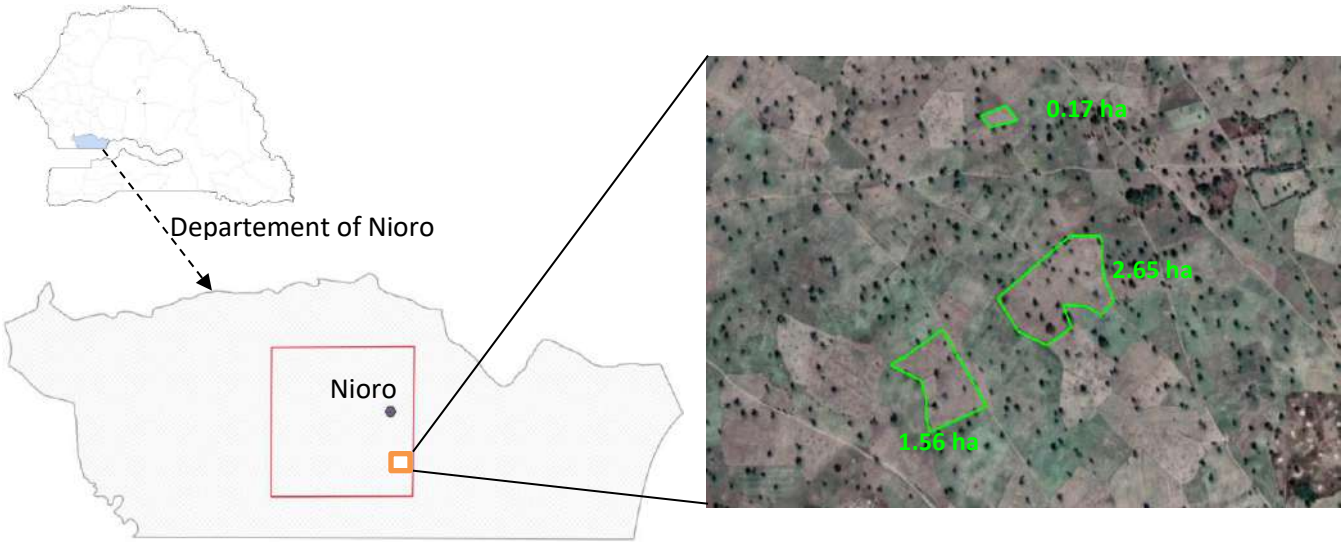


Fig.1: Location of study area

Field data

The three crops targeted in the current study have the following major characteristics:

(i) Millet is an herbaceous cereal with a phenological cycle of 75 to 90 days and height at maturity of 220 to 250 cm [20, 21, 22, 23];

(ii) Maize is an herbaceous cereal with a phenological cycle of 75 to 80 days reaching 175 to 200 cm at maturity [24, 25];

(iii) Peanut is a creeping legume with a cycle of 90 to 120 days and height at maturity of 30 to 70 cm [26, 27].

In total, an in-situ database of 150 control plots (50 per crop) was set up to serve as a training and validation data. The data were collected during the field work using a GPS to digitize the geographical boundaries of the plots. To avoid edge effects and eliminate mixed pixels between adjacent crop plots, contour boundaries were adjusted using GOOGLE EARTH.

III. DATA AND METHODS

C-band sentinel-1 (SAR sensor) data are used. This data has 10 meters of spatial resolution in two polarizations (VV and VH) and temporal repeatability of 12 days. A total of 14 images of the area were obtained from the ESA website [28] for the period of June to December 2016. These were downloaded and corrected for geometric distortions (geocoding, georeferencing), and then filtered to reduce speckles. The data were normalized (radiometric calibration) to transform the backscattered signal (Digital Number) into backscattering coefficient σ ° (in dB), a quantity proportional to the ratio of received signal power and transmitted signal power by the antenna [29].

The first step was to extract the pixel values of the control plots for all selected and corrected images, and to analyze them in order to identify the best combinations able to discriminate the three crops.

(a) Extraction of pixel values of the control for all images: After adjusting the boundaries of the control plots, and correcting the radar data, pixels values of all control plots of the images (from June to December) were extracted.

(b) The second part is the analysis of the temporal signal of agricultural and non-agricultural areas. This was to create a mask of non-agricultural areas and focus on the cropped areas.

(c) Comparison was made of the temporal evolution of crops signals during their different phenological phases in both polarisations, with the aim to identify the most discriminating periods.

(d) In the following step, an ANOVA (Analysis of Variance) was performed in order to select the data having the capacity to discriminate the three cultures (millet, maize and peanut). The ANOVA was used to compare the mean of the signal in pairs for each polarization at each date. For each image (date), when the p-value was higher than 0.05, we concluded that the two crops signals were not different. Then, a check was made with the confidence interval around the difference. For each data, when the confidence interval included the value of zero (max positive and min negative), the data was deemed not able to discriminate crops, then it was excluded.

(e) In the last step, a CART (Classification And Regression Tree) was done on the selected data by the ANOVA. The general principle of CART is to recursively partition the input data (pixel value) in a binary way, then to determine an optimal sub-partition for the prediction [30]. Also, CART is a classification method that uses in situ data to build a descriptive and predictive model of a relationship between a set of predictors and a categorical variable [31]. Here 2/3 of the data were used to build the CART model and the remaining 1/3 was used for the validation, thus making it possible to calculate the confusion matrix.

IV. RESULTS AND DISCUSSIONS

a- Maps of agricultural areas

The first task was to analyse the signals of the different land covers in order to mask the non-agricultural zones. Figure 2 shows significant differences between the different types of land use, especially at the beginning of the rainy season (June 29, July 23), where signals from agricultural areas stand out from those of others (habitat, water and natural vegetation). VV polarization is more useful in this regard than VH polarization. There was also a seasonal sensitivity of the vegetation to the radar signal, with the maximum sensitivity in the middle of the season corresponding to the peak of growing season for vegetation (when plant content is high). This consistent with results obtained over the entire Sahelian band where the C-band signal is very sensitive to seasonal dynamics [13, 14, 15, 32, 33, 34].

Images of June 29 (in VH) and July 11 (VH and VV) provide the greatest differentiation of agricultural and non-agricultural zones and so these were combined to create a mask of non-agricultural areas by using a supervised classification.

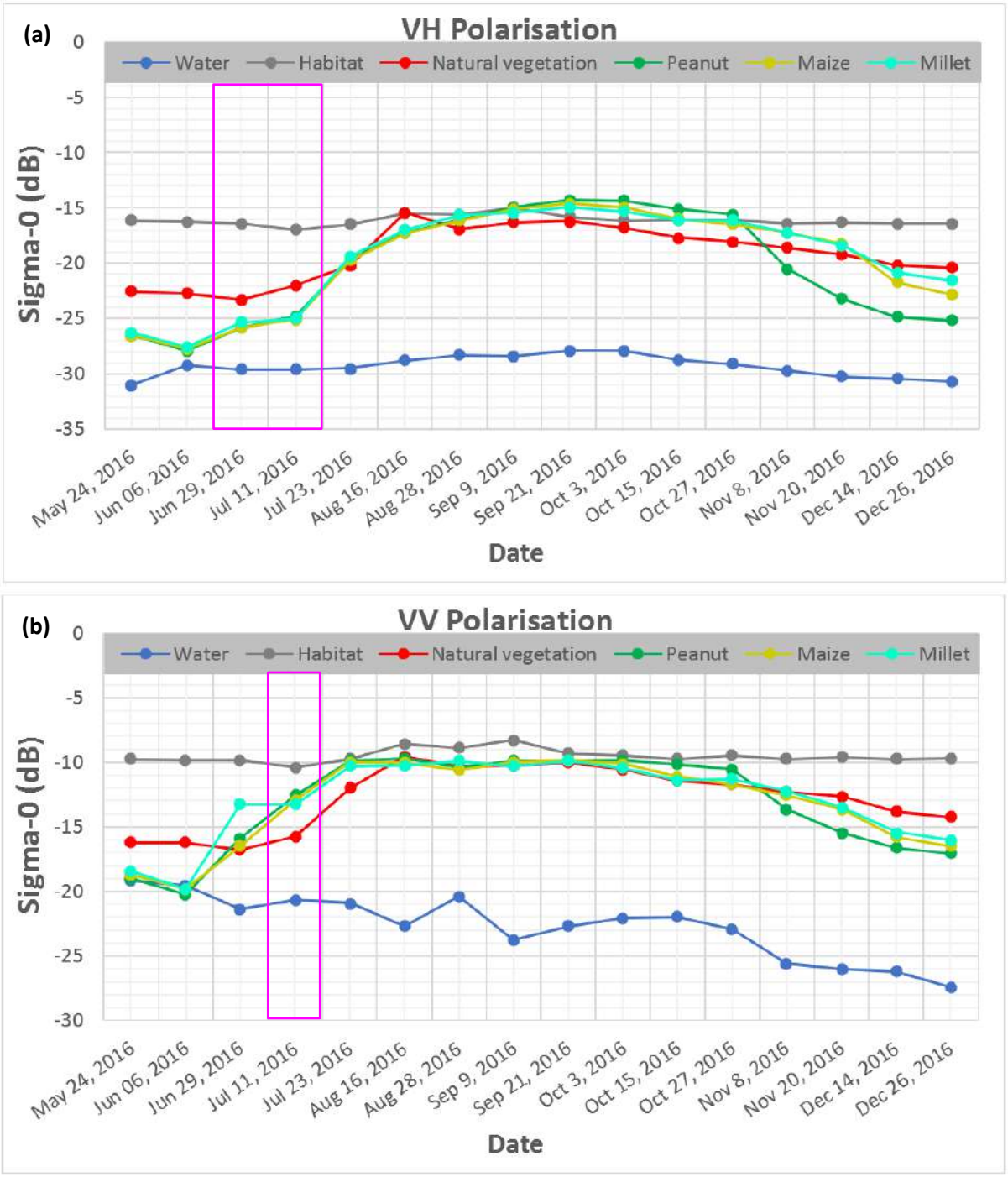


Fig.2: Temporal variation of the signals of the different land uses in VH (a) and VV (b) polarisation

The color composition in "false color" of these three images (VH of June 29, VH and VV of 11 july 11) in Figure-3 showed significant differences between agricultural and non-agricultural areas. The density curves of different land uses (Figure-3) showed the possibility to extract agricultural areas. Indeed, in polarization VH (June 29 and July 11) water areas mixed slightly with agricultural areas. However, the polarization VV (Figure-3) allowed the separation of the different classes.

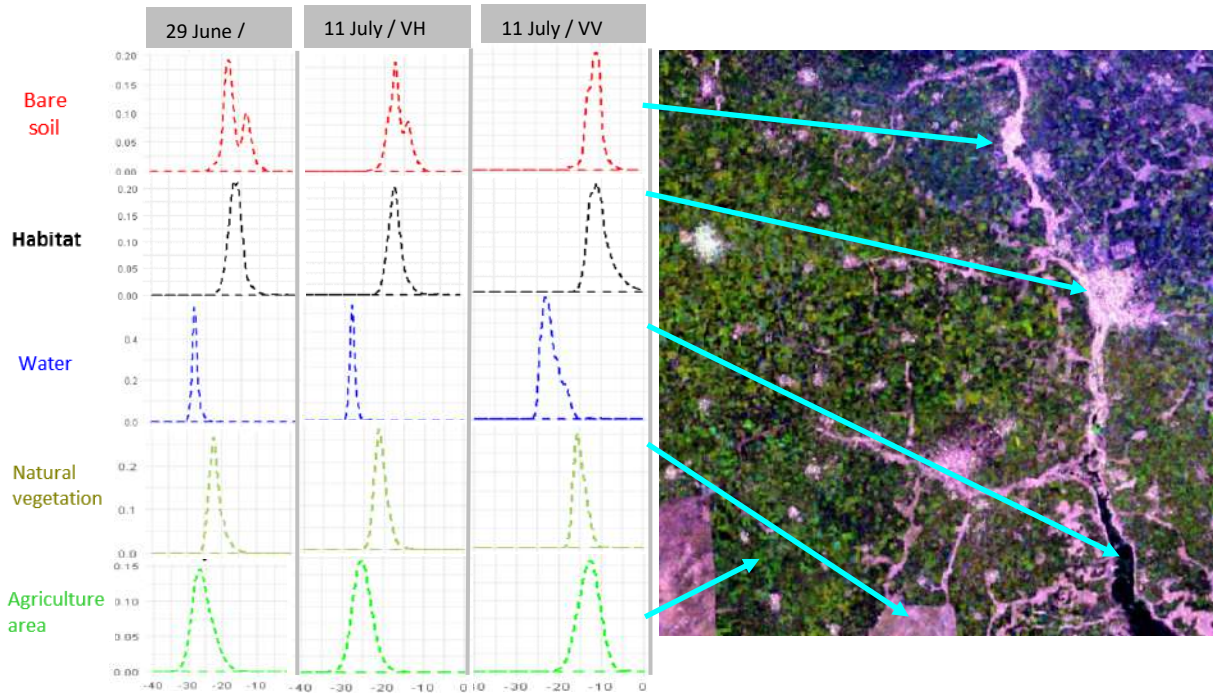


Fig.3: Colored composition and density curves of the different land cover and color composit of the images of June 29 (VH) and July 11 (VH and VV)

Figure 4 shows the resulting mask map of agricultural, non-agricultural and water areas (with a Kappa coefficient of 0.91). All subsequent analysis was limited to the agricultural areas.

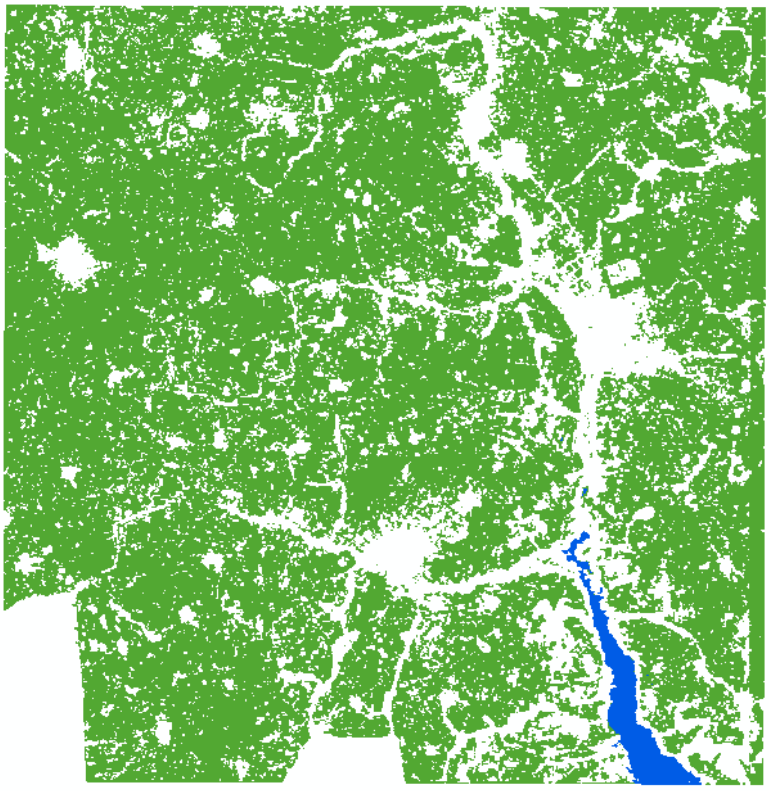


Fig.4: Agricultural areas (green), non-agricultural areas (white) and water areas (blue) .

b- Analysis of temporal signal of three crops (millet, maize et peanut) in VV and VH polarisations

The crop signals were strongly confused during the growth season under polarizations (Figure 5a and 5b), making it impossible to distinguish between these three crops. This happens because the C-band radar signal is sensitive to aerial vegetation as well as to physical surface parameters such as roughness and soil moisture [18, 17, 35, 36, 37, 38]. As a result, when vegetation cover was low, the soil contribution dominated in the signal [39], thus limiting the ability to differentiate crops.

Figure 5a and 5b show that crops signal varies respectively between -18 to -10 dB (8 dB amplitude) in VH polarization and -26 to 14 dB (12 dB amplitude) in VV polarization. This is perfectly normal because the Fresnel reflectivity coefficients governing the radar response depend on the polarization [11].

It was also observed that the signal in VH polarization reached its maximum value around the 200th Julian day corresponding to the 18th of July when the VV is at only half of its maximum value. This saturation of the VH signal at the beginning of the season shows a strong sensitivity of this polarization to the low vegetation cover.

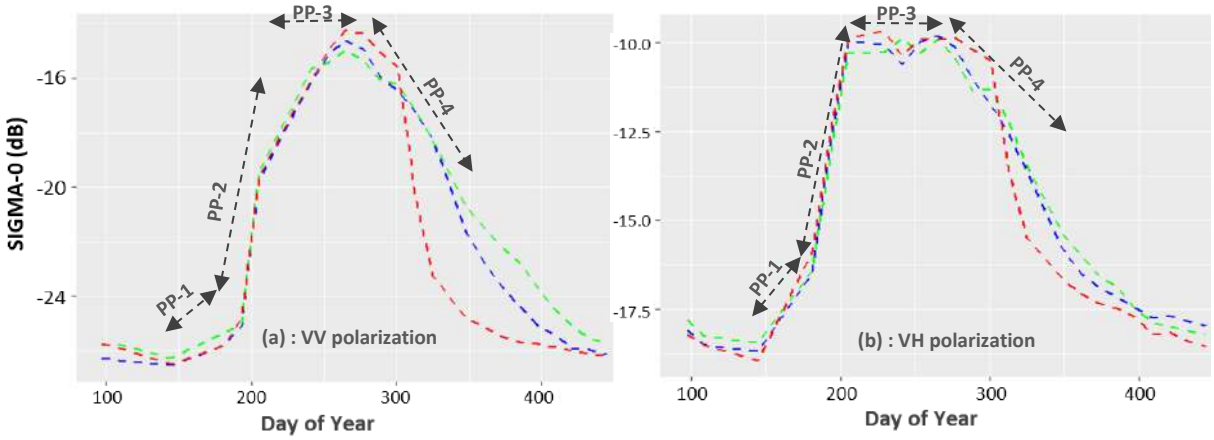


Fig.5: Peanut (red), maize (blue) and millet (green) during their different phenological phasis (PP)

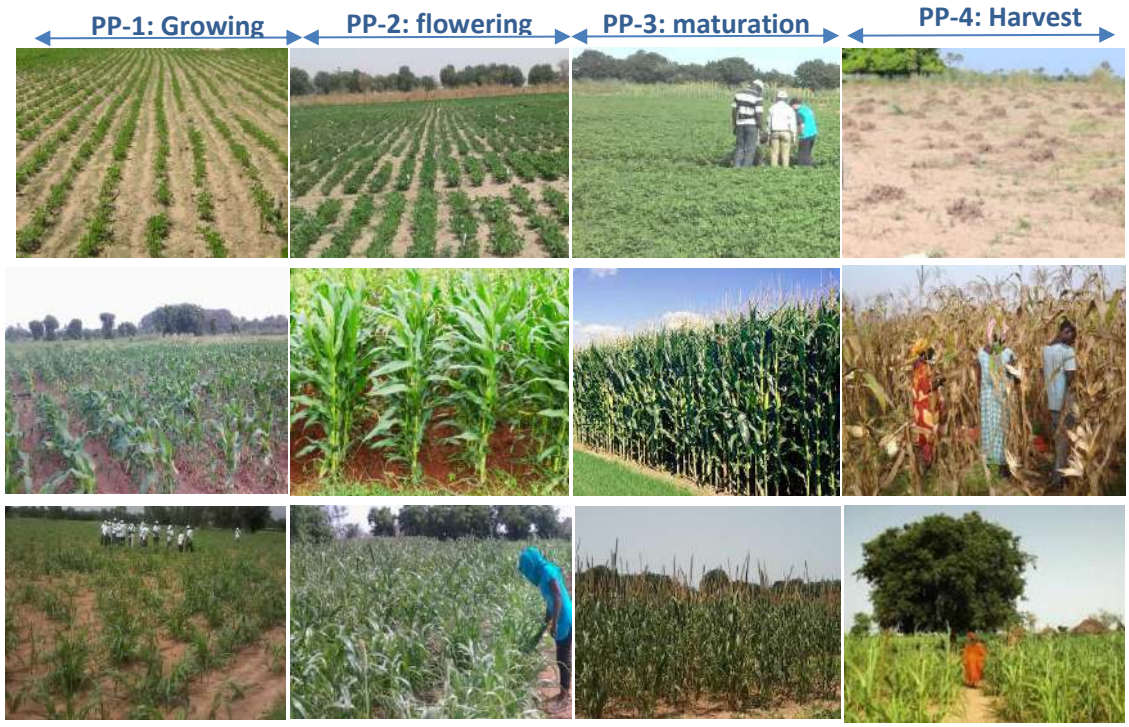


Fig.6: Photo of the three crops (peanut, maize and millet) during their different phenological phasis (Photo ISRA, Institut Sénégalaise de recherche Agricole)

A slight difference between the three crops in the VH signal was noted between the 200th and 265th day of year (July 18 to September 21) corresponding to the period of growth and maturation. After this period, the peanut signal remained high especially in VV polarization. This is because millet and maize reached their maturity more rapidly and they were being harvested, leading to a decline in their signals. However, the way that these two crops are harvested (cutting the ears and leaving the stems in place) makes their signal slowly decrease compared to that of the peanut where the harvest is done by cutting everything and leaving a bare soil (Figure-6). This explains the sudden drop of the peanut signal, which was much more marked in VV polarization (Figure-5).

To better understand the noted differences, an analysis of the distribution of values is made for each date (Figure 7). It should be noted that for almost all the dates and for each polarization, more than 50% of the values were within a range of less than 3 dB, for all crops. On the other hand, the distribution was normal (on average the number of values above the median was equal to the number of values below). Thus, the distribution of values was not related to either the type of crop or the phenological phase.

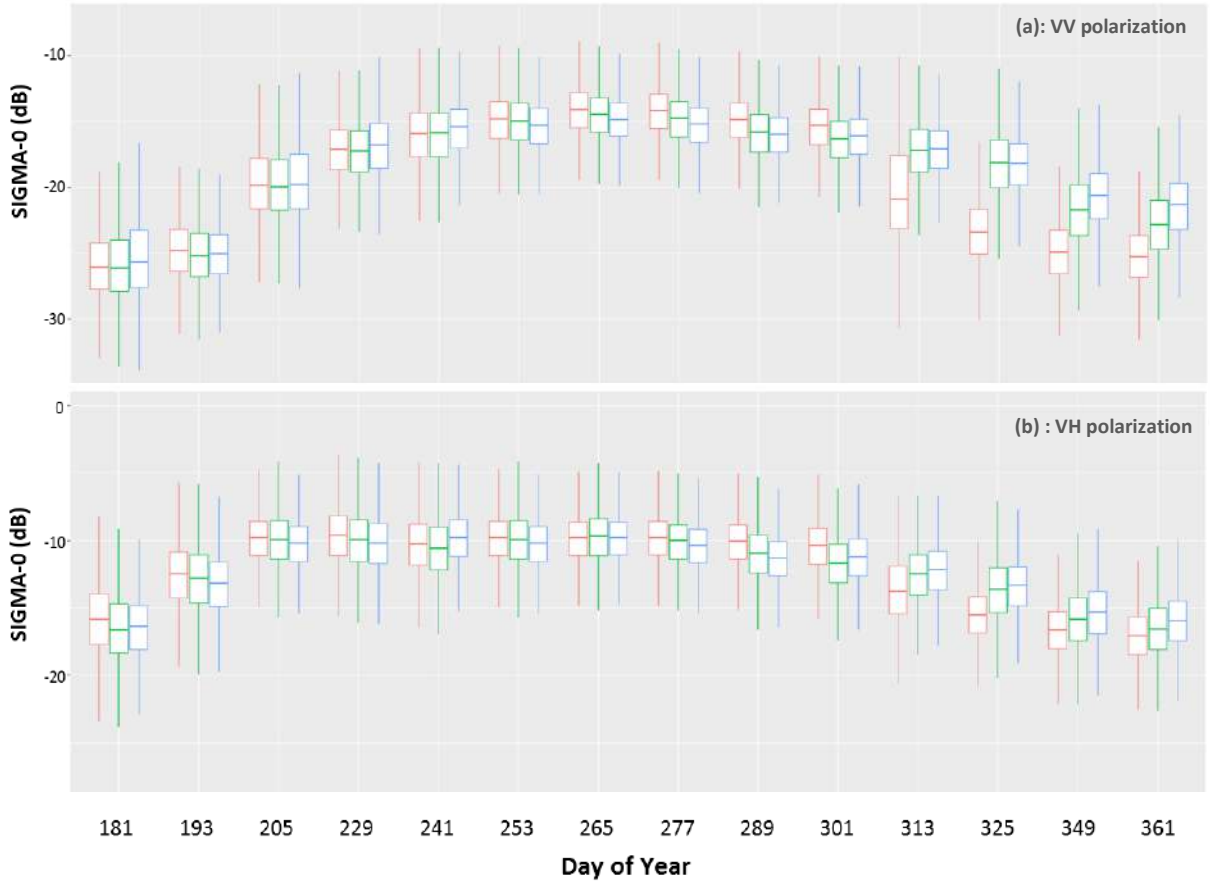


Fig.7: Distribution of radar signal (in VV and VH polarisation) of peanut (red), millet (blue) and maize (green) during the rainy season

c- ANOVA (Analysis of variance) of millet, maize and peanut signals in VH and VV polarisations

ANOVA identified dates to discriminate different crops. This part consisted in comparing crop reflectance values in pairs while calculating a coefficient of variation of the difference between crops signals for each date (Figure 8). An image was discarded when the deviation around the variance between two crops contains the value zero, indicating that it is not possible to distinguish between the two crops for this date. Table-1 summarizes the results of the ANOVA with "1" for acceptable image and "0" non-discriminative image. In VV polarization, 12 variables were considered discriminating compared to 9 variables for VH.

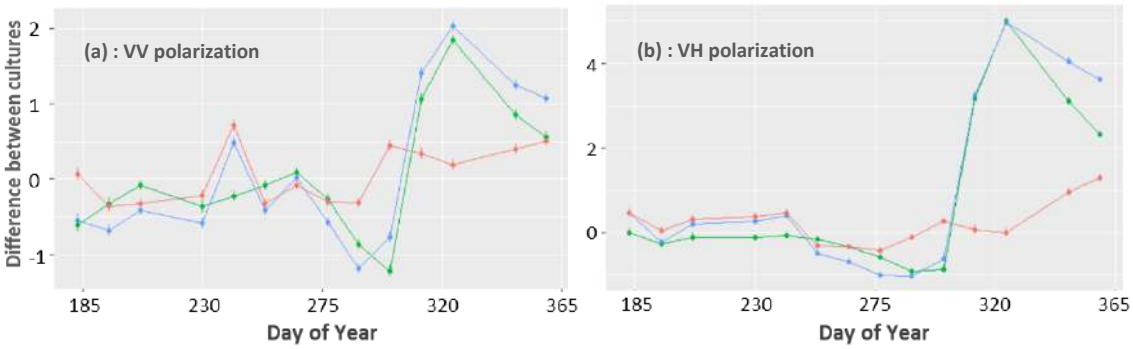


Fig.8: Confidence interval associated with the difference between different crops compared two by two for all dates (red: millet-maize, green: peanut-maize and blue: peanut- millet)

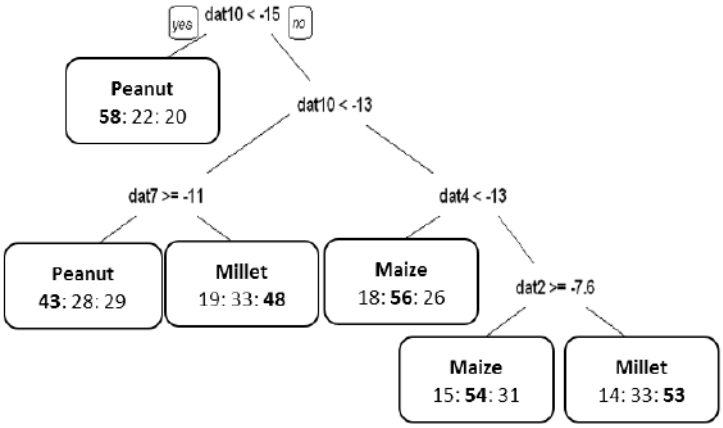
Table-1: Summary of the ANOVA result (1) for the optimal dates and (0) for wrong date (dat1, dat2… mean numero of the selected image)

Month	Jun e	July		August		September		October			November		December	
Date	**29**	**11**	**23**	**16**	**28**	**09**	**21**	**03**	**15**	**27**	**08**	**20**	**14**	**26**
Day of year	**181**	**193**	**205**	**229**	**241**	**253**	**265**	**277**	**289**	**301**	**313**	**325**	**349**	**361**
VV	0	1	1	1	1	1	0	1	1	1	1	1	1	1
		dat1	dat2	dat3	dat4	dat5		dat6	dat7	dat8	dat9	dat10	dat11	dat12
VH	0	0	1	1	0	1	1	1	1	1	0	0	1	1
			dat1	dat2		dat3	dat4	dat5	dat6	dat7			dat8	dat9

d- Classification and regression trees (CART)

In the CART model, the type of crop is the predicted variable, using reflectance values resulting from the selected images (explanatory variables). In addition to the first selection made from the ANOVA, the CART itself selects the best images (i.e. dates) to separate crops.

(i) VV polarization (Figure-9): the explanatory variables selected by the CART, allowing the best differentiation of the three cultures, were the reflectance of the images of 23th of July (dat2), 28th of August (dat4), 15th of October (dat7) and 20th of November (dat10).

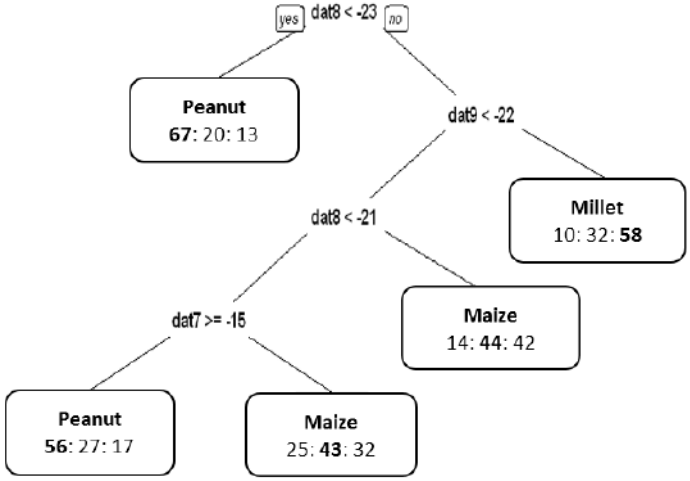


VV Polarization

	Peanut	Maize	Millet	Error %
Peunut	83.2	2.8	14.0	16.8
Maize	48.7	11.4	39.9	88.6
Millet	40.9	5.6	53.5	46.5
Global error = 47.3%				

Fig.9: Graph of CART result (in %) and confusion matrix (VV polarisation)

(ii) VH polarization: There were 9 explanatory variables but the model selected only three images: 27th of October (dat7), 14th of December (dat8) and 26th of December (dat9). The evaluation of the confusion matrix obtained from the VH data yielded a global classification error of 40.8% with still a high confusion for maize (Figure-10).



VH Polarization

	Peanut	Maize	Millet	Error %
Peanut	82.8	9.9	7.3	17.2
Maize	35.3	27.8	36.9	72.2
Millet	19.3	21.4	59.3	40.7
Global error = 40.8%				

Fig.10: Graph of CART result (in %) and confusion matrix (VH polarisation)

The evaluation of the two confusions matrix shows a very good recognition for peanut with an error of 16.8% in VV and 17.2% in VH polarisation (Figures 9 and 10 respectively). This is because the behavior of the peanut, with respect to the radar signal following the two polarizations, is different from that of the two other plants. Indeed, the size of the peanut plant rarely exceeds 50 cm while the others are more than one meter high. On the other hand, harvesting of a peanut field results in bare soil, unlike the other two crops where stalks remain after harvest of the ears before slowly decaying (Figure-6).

There was strong confusion for maize under both VV and VH polarisation with maize being incorrectly classified as peanut (48.7% error under VV and 35.3% under VH) and as millet (39.9 % under VV and 31.9% under VH), with a global error of 88.6 % (VV) and 72.2 %(VH). This strong confusion results from the fact that in this part of Senegal, there are two types of maize crop. Commercial maize is planted at the beginning of the rainy season and harvested in September. The fields are then often ploughed again and replaced by watermelon which is a creeping plant with a morphology identical to that of peanut and harvested at the same time as peanut. The second type of maize crop is used for food; it is sown later (mid-August) and harvested at the same time as millet. These two reasons explain the strong confusion noted for maize plots. To improve accuracy in maize discrimination, it is necessary to differentiate between the two types of maize in the sample.

Millet performs better with an overall classification error of 40.7% in VH and 46.5 in VV, indicating that millet discrimination is independent of polarization. However, VH polarisation proves better at distinguishing between millet and peanut, with only 19.3 % error compared to 40.9 % error for millet and maize. VV polarisation provides better discrimination between maize and millet with an error of 5.6%, compared with 21.4 % for VH.

V. CONCLUSION

This work explored the ability of Sentinel-1 radar data for crop monitoring in the Sahelian context where agriculture is characterized by small plots and often mixed crops. Such context is not suitable for a straightforward duplication of methods used in other countries. This difficulty has always been a handicap for monitoring crops in the Sahel. However, in recent years, the availability of time series of high spatial resolution images has brought about new interest from scientists. Radar data, unlike optical data, can be adapted to agricultural monitoring in the Sahelian belt. This is because agriculture is almost exclusively rainfed, and during the rainy season, cloud cover is often high, severely limiting the use of optical data.

This study aimed to discriminate three crops (millet, maize and peanuts) from a series of Sentinel-1 radar images, initially seeking to mask non-agricultural areas. A series of fourteen images was used in this study.

The analysis of the temporal profile of different land uses (water, natural vegetation, habitat and bare soil) showed that there is a big difference between agricultural and uncultivated areas at the beginning of the rainy season.

This difference allowed to create a mask of the non-agricultural areas and to concentrate only on the cropped ones.

The analysis of variance (ANOVA) of the three cultures, performed on the time series made it possible to identify and eliminate the non-discriminating data (dates). The prediction model constructed with the data in VV and then VH produced rather large overall errors (47.3% in VV and 40.8% in VH). However, there was a very good ability of Sentinel-1 data to discriminate peanut from other crops with only 16.8% error in VV and 17.2% in VH, which is a big achievement for agricultural monitoring in this part of the world where mapping of crop areas is very difficult. Maize discrimination remained the main limitation of this study. Indeed, given the cultivation practices of maize in this zone (commercial maize sown very early and food corn sown later), it was not easy to discriminate, especially since that difference was not taken into account for the sampling. Therefore, to improve these results it is necessary to differentiate both types of maize crop during the sampling. The use of more advanced discrimination algorithms or prediction models could also help to better analyze the potential of Sentinel-1 radar time series for crop monitoring and mapping in the Sahel.

REFERENCES

[1] Jarlan, L. Inversion des données des diffusiomètres spatiaux pour le suivi de la végétation en zone semi-aride : application au Sahel africain. Thèse de doctorat, Université Paul Sabatier, Toulouse, 2001, 263 p.
[2] Akbari, M.; Mamanpoush, A.R.; Gieske, A.; Miranzadeh, M.; Torabi, M.; Salemi, H. Crop and land cover classification in Iran using Landsat 7 imagery. Int. J. Remote Sens. 2006, 2006, 27, 4117–4135
[3] Fritz, S.; See, L.; Rembold, F. Comparison of global and regional land cover maps with statistical information for the agricultural domain in Africa. Int. J. Remote Sens. 2010, 31, 2237–2256, doi:10.1080/01431160902946598
[4] Vancutsem, C.; Marinho, E.; Kayitakire, F.; See, L.; Fritz, S. Harmonizing and combining existing Land Cover/Land Use datasets for cropland area monitoring at the African continental scale. Remote Sens. 2012, 5, 19–41.
[5] Delrue, J.; Bydekerke, L.; Eerens, H.; Gilliams, S.; Piccard, I.; Swinnen, E. Crop mapping in countries with small-scale farming: A case study for West Shewa, Ethiopia. Int. J. Remote Sens. 2013, 34, 2566–2582, doi:10.1080/01431161.2012.747016.
[6] Lambert, M.J.; Waldner, F; Defourny, P. Cropland Mapping over Sahelian and Sudanian Agrosystems: A Knowledge-Based Approach Using PROBA-V Time Series at 100-m. Remote Sens. 2016, 8, 232; doi:10.3390/rs8030232
[7] Nagai, S.; Saigusa, N.; Muraoka, H.; Nasahara, K.N. What makes the satellite-based EVI–GPP relationship unclear in a deciduous broad-leaved forest? Ecol. Res. 2010, 25359–65
[8] Wu, W.; Shibasaki, R.; Yang, P.; Zhou, Q.; Tang, H. Remotely sensed estimation of cropland in China: A comparison of the maps derived from four global land cover datasets. Can. J. Remote Sens. 2017, 34, 467–479, doi:10.5589/m08-059.
[9] Karkauskaite, P.; Tagesson, T.; Fensholt, R. Evaluation of the plant phenology index (PPI), NDVI and EVI for start-of season trend analysis of the Northern Hemisphere boreal zone. Remote Sens. 2017, 9485
[10] Le Toan, T.; Paulsader, M.; Flouzat, G.; Fluhr, A. Soil moisture content and microwave backscatter in the 1.5-9 GHZ region. Invited paper, Int. Geosci. Remote Sensing. Symp., Washington, DC, june 1981.
[11] Ulaby, F.T.; Batlivala, P.B.; Dobson, M.C. Microwave backscatter dependence on surface roughness, soil moisture and soil texture: Part I-Bare soil. IEEE Trans. Geosci. Electron. GE-16(4), 1978, p. 286-295.
[12] Bruckler, L.; Witono, H.; Stengel, P. Near surface soil moisture estimation from microwave measurements. Remote sensing. Environment, 1988, 28, p. 101-121
[13] Frison, P.L.; Mougin, E.; Hiernaux, P. Observations and interpretation of seasonal ERS-1 wind scatterometer data over Northern Sahel (Mali). Remote Sensing of Environment, 1998, 693, 233– 242.
[14] Jarlan, L.; Mougin, E.; Frison, P.L.; Mazzega, P.; Hiernaux P. Analysis of ERS wind scatterometter time series over Sahel (Mali). Remote Sensing of Environment, 2002, 81, 404-415.
[15] Zine, S. Contribution de la télédétection satellitale radar pour le suivi des paramètres de surface d'une zone sahélienne agro-pastorale, thèse de doctorat de l'Université de Marne-la-Vallée, 2004.
[16] Calvet, J.C.; Wigneron, J.P.; Walker, J.; Karbou, F.; Chanzy, A.; Albergel, C. Sensitivity of passive microwave observations to soil moisture and vegetation water content: L-band to W-band. IEEE Trans. Geosci. Remote Sens. 2011, 49:1190–1199. doi:10.1109/TGRS.2010.2050488
[17] Faye, G.; Frison, P.L.; Diouf, A.A.; Wade, S.; Kane, C.A.; Fussi, F.; Jarlan, L.; Niang, F.K.N.; Ndione, J.A.; Mougin, E. Soil estimation in the Ferlo region (Senegal) using Radar Envisat/ASAR and Optical Spot/Vegetation data. Egyptian Journal of Remote Sensing Space Sci, 2017, 21 (2018) S13–S22
[18] Bousbih, S.; Zribi, M.; Lili-Chabaane, Z.; Baghdadi, N.; El Hajj, M.; Qi Gao.; Mougenot, B. Potential of Sentinel-1 Radar Data for the Assessment of Soil and Cereal Cover Parameters. Sensors 2017, 17, 2617; doi:10.3390/s17112617
[19] MEPN. Schéma directeur de la zone éco-géographique sylvopastorale, Sénégal, 1999, 20 pages.
[20] Tostain, S. Le mil, une longue histoire : hypothèses sur sa domestication et ses migrations. Plantes et Paysages d'Afrique, 1998, 461–490.

[21] Bezançon, G.; Pham, J.L. Ressources génétiques des mils en Afrique de l'Ouest : Diversité, conservation et valorisation. (G. Bezançon & J. L. Pham, Eds.). IRD Editions, 2004.
[22] Hamon, P. Diversité génétique des plantes tropicales cultivées. Editions Quae, 1999.
[23] Brink, M.; Belay, G.M. Ressources végétales de l'Afrique tropicale 1. Céréales et légumes secs. (M. Brink & G. Belay, Eds.). Fondation PROTA / Backhuys Publishers / CTA, Wageningen : Pays-Bas, 2006.
[24] Durovray, J. L'amélioration variétale du maïs au Sénégal. Agronomie Tropicale XXXI-3, XXVIII, 1976, 259-264 .
[25] Mémento de l'agronome, F. M. des affaires étrangères. Mémento de l'agronome. (F. M. des affaires Étrangères, Ed.). Editions Quae, 2002.
[26] Chevalier, A. L'origine botanique et l'amélioration des Arachides cultivées. Essai d'une classification systématique. Revue de Botanique Appliquée et D'agriculture Coloniale, 1929, 9(90), 97–102
[27] Gillier, P.; Silvestre, P. L'ARACHIDE. G.-P. Moisonneuve et Larose, 1969.
[28] Copernicus Open Data Hub. Available online: https://sentinel.esa.int/web/sentinel (accessed on mars 2017).
[29] Baup, F.; Mougin, E.; De Rosnay, P.; Timouk, F.; Chênerie, I. Surface soil moisture estimation over the AMMA Sahelian site in Mali using ENVISAT/ASAR data. Remote Sensing of Environment, 2007, 109 (2007) 473–481
[30] Breiman, L.; Friedman, R.A.; Olshen, R.A.; Stone, C.G. Classification and Regression Trees. Pacific Grove, CA: Wadsworth, 1984.
[31] Salford-Systems, 2001. Classification and regression trees a robust decision-tree technology for data mining, predictive modelling and data processing. San Diego, USA, 2001, p.335.
[32] Faye, G.; Frison, P.L.; Wade, S.; Ndione, J.A.; Beye, A.C.; Rudant, J.P. Etude de la saisonnalité des mesures des diffusiomètres SCAT : apport au suivi de la végétation au Sahel, cas du Ferlo au Sénégal. Télédétection, 2011, Vol. 10, No. 1, pp. 23–31.
[33] Frison, P.L.; Mougin, E. Monitoring global vegetation dynamics with ERS-1 wind-scatterometer data, International Journal of Remote Sensing, 1996, 17, pp. 3201-3218.
[34] Jarlan, L.; Mazzega, P.; Mougin, E.; Lavenu, F.; Marty, G.; Frison, P.L. Mapping of Sahelian vegetation parameters from ERS scatterometer data with an evolution strategies algorithm. Remote Sensing of Environment, 2003, 87, 72−84.
[35] Mattia, M.; Toan, T.L.; Souyris, J.C.; Carolis, G.D.; Floury, N.; Posa, F.; Pasquariello, G. The effect of surface roughness on multifrequency polarimetric SAR data. IEEE Trans. Geosci. Remote Sens. 1997, 35, 954–966
[36] Calvet, J.C., Wigneron, J.P.; Walker, J.; Karbou, F.; Chanzy, A.; Albergel, C. Sensitivity of passive microwave observations to soil moisture and vegetation water content: L-band to W-band. IEEE Trans. Geosci. Remote Sens, 2011, 49:1190–1199. doi:10.1109/TGRS.2010.2050488
[37] Zribi, M.; Gorrab, A.; Baghdadi, N.; Lili-Chabaane, Z.; Mougenot, B. Influence of radar frequency on the relationship between bare surface soil moisture vertical profile and radar backscatter. IEEE Geosci. Remote Sens. Lett. 2014, 11, 848–852.
[38] Alexakis, D.D.; Mexis, F.K.; Vozinaki, A.K.; Daliakopoulos, I.N.; Tsanis, I.K. Soil Moisture Content Estimation Based on Sentinel-1 and Auxiliary Earth Observation Products. A Hydrological Approach. Sensors 2017, 17, 1455
[39] Baghdadi, N.; Zribi, M.; Bruand, A.; King, C. Potentiel of ASAR/ENVISAT for the characterization of soil surface parameters over bare agricultural fields. Sensors 2010, 10, 8899–8900.

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Quality of water and sediment in whiteleg shrimp (*Litopenaeus Vannamei*) pond

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Abstract*— *Currently, the farming of saltwater and brackish water shrimps, especially whiteleg shrimp farming, is being interested and developed in terms of both area and level of intensive farming. This study was conducted to evaluate the environmental quality of water and sediment at the beginning and end of the pond of whiteleg shrimp. Water samples were collected to determine water quality indices including temperature, pH, salinity (S), turbidity, dissolved oxygen (DO), total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonium (NH_4^+-N); nitrate (NO_3^--N), total nitrogen (TN) and total phosphorus (TP). For sediment samples, organic matter (OM), total nitrogen (TN), total phosphorus (TP) were analyzed. The results showed that the water quality in the pond through the sampling periodswas mostly suitable for the growth of shrimp and within the allowed values of the regulations, except for salinity lower than QCVN 38: 2011/BTNMT and QCVN 02-19: 2014/BNNPTNT. Content of organic matters, total nitrogen, and total phosphorus accumulated in the bottom of the pond increased by 0.15%, 0.042%, and 0.003% respectively. The study provides important information on water and sediment characteristics for shrimp pond management.

Keywords*— *sediment, water quality, whiteleg shrimp, nitrogen, phosphosrus.

I. INTRODUCTION

Aquaculture is one of the key economic sectors in Vietnamese agriculture, playing an important role in meeting the consumer demand and exporting to the world market. In recent years, white leg shrimp (Litopenaeusvannamei) are popularly cultured in Vietnam, because they have superior properties compared to tiger shrimp such as faster growth, better tolerance at high farming densitiesThe Mekong River Delta has a crisscrossing river system, long coastline with favorable climatic conditions for fisheries development and has become a key seafood production place, accounting for more than 90% of seafood quantity of the country. Aquaculture is rapidly developing, farming systems become more diverse. According to Soc Trang Department of Agriculture and Rural Development, the brackish water shrimp farming area in Vinh Chau town in 2019 is 7,695 ha, reaching over 32% of the plan (white leg shrimp is 6,077 ha, tiger shrimp is 1,618 ha). Shrimp farming not only contributes to increase seafood export, but also has a positive impact on socio-economic issues, improving the life of aquaculture farmers. However, white-leg shrimp are mainly cultured in intensive form, leading to more polluted environment and disease outbreaks and excessive antibiotic residues in shrimp meat, which greatly affects exports. Since then, water sources, pathogens, and risks in the farming process have become issues of concern. Currently, the quality of the environment in some fisheries areas is polluted due to ecological imbalance in coastal areas. This study was conducted to assess the environmental quality of water and sediment in the white leg shrimp pond to provide useful information for the environmental managers and shrimp's consumers.

II. MATERIALS AND METHODS

2.1 Water sampling and analysis

In white leg shrimp pond, samples were taken as pooled sample. After collecting samples, stored in a cool tank then the sample was transported to the laboratory of the College of Environment and Natural Resources for the analysis at the environmental quality laboratory. Temperature (T), pH, salinity (S‰), turbidity, dissolved oxygen (DO) parameters were measured directly in the field while the total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonium (NH_4^+-N), nitrate (NO_3^--N), total nitrogen (TN) and total phosphorus (TP) were measured using the

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standard methods (APHA,1998). Surface water was assessed using QCVN 38: 2011/BTNMT, the quality of surface water to protect aquatic life.

2.2 Sediment sampling and analysis

The sediment sample was collected using petersengause and stored in plastic bag. The sample was dried at room temperature, crushed and sieved through the 0.5 mm pore size mesh to analyze organic matter, total nitrogen, and total phosphorus. Organic matter was analyzed by Walkley-Black dichromate method (Walkley-Black dichromate wet oxidation method), total nitrogen (TN) analyzed by Kjeldahl method, and total phosphorus (TP) analyzed by colorimetric method after digestion of the sample with mixture of H_2SO_4 and $HClO_4$. The crushed soil sample (0.5 g) was digested using a microwave digester (Milestone, Ethos) using the method of the US Federal Environmental Protection Agency (EPA3051) by adding 10 ml of 65% nitric acid and operating under 1,000 watts of electricity at 175ºC for 15 minutes (Cui et al., 2010).

III. RESULTS AND DISCUSSION

3.1 Water quality in the white leg shrimp pond

3.1.1 Temperature and pH

Temperature is the most important factor affecting aquaculture. Temperature affects most of the other parameters characteristic of water quality. During the first and second sampling sessions, the water temperature measured at 8:00 fluctuated between 32 and 34ºC (Figure 1).

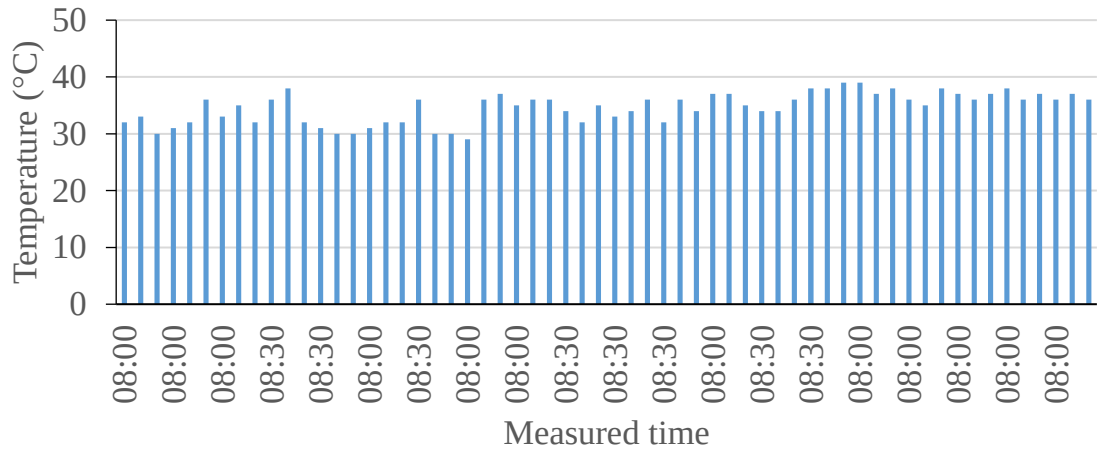

Fig.1: Daily measurement of temperature in the shrimp pond

According to QCVN 02-19:2014/BNNPTNT, the allowable temperature in white leg shrimp pond water is 18-33ºC. From the above results, it shows that the water temperature in shrimp ponds over 2 sampling phases was higher than QCVN 02-19:2014/BNNPTNT. The sample measurement results showed that the pH value in shrimp pond water through the sampling times ranged from 8.1-8.2 (Figure 2). A small change in pH also affects shrimp, because pH is one of the environmental factors affecting aquatic organisms, when the environmental pH is too high or too low is detrimental to the growth of aquatic life. In water environment, pH changes due to hot weather or heavy rain. According to QCVN 02-19:2014/BNNPTNT, the permissible pH value in the pond water of black tiger shrimp and white leg shrimp is 7-9 and the daily fluctuation is not more than 0.5. In general, the average pH value in shrimp pond water over 2 sampling sessions was relatively suitable for shrimp growth and development and is within the allowable limits of this regulation.

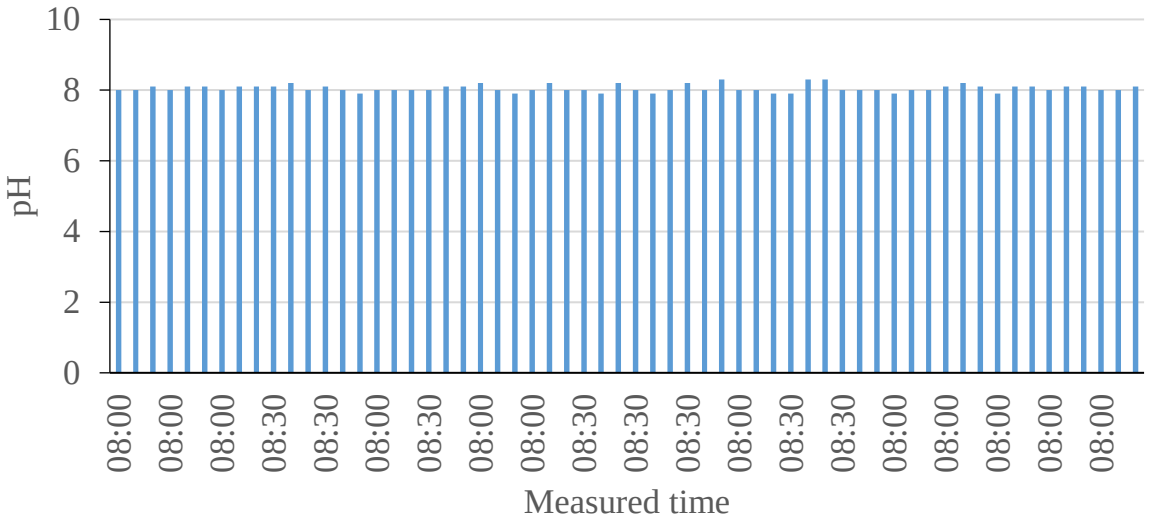

Fig.2: Daily measurement of pH in the shrimp pond

3.1.2 Dissoloved oxygen and salinity

The average dissolved oxygen concentration in the water of the shrimp pond over the two sampling cycles ranged from 5.8 to 6.6 mg/L (Figure 3). Dissolved oxygen concentrations in the pond water in the second collection time was lower. This happened since the oxygen demand increases as there is more shrimp feed and waste accumulated in the bottom of the pond over time. Dissolved oxygen in the pond is usually consumed by the living activities of shrimp, fish, shrimp size, organic matter decomposition by microorganisms and other organisms living in the pond environment. According to QCVN 02-19: 2014/BNNPPTNT, the permitted concentration of dissolved oxygen in shrimp pond water is greater than 3.5 mg/L. Therefore, the dissolved oxygen concentration through the sampling sessions was relatively consistent with this standard.

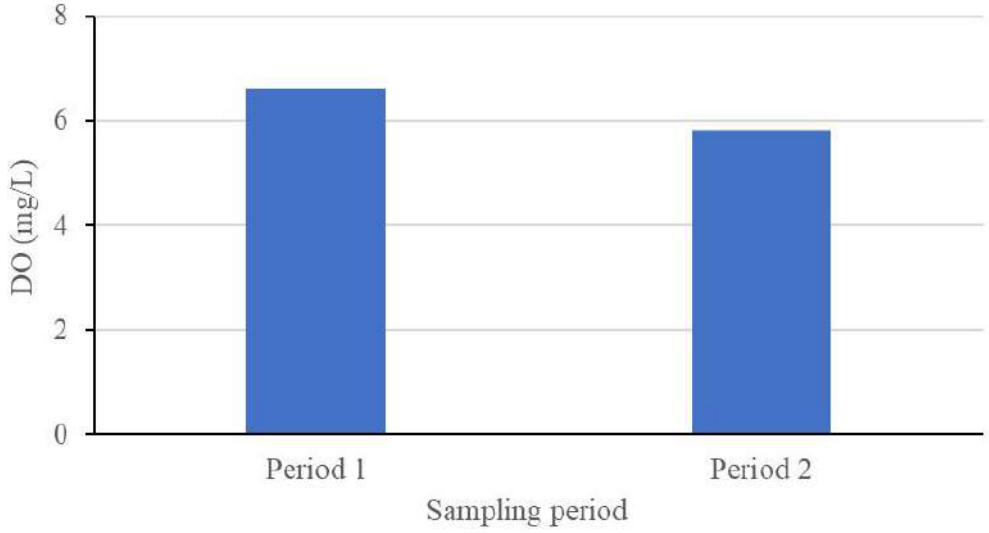

Fig.3: DO in the shrimp pond

The survey showed that the salinity in the shrimp pond water through the sampling sessions tended to decrease. The mean salinity values ranged from 4.5–5 ‰ (Figure 4). The reason for the decrease in salinity is that the water level in the pond decreases, the hot sun evaporates during the culture process, making the salinity increase. According to QCVN 02-19: 2014/BNNPTNT, the permissible salinity in the shrimp ponds is 5-35‰. From the results of this study, it showed that the salinity in shrimp pond water in the second sampling phase was not consistent with this standard.

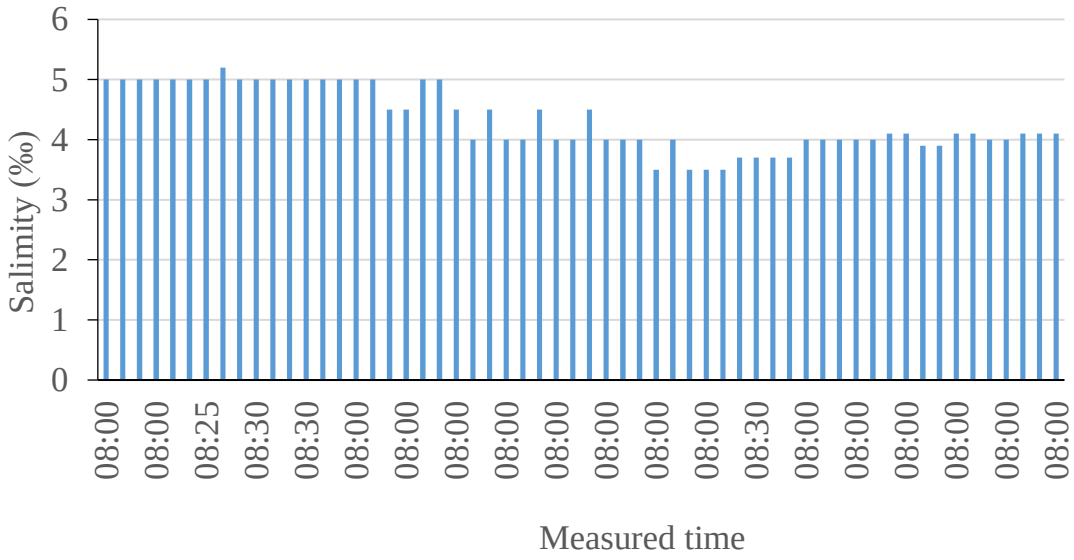

Fig.4: Daily measurement of salinity in the shrimp pond

3.1.3 Turbidity and total suspended solids

Water turbidity is related to the amount of material suspended in the water, which is its ability to block the sun's light. High turbidity reduces sunlight penetration into water, reduces oxygen production in the pond. The results of analyzing turbidity through 2 collection times showed that the first collection time turbidity was 12,515 NTU and the second time was 13.1 NTU (Figure 5), it showed that after 3 month, the turbidity increased to 0.585 NTU, the main reason could be due to the shrimp activities, food left and phytoplankton causing increasing turbidity.

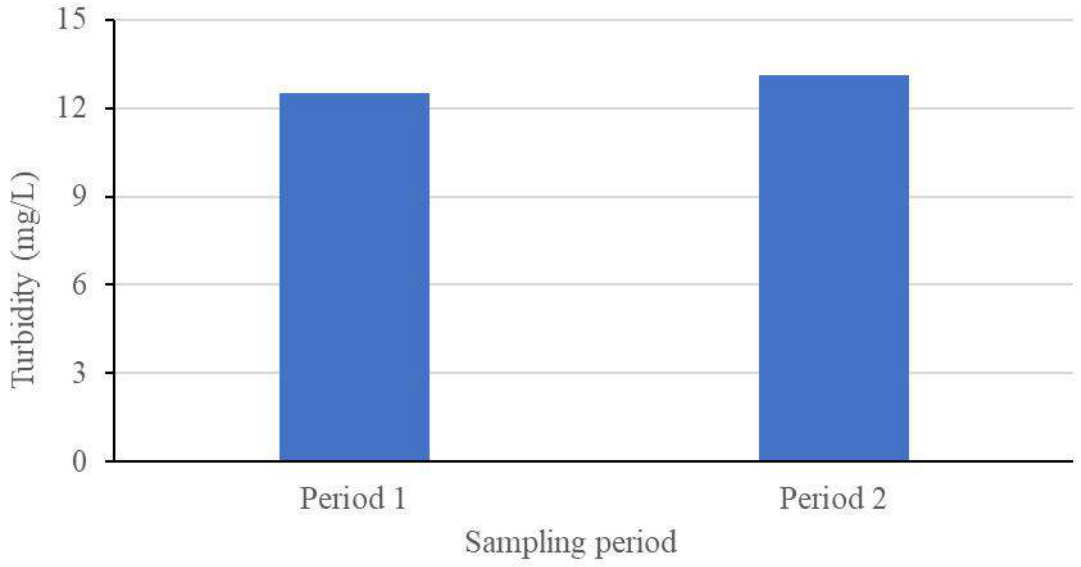

Fig.5: Turbidity in the shrimp pond

The average TSS concentration of the shrimp pond over 2 sampling cycles ranged from 20-22 mg/L (Figure 6). The increase in total suspended solids in the pond depends on the amount of phytoplankton, soil erosion, feed added to the pond, and mechanical movements in the pond (shrimp movement, waves). In general, TSS in the study pond water was suitable for shrimp development, so TSS in the pond is not a factor affecting the culture environment and shrimp yield. According to QCVN 38: 2011/BTNMT, TSS value in surface water for the purpose of protecting aquatic life is

less than 100 mg/L. From the above study results, TSS was suitable for the shrimp over the sampling times.

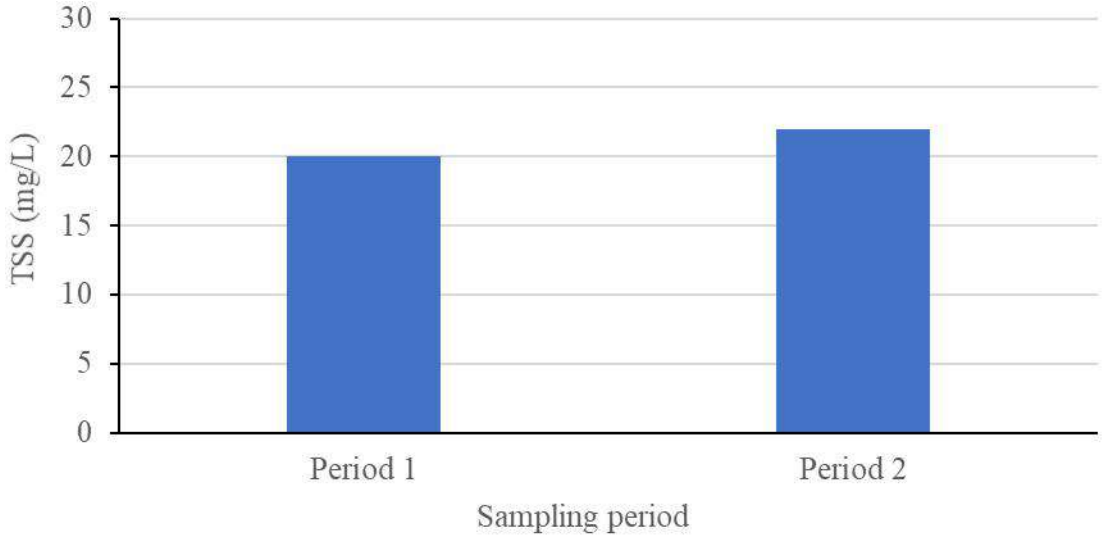

Fig.6: TSS in the shrimp pond

3.1.4 Chemical and biological oxygen demands

The results of COD in the pondwater showed that COD tended to decrease. At the beginning of the cultivation, COD concentration was 8.64 mg/L, but decreased to 7.8 mg/L at the third month (Figure 7). According to Smith et al. (2002) and Boyd (1998), the COD concentration in shrimp ponds should be controlled below 20 ppm (20 mg/L). As could be seen that the concentration of COD classified the water in the shrimp pond clean when COD ranges from 6-20 mg/L (Be, 1995).

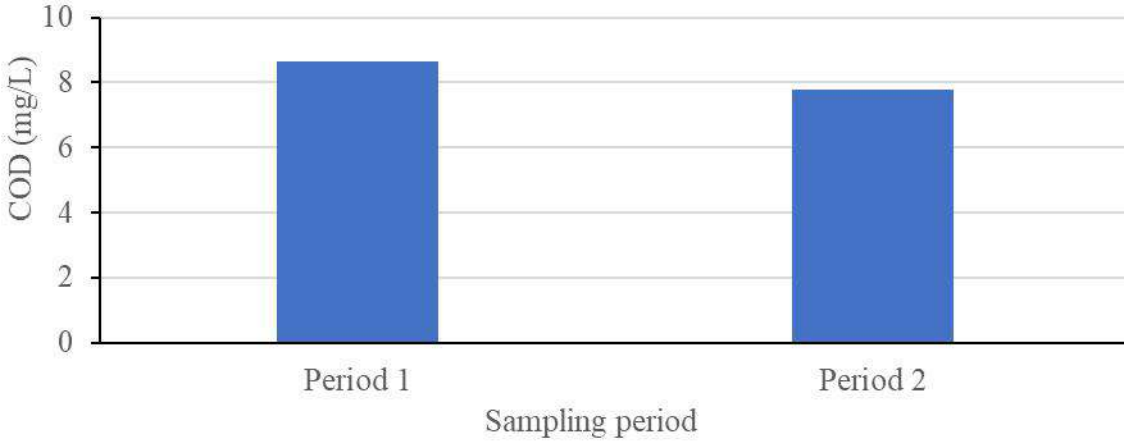

Fig.7: COD in the shrimp pond

The concentration of BOD fluctuatedin the ranges of 3.04-3.28 mg/L, the results of the second sampling time was lower than that in the first 1 (Figure 8). A typical aquaculture pond has a BOD value of 5-20 mg/L, higher BOD causes the higher the level of rich organic matter.

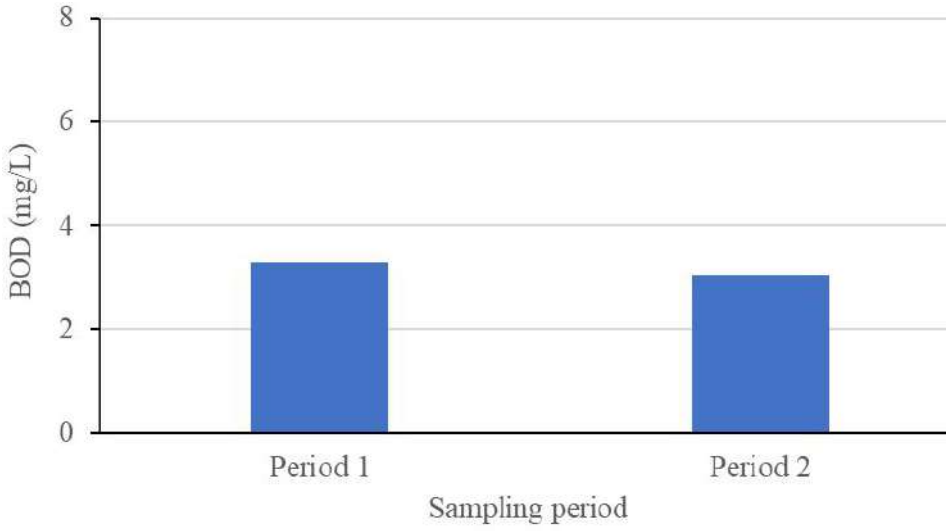

Fig.8: BOD in the shrimp pond

3.1.5 Ammonia and nitrate

The amonia concentration of the first sample was 0.386 mg/L and the second one was 0.188 mg/L (Figure 9). This could be because the conversion of organic nitrogen to nitrite and nitrate taking place in the shrimp pond. The process is governed by the pH value. The high ammonia concentration could harm shrimp growth and production.

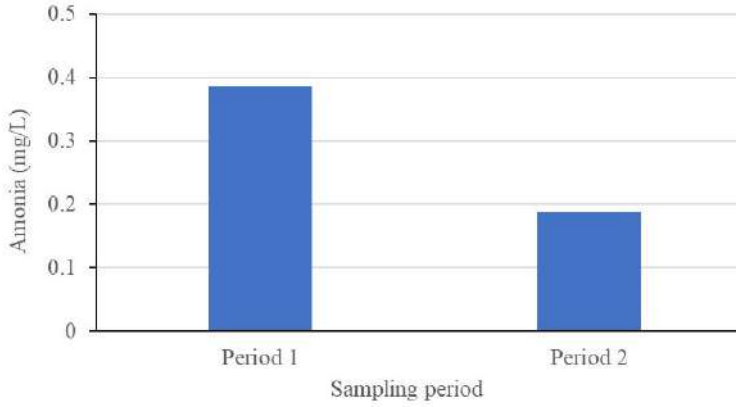

Fig.9: Ammonia in the shrimp pond

The average nitrate concentration of the shrimp pond over 2 sampling times ranged from 0.058-0.286 mg/L (Figure 10). Nitrate in the second sampling time was higher than the first one showed that after 3month, the pollution level of the pond decreased compared to the beginning.

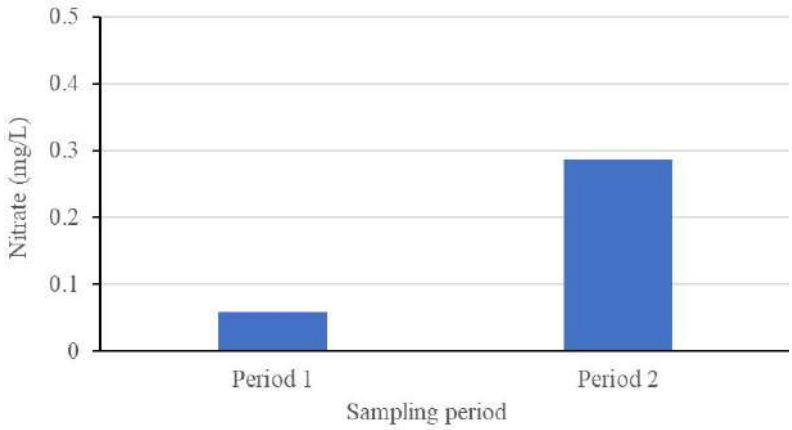

Fig.10: Nitrate in the shrimp pond

3.1.6 Total nitrogen and phosphorus in the shrimp pond

The results showed that the concentration of TN fluctuated in the range of 2,289-2,993 mg/L (Figure 11). In intensive shrimp ponds, nitrogen supplied to aquatic animals is the nitrogen in synthetic feeds. Normally, shrimp only absorb 25% of nitroen or 75% of the amount of nitrogen that is dispersed into the water as waste. Feed added to the pond is the main factor affecting the amount of nitrogen in the pond stored in the pond. Nitrogen storage in aquaculture ponds is relatively large depending on the nature of the pond, the efficiency of feed use, feed source and density of cultured shrimp.

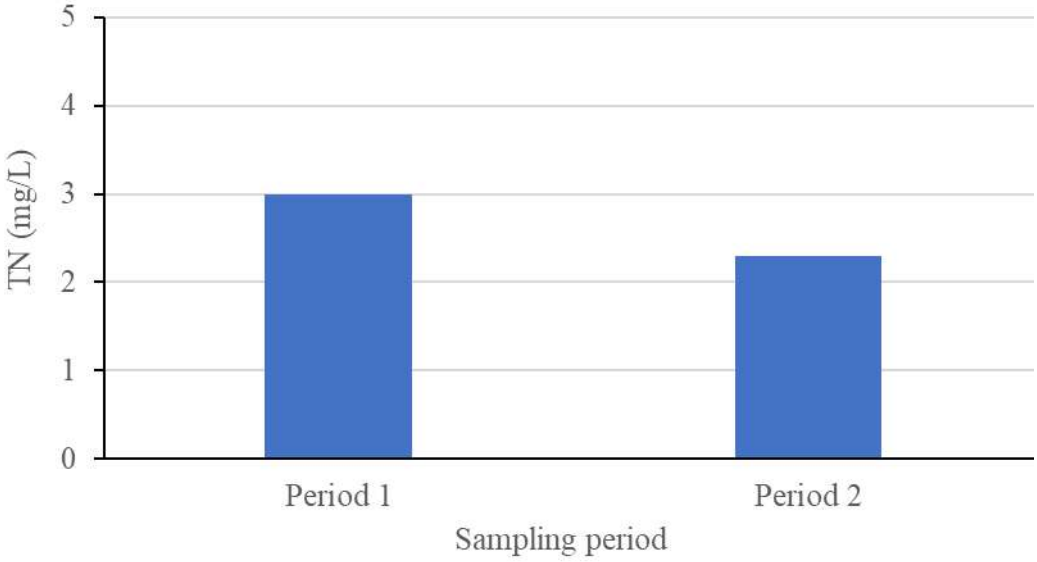

Fig.11: Total nitrogen in the shrimp pond

Phosphorus in the studying pond after 90 days of culture ranged from 0.02-0.03 mg/L (Figure 12). Due to the dissolution of the food, the deposited organic matter is decomposed by microorganisms and released phosphorus into the water, causing phosphorus concentration in the water to increase over time. In addition, according to Boyd (1998), after the floating plants die, 20-30% of the total phosphorus in their body decomposes into dissolved inorganic salts and 30-40% in dissolved organic form. The decomposition of phytoplankton after death and the release from food to phosphorus forms and increased total phosphorus concentration after the second sampling. According to Manh (2010) total phosphorus concentration in water in intensive shrimp ponds was from the beginning to the end of the crop ranged from 0.1 to 0.15 mg/L.

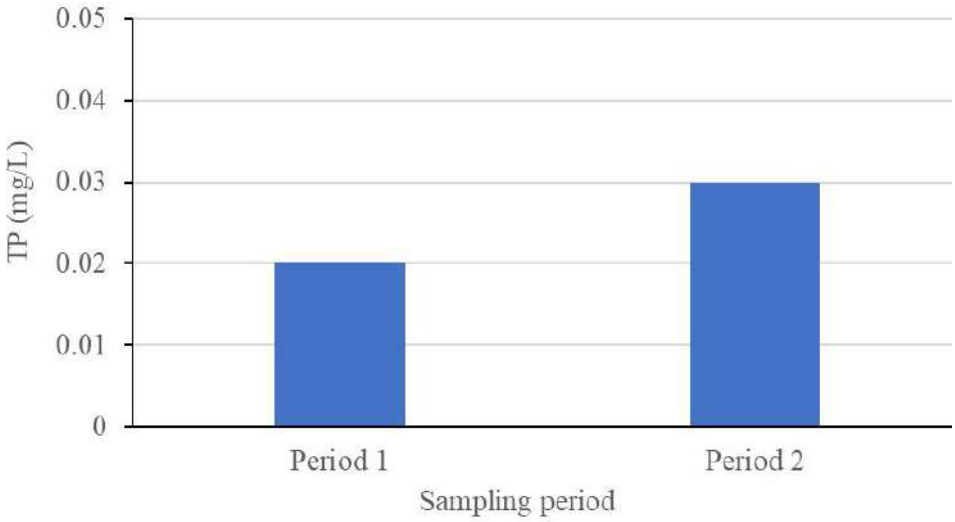

Fig.12: Total phosphorus in the shrimp pond

3.2 Quality of sediment in the shrimp pond

3.2.1 Organic matters

The amount of organic matter in the sediment increased and ranged from 1,047 to 1,197% (Figure 12). Organic matters in the sediment increases over time due to feed input during culture, partly converted from shrimp waste such as manure and molting and partly dissolved in water and in sediment. Organic matter is one of the reasons affecting the management of the shrimp pond and directly on the shrimp, the organic matter that is deposited on the pond bottom reduces the shrimp habitat area, their decomposition also causes dangerous for the lives of shrimp through generating toxic gases such as NH_3, H_2S at the bottom.

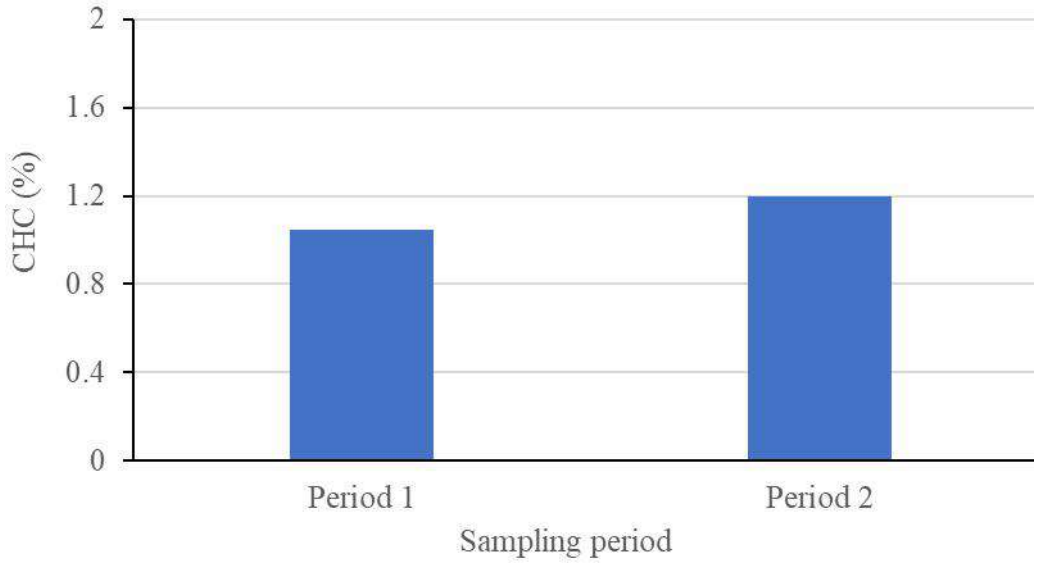

Fig.13: Organic matters in the shrimp pond

3.2.2 Total nitrogen in the shrimp pond

It was shown that nitrogen content in the sediment ranged from 0.062-0,104% (Figure 14). When the culture period is longer, the total nitrogen in the pond sediment increases due to the supply of nutrients from outside. The amount of nitrogen at the bottom of the pond depends greatly on the amount of stored organic matter: uneaten feed sources, shrimp waste products, the efficiency of using microorganisms is the cause of the nitrogen content in the pond bottom to increase.

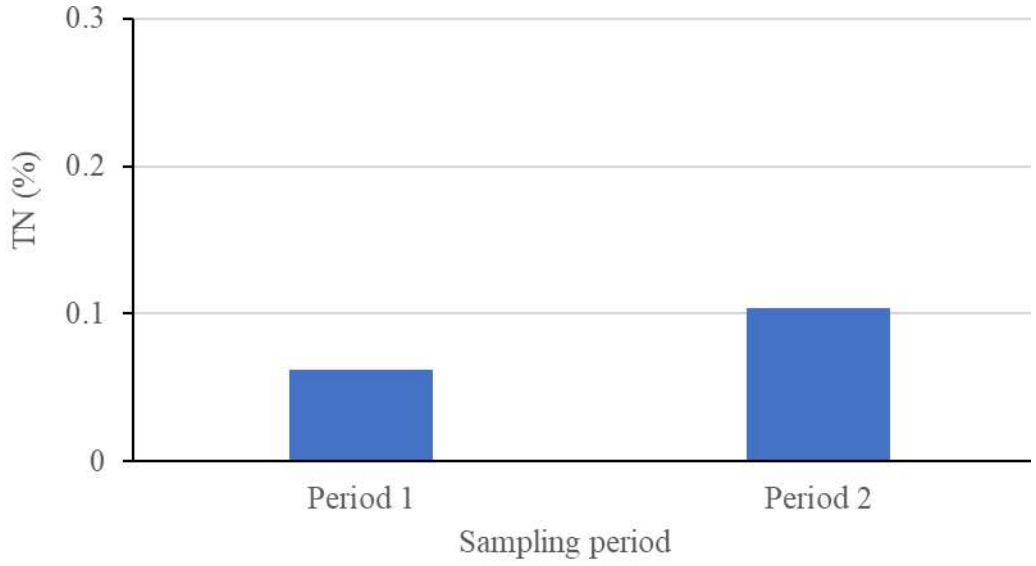

Fig.14: Total nitrogen in the shrimp pond

3.2.3 Total phosphorus in the shrimp pond

Phosphorus content at the bottom also increased over time of culture, ranging from 0.197 to 0.2% as P_2O_5 (Figure 15). Excess food, soil environmental characteristics, microbial decomposition, material conversion cycle in the pond are factors affecting phosphorus accumulation in the pond bottom. During the farming process, shrimp wastes and dead bodies of aquatic species settle on the pond bottom each day, together with the periodic fertilization in the pond, creating phosphorus in the pond bottom. Input phosphorus from a fertilizer or food source is first dissolved and hydrolyzed into a dissolved phosphate form. The amount of phosphorus dissolved in water would decrease rapidly as algae absorb and settle into the bottom mud layer. Aquatic animals also excrete a major amount of phosphorus in feces. Some of the phosphorus in algae or humus is also consumed by the plankton and excreted in the form of feces. Before being absorbed, all forms of phosphorus are converted to single phosphate, single phosphate is capable of participating in many chemical reactions: reacting with calcium, iron and aluminum. The reaction products have low solubility and are deposited into the sediment. These are the causes of phosphorus accumulation and increasing phosphorus in pond bottom sediment in the second sampling period.

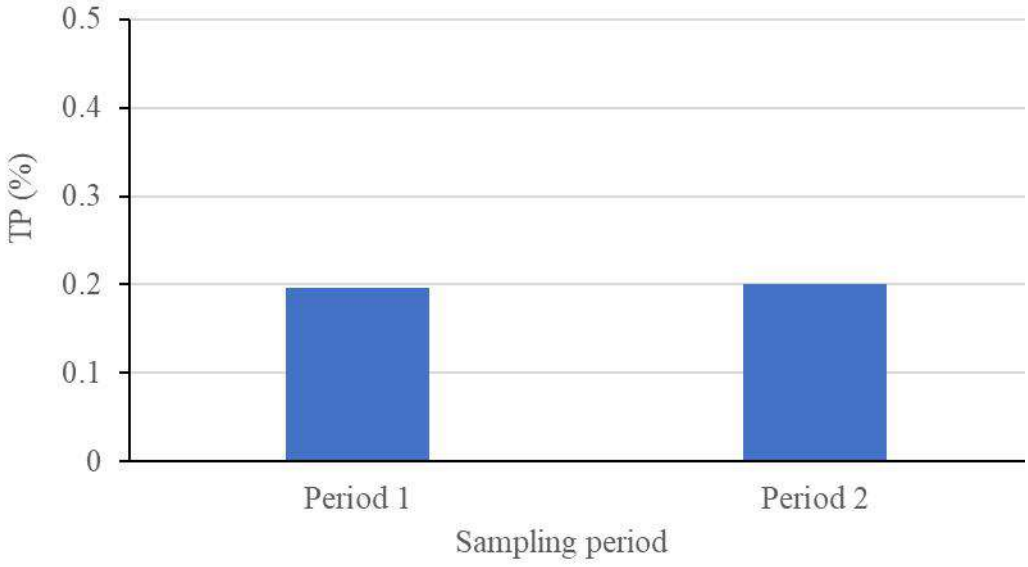

Fig.15:Total phosphorus in the shrimp pond

IV. CONCLUSION

Water quality parameters in the pond including temperature, pH, BOD, TSS, COD, TP, TN through sampling period were mostly suitable for the growth of shrimp and were within the allowed areas of regulations QCVN 38: 2011/BTNMT and QCVN 02-19: 2014/BNNPTNT. Content of organic matter, nitrogen, phosphorus accumulated in pond sediment after 90 days increased by 0.15%, 0.042%, and 0.003%, respectively. At present, the model of shrimp culture according to the process that the water was not changed and supplying water to the pond was only one timethus reducing harvesting time and reducing harm to outside environment. This whiteleg shrimp farming model with little impact on the water and soil environment if it is well managed. However, appropriate treatment measures are needed for treating wastewater from the shrimp pond to sustain the environment.

REFERENCES

[1] American Public Health Association. Standard Methods for the Examination of Water and Wastewater, 20th edition, Washington DC, USA; 1998.
[2] Boyd, C. E. 1998. Water quality for pond Aquaculture. Deparment of Fisheries and Allied Aquaculture Auburn University, Alabama 36849 USA.
[3] Kungvankij, P., T.E. Chua, J. Pudadera, G. Corre, L.B. Tiro, I.O. Potestas, G.A. Taleon and J.N. Paw, 1986. Shrimp culture: pond design, operation and management. NACA training manual series. 2:50-68.
[4] QCVN 02-19:2014/BNNPTNT. National Technical Regulation on Brackish Water Shrimp Farming - Conditions for ensuring veterinary hygiene, environmental protection and food safety.
[5] QCVN 38:2011/BTNMT. National technical regulation on surface water quality protecting aquatic life
[6] Nguyen Van Manh, 2010. Effect of intensive farming techniques of giant tiger shrimp (Penaeus monodon) on pond sediment. Master thesis specializing in environmental science. Can Tho university. Trang 6, 42.
[7] Cui, B., Zhao, H., Lia, X., Zhang, K., Rena, H., Bai, J., 2010. Temporal and spatial distributions of soil nutrients in Hani terraced paddy fields, Southwestern China. Procedia Environmental Sciences 2 (2010) 1032–1042.

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Effect of water-washed neem (*Azadirachta indica*) fruit on rumen digesta fatty acids and biohydrogenation intermediates of fattened West African dwarf rams

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Abstract**—** *This study was conducted to determine the rumen digesta fatty acid profile and biohydrogenation intermediates of West African dwarf rams fattened with diets containing water-washed neem (Azadirachta indica) fruit (WNF). Twenty-five yearling rams (12.3±2.0 kg) were assigned to one of the five dietary groups with five animals per group in a completely randomised design. Each group received a total mixed ration formulated with 0% (T1), 2.5% (T2), 5.0% (T3), 7.5% (T4), and 10.0% (T5) WNF inclusion for 90 days. Chemical analysis was carried out on WNF and the feed using standard procedures. Digesta was collected from the rumen after slaughtering the animals for the determination of fatty acids profile and biohydrogenation intermediates, after the feeding trial. Oleic, palmitic, stearic, and linoleic acids were not significantly (P>0.05) affected by the different treatments. Rumenic acid was linearly lower (P=0.006) in T1 compared to other treatments. The ratio of vaccenic to rumenic acids was linearly and quadratically reduced (P=<0.001) with increased inclusion of WNF. Inclusion of WNF linearly and quadratically increased (P=<0.001) DI-Rumenic acid. The PUFA/SFA was quadratically (P=0.012) lower in T1 compared to T3. Inclusion of water-washed neem fruit in diets of rams increased the concentration of rumenicacid, a conjugated linoleic acid which when incorporated into the animal's tissue has health promoting benefits when consumed by man. Therefore, the proportion of rumenic acid in mutton should be boosted for increased incorporation into ruminant's tissues.*

Keywords**— Neem fruit, Biohydrogenation, Rumen digesta, Rumenic acid.**

I. INTRODUCTION

The type, composition and activity of rumen microbes are of immense significance to the output of fermentation. This is key to the different strategies for better ruminal function especially, where most often, the output is a product of inefficiently used feed resources. Saturation of fatty acids in the rumen is one of the direct roles played by rumen microbes in an effort to detoxify the rumen ecosystem of excess hydrogen ion for their survival *via* biohydogenation. Therefore, the output of fat used in ruminant feeding could be improved upon through a proactive approach such as direct microbial interference that is based on an easy to adopt technology.

The rumen is the habitat for a host of microbes which relate diversely as well as influence fermentative output in a variety of ways. Gram positive or negative bacteria can be suppressed or proliferated by feed constituents and this could either limit or enhance the activities of these microbes on fat alteration in the rumen leading to complete or incomplete metabolism with the production of intermediates. The selective elimination of gram positive bacteria by herbs including neem leaf and enhancement of the gram negatives (Faniyi, 2016) could result in better microbial output due to competitive advantage. Broudiscou et al. (2002) reported the enhancement of some microorganisms by some plant species concomitantly decreased methane production. Reduced methane generation increased conjugated fatty acid production due reduced protozoa or gram positive bacteria which limited the production and availability of hydrogen for biohydrogenation (Ramos Morales et al., 2012).

Neem (*Azadirachta indica*) fruit is medicinal and could be safely incorporated in ruminants' diets. Neem contains numerous phytochemicals not limited to margosate, nimbidin, nimbin, salanin tannin, saponin, flavonoid, alkaloid, glycoside, and terpenoids, at different concentrations in different plant parts but with proven antimicrobial properties. These phytochemical constituents when beyond the beneficial threshold limit its use. Water-washing is one of the processing methods for increasing the acceptability and utilization of neem. The ability of neem leaf to increase the total number of beneficial microbes and digestibility in sheep (Faniyi, 2016; Faniyi, 2019) and the fruit to compete favourably with salinomycin in the reduction of coccidial egg count (Tipu et al., 2002; Jack et al., 2020) with reduced methane generation at 5% optimal inclusion level (Jack, 2019) could play a significant role in increasing the efficiency of rumen fermentation and fatty acid transformation for better output. Therefore, rumen digesta fatty acid profile and biohydrogenation intermediates of West African dwarf rams fattened with diets containing water-washed neem fruit were investigated.

II. MATERIALS AND METHODS

2.1 Experimental site

The experiment was undertaken at the Sheep and Goat Unit of the Teaching and Research Farm and the Ruminant Laboratory, Department of Animal Science of the University of Ibadan, Ibadan (latitude: 7° 27' N; longitude: 3° 45' E; altitude: 200-300m above sea level; climate: humid tropical with mean annual rainfall of 1250mm and average temperature of 25-29°C) (Adewumi, 2010).

2.2 Experimental animals, management, and diets

Twenty-five healthy WAD rams (10-12 months) were divided into five groups of five animals in a randomised complete randomised design and housed in well-ventilated and concrete- floored pens containing feeders and waterers. Rams in each group were offered one of the five diets (Table 1). The experimental diets and potable water were offered *ad libitum* at 0800 daily for 90 days. Prior to the commencement of the experiment diets, rams were offered the diet with 0% water-washed neem fruit inclusion and administered prophylactic treatments using Ivomec Super, Oxytetracycline (long acting) antibiotics, multivitamins and minerals and allowed a few weeks to acclimatise.

Table.1: Ingredient and chemical composition of experimental diets consumed by rams

	Inclusion levels of water-washed neem fruit				
Attributes	**0%**	**2.5%**	**5%**	**7.5%**	**10%**
Ingredients **(%)**					
Water-washed Neem Fruit	0.00	2.50	5.00	7.50	10.00
Cassava Peel	53.00	50.50	48.00	45.50	43.00
Dried Brewer's Grains	10.00	10.00	10.00	10.00	10.00
Palm Kernel Cake	11.00	11.00	11.00	11.00	11.00
Groundnut Haulms	20.00	20.00	20.00	20.00	20.00
DiCalcium Phosphate	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Grower's Premix*	1.00	1.00	1.00	1.00	1.00

Salt	1.00	1.00	1.00	1.00	1.00
Urea	1.00	1.00	1.00	1.00	1.00
Phytochemical composition of water-washed neem fruit (% dry matter)					
Margosate (mg/100g)	64.33±2.52				
Azadirachtin (mg/100g)	218.33±2.52				
Tannin (µg/100g)	6.93±0.68				
Saponin (µg/100g)	321.67±7.96				
Chemical composition (%DM)					
Crude protein	15.06	15.14	15.62	15.62	15.70
Ether extract	2.20	2.24	2.28	2.32	2.36
Neutral detergent fibre	43.67	44.83	44.90	43.67	44.40
Metabolisable energy (Kcal/Kg)					
	2384.68	2366.68	2349.11	2342.70	2299.93

T1: Diet with 0% Neem fruit; T2: Diet with 2.5% neem fruit; T3: Diet with 5% Neem fruit; T4: Diet with 7.5% Neem fruit; T5: Diet with 10% Neem fruit. *Vitamin A 8,000,000 I.U, Vitamin D3 1,7000000 I.U, Vitamin E 5000 mg, Vitamin K3 1500 mg, Folic Acid 200 mg, Niacin 1500 mg, Vitamin B2 3000 mg, Vitamin B12 5 mg, Vitamin B1 1000 mg, Vitamin B6 1000 mg, Iron 25,000 mg, Manganese 45000 mg, Copper 3000 mg, Zinc 35000 mg, Choline Chloride 100,000 mg

Source: Jack (2019).

Table.2: Fatty acid profile of digesta from WAD rams fattened with diets containing water-washed neem fruit

Parameters (mg/g of total fatty acid)	**Inclusion levels of water-washed neem fruit**					**SEM**	**P-value**	
	0%	**2.5%**	**5%**	**7.5%**	**10%**		**L**	**Q**
C12:0, lauric acid	9.13	8.41	8.29	9.09	9.76	0.33	0.459	0.239
C14:0, myristic acid	6.26	5.07	4.07	4.73	7.13	0.53	0.706	0.068
C16:0, palmitic acid	32.03	28.42	28.76	24.70	33.14	1.64	0.903	0.194
C16:1, palmitoleic acid	5.02	5.20	5.73	5.16	6.70	0.40	0.298	0.659
C17:0, margaric acid	0.90	0.67	0.43	0.78	1.37	0.18	0.449	0.187
C18:0, stearic acid	25.13	24.74	24.60	25.17	25.60	0.34	0.635	0.489
C18:1, oleic acid	94.97	108.90	102.29	88.84	122.06	5.46	0.387	0.493
C18:2, linoleic acid	21.70	21.80	22.42	21.30	22.72	0.50	0.711	0.855
C18:3, linolenic acid	10.17	10.09	11.40	10.61	11.44	0.40	0.341	0.941
C20:4, arachidonic acid	2.72	3.74	4.16	3.72	4.04	0.27	0.201	0.345

SEM: standard error of mean; L: linear regression; Q: quadratic regression.

2.3

Rumen digesta collection and fatty acid profile

After 90 days of feeding, the rams were slaughtered after withdrawing feed except water for 16 hours and their

respective rumen digesta sample collected into sterile containers and chilled until used for fatty acid analysis.

2.4 Chemical analyses

Proximate analysis, fibre fractions and phytochemical constituents of water-washed neem fruit and feed samples were done as reported in Jack (2019). Fatty acid profile was carried out according to AOCS (1978). Rumenic and vaccenic acids were determined using spectrophotometric method as described by AOAC (2005). Desaturase index was calculated as defined by Perfield li et al. (2007): [(product of Δ9-desaturase)/(product of Δ9-desaturase + substrate of Δ9-desaturase)]. The estimation of polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA), unsaturated fatty acids (UFA), and saturated fatty acids (SFA) were done by adding up the corresponding fatty acids determined from the sample (Miri et al., 2013).

2.5 Statistical analysis

Data obtained were analysed using Analysis of Variance (ANOVA) and General Linear Model procedure of SPSS (2006).

III. RESULTS AND DISCUSSION

3.1. Fatty acid profile of rumen digesta

Palmitic and stearic acids constituted 38.31-43.60% and 33.25-39.04% of the total saturated fatty acids, respectively while 68.08-72.98% of the unsaturated fatty acids were attributed to oleic acids (Table 2). All the contrasts tested were similar across the fatty acids (Table 2b). The differences in values of fatty acids obtained in this study and those reported by other researchers (Vasta et al 2010; Campidonico et al., 2016) could be a function of the age, breed, feed offered, duration of digesta collection after last feeding, and method of analysis. Alterations of fatty acid constituents in the rumen are reflective in fatty acid components of the muscle (Ya´n˜ez-Ruiz et al., 2007; Vasta et al., 2009). Increased saturated fatty acids in tissues consumed by man have been implicated in coronary heart disease in man **(**Menotti et al., 1999**)**. However, with desaturation, saturated fatty acids known for their negative influence on human health can be altered. Desaturation can take place in the rumen, muscle and mammary gland of ruminants. Byers and Schelling (1993) reported the conversion of about 10% stearic acid to oleic in the enterocyte. Oleic acid, a mono unsaturated fatty acid can also be converted to vaccenic acid in the rumen (Jenkins et al., 2008) and mammary gland (Miri et al., 2013). Vaccenic is an intermediate of biohydrogenation and a precursor to rumenic acid that is known for its health promoting effect when consumed by man.

Table.2b: Fatty acid profile of digesta from WAD rams fattened with diets containing water-washed neem fruit

Parameters (mg/g of total fatty acid)	**P-Value for Contrast***											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
C12:0, lauric acid	0.785	0.924	0.771	0.590	0.532	0.467	0.911	0.737	0.969	0.204	0.437	0.911
C14:0, myristic acid	0.455	0.496	0.825	0.603	0.484	0.211	0.654	0.547	0.374	0.265	0.261	0.654
C16:0, palmitic acid	0.456	0.485	0.517	0.840	0.515	0.554	0.820	0.669	0.200	0.932	0.474	0.820
C16:1, palmitoleic acid	0.541	0.463	0.456	0.242	0.898	0.609	0.330	0.455	0.923	0.639	0.711	0.330
C17:0, margaric acid	0.853	0.935	0.744	0.450	0.702	0.450	1.000	0.876	0.841	0.242	0.511	1.000
C18:0, stearic acid	0.916	0.991	0.820	0.714	0.760	0.676	0.976	0.884	0.979	0.436	0.676	0.976
C18:1, oleic acid	0.166	0.282	0.236	0.167	0.425	0.726	0.204	0.120	0.312	0.992	0.411	0.204

C18:2, linoleic acid	0.806	0.768	0.847	0.585	0.957	0.699	0.591	0.687	0.830	0.939	0.799	0.591
C18:3, linolenic acid	0.523	0.401	0.487	0.375	0.956	0.391	0.317	0.487	0.753	0.777	0.638	0.317
C20:4, arachidonic acid	0.108	0.104	0.148	0.154	0.260	0.125	0.093	0.102	0.270	0.914	0.129	0.093

*Contrast values of P<0.05 are significantly different; 1(WN0 Vs WN2.5, 5, 7.5, 10); 2(WN0 Vs WN5, 7.5, 10); 3(WN0 Vs WN7.5, 10); 4(WN0 Vs WN10); 5(WN0 Vs WN2.5); 6(WN0 Vs WN5); 7(WN0 Vs WN5,10); 8(WN0 Vs 2.5, 5, 10); 9(WN0 Vs WN7.5); 10(WN2.5, 5 Vs WN7.5,10); 11(WN0 Vs WN2.5, 5); 12(WN0 Vs WN5,10).

3.2. Fatty acid intermediates and desaturase index of digesta

Lower rumenic acids (P=0.006) was obtained in T1 compared to other treatments (Table 3). However, increased inclusion of WNF linearly and quadratically reduced VA/RA. Using contrast to compare the means, difference existed for RA except in contrast 5 and 10 while only contrast 10 was not affected in VA/RA (Table 3b). DI-16, DI-18, and total DI were not affected by the different contrast while DI-RA was affected by all the tested contrast. The increase in rumenic acid could be attributed to decreased microbial population and activities, and probably, increased desaturation of vaccenic acids. Increased rumenic acid could by implication be attributed to the reduction in the population of gram positive bacteria which probably could have resulted in the incomplete conversion of fatty acids that are unsaturated to stearic acid thus causing accumulation of intermediate products. Desaturation of precursors such as vaccenic acid could have played a major role as well since bacteria and fungi can undertake desaturation but not protozoa. Devillard et al. (2006) reported the inability of desaturation to occur in protozoal fraction of ruminal digesta.

Table.3: Fatty acid intermediates and desaturase index of digesta from WAD rams fattened with diets containing water-washed neem fruit

Parameters (mg/g of total fatty acid)	**Inclusion levels of water-washed neem fruit**					**SEM**	**P-value**	
	0%	**2.5%**	**5%**	**7.5%**	**10%**		**L**	**Q**
C18:1 *trans*-11, Vaccenic acid	0.06	0.04	0.05	0.05	0.05	0.001	0.455	0.101
C18:2 *cis*-9 *trans*-11 CLA, Rumenic acid	0.17	0.21	0.24	0.23	0.24	0.01	0.006	0.069
RA/LA	0.01	0.01	0.01	0.01	0.01	0.0004	0.005	0.031
VA/RA	0.33	0.20	0.20	0.21	0.21	0.01	<0.001	<0.001
SA/VA	453.16	576.16	498.71	523.93	516.70	14.39	0.378	0.132
DI-C16	0.14	0.15	0.16	0.17	0.17	0.01	0.114	0.553
DI-C18	0.79	0.81	0.80	0.78	0.82	0.01	0.496	0.477
DI- *cis*-9 *trans*-11 C18:2 CLA, Rumenic	0.76	0.83	0.83	0.83	0.83	0.01	<0.001	<0.001
Total DI	0.58	0.63	0.61	0.59	0.62	0.01	0.324	0.511

SEM: standard error of mean; LA: linoleic acid; RA: rumenic acid; VA: vaccenic acid; SA: stearic acid; DI: desaturase index; CLA: Conjugated linoleic acid; L: Linear regression; Q: Quadratic regression.

Table.3b: Fatty acid intermediates and desaturase index of digesta from WAD rams fattened with diets containing water- washed neem fruit

Parameters (mg/g of total fatty acid)	**P-Value for Contrast***											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
C18:1 *trans*-11, Vaccenic acid	0.011	0.003	0.007	0.088	0.180	0.016	0.012	0.033	0.040	0.512	0.082	0.012
C18:2 *cis*-9 *trans*-11 CLA, Rumenic acid	0.003	0.002	0.004	0.006	0.067	0.004	0.002	0.004	0.015	0.653	0.008	0.002
RA/LA	0.002	0.002	0.003	0.008	0.058	0.004	0.002	0.004	0.005	0.518	0.007	0.002
VA/RA	0.033	0.032	0.035	0.034	0.030	0.019	0.028	0.031	0.036	0.526	0.027	0.028
SA/VA	0.025	0.071	0.058	0.111	0.007	0.238	0.114	0.026	0.080	0.520	0.023	0.114
DI-C16	0.140	0.110	0.104	0.154	0.457	0.261	0.146	0.183	0.151	0.441	0.283	0.146
DI-C18	0.272	0.456	0.370	0.146	0.179	0.784	0.266	0.144	0.277	0.804	0.390	0.266
DI- *cis*-9 *trans*-11 C18:2 CLA, Rumenic	0.028	0.027	0.031	0.030	0.024	0.013	0.023	0.025	0.031	0.521	0.021	0.023
Total DI	0.305	0.359	0.377	0.224	0.197	0.389	0.269	0.238	0.649	0.419	0.248	0.269

*Contrast values of P<0.05 are significantly different; 1(WN0 Vs WN2.5, 5, 7.5, 10); 2(WN0 Vs WN5, 7.5, 10); 3(WN0 Vs WN7.5, 10); 4(WN0 Vs WN10); 5(WN0 Vs WN2.5); 6(WN0 Vs WN5); 7(WN0 Vs WN5,10); 8(WN0 Vs 2.5, 5, 10); 9(WN0 Vs WN7.5); 10(WN2.5, 5 Vs WN7.5,10); 11(WN0 Vs WN2.5, 5); 12(WN0 Vs WN5,10).

Rumen biohydrogenation is initially carried out by gram-positive bacteria and fungi and subsequently by gram-negative bacteria resulting in the isomerisation of linoleic acid to rumenic acid and the biohydrogenation of rumenic acid to vaccenic acid, and vaccenic acid to stearic acid, respectively (Kemp and Lander, 1984; Harfoot and Hazzlewood, 1997; Nam and Garnsworthy, 2007). For linolenic acid, after isomerisation, it is followed by progressive hydrogenation to vaccenic acid and then to stearic acid (Kemp and Lander, 1984). Therefore, the ratio of RA/LA, VA/RA and SA/VA are indicative of the rate at which the process of ruminal biohydrogenation took place.

Higher RA/LA indicated that isomerisation of linoleic acid to rumenic acid was favoured with increased inclusion of water-washed neem fruit in the diets of rams. Lower VA/RA ratio pointed to the hindrance posed by incorporation of water-washed neem fruit with respect to the conversion of rumenic acid to vaccenic acid. This could be attributed to reduced microbial activities of Group A bacteria and fungi responsible for the transformation of rumenic acid to vaccenic acid. Desaturation of unsaturated fatty acids in ruminal digesta by bacteria but not protozoa was reported by Devillard et al. (2006) and the ability of fungi (*Piromyces communis*) to desaturate stearic acid to oleic acid by Kemp et al. (1984). DI-rumenic increased with increased inclusion of neem fruit. This may be attributed to increased activity of *delta 9-desaturase* by bacteria and fungi in the microbial mass.

3.3. Estimated fatty characteristics of rumen digesta

Fatty acids as influenced by the different degrees of saturation were not affected by the treatments. However, PUFA/SFA was quadratically lower (P=0.012) in T1 compared to T3 (Table 4). Contrast was not affected in SFA, UFA, MUFA, PUFA, UFA/SFA. However, PUFA/SFA was affected by contrast 1, 2, 6, and 11. Lower PUFA/SFA observed in the control indicated the increase production of SFA over PUFA. This could be as a result of the activities of increased protozoa and bacteria. The hydrogen producing activity of protozoa, fibrolytic fungi and bacteria, particularly gram positive bacteria in the rumen could have made reducing power available for the conversion of unsaturated fatty acids to vaccenic acid. This by implication means that there would have been no formation of stearic acid without the availability of vaccenic acid as provided mainly by the activities of gram positive bacteria. Long chain fatty acids (C18) have antimicrobial effect on bacteria which increased with increase extent of unsaturation with the cis-isomers being to a greater extent disruptive compared to trans-isomers (Chalupa et al., 1984) and this is in addition to the antimicrobial properties of the phytochemicals in neem fruit. The disruptive effect of these amphiphilic lipids are less on bacteria than on rumen protozoa and fungi (Ushida et al., 1992). Medium chain fatty acids have also been reported to defaunate the rumen *in vivo* (Machüller and Kreuzer, 1999) and lowered the population of methanogens *in vitro* (Jordan et al., 2006). These microbes have varying fatty acids composition which on destruction may probably form part of the biomass and would influence the fatty acid composition of the digesta.

Table.4. Estimated fatty acid characteristics of digesta from WAD rams fattened with diets containing water-washed neem fruit

Parameters (mg/g of total fatty acid)	**Inclusion levels of water-washed neem fruit**					**SEM**	**P-value**	
	0%	**2.5%**	**5%**	**7.5%**	**10%**		**L**	**Q**
SFA	73.46	67.31	66.14	64.47	77.00	2.76	0.840	0.159
UFA	134.81	149.99	146.30	129.91	167.26	6.69	0.370	0.588
MUFA	100.04	114.14	108.07	94.05	128.81	5.79	0.375	0.500
PUFA	34.76	35.85	38.23	35.86	38.45	1.09	0.403	0.866
UFA/SFA	1.88	2.24	2.19	2.02	2.17	0.06	0.373	0.276
PUFA/SFA	0.48	0.54	0.58	0.56	0.50	0.01	0.434	0.012

SEM: standard error of mean. SFA: saturated fatty acid; UFA: unsaturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid; L: Linear regression; Q: Quadratic regression.

Table.4b: Estimated fatty acid characteristics of digesta from WAD rams fattened with diets containing water-washed neem fruit

Parameters (mg/g of total fatty acid)	P-Value for Contrast*											
	1	2	3	4	5	6	7	8	9	10	11	12
SFA	0.528	0.582	0.738	0.706	0.517	0.443	0.817	0.668	0.349	0.550	0.416	0.817
UFA	0.168	0.251	0.185	0.147	0.489	0.674	0.200	0.132	0.589	0.980	0.425	0.200
MUFA	0.169	0.276	0.221	0.162	0.444	0.722	0.205	0.125	0.382	0.983	0.424	0.205
PUFA	0.453	0.394	0.482	0.353	0.780	0.382	0.301	0.395	0.777	0.964	0.504	0.301
UFA/SFA	0.285	0.325	0.376	0.265	0.197	0.315	0.256	0.231	0.542	0.340	0.218	0.256
PUFA/SFA	0.044	0.045	0.131	0.526	0.123	0.020	0.077	0.064	0.053	0.286	0.028	0.077

*Contrast values of P<0.05 are significantly different; 1(WN0 Vs WN2.5, 5, 7.5, 10); 2(WN0 Vs WN5, 7.5, 10); 3(WN0 Vs WN7.5, 10); 4(WN0 Vs WN10); 5(WN0 Vs WN2.5); 6(WN0 Vs WN5); 7(WN0 Vs WN5,10); 8(WN0 Vs 2.5, 5, 10); 9(WN0 Vs WN7.5); 10(WN2.5, 5 Vs WN7.5,10); 11(WN0 Vs WN2.5, 5); 12(WN0 Vs WN5,10).

IV. CONCLUSION

Increased inclusion of water-washed neem fruit increased the concentration of rumenic acid in the digesta. However, further inclusion beyond 5% becomes unnecessary since the concentration of rumenic acid was similar. The increased concentration in digesta if passed down to ruminant tissues will be beneficial to humans when consumed. Rumenic acid is a conjugated fatty acid known for its health promoting benefits. Therefore, increasing the proportion of rumenic acid in mutton will go a long way in promoting health when made available to the tissues.

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REFERENCES

[1] Adewumi, M.K., 2010. Nutritive value of some crop residues with or without baker's Yeast (*Saccharomyces cerevisiae*) as supplements for West African dwarf sheep. *Trop. Anim. Prod. Invest.* 13(1), 7-12.

[2] AOAC, 2005. Determination of rumenic and vaccenic acids in biological samples. Official methods of analysis of Association of official Analytic Chemists. . International Gaithersbury, MD, USA,

[3] AOCS., 1978. Official and Tentative Methods of the American Oil Chemists Society, 3rd edition, Champaign, Illinois, 203-207

[4] Broudiscou, L.P., Papon, Y., Broudiscou, A.F., 2002. Effects of dry plant extracts on feed degradation and the production of rumen microbial mass in a dual flow fermenter. *Anim. Feed Sci. Technol.* 101, 183–189. https://doi.org/10.1016/S0377-8401(02)00221-3

[5] Byers, F.M., Schelling, G.T. 1993. Lipids in ruminant nutrition, in: Church, DC (Ed), The ruminant animal: digestive physiology and nutrition. Waveland Press Inc., USA, pp 298-312

[6] Chalupa, W.. Rickabaugh, B., Kronfeld D.S.,Sklan, D., 1984. Rumen fermentation *in vitro* as influenced by long chain fany acids. *J. Dairy Sci. 67*,1439-1444. https://doi.org/10.3168/jds.s0022-0302(84)81459-9

[7] Campidonico, L., Toral, P.G., Priolo, A., Luciano, G., Valenti, B., Hervas, G., Frutos, P., Copani, G., Ginane, C., Niderkorn, V., 2016. Fatty acid composition of ruminal digesta and longissimus muscle from lambs fed silage mixtures including red clover, sainfoin, and timothy. J. anim. Sci. 94(4), 1550-1560. https://doi.org/10.2527/jas.2015-9922.

[8] Devillard, E., McIntosh, F.M., Newbold, C.J., Wallace, R.J., 2006. Rumen ciliate protozoa contain high concentrations of conjugated linoleic acids and vaccenic acid, yet do not hydrogenate linoleic acid and or desaturate stearic acid. *Bri. J. Nutr.* 96,697-704. https://doi.org/10.3168/jds.s0022-0302(84)81459-910.1079/BJN20061884

[9] Faniyi, T.O., 2016. Effects of some herbs and spices on rumen modulation in West African Dwarf sheep. Ph.D. Thesis,

Department of Animal Science, University of Ibadan, Nigeria. pp 232

[10] Faniyi, T.O., Prates, E.R., Adegbeye, M.J., Adewumi, M.K., Elghandour, M.M.Y., Salem, A.Z.M., Ritt, L.A., Zubieta, A.S., Stella, L.., Ticiani, E., Jack, A.A., 2019. Prediction of biogas and pressure from rumen fermentation using plant extracts to enhance biodigestibility and mitigate biogases. Environmental Science and Pollution Research, 26:27043–27051. https://doi.org/10.1007/s11356-019-05585-1

[11] Hook, S.E., Wright, A.G., McBride, B.W., 2010. Methanogens: Methane producers of the rumen and the mitigation strategies. Review Article. *Archaea* Volume 2010, Article ID 945785, 11, http://dx.doi.org/10.1155/2010/945785

[12] Harfoot, C., Hazlewood, G., 1997. Lipid metabolism in the rumen, in: Hobson, P.N., Stewart, C.S. (Eds), The rumen microbial ecosystem. Chapman and Hall, London, pp 382-426.

[13] Jack, A.A., 2019 Effect of water-washing on chemical composition and *in vitro* biogas production of West African dwarf rams offered diets containing water-washed neem (*Azadirachta indica*) fruit. *Nig. J. Agric. Food. Environ*., 15(3), 43-52.

[14] Jack, A.A., Adewumi, M.K., Adegbeye, M.J., Ekanem, D.E., Salem, A.Z. M., Faniyi, T.O., 2020. Growth promoting effect of water-washed neem (*Azadirachta indica* A. Juss) fruit inclusion in West African dwarf rams. Trop. Anim. Health Prod. https://doi.org/10.1007/s11250-020-02380-w

[15] Jenkins, T.C., Wallace, R.J., Moate, P.J., Mosley, E.E., 2008. Review: Recent advances in biohydrogenation of unsaturated fatty acids within the rumen microbial ecosystem. *J. Anim. Sci.* 86 (2), 397-412. https://doi.org/10.2527/jas.2007-0588

[16] Jordan, E., Lovett, D.K., Hawkins, M., Callan, J.J., O'Mara, F.P., 2006. The effect of varying levels of coconut oil on intake, digestibility and methane output from continental cross beef heifers. *Animal Science* 82:859-865. https://doi.org/10.1017/ASC2006107

[17] Kemp, P., Lander, D.J., 1984. Hydrogenation *in vitro* of a linolenic acid to stearic acid by mixed culture of pure strains of rumen bacteria. *J. Gen. Microbiol.* 130, 527–533. https://doi.org/10.1099/00221287-130-3-527

[18] Kemp, P., Lander, D.J., Orpin, C.G., 1984. The lipids of the rumen fungus *Piromonas communis. J. Gen. Microbiol.* 130, 27–37. https://doi.org/10.1099/00221287-130-1-27

[19] Machüller, A., Kreuzer, M., 1999. Methane suppression by coconut oil and associated effects on nutrients and energy balance in sheep. *Can. J. Anim. Sci.* 79, 65-72. https://doi.org/10.4141/A98-079

[20] Menotti, A., Krombout, D., Blackburn, H., Fidanza, F., Buzina, R., Nissinen, A. 1999. Food intake pattern and 25-year mortality from coronary heart disease: Cross-cultural correlations in the Seven Countries Study. The Seven Countries Study Research Group. *Eur. J. Epidemiol.* 15:507-515. https://doi.org/10.1023/a:1007529206050

[21] Miri, V.H., Tyagi, A.K., Ebrahimi, S.H., Mohini, M., 2013. Effect of cumin (*Cuminum cyminum*) seed extract on milk fatty acid profile and methane emission in lactating goats. *Small Rum. Res.* 113, 66-72. https://doi.org/10.1016/j.smallrumres.2013.01.015

[22] Nam, I.S., Garnsworthy, P.C., 2007. Biohydrogenation pathways for linoleic and linolenic acids by Orpinomyces rumen fungus. *Asian-Austral. J. Anim. Sci.* 20(11), 1694-1698. https://doi.org/ 10.5713/ajas.2007.1694

[23] Perfield Ii, J.W., Lock. A.L., Griinari, J.M., Sæbø, A., Delmonte, P., Dwyer, D.A., Beauman, D.E., 2007. Trans-9, cis-11 conjugated linoleic acid reduces milk fat synthesis in lactating dairy cows. *J. Dairy Sci.* 90, 2211-2218. https://doi.org/10.3168/jds.2006-745

[24] Ramos-Morales, E., Mata Espinosa, M.A., McKain, N., Wallace, R.J., 2012. Recinoleic acid inhibits methanogenesis and fatty acid biohydrogenation in ruminal digesta from sheep and in bacterial culture. *J. Anim. Sci.* http://dx.doi.org/10.2527/jas.2011-4670.

[25] SPSS., 2006. SPSS 15.0 for windows. SPSS Inc.www.spss.com

[26] Tipu, M.A., Pasha, T.N., Ali, Z. 2002. Comparative efficacy of salinomycin sodium and Neem fruit (*Azadiracht indica*) as feed additive anticoccidials in broilers. *Inter. J. Poult. Sci.* 1(4): 91-93.

[27] Ushida, K., Umeda, M., Kishigami, N., Kojima, Y. 1992. Effect of medium chain and long chain fatty acid calcium salts on rumen microorganisms and fibre digestion in sheep. *Anim. Sci. Technol. (Japun) 63,* 591-597.

[28] Vasta, V., Mele, V., Serra, A., Scerra, M., Luciano, G., Lanza, M., Priolo, A., 2009. Metabolic fate of fatty acids involved in ruminal biohydrogenation in sheep fed concentrate or herbage with or without tannins. *J. Anim. Sci.* **87:**2674–2684. https://doi.org/10.2527/jas.2008-1761

[29] Vasta, V., Ya´n˜ez-Ruiz D.R., Mele M., Serra A., Luciano G., Lanza M., Biondi L., Priolo A., 2010. Bacterial and protozoal communities and fatty acid profile in the rumen of sheep fed a diet containing added tannins. Appl. Environ. Microbiol. 76(8), 2549–2555. https://doi.org/10.1128/AEM.02583-09_

[30] Ya´n˜ez-Ruiz, D.R., Williams, S., Newbold, C.J., 2007. Effect of the absence of protozoa on rumen biohydrogenation and the fatty acid composition of lamb muscle. *Br. J. Nutr.* **97:**938–948. https://doi.org/10.1017/S0007114507675187

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Efficiency Analysis of Crop Production in Gurage Zone: The Case of Abeshige Woreda, Snnpr Ethiopia

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Abstract*— *Efficiency is an accomplishment through operation to use least amounts of inputs to achieving a highest level of output it is an important area of study because ensuring efficiency minimizes the wastage of resources while accomplishing the desired outputs. This study was to decide the economic efficiency of crop producing rural farmers in abeshigeworeda or district which is one of the districts in gurage zone, SNNPR. Six kebeles and 399 sample respondents were selected through applying stratify sampling procedure. The descriptive statics, Parametric Stochastic Frontier Production Function, the Cobb Douglas production function and Tobit regression methods were used to accomplish the objective of the study. The rural farmers ranked constraints were analyzed through using Kendall's coefficient of concordance to test for the degree of agreement in ranking. Technical efficiency estimates range from 19.94 percent to 95.16 percent with a mean efficiency of 64.69 percent, while Allocative efficiency estimates range from 15.52 percent to 97.69 percent with a mean of 57.47 percent. The economic efficiency estimates range from 10.9 percent to 81.29 percent with a mean of percent. As the result indicated, crop output was positively and significantly influenced by labor, seed, fertilizer, house hold size and land size. This study therefore recommended that would improve the application of full packages of fertilizer and improved seed, appropriate use of productive labors, line method of seeding and membership of individual farmers.

Keywords*— *Allocative, Economic, Cobb Douglas, Technical, Tobit and efficiency.

I. INTRODUCTION

1.1 background of the study

There are two basic pressures that enforcing nations, specially developing countries like Ethiopia, in order to increase agricultural production and productivity while the first one is the food security challenges that is demanded to feed the existing population size of the nations. The other force is the demand of producing surplus products to supply to domestic and also to international markets thereby able to earn foreign currency. Ethiopia had designed and implemented agricultural development policy and strategies in 2003 to respond about those basic challenging pressures which is broadly incorporated ensuring of food security and accelerated economic growth through enhancing of farmers market oriented production system. More over the policy document focused up on the subsistent characteristics of the farms and small scale producers which are the majority of agricultural products have supplied (Alemayehu et al, 2011).

As components of growth, export has been one of the strategic area of the country despite a great gap has been observed between the import and export commodity values of the country. According to CIA 2017, the annual export value of the country was 4.14 billion USD whereas the total import commodity value was 12.08 USD as a result the trade deficit of the country was negative 31% by the year 2016. Ethiopia mainly exports agricultural outputs and imports some sophisticated industrial commodities. The country's production and productivity of the agricultural sector improves in some extent and the overall real economic growth of the country by the year 2017 was around 8.5%, though, it has facing troubles due to low volume and value of export products to foreign trades, the availability of food insecurity which is not balanced with the current population pressure i.e. 99.47 million with the average growth rate of 2.89 % per year (CIA world fact book, 2018).

In Ethiopia, Pulses are one of agricultural crop grown on 12.4 percent of the total area cultivated, by a total of 6.8

million farmers. Together, these holders produce a yearly average of 1.5 million ton of pulses, which is 8.5 percent of total crop production (Alemayehu et al, 2011). Producing crops has a number of advantages to ensure the food security and economic demands of a producer because it allows for double cropping in a season using early maturing cultivars and it serves for consumption and as a source of cash to farmers. Moreover to this, it contributes towards a balanced diet because of its high protein content and convenient for intercropping because of its short growth duration and diversegrowth habit. It serves as an export commodity to earn foreign currency (walelign: 2015).

1.2 Statement of the problem

The global efficiency level is very low when it compared to the expected potential productivity level and hence the attained average yield of the crop so far in the world is 8 qt/ha(walelign, 2015). The presence of such low level of production efficiency at global level is as a result of production efficiency differences between regions and nations of the world. As many of literatures indicated, the efficiency level of crop production is determined by a number of factors of production and their effect is also different from place to place. Some regions like the developed world has a better skills, knowledge, policies, institutional capacity and application of technologies that can lead them to achieve the maximum and potential productivity level of crop whereas countries in the developing world have shown very low production efficiency performance.

The average productivity of the crop in Ethiopia and for SNNPR is recorded as 12.6 qt/ha and 11.46qt/ha respectively (ibid). This implies that as there is a great potential to increase productivity and production of the crop. Improving the crop's productivity and production within Ethiopia should be intensified as a result of its current socio economic and demographic existence that requires equitable source of domestic nutritional food supply, the presence of higher demands for foreign imported products with low capacity of exportable products that has brought unbalanced trade problem and this in turn resulted a great shortage of foreign currency within the country. In other speaking as primary sources of all demands of the country, currently agricultural production and productivity is not proportionate with the total population demands and the targeted economic growth rate to be achieved(Essa: 2011).

According to Agete*et al*. (2014), Ethiopia is the top twelve producers of total legumes in the world generally, the current national average productivity of the crop is 14.8qt per hectare whereas the average research demonstrated productivity potential is 34 qt per hectare in the country (Mulugeta et al., 2015). This implies that as there is a great yield differences within the two fields, even the nationally attained productivity result is lower than half of the research demonstrated productivity potential and hence it needs a great attention to improve the existing situation.

To address the causes of the yield gap problem, different works of scholars have been conducted though many of them have considered only the evaluation of technical efficiency and allocative part but they were not include economic efficiency measurements of the crop and hence it needs to asses integrated efficiency measurement applications that must include economic efficiency. On the other hand, from the reviewed sample empirical findings of the previous works, it can be to understand that as there are a number of elements in the variable set that can be determine the efficiency level of agricultural production even they have not been exhausted yet by the previous works completely. Moreover, the already conducted works can be considered as bases for this new research to be conducted to check their compliance or variation with the new findings especially for those models of research which are included similar variables. As a result, this study has the objective of to estimate the economic efficiency of rural farmers and also identify the prompting factors that upsetting the existing level of efficiency. Moreover, the study was conducted on crop production, data taking from SNNPR Ethiopia, Gurage zone, Abeshigeworeda or district.

The main objective of the study is to examine the economic efficiency of crop production in SNNPRS, Gurage Zone: AbeshigeWoreda or district, with having the following specific objectives:

I. To assess the level of technical, allocative and economic efficiency of rural farmer crop producers.
II. To analyze the factor affecting technical and economic efficiency of crop production

This research is intended to address the main factors in the process of exported oriented crop production in Gurage zone, Abeshigeworeda or district. Through addressing those limiting factors of production and also quantifying the levels of their impact on technical, allocative and economic efficiencies that provides the relevant inputs to concerned government organizations like agricultural and natural resource bureaus, national level policy makers and other non-governmental organizations who are engaged in agricultural production generally, crop production particularly.

II. LITERATURE REVIEWS

2.1 Theoretical reviews

Efficiency and agricultural production

The term efficiency in agricultural production system is a simple way of performance evaluation in the relationship between input conversions towards output. In traditional simple straight forward way of measuring efficiency of a farm could be the achievement of yield per hectare of land. But a given output is a function of multiple in puts in the reality, this is very simplistic way of measurement in that it only considers a single of production (Solomon: 2014).Therefore efficiency measurement in agricultural production is very important to optimize or to get the maximum level of output through using of alternative options or combination of inputs among the multiple ones that can influence the level of out puts. The scope of agricultural production can be expanded and sustained by farmers through efficient use of resources (ESSA 2011: Hailu 2005). For these reasons, efficiency has remained an important subject of empirical investigation particularly in the developing economies where majority of the farmers are resource poor (ESSA, 2011: Umoh, 2006).

Efficiency measurement approaches

Basically there are two approaches in measurement of efficiency. These are input oriented and output oriented approaches. The former one deals with to answer the questions that by how much input of quantities can be proportionally reduced without changing the output quantity produced. This is an input oriented measure of efficiency. The later one deals with the question as by how much output could be expanded from a given level of inputs. However, both measures will coincide when the technology exhibits constant returns to scale, but are likely to vary otherwise (Coelli and Battese, 2005).

i. Input oriented measurement approaches

In his first work on efficiency, Farrell (1957) illustrated his idea about measuring efficiency with figure, as follow. The SS' is an isoquant, representing technically efficient combinations of inputs, X_1 and X_2, used in producing output Q. SS' is also known as the best practice production frontier. AA' is an isocost line, which shows all combinations of inputs X_1 and X_2 to be used in such a way that the total cost of inputs is equal at all points. However, any firm intending to maximize profits has to produce at Q', which is a point of tangency and representing the least cost combination of X_1 and X_2 in production of Q. At point Q' the producer is economically efficient.

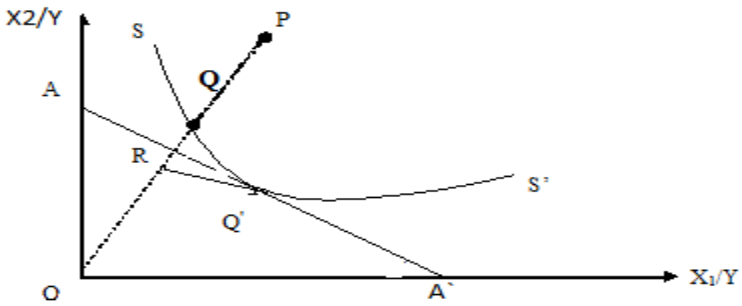

Fig.1: Input oriented measures of technical efficiency; Source: Coelli (1995).

Given figure 1, suppose a farmer is producing his output depicted by isoquant SS' with input combination level of (X_1 and X_2). Production at input combination at point P is not technically efficient because the level of inputs needed to produce the same quantity is Q on isoquant SS'. In other words, the farmer can produce at any point on SS' with fewer inputs (X_1 and X_2), in this case at Q in an input-input space. The degree of TE of such a farm is measured as *OQ OP*, which is proportional in all inputs that could theoretically be achieved without reducing the output. Hence all farmers that produce along the isoquant are 100 percent technically efficient (*ibid*).

ii. Output oriented measurement approaches

In the output oriented perspective, efficiency is evaluated keeping inputs constant. According to Farrell (1957), output oriented measures can be illustrated by considering the case where production involves two outputs (Y_1 and Y_2) and a single input (L). If the input quantity is held fixed at a particular level, the technology can be represented by a production possibility curve in two dimensions

2.2 Empirical Reviews

Efficiency estimation of crop production

Efficiency measurement is an important and it has a vital role to ensure agricultural production and productivity there by enhancing economic growth of a nation especially for those developing economies whose food energy and source of income majorly relied on agricultural production.

According to Tamirat*et al*.(2017) conducted a research on Determinants and Resource Use Efficiency of Haricot Bean Production in Halaba Special District, Southern Ethiopia through the application of estimation of production function, and allocative efficiency index (MVP/MFC). The result of this study revealed that haricot bean output was positively and significantly influenced by plot size, amount of fertilizer applied, labor input in man

days, level of education of the household head, farming experience, frequency of extension contact and types of haricot bean seed used. Resource utilization was found inefficient for the crop in the study area. The result of allocative efficiency index indicated, fertilizer (0.4), pesticide (0.2), labor (0.5) and oxen power (0.0) were over utilized resources.

Essa (2011) determined the economic efficiency of smallholder crops production in the central high lands of Ethiopia. He used a two- limit Tobit regression model results revealed that while family size, farming experience, credit access, walking distance to the nearest main market, and total own land cultivated during the long rainy season affect technical inefficiency positively and significantly; age of household head was found to have a negative and significant influence on technical inefficiency. The results also showed that whereas economic inefficiency was positively and significantly affected by family size, farming experience and membership to associations; for household heads having a role in their community contributed negatively and significantly to economic inefficiency. Moreover the study results also showed that about 37 percent of the farmers in aggregate operate under decreasing returns to scale.

Solomon (2014) estimated and investigated those factors which are affecting technical efficiency of major crops in Ethiopia through using stochastic frontier model. According to this study, land and seed were major determinants of maize production in Ethiopia. Generally, all significant input variables were found to be affect output positively, as it was expected. Moreover, the model output depicted that the mean level of TE for major crops, *Teff*, Wheat and Maize production was found to be 63.56, 67.26, 84.16 and 91.41 percent, respectively. The inefficiency effect analysis shown that, age of the household head found to be the determinant of technical inefficiency, of *teff* production. Knowledge about land policy, participation in soil and water conservation activities and education was found to have negative and significant effect on major crops and wheat technical inefficiency (1% significance level). In this study frequency of extension contact, the wealth status of farmers, the fertility status of plots of wheat have affected technical efficiency significantly. Similarly the study investigated flat teff and maize plots are more efficient than otherwise. The other plot specific variable that was found to have negative and significant effect on technical inefficiency of major crop production was adoption of improved seed.

A study that had done by Enderias *et al* (2013), on productivity and technical efficiency analysis of small holder maize producer in southern Ethiopia, used and applied data envelopment analysis model to determine the levels of technical efficiency and a Tobit regression model to identify factors influencing technical efficiency. Based on this study investigation, productivity of maize was significantly influenced by the use of labor, fertilizer, and oxen power. The study also indicated that the mean technical efficiency was found to be 40 percent indicating that there was substantial level of technical inefficiency of smallholder farmers in maize production. Important factors that significantly affected the technical efficiency were agro-ecology, oxen holding, farm size and use of high yielding maize varieties.

As it cited by Solomon (2014), Geta *et al*. (2013) undertook a study in SNNPR having the aim to assess the productivity and Technical efficiency of small holder farmers, from 325 randomly selected farmers from Woliyta and Gamgofa zones of SNNPR and hence found that as there was significant level of inefficiency among maize producing farmers. (They used a two stage estimation technique of TE followed by tobit regression model) to identity factors influencing TE. The result showed that production of maize was significant influenced by the use of labor, fertilizer and oxen power. The mean TE was found to be 40% important factors that significantly affected the TE were agro ecology, oxen holding, farm size, and use of high yielding maize varieties. However, in this study some important farmer's characteristics like age and sex of the house hold heads were not considered in their analysis. The study also conducted on a single and frequently used by previous researches of maize crops. Moreover like majority of previous research works considered only then evaluation of technical efficiency part but not include economic efficiency measurements of the crop.

Generally all the previously conducted research findings indicated that as there are a potential to improve crop productivity or the existence of inefficiency of production at different agro ecology and other existed parameters, thus, it needs to provide a strong emphasis to incorporate those findings in policy and institutional frameworks and also making those influencing determinants of efficiency are favorable for agricultural production. These works can be also considered as a base for new researches to be conducted in the areas of efficiency measurement and use to check their compliance or variation with the new findings especially for those models of research which are included similar variables. On the other hand from the above reviewed samples of empirical findings of the previous works, it can be to understand that as there are a number of elements in the variable set that can determine

the efficiency level of agricultural production. However, even they have not been exhausted yet by the previous works completely (Essa, 2011). Regarding to the empirical works which have been conducted in Ethiopia depicted that as a number of efficiency based studies have been conducted at different parts of the country though it demands further investigation at different dimension and parameters because in Ethiopia and in other developing countries, agriculture is a dominant elements of their economy and also this agricultural products are sourced from small holder farmers that were produced in a fragmented lands.

ESSA (2011) explained also such kinds of studies are highly relevant to Ethiopia where resources are meager, opportunities for developing and adapting better technology are scarce and with high population pressure that demands equitable sufficient food source. More over to this, agricultural products are the major components of export goods of the country. The other point that should be raised is most of the conducted researches have concentrated on TE of farmers though it needs to asses integrated efficiency measurement applications that must include economic efficiency. As a result this study has the objective to estimate the economic efficiency of rural farmers and also identify the factors affecting the existing level of efficiency. Moreover, the study was conducted on crop production, data taking from Guragezone, Abeshigeworeda or district under SNNPR Ethiopia.

2.3. Conceptual frame work

Various levels of exogenous and endogenous factors can determine the level of efficiency in agricultural production process. These production influencing factors can be also categorized basically into socio economic, climatic, and institutional and farm related characteristics

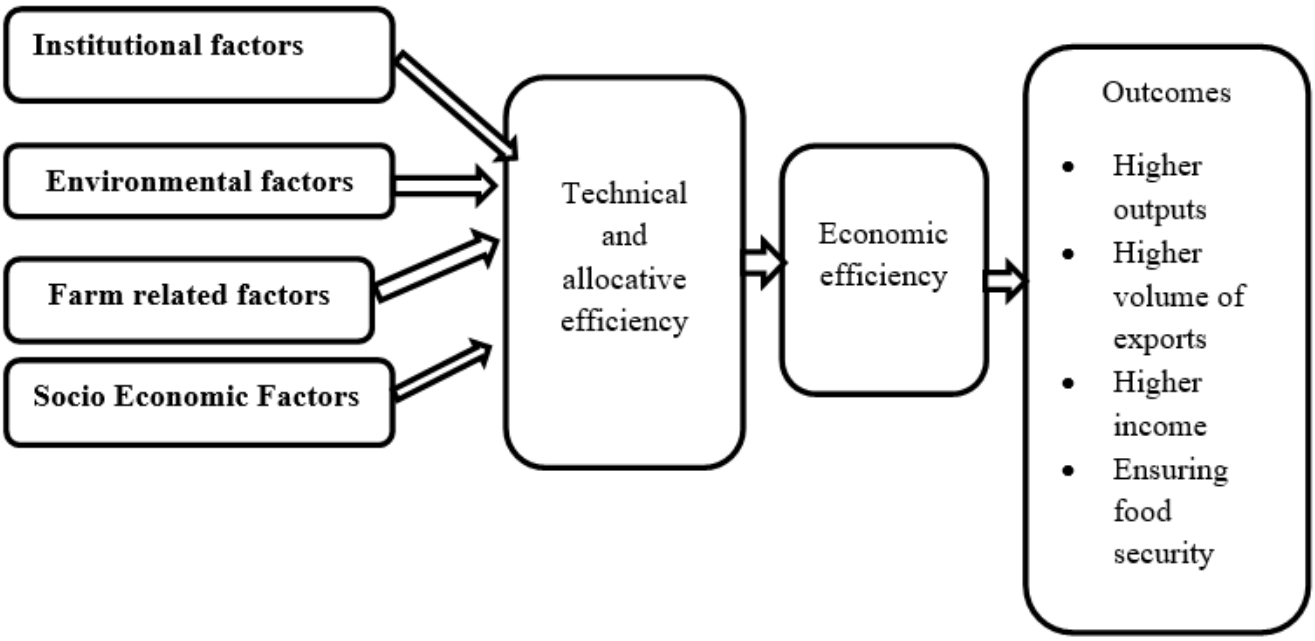

Fig. 2: Source: own conceptualization.

III. METHODOLOGY OF THE STUDY

3.1 Method of data collection and sources of data

3.1.1 Population and sampling techniques

The total population of this study comprises those farmers who produced crop by the year 2010/2011 spring (locally belg) cropping season at Abeshige districts in gurage zone of southern region. According to the woreda or district's agricultural office information 125650 households were participated in crop production in 2010/2011 spring (locally Belg) season. Therefore the population size of the study was 125650 rural farm house holds from the woreda or district and the targeted interviewers were selected from the population by the application of stratified sampling techniques. Six potential crop producer's kebeles or village had been selected randomly out of the identified producer kebeles or village with under consideration of production potential and the accessibility of rural farms. Randomly selected out of the six potential kebelesor villages as a result 399 representative household samples were selected randomly out of the population of the woreda or district. The total sample size of the study was

determined based up onDeVaus (2002) formula below here:

$n = \frac{N}{1+N(a)^2}$ Where: n = sample size, N= population universe and a= the level of precision

The formula adopted a confidence level of 95% and the margin of error is therefore 5% which is acceptable in social science research. The break down for each of the group is calculated as follows:

Number of respondents: $n = \frac{125650}{1+125650(0.05)^2} \Longrightarrow n = \frac{125650}{1+125650(0.0025)} \Longrightarrow \frac{125650}{315.12.5} = 399$

Based on the above procedure the selected kebeles or villages are presented in the next table1.

Table.1: Sample selected Kebeles or villages

S.n	Name of selected kebeles orvillages	Total rural farmers in the kebeles or villages	Sample rural frames
1	BidoTadale	825	66
2	Fitejaju	1050	85
3	borar	964	78
4	Boketaserite	585	47
5	Nachakulit	675	54
6	chisanagafersa	850	69
Total		**4949**	**399**

1.1.2. Analysis of data

The data analysis of this study was conducted by using both methods of analysis, namely descriptive statics and parametric (econometric) analysis.

3.2 Descriptive analysis

In this method of analysis the descriptive statically technique was applied in order to explain those institutional, socio economic and demographic characteristics of rural crop producers. By using this method of analysis the level of input uses in the production, and related out puts and the distribution of efficiency among rural farmers were presented by using percentages and by a central tendency measurement tools such as mean, frequency, standard deviations.

3.3 Econometric analysis

According to Farrel (1957) agricultural production efficiency measurement has three components. These are technical, allocative and economic efficiency components and out of these components, the two (technical and allocative) efficiencies can be computed from production function whereas the economic efficiency of a farm can be computed from the combination of technical and allocative efficiency results.

Technical efficiency of an agricultural production represents the ability of a farm to maximize output for a given set of resource inputs whereas allocative efficiency indicates the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost(Nay, 2012). Among the components of the econometric models, the stochastic frontier production function together with the maximum likelihood measurement approaches are used to estimate the impacts of productive inputs on the outputs of crops production and also Tobit regression model was used to identify the level of economic inefficiencies that are emerged as a result of potential factors affecting in the production processes.

3.3.1 Cobb-Douglas Stochastic frontier production function

According to Battese and Coelli, (1992) The technique assumes that farmers may deviate from the frontier not only due to measurement errors, statically noises or any systematic influencing factors but also because of technical inefficiency. In addition the model allows the estimation of farmers as well as the determinants of technical efficiency simultaneously by the maximum likelihood method

There are two steps of procedures in order to applying this method of analysis. The first one is the impact of productive input use on the output value of crop producers which was determined through the application of the Cobb Douglas production function estimation and through using the ordinary least square method. The second step is the estimation of the TE level of crop producers within the

study area through applying stochastic frontier production function (SFP) model. As a result Cob-Douglas production function that was fitted with the stochastic frontier models of crop production is as follows:-

$$Yi = f(Xi, \beta) + \varepsilon i, \quad (1)$$

Where Y_i is the output of the j^{th}farm, X_i is a vector of inputs, β is a vector of unknown parameters, εi=Vi-Ui, Vi represents the random error term which is out of the capacity of rural farmers to control, Ui represents the technical inefficiency parts of farm production.

3.3.2 Empirical models

I. Technical Efficiency model specification

As the production of individual farm assumed to be characterized by Cobb-Douglas production function then the empirical normalized stochastic frontier production function can be specified as indicated below here.

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + e_i, \quad \textit{(2)}$$

Where

Y_j: crop outputs of jthrural farm in (kg/ha), 1n: denotes the natural logarithm, ß:Stands for the vector of unknown parameters to be estimated, X_1: is a variable that denotes the amount fertilizer used by the rural farmer in (kg/ha), X_2: labor (man per day/hectare), X_3: seed amount used in (kg/hectare), *j:*- represents the j^{th} observation of the sample, i:- represents the i^{th}rural farmer within the sample and ei=Vi-Ui where V_i are two sided normally distributed random error

The definition of variables for Cob Douglas Production Function

The lists of variables which are included in the analysis of this study are production amount and seed, labor, fertilizer which are the inputs used for crop production.

Output**(Y)**is the total quantity of crop produced by each rural farmer household in 2010/2011spring or (locally belg) cropping season. It is measured in kg per hectare.

Fertilizer(X_1) it includes NPSB fertilizers which was inorganic and bought and used by producers during spring or (locally belg) season of 2010/2011 production year and measured in kilograms).

Labor(X_2) considers all labor activities that applied for crop production. It is measured as adult man days perhect are and is the sum of family labor and daily laborer.

Seed(X_3) the amount of seed volume that was used by crop producers in 2010/2011 and measured in kilograms.

II. Allocative Efficiency model specification

As of the literature written by chukwuji et al. (2006) indicated the allocative efficiency analysis of agricultural production can be performed by estimating a Cobb-Dougals function through using the ordinary least squares (OLS), followed by computing the value of marginal products (VMP) for each particular factor of production, then after compare it with the marginal input cost (MIC). Using the coefficient estimates from the analysis, the marginal product (MP) of the i^{th} factor X is calculated as

$$\text{MP} = \frac{\delta Y}{\delta X} = \boldsymbol{\beta} \frac{Y}{Xi}, \quad (3)$$

Where, Y is the geometrical mean of crop yield(mean of natural logarithm),

X_i is the geometrical mean of inputs,β_i is the OLS estimated coefficient of input.

The value of the marginal product of input (MP) can be obtained by multiplying marginal physical product by the price of output (P_y).

Thus, allocative efficiency (AE) $= {}^{MP}/_{Pi}$, where Pi= marginal cost of the i^{th} input. Since rural farmers are price takers in the input market, the marginal cost of inputi approximates the price of the factor i, P_{xi}. As a result of the above computation we can to conclude the following points. If MPi>P_{xi}, the input is underused and farm profit can be improved by increasing the use of this input. Conversely, if MP<P_{xi} ,the input is over used and to raise farm profits its use should bereduced. The point of allocative efficiency (maximum profit) is reached when MP_i=P_{xi}.

III. Economic efficiency model

The economic efficiency level of farmers can be obtained by multiplying its respective technical and allocative efficiency levels.

A Tobit regression Model specification

According to Hosmer et al. (2000) the two limit tobit regression model is binomial that refers to the instance in which the observed outcome can have only two possible types (e.g. “yes” vs. “no”). Regularly, the outcome is coded as “0” and “1” in binary Tobit regression as it leads to the most straight forward interpretation. The target group (referred to as a “case”) is usually coded as “1” and the reference group (referred to as a “non-case”) as “0”. The Specification of a two limit tobit Regression Model for this study is constructed to show the relationship between inefficiency index with farm and farm head related attributes as follow:

$$Eindx = \beta_0 + \beta_1 gen + \beta_2 age + \beta_3 edu + \beta_4 hfsize + \beta_5 cop + \beta_6 tpseed + \beta_7 frql + \beta_8 mdseed + \beta_9 rfsize + \beta_{10} lown + \varepsilon_i \text{ , (4)}$$

Variable Description, measurement and Tobit regression mode

Efficiency indices (Eindx):are the dependent variable which represents the technical, allocative and economic efficiency scores of an individual crop produced rural farmer or farm of Abeshigewpreda or district. The efficiency level of the rural farmers was obtained from the calculation of frontier production function. The description of independent variables expected to influence the dependent variable are listed below here and if the respective parameters signs of variable is positive it can be to conclude as it has a positive effect on production efficiency where as if it is negative implies that it has a negative impact on production efficiency.

Gender of household head (gen): Gender is a binary variable where 1=male and 0=female, that is included to estimate the impact of gender on technical efficiency level of farmers. Female headed household would have better opportunity to carry out frequent follow up and supervisions of the rural farm activity on their plot.

The house hold head age (age): Age is defined as the age of the respondent that measured by years and is also considered as the experience of the farmers in primary decision making in the farming operation or the number of years the farmers have being involved in crop farming. As different literatures have shown, negative coefficient is expected to inefficiency effect.

Household's family size (hfsize): Household Size measures the number of people (adult men and women and children) who were living with the rural farmer during the 2010/2011 spring (belg) cropping season. The expected sign for household size is positive.

Education (edu):Education is a continuous variable measured by the number of years spent in school. Education as a human capital variable is a relevant factor in technology adoption. Educated farmers easily adopt improved farming technology and therefore should have higher efficiency scores than farmers with low level of education (Seyoum*et al*., 1998). Educated farmers are expected to acquire, analyze and evaluate information on different inputs, outputs and market opportunities much faster than illiterate farmers. The expected impact of education on efficiency is positive.

Cooperative membership of rural farmer (COP):The effect of this variable is captured by the existence the farmer whether he is a member of a seed multiplication and a multipurpose cooperatives or not and it is a binary. If a farmer is a member of a cooperative, he will be the more efficient, thus, positive coefficient is expected.

Types of seed used (tpseed):Improved Seed was a measure of the amount of crops seeds in kilograms (kg) used in 2010/2011 spring or (locally Belg) cropping season. This is a dummy variable and takes a value of 1 if a farmer uses improved seed and 0 otherwise. Improved seeds are associated with high productivity level and better capacity to resist diseases (Abay, 2007). Therefore, use of improved seed is expected to have positive effect on haricot bean output surplus.

Frequency of land plough for crop (frql):The effect of this variable would be examined the land preparation of a farmer measured by a number of land plough activities before sowing of seed. It is expected to have a positive influence on technical efficiency.

Method of crop seeding (mdseed):It is binary variable having value of 1 if household applied a row planting, and 0, for broadcasting. The effect on the production of farmer being involved in a row planting is easier to carry out agronomic management practicesand It gives more yield and hence positively complement farm activities.

Rural Farm land Size (rfsize):Farm size is the area of land in hectares of haricot bean cultivated. The variable was used to investigate its influence on output. During the survey, the dataon size of land was collected interms of hectare. Basically, land is the main factor of production and thus positive coefficient is expected.

Land ownership status of the rural farmer (lown): This refers to the farm land ownership status of the house hold measured from 1 to 4 if the farm land is its own= 1, if the farm land is rental=2, if the farm land is share cropping =3, for any other type =4 . If the farm land is owned by the house hold, farmer's efficiency will be expected to increase. Thus, the sign of this variable is expected to be positive.

IV. RESULT AND DISCUSSION

Empirical results of the study

The main purpose of this study is to assess determines the level of crop output efficiency which was produced by abeshigeworeda or district and the related influencing factors of crops production. The production of individual farm was characterized by Cob-Douglas production function.

4.1 Results from Cobb Douglas production function

The concern of this production function model is mainly to determine the level of crops production yield which was attained by producers in the study area and also to identify the influencing factors in each output level. The variables that used in the production function were presented below here and it indicated the average yield of the survey was 1135.039 Kg/ha with the minimum amount of 333.33 Kg/ha and maximum amount of 2400 kg/ha.

Table.2: Summary of variables used in crops production function

Variable	Units	Means	Std. Dev	Min	Max
Yield	kg/ha	1135.04	437.50	333.3	2400
Seed	kg/ha	68.60	24.05	30	120
Fertilizer	kg/ha	58.02	51.17	0	200
Labor	Man day/ha	9.7	4.09	1.33	200

Source: Primary data (2010/2011 spring (locally belg) cropping season)

Based on the above statically variables, the maximum likelihood estimation (MLE) of the production parameter of crops producers of Abeshigeworeda or district in guraze zone are presented as follows.

Table.3:The MLE of the Cobb-Douglas stochastic frontier production Function

Variables (Output)	Parameter	MLE Coefficient	Std. Error	Z-Statistics
Constant	βo	5.120***	0.3920	13.06
Fertilizer	β1	0.3061***	0.0604	5.07
Seed	β2	0.1919**	0. 0942	2.04
Labor	β3	0.1141***	0.0548	2.08
Wald chi-square			48.24 (0.000)***	
Model Variance			0.0994	
Gamma			0.6076	
Log Likelihood			-35.807997	

Source:- survey data 2010/2011 spring (locallybelg) cropping season

All the three coefficients have positively influenced crops production and also they were statically significant at 5% and 1% levels. This implies that as each of these variables is increased and the other factors affecting are remaining constant, the output of crops will be increased. The coefficient that representing the volume of fertilizers which was used by producers has a positive sign and revealed 1% level of significance relationship with production outputs. This implies that a percentage increment on the volume of fertilizers can increases the volume of crops output by 0.31 percent. This result is supported by the findings of Tewodros (2015).

The coefficient of seed was found to be positive and statistically significant at 5% level. The implication of this result is a percent change in the volume of seed used by the farmers can increased the yield of crops by 0.19 percent. In the contrary of this result, the study result conducted by Tamirat (2017) revealed that seed has negative and insignificant impacts on crops yields. The other variable coefficient is labor and it was estimated with a positive and significant at 5% level. This result showed that the output can be increased by 0.11 percent with a percentage increase in labor. The result is consistent with the findings of Tewodros (2015) and Tamirat (2017) which found the similar results that labor has positive and significant influences on crops yields.

Since results of the walid chi-square statics is 48.24 with p-value 0.000 and at 1% significant level, it can be to conclude that there is inefficiency in production of crops production with in the study area. The coefficient score of sigma is about 0.6076 this implies that the proportion of variation in the model is as a result of technical efficiency. As the score indicated about 60.8% of the variation in crops output was as a result of the differences in technical efficiency. In other words about 61 percent of the variation with in the error term was due to the inefficiency component. Based on this information it can be to conclude that about 39% of the variation was due to random shocks that cannot be controlled by rural farmers. Therefore, if it can to minimize the gap of technical inefficiencies between producers there is the opportunity to maximize the crops out puts with in the study area.

4.2 Efficiency analysis

The technical, allocative and economic efficiency of crops farms were estimated to develop holistic analysis of then existing farm's performance with in the study area.

4.2.1 Technical Efficiency Analysis

The results of this study showed that technical efficiency of the farmers ranging from 19.95 percent to 95.17 percent with a mean value of 64.69 percent. The implication of this result is that the best performing producer attained at 95.17 percent efficiency while the least performing farmer achieved about 19.95% efficiency level.

4.2.2 Allocative Efficiency analysis

The allocative efficiency score of crops producer rural famers with in the study area is ranging from 15.52 to 97.69% with an average score of 57.47%. This result revealed that crops producing rural farmers have the room to increase their allocative efficiency level by 42.53% if production constraints are solved.

4.2.3 Economic Efficiency analysis

Table.3 below here indicated also the economic efficiency score of crops producing rural farmers of Abeshigeworeda or district in gurage zone. These efficiency scores has gotten from the combination effect of the technical and alloctive efficiency factors. As the result of the study revealed, the average economic efficiency of the farmers in the study area is about 35.94% whereas the scores ranging from the lower value 10.9% up to the maximum value of 81.29%. When we are comparing the EE against the TE of the study, it is clearly observable that the TE is higher than the EE. The important point to realize here is providing a great attention to maximize the EE of rural farmer crops producers in the study area.

Table .4: Frequency Distribution of Technical (TE), Allocative (AE) and Economic (EE) of crops producing rural farmers.

	Technical efficiency		**Allocative efficiency**		**Economic efficiency**	
Efficiency scores (%)	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
<=20	**1**	**1**	**1**	**1**	**16**	**16**
21--40	**10**	**10**	**26**	**26**	**50**	**50**
41—60	**34**	**34**	**30**	**30**	**24**	**24**
61—80	**29**	**29**	**22**	**22**	**9**	**9**
81---100	**26**	**26**	**21**	**21**	**1**	**1**
Mean (%)	**64.70**		**57.48**		**35.94**	
Minimum (%)	**19.95**		**15.52**		**10.9**	
maximum	**95.17**		**97.69**		**81.29**	
Std. Dev.	**19.55**		**21.99**		**16.13**	

Source:- survey data 2010/2011 spring (locally belg) cropping season

Based on the frequency distribution indicated in the above table 4, the highest number of producers has the TE between 41% and 60% which is holding 34% of the rural farmers under the study. Regarding to AE the greater number of farmers achieved the AE between 41% and 60 which representing 30% of total respondents. Lastly, the

EE scores of producers is higher with in the group between 21% and 40% achieved group which comprises 50% of the total producers.

Factor affecting efficiency in crops producer in the study area

Based on the estimated parameter resulted from Tobit regression model, the influencing factors impact on production and their respective signs were identified. The positive or negative signs indicated the effects of each explanatory variable on the scores of TE, AE and EE of production. Therefore those variables with a higher impact value should be given an attention in order to improve the existing efficiency level of crops production in Abeshigeworeda or district and results of the variables are presented below here.

Gender:of the farmer showed that female crop producers have a negative relationship with TE but a positive relationship with AE and EE. Therefor based on the result, it can be to conclude being a male has higher TE has ability reduced inefficiency but lower AE and EE. This study result is agreed with the findings bakery et al (2015).

Household family size: the result coefficients of the TE for showed a negative and insignificant relationship. But the estimated coefficients for the allocative and economic efficiency groups for the variable showed a positive relationship with the independent variable and it was statistically significant at 5% level. This result is similar with the findings of Essa (2011) that economic inefficiency was positively and significantly affected by family size but showed variation on the results of TE.

As the estimated coefficients result for education level of the farm head indicated, it has a positive relationship with TE and EE but negative relationship with AE of a farmer. This finding showed a compliance with the findings Tamirat(2017) and Tewodros (2015). As education is a fundamentals tool for crop production and development there might be knowledge and skill ignorance by some farm house holds or the farm households missed the application of their knowledge and skills of production. This might be one of the reasons for the existence of poor resource allocation during the haricot bean crop production.

The estimated coefficient for membership in cooperative revealed a positive relationship with EE of the farmers. Farm heads that had joined cooperative institutions showed a tendency of increasing efficiency against non-members in crop production. This happening is as a result of providing the cooperative institutions particularly different service like timely input supply, mechanization, credit, storage and technical training services to their individual members which might be the sources of motivation of the small scale crop producers in Abeshigeworeda or district. Similar result was found by Bakary and *et al*.(2014).

The estimated coefficient of land size is directly related with all the three categories of efficiencies at a significant level of 1%. As the size of land increases, motivation of the farmers in the study area also increased in turn enable to increase all the three efficiency categories. This has an agreement with the study's results conductedBakary*et al*.(2014) who found land size have a positive and significant influence on outputs.

Though significant, all the three estimated coefficients of land ownership status indicated a negative relationship with all three efficiency categories and the AE and EE are significant at 1% level of significance. Regarding to this variable, there were different dummy variables which the above results were bases upon. The results were obtained by performing each dummy variable against the remaining counterparts. If we assigned 1 for owned land status, then all the remaining three dummy variables take 0 and the like. The above result interpretation is that land owned farm heads were less efficient technically, allocatively and economically when they compared to those farmers who didn't have their owned lands.

Table.5: The estimated TE, AE and EE results of Tobit regression model

variable	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	coefficient	**Std, Error**	**coefficient**	**Std, Error**	**coefficient**	**Std, Error**
constant	0.4556	0.1130	0.4889	0.1230	0.2320	0.0895
gender	-0.009	0.0336	0.0642	0.0366	0.0355	0.0266
age	0.0035	0.0022	-0.004	0.0024	-0.008	0.0017
Household size	-0.006	0.0073	0.0251	0.0080	0.0120	0.0058
Education level	0.0082	0.0046	-0.006	0.0049	0.0002	0.0036
Coop membership	0.0350	0.0382	0.1037	0.0416	0.0634	0.0302

Types of seed	0.1090	0.330	-0.154	0.0360	-0.028	0.0262
Freq of land ploug	0.0123	0.0240	0.0044	0.0259	0.0125	0.0188
Method of seeding	0.2331	0.0367	-0.054	0.0399	0.0999	0.0290
Land size	-0.279	0.0854	0.7408	0.0929	0.3284	0.0676
Land Ownership	-0.043	0.0625	-0.167	0.0680	-0.173	0.0495

Source: survey data 2010/2011spring (locallybelg) cropping season

V. CONCLUSION AND RECOMMENDATION

The results of this study showed that technical efficiency of the farmers ranging from 19.95 percent to 95.17 percent with a mean value of 64.69 percent. The implication of this result is that the best performing producer attained at 95.17 percent efficiency while the least performing rural farmer achieved about 19.95% efficiency level. The allocative efficiency score of crop producer farmers with in the study area is ranging from 15.52 to 97.69% with an average score of 57.47%. This result revealed that crop producing farmers have the room to increase their allocative efficiency level by 42.53% if production constraints are solved. As the result of the study revealed, the average economic efficiency of the farmers in the study area is about 35.94% whereas the scores ranging from the lower value 10.9% up to the maximum value of 81.29%. Regarding to the yield of crops per hectare of land is ranging from 3.33 q/ha and 24 q/ha with a mean yield amount is 11.35 q/ha.

From Tobit regression model, among the socio economics attributes of farmer and farms, particularly for method of seeding and farmers applying line sowing are more efficient than those farmers who used broadcasting seeding method with high significant level under TE and EE. The farmers who are a member of cooperative institutions are highly efficient when they compared to non-members with the significant level under all the three efficiency categories. Respondent farmers who have the experience for a well land preparation showed higher positive relationship for the entire three efficiency category. Farmers who plough their land more than three times before sowing were more efficient when compared to those farmers who plough less than 3 times. Based on the above obtained the three categorical mean efficiency level of crop producing farmers with in the study area, the farmers were not operating at maximum level of production.

Based on the above findings of the study the proposed recommendations are provided below here.

I. As the results of the study indicated, among the basic production inputs the application of fertilizer and improved seed have shown a positive impact on efficiency though the farmers used under the recommended dose. Therefore the zonal and woreda level agricultural bureaus should promote strongly to change the existing under dose application and also the rejection of inputs completely. Not only can the recommended rate of inputs increase the output of the crop but also increasing the number of technology adopting farmers.

II. Since membership in cooperative institution particularly in seed production and marketing cooperatives has shown a positive impact on crops production efficiency, therefore the formation of similar institution and also bringing nonmember farmers to membership is must be a strategy to enabling farmers to use a modern agricultural production services like timely and a better quality input access, input and output marketing, credit services, mechanization and storage facility services etc.

III. The other findings of this study was increasing the frequency of land plough is positively affected production efficiency. Therefore agricultural, development agents should promoting a better land preparation by farmers through increasing the number of plough 3 and more than 3 times hence it can helps greatly the efforts to increase the productivity of the crop. Promoting line sowing is also crucial against broad casting methods to increase the yield of the crop.

The above listed points are the major recommendations which drown from the finding of the study.

REFERENCES

[1] Aigner, D.J., Lovell, C.A. and Schmidt, P. (1977).Formulation and Estimation of Stochastic Frontier

Production Function Models.*Journal of Econometrics* 6:21-37.

[2] BakaryKaddy. Sulyman.Sanyang(2014*) Evaluation of Technical, Allocative and Economic efficiency of rice producers*: A Case Study in central river Region north and south of the Gambia. A Thesis of MSC in Agricultural Economics.University Of Kwame Nkrumah.

[3] Boere A., Thijs R., Daphne W., Kidane D. and Wannes D. 2015. Business Opportunities Report Oilseeds and pulses #5 in the series written for the "Ethiopian Netherlands business event 5-6 November 2015, Rijswijk, The Netherlands".

[4] Burhan, O., Ceylan, R.F. and Hatice, K. (2009) A Review of Literature on Productive

[5] CIA.(2018) "Ethiopia." *cia.gov*.Central Intelligence Agency. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/et.html.[Accessed 12 May 2018].

[6] Coelli, T.J. and Battese, G.E. (2005) *An Introduction to Efficiency and Productivity Analysis*, Efficiency in Agricultural Production. *Journal of Applied Scienes Research*, 5(7): pp 796-801.

[7] Endrias, Ayaleneh, Kassa and Eyasu(2013) Productivity and efficiency analysis of Smallholder Maize producers in southeren Ethiopia. Journal of Human Ecology, 41(1): pp 67-75.

[8] EssaChanie(2011) *Economic Efficiency of smallholder major crops production in the central highlands of Ethiopia*. Masters of Thesis in Agricultural and Applied Economics specialization in Agricultural Policy and Trade from University of Egerton. [Accesed 15 May 2018)

[9] FAO and WFP (2010) quoted by Solomon bizuayehu (2014), *Crop and Food Security Assessment Mission to Ethiopia.*[Internet]. Food and Agriculture Organization and World Food Program, May 2018].

[10] Khairo, S.A. and Battese, G.E. (2004).*A Study of Technical Inefficiencies of Maize Farmers within and outside the New Agricultural Extension Program in the Harari Region of Ethiopia*, Kluwer Academic Publishers, Boston.

[11] Kumbhakar, S.C. and Tsionas, E.G. (2006) quoted by Essa (2011). Estimation of Stochastic Production Functions with Input-Oriented Technical Efficiency.*Journal of Econometrics* 133(1): 71-96.

[12] Mersha, F.G. (2004). *Analysis of Technical Efficiency of Wheat Production*: A Study in Machakel*Woreda*, Ethiopia. Unpublished MSc Thesis, Alemaya University.

[13] Mulugeta, A., Tesfaye, K. and Dagne, K. 2015. The Importance of Legumes in the Ethiopian Farming System

[14] Omonona, B.T., Egbetokun, O.A. and Akanbi, A.T. (2010) quoted by Essa (2011). Farmers Resource – Use and Technical Efficiency in Cowpea Production in Nigeria.*Economic Analysis and Policy* 40 (1): 87-95.

[15] Seyoum, A., Dorosh, P. and Sinafikeh, A. (2011) *Crop Production in Ethiopia: Regional Patterns and Trends.* Ethiopia Strategy Support Program (ESSP), February 2018].

[16] Tamirat, G., Tewodros, T., and Deribe K. (2017). Determinants and Resource Use Efficiency of Haricot Bean Production in Halaba Special District, Southern Ethiopia.*Journal of Economics and Sustainable Development*8(17): pp 12-18.

[17] Tewodros, T. 2014. Determinants of Smallholder Pulse Producers Market Orientation in Southern Ethiopia, *Asian Journal of Business Management.*6(2): 101-103

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Assessment of Fiber-Enriched Pita Bread in The Lebanese Market: A Positive Correlation Between Dry Crude Fiber Content and TTA

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Abstract— *Due to increased health awareness, many people are making the switch from the traditional low-fiber Lebanese white pita bread to healthier high-fiber pita bread alternatives. Even though the price-to-weight ratio of white pita bread is controlled and unified among all Lebanese bakeries and brands and is enforced by the Lebanese Ministry of Economy and Trade, there is a highly significant difference in the price-to-weight ratio among the different brands that offer high-fiber pita bread. We sought to investigate the root cause of this difference by assessing the composition of two of the most sold high-fiber pita bread types in Lebanon (brown and oat). We tested brown and oat pita bread from three different Lebanese bakeries for price-to-weight ratio, fiber content, TTA, pH, moisture, and calories per gram. Using Pearson correlation coefficient, we did not detect any correlation between the price and any of the tested properties; however, a highly positive correlation between crude fiber content and TTA was detected.*

Keywords— ***Pita, bread, Fiber, TTA, bran, oat.***

I. INTRODUCTION

Bread is the corner stone of the Lebanese diet; it is the essential ingredient of every meal consumed by the Lebanese public from breakfast to dinner, including snacks [1]. Traditionally, Pita bread was, and still is, used to scoop up food from the plate similar to using chips or crackers to dip into sauce, except that the deformability of pita bread allows for a more utilitarian use to grab solid or semi-solid food and to scoop up liquid or semi-liquid food [1]. Bread is also used to prepare wrap sandwiches in restaurants, for kids to take to school, and as quick snacks for the whole family.

In recent years, the global spread of fast food chains and the continued shift from a Mediterranean based diet to a more Westernized diet has led to a significant increase in obesity, high cholesterol, high blood pressure, diabetes, cognitive disorders, and other diseases among the Lebanese and Mediterranean populations [2]. In the wake of such transformations, many calls have been made by nutritionists and dieticians for a more balanced and healthy diet, which encouraged a large section of the Lebanese population to switch from white pita bread to a healthier alternative form of pita bread that contains more fiber (e.g. brown and oat) [1]. This shift in consumer demand has led to a shift in the baking industry towards a "healthy and fit" trend that has manifested as a clear diversification in the contents of the bread menu, which is constantly adding new varieties of healthier pita bread (low salt, low calories, high-fiber, fortified, etc.) [3]. Because almost everyone in Lebanon relies so heavily on bread in their diet, the Ministry of Economy and Trade (MOET) has long since taken it upon itself to control the price of wheat in order to make sure that the price of white pita bread remains affordable to all families, especially those with limited income. Unlike the case of white pita bread, which has a fixed price of 1.67 LL/g, there is no control on the price of alternative bread, which allowed bakeries to set the price based on market demand, customer demographics, and perceived brand name.

In this study, we chose two of the most popular healthier alternatives to white pita bread (brown and oat), and especially since we could not find any published literature containing any assessments done on either type of bread in Lebanon. The Lebanese Standards Institution, LIBNOR,

has a set of criteria for brown bread, which includes type of cereal used, type of yeast used, crude fiber content, moisture content, salt content, mineral oil content, and few others; however, it does not have any preset criteria for pH or TTA, both of which have a significant impact on bread freshness, taste, and microorganism growth [4]. In addition, LIBNOR has no clear criteria for oat bread. The assessment done in this study focused on the fiber content, moisture content, TTA, pH, and calories in brown and oat pita bread purchased from three different bakeries that represent both multi-chain big businesses and small family owned and operated bakeries. Findings were compared with the adopted LIBNOR standards in terms of brown bread, and a comparison between brown and oat pita bread was done across the three different brands to determine if there are any major differences in the aforementioned properties that would explain or justify the significant difference in the price tag of these types of bread across the available brands.

II. MATERIAL and METHODS

1.1. Samples

Samples of bread were collected from 3 bakeries in Lebanon during Oct, 2019-Feb, 2020 period of time (major, medium and corner bakery). Two types of bread (Brown and Oat) were bought with three different production dates. Three samples of the two bread types were collected and coded as following: S1 brown, S2 oat, W1 brown, W2 oat, C1 brown, and C2 oat. Upon purchasing, the whole bread bag was weighed, and the loaves were counted. Each loaf was packed in a sealed bag. Samples were frozen at -4ºC until tested.

1.2. Reagents

All Chemicals were bought from Sigma-Aldrich.

1.3. General Procedure for Crude Fiber Analysis

The crude fiber was determined according to AOAC method (962.09) [5]. Two grams of 8 h dried bread (110 ºC) or none dried bread. The sample was extracted with 10.0 mL of dichloromethane. The remained solid was transferred to a 250 mL rounded flask, and 100 mL of 0.25 N H_2SO_4 were added to the rounded flask with magnetic stirrer. After installation of reflux condenser, the flask was set under reflux in an oil bath for 30 min. While hot, the solution was filtered through a Buchner funnel using a filter paper using vacuum filtration. The residue was washed with hot water until no longer acidic. The residue was then transferred to a rounded flask with addition of 100 mL of 0.3 M NaOH solution. The resulting slurry was refluxed for another 30 min. While hot, the solution was filtered again using pre-weighted filter paper. The remaining crude fiber with filter paper was dried in the oven for 2h, and then it was cooled in the desiccator before reading its weight. The crude fiber content percentage was calculated by dividing the mass of crude fiber over the mass of sample [6].

1.4. Moisture Content

Moisture content of bread was determined by AOAC method (925.10) [7]. Two grams of bread sample was weighed and placed in a hot air oven for 8 h at 110 ºC. Samples were removed from the oven and cooled in a desiccator before measuring their weight. The percentage of moisture content was calculated based on the dried sample and the original sample [6].

1.5. pH and TTA

pH and TTA (Titratable Acidity) of bread were determined by AACC 02-52.01 method. After mixing 10 g of bread sample with 90.0 mL of distilled water, the slurry was stirred for 30 min. Then the pH was measured using calibrated pH meter (OHAUS STARTER300) [8].

1.6. Calorimetry

The samples were measured for their caloric content using an oxygen bomb calorimeter according to the manual provided with the calorimeter (IKA® C200, Werke GmbH & Co.KG, Germany). All the samples were dried in an oven at 110 ºC for 8 hours

1.7. Statistical Analysis

All analyses were performed with three replicates. The statistical analyses were done using the IBM SPSS (Statistical Package for the Social Sciences, version 22.0) program. Analysis of variance consisted of univariate analysis was performed followed by Tukey's Honest Significant. Bivariate correlations obtained as Pearson's correlation coefficients (two tailed), cluster analysis, and principal component analysis were performed for analyzed bread samples using IBM SPSS.

III. RESULTS

1.8. Price

White pita bread is an essential part of the Lebanese diet, and its price-to-weight ratio is controlled and enforced by the Ministry of Economy and Trade (MOET) to make sure that every family in Lebanon can afford to put bread on the table. At the time when the samples were collected, the price for white pita bread was fixed at 1500 LL/900g (1.67 LL/g) regardless of the bakery or the region of sale. However, the MOET does not regulate the price-to-weight ratio of other types of pita bread (e.g. brown and oat).

Both brown (designated by number 1) and oat (designated by number 2) pita bread were purchased from three different bakeries (designated by C, W, and S). In our study, we weighed each pack of pita bread upon purchase and then used that value to determine the price to weight ratio for each of the 6 samples of bread used in the experiment. As expected, we detected a high significant difference ($p<0.001$). In the price of the selected samples compared to white pita bread as the prices of brown and oat pita bread purchased from all three bakeries ranged between 2.26 and 8.84 LL/g (Fig. 1). In addition, when we compared the 6 different samples among themselves, only W1 and S1 were similar while all remaining products were significantly different from each other (Fig. 1). However, it was clear that the price of oat bread was significantly higher than the price of brown bread across all 3 bakeries (Fig. 1). In addition, brown and oat pita bread products of the C brand were significantly cheaper than brown and oat pita bread products of S and W brands, respectively, and the oat bread of the W brand (W2) stood out as the outlier of the group, nearly double the price of the nearest competitor (Fig. 1).

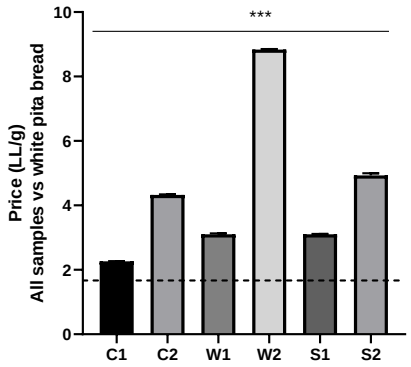

Fig.1: Price comparison among the six different samples of bread.

1.9. Crude Fiber and Moisture Content

Clearly both types of bread were priced differently and some brands were more expensive than others, however, was the difference due to a clear measurable difference in the composition of the bread, or were some bakeries selling their customers a product that was not compliant with the standards adopted by the Lebanese Standards Institution (LIBNOR)? To answer both questions, we conducted a series of experiments to assess the crude fiber and moisture content of the bread, in addition to several other properties.

According to LIBNOR standards, the crude fiber and moisture content of brown bread must not exceed 3 and 26%, respectively; however, there are no stated regulations regarding the amount of soluble and insoluble dietary fibers in brown pita bread. In addition, there are no set standards for oat pita bread, which is why we compared the results of oat pita bread to the standards set for brown pita bread. Based on our findings, all tested samples had a dry crude fiber content that did not exceed the 3% limit, in fact, all samples had a crude fiber content that was significantly below the maximum allowed limit except for sample C2 (Fig. 2A). When looking into the moisture content, all samples were within the approved limit and only sample C2 was significantly below the maximum allowed limit (Fig. 2B).

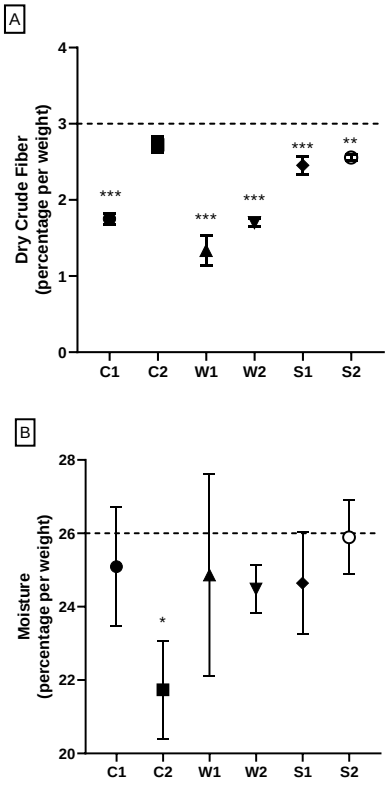

Fig.2: Dry crude fiber and moisture content of brown and oat pita bread.

1.10. TTA, pH, and Energy

We determined that all 6 bread samples were within the LIBNOR standards for crude fiber and moisture content, so we looked next at TTA, pH, and energy (Fig. 3). As was stated earlier, LIBNOR has no set standards for TTA, pH, or energy for pita bread. Upon testing the samples, we did not detect any significant difference in the energy (cal/g) content among all 6 samples (Fig. 3C), in addition, only C2 and W1 exhibited a significant difference in pH when compared to each other ($p=0.0203$; Fig. 3B). However, comparing TTA values among all 6 samples showed a large margin of difference among the tested samples, but the statistical significance was not reported in figure 3A, instead, we reported the differences in TTA

among all samples in the form of a comparison between each sample and all remaining samples, and we reported the results in figure 4.

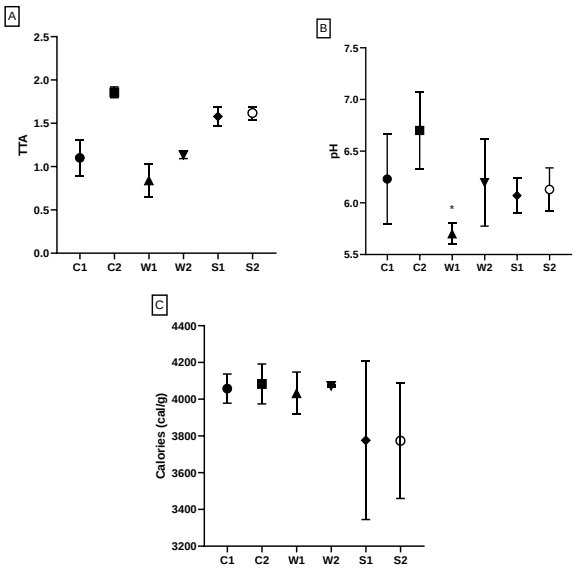

Fig.3: TTA, pH, and energy of brown and oat pita bread.

1.11. Crude Fiber and TTA

Initially, we determined that all tested samples were within the allowed range for crude fiber content, but since the difference in the price among all 6 samples was very highly significant (Fig. 1), we compared the crude fiber content and TTA among all 6 samples trying to determine if the differences in the price were correlated with the differences in crude fiber content and TTA values. Based on the literature, dietary fiber decreases the risk of colon cancer, optimizes blood lipids which helps in reducing the possibility of obesity, reduces hypertension and cardiovascular diseases, reduces the risk of developing diabetes in pre-diabetic people, and is a natural laxative that helps regulate bowl movement [9]. On the other hand, pH and TTA have a significant impact on bread quality. Both, pH and TTA, are dependent on fermentation time, sugar content, flour type, and other additives [10]. Generally speaking, the higher the TTA the more flavor the bread will have; however, very high levels can cause a sour off-flavor [11]; and since our initial results did not detect a significant difference in the pH level among the samples, we checked the TTA values only. We compared the crude fiber content of all 6 samples among each other, and aside from samples C1 and W1, all samples had significantly different amounts of crude fiber compared to each other (Fig. 4A-F). Also, we compared the TTA values for all 6 samples among each other and determined that C1, W1, and W2 had similar TTA values were significantly lower than those for C2, S1, and S2 (Fig. 4G-L).

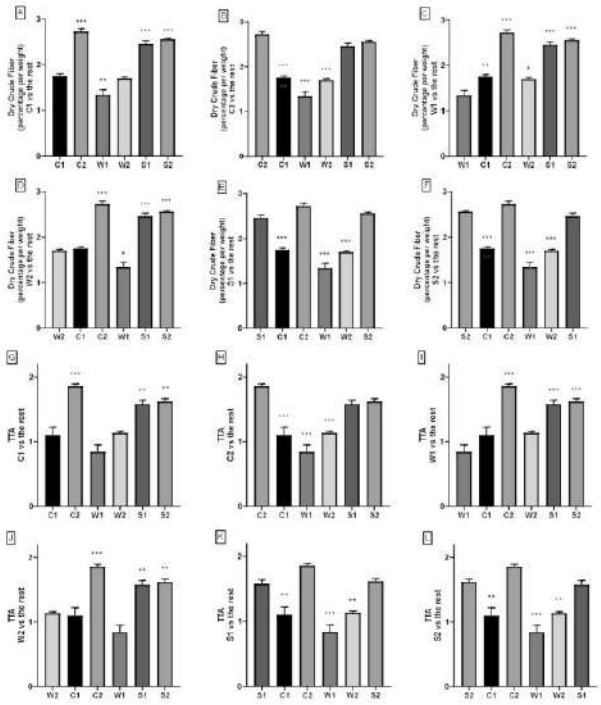

Fig.4: Crude fiber and TTA comparison among the six different samples of bread.

1.12. Correlation between Crude Fiber and TTA

Unfortunately, we were unable to find any correlation between the price of pita bread and any of the tested properties including crude fiber content and TTA values; however, a very interesting observation was the detection of a positive correlation between crude fiber content and TTA among the samples. A Pearson's r was computed to assess the relationship between the amount of crude fiber found in the sample and the TTA value of the sample. We detected a positive correlation between the two variables, r = .959, n = 6, p = .0025, two-tailed. A scatterplot summarizes the results (Fig. 5).

IV. CONCLUSION

As was mentioned earlier, pita bread is a staple food of the *Lebanese* diet, which is why the MOET regulates and enforces the price of wheat and flour that are sold to bakeries in order to fix the price of white pita bread that is sold to the public. However, people are increasingly switching from the traditional white pita bread to healthier forms of pita bread that contain more fiber, which bakeries still produce using the same wheat and flour that they

purchase for a regulated price while adding few additives to the mix [12].

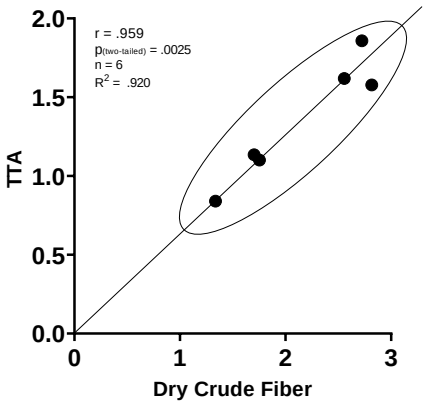

Fig.5: A scatterplot showing the correlation between TTA and Dry Crude Fiber content.

We determined that the price-to-weight ratios of brown and oat pita bread purchased from three different bakeries were significantly larger than that of white pita bread, which could be argued as being the cost of the other additives like bran, oats, etc. that bakeries use to make their high-fiber bread; however, even the ratios were significantly different among the same type of bread when compared across the three different brands. While trying to determine any possible differences among the different samples of bread that would justify the differences in price, we looked into crude fiber content, moisture, pH, TTA, and energy.

The primary reason people are switching to alternative pita bread products is that they are seeking to increase the fiber intake in their diet. Increased dietary fiber intake helps decrease the risk of colon cancer, optimizes blood lipids which helps reduce the risk of obesity, hypertension, and cardiovascular diseases, and decreases D-glucose absorption and insulin secretion, which is very important in the prevention and control of diabetes. Also, fiber is a laxative, which helps regulate bowl movement [13]. Since LIBNOR has a set standard for crude fiber content for brown bread not to exceed 3%, we compared the crude fiber content of all six samples of bread to determine if the fiber content was the primary reason for the difference in the price (i.e. more fiber equals higher price). Even though the tested samples had varying concentrations of crude fiber, they were all within the limit set by LIBNOR, but we did not detect any correlation between the price of the bread and its crude fiber content.

Moisture in bread has many implications on its hardness, chewiness, textural characteristics, taste, bacterial and mold growth, and shelf life [14]. When we tested the moisture content of all bread samples, we determined that all samples were within the limits set forth by LIBNOR (not to exceed 26%); also, we did not detect any difference in the moisture content among the tested samples.

The pH and TTA values are significant factors that affect bread freshness, flavor, and microbiota. Both, pH and TTA, are dependent on fermentation time, yeast type, sugar content, flour type, and other additives [10]. The pH range for brown bread is usually between 2.5 and 7.0 depending on the strain of yeast used and duration of dough fermentation; while the TTA range for brown bread is usually between 0.6 and 4.25, also depending on the strain of yeast used and duration of fermentation [15]. LIBNOR has no set standards for pH or TTA for brown or pita bread; however, the pH range of the tested samples was between 5.70-6.70 and the TTA range was between 0.84-1.86. Even though we did not detect major significant variations in the pH levels among the six bread samples, we did detect significant differences in the TTA levels. In fact, the six bread samples were divided into two groups in terms of TTA values where C1, W1, and W2 had similar TTA values that were significantly lower than C2, S1, and S2, which were similar among themselves. Similar to crude fiber and moisture, we were unable to detect any correlation between pH or TTA and the price of bread.

Finally, we looked into the energy content of the bread samples trying to determine if the price was related in a way to the caloric energy of the product (i.e. low-calories equal higher price). LIBNOR has no set values for the energy content of pita bread, and when we assessed the energy content of all samples, we determined that the samples ranged between 3773 and 4083 calories/gram with no significant difference among the tested samples. It was also surprising that two of the brands had the exact same nutritional food label. Such discrepancies in the label should be investigated by the Consumer Protection Agency.

At the end of our investigation, we were unable to detect any correlation between the price of the bread and any of the tested properties. It maybe some other property that we did not test (e.g. freshness, taste, elasticity, appearance, crumb color, crumb firmness, etc.), or it could be a matter of brand name perception. However, an interesting observation that was not reported by any previous study was the discovery of a very positive correlation between crude fiber content and TTA values. This finding is in line with a previous study that investigated the effect of the addition of live yeast cells on in vitro oat straw rumen fermentation, it was determined that live yeast cells reduced the pH of rumen by increasing the production of propionic acid, butyric acid, valeric acid, and isovaleric

acid [16]. Further analysis on the correlation between TTA and crude fiber content should be carried out on several cereal products to determine if the simple and cheaper TTA test could be an accurate alternative to predict crude fiber content in cereal products such as bread and animal feed.

REFERENCES

[1] Chbeir R., Mikhael M. (2017). Breaking the Bread Market: Lebanon's Modern-day Bakeries. BLOMINVEST BANK S.A.L.; https://blog.blominvestbank.com [accessed date: Sept 22, 2020]

[2] Kopp W. (2019). How western diet and lifestyle drive the pandemic of obesity and civilization diseases. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 12: 2221–2236. Doi: 10.2147/DMSO.S216791

[3] Ibrahim U. K., Salleh R. M., and Maqsood-ul-Haque S. N. S. (2015). Bread towards Functional Food: An Overview. *International Journal of Food Engineering.* 1(1), 39-43; Doi: 10.18178/ijfe.1.1.39-43

[4] Tarar O.M., Ur-Rahman S., Ud Din G.M., Murtaza, M.A. (2010). Studies on the shelf life of bread using acidulants and their salts, *Turkish Journal of Biology*, 34, 133-138

[5] AOAC, 1990. AOAC Method 962.09 Official Methods of the Association of Official Analytical Chemists, 15th Edn., 777, Arlington, VA, USA

[6] Tiimub B. M. (2013). Proximate analyses of three brands of bread under different storage conditions available on the Ghanaian market. *Food Science and Quality Management*, 12, 23–30.

[7] AOAC, 1990. AOAC Method 925.10 Official Methods of the Association of Official Analytical Chemists, 15th Edn., 777, Arlington, VA, USA

[8] Yin Y.; Wang J.; Yang S.; Feng J.; Jia F.; Zhang C. (2015) Protein Degradation in Wheat Sourdough Fermentation with Lactobacillus plantarum M616. *Interdisciplinary Sciences: Computational Life Sciences*, 7, 205–210; Doi: 10.1007/s12539-015-0262-0

[9] Olubunmi I. P., Babatunde K. S., Bolanle O. O., Seyioba S. O., Taiwo L.T., Olukayode O. A., Nwankego E. G. (2015). Quality evaluation of fibre-enriched bread. *International Journal of Nutrition and Food Sciences.* 4(4), 503-508; Doi: 10.11648/j.ijnfs.20150404.23.

[10] Abedfar A., Sadeghi A. (2019). Response surface methodology for investigating the effects of sourdough fermentation conditions on Iranian cup bread properties. *Heliyon.* 5, e02608; DOI: doi.org/10.1016/j.heliyon.2019.e02608

[11] Measuring pH and TTA, Baking Update, Practical technology from Lallemand Inc, (2018), volume 3; https://lallemandbaking.com/wp-content/uploads/2018/04/3_15PREFERMENTS.pdf [accessed date: Sept 22, 2020]

[12] Mounayar R., Jreij R., Hachem J., Abboud F. and Tueni M. (2019). Breakfast intake and factors associated with adherence to the Mediterranean diet among Lebanese high school adolescents. *Journal of Nutrition and Metabolism*, 2019, pp.1-10; Doi:10.1155/2019/2714286

[13] Kurek M., and Wyrwisz J. (2015). The Application of Dietary Fiber in Bread Products. *Journal of Food Processing & Technology.* 6(5), 1-4, doi:10.4172/2157-7110.1000447.

[14] Pastuszka D., Gambuś H., Ziobro R., Mickowska B., Buksa K., Saba R. (2012). Quality and nutritional value of wheat bread with a preparation of oat proteins. *Journal of Microbiology, Biotechnology and Food Sciences.* 1(February Special issue), 980-987.

[15] Anastasio M., Pepe O., Cirillo T. et al. 2010). Selection and use of phytate-degrading lab to improve cereal-based products by mineral solubilization during dough fermentation. *Journal of Food Scienc*e. 75. M28-35; Doi:10.1111/j.1750-3841.2009.01402.x

[16] Ruiz, O., Castillo, Y., Arzola, C., Burrola, E., Salinas, J., Corral, A., Hume, M. E., Murillo, M. And Itza, M. (2016). Effects of Candida norvegensis Live Cells on In vitro Oat Straw Rumen *Fermentation. Asian-Australasian Journal of Animal Sciences, 29, 211-218; DOI:* 10.5713/ajas.15.0166

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Analysis of Scottish Seine Fishing Gear Operating in the waters of Majene West Sulawesi Province

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Abstract— *The purpose of this study is to evaluate Scottish Seine fishing gear and to analyze Scottish Seine fishing gear in technical and biological aspects in review based on the Minister of Marine Affairs and Fisheries Regulation No. 2 of 2015. The analysis used in this research is multiple linear regression analysis and analysis of the size of the first maturity of gonads. There are three types of fishing gear operating areas for the Scottish Seine in Majene waters, namely the Scottish Seine which is operated in close FADs, medium FADs and long FADs. The results obtained were that one of the fish caught was sortfin scad fish which produced a fish that was fit to be caught. However, the catch of the three FADs' Scottish Seine fishing gear was predominantly unfit for catching fish. Scottish Seine fishing gear in Majene waters is in accordance with the regulation Minister of Marine Affairs and Fisheries Regulation No. 2 of 2015 produce fish catches that are not suitable to be caught. The use of FADs which causes the catch of Scottish Seine fishing gear to produce fish that are not suitable to be caught, and the use of a relatively small mesh size of the Scottish Seine fishing gear.*

Keywords— ***Technical And Biological Aspects, Scottish Seine Fishing Gear, Sustainable Fishing***

I. INTRODUCTION

The attention of the Government of Indonesia towards sustainable capture fisheries management continues to be increased. One of the most interesting is the issuance of Minister of Marine Affairs and Fisheries Regulation No. 2 of 2015 concerning the prohibition of using Trawls and Seine nets in the Fisheries Management Area of the Republic of Indonesia. 2 of 2015 concerning the prohibition of using Scottish Seine fishing gear is resulting in a decrease in fish resources and threatens the environmental sustainability of fish resources. Panggabean et al, (2016). One area that uses the Scottish Seine's fishing gear a lot is Majene District. Scottish Seine is the dominant pelagic fishing gear in Majene Regency. This tool is a traditional fishing tool that has been passed down from generation to generation.

While the results of Ulpa (2006) study in Majene waters on the Scottish Seine fishing gear found that the dominant fish caught, namely sortfin scad fish showed that the size of the catch of sortfin scad fish was 200 mm for the first time. According to Dahlan (2015) states that sortfin scad fish the size of the first time to spawn was 195 mm, so that it is based on the size of fish fit to be caught in Majene waters on the Scottish Seine fishing gear, which is to produce catchable fish. Then based on several observations in the field that the problems between Scottish Seine fishing gear in other water areas have differences according to their characteristics, several previous studies, one of which is Simbolon (2011) at the port of Ratu, stated that the Scottish Seine fishing gear has a *mesh size* that is relatively small compared to the target catch (fit to be caught) so that the results obtained at the size of the fish catch are not producing fish that are fit to be caught. Then Sutono (2016) in the coastal waters of Tegal, the Scottish Seine fishing operation is carried out near the coast within 1 - 2 miles, the results show that the fish caught are predominantly small fish (unfit to catch) this can cause fish resources to decline due to fishing exaggerated.

Seeing the difference in the size of the fish catch in the Scottish Seine fishing gear in the territory of Indonesia, a study was carried out on the use of the Scottish Seine fishing gear, especially in the waters of Majene Regency by looking at several aspects, namely technical and biological aspects, so that the sustainability of the Scottish Seine fishing gear was carried out. especially in the area of Majene Regency, West Sulawesi. The purpose of this study is to evaluate the Scottish Seine fishing gear in a review of the Ministry of Marine Affairs and Fisheries Regulation No. 2 of 2015 and to analyze the technical and biological aspects of Scottish Seine fishing gear in Majene waters, West Sulawesi.

II. RESEARCH METHODS

This research was conducted in the waters of Majene Regency, West Sulawesi, to be precise in Pangaliali Village, Majene Harbor. The research was carried out in May - November 2019. The method used in the study was the census method of all Scottish Seine fishing gear populations, and measurement of fish catches. Data was collected by following fishing operations for 30 fishing trips of far, medium and near FADs. Measurement of the catch was carried out by using a stratified random sampling method of 1,170 sortfin scad fish observation was carried out by measuring the length and weight of the fish and looking at the sex and gonad maturity of the fish, measuring the total length of the fish using a ruler with the smallest scale of 1 mm. The required data was obtained after the ship landed its catch at fish auction Pangaliali waters, Majene Regency.

A. Data Analysis

1. Technical Aspects

Data analysis carried out in this study was processed using the Multiple Linear Regression Analysis Model, which is to determine the effect of fish catch size, the independent variable (X) is the *mesh size* of the bag (close FAD, medium FAD and far FAD) dependent variable (Y) size of fish catch.

2. Biological Aspects

Measurements of the parameters of the biological aspects in this study are to determine the length and weight of the catch of sortfin scad fish on the Scottish Seine fishing gear operating in Majene waters, the measurement of the fish is carried out every day from May to November. The size of the fish that is fit to catch is the size of the fish that the gonads ripen the first time. This is to determine the categories of biologically fit and unfit for fishing. The basis used to determine the maturity level of the gonads is, among others, the observation of macroscopic morphological features, namely shape, length, weight, color and development of gonad contents. The criteria for the level of gonad maturity used the Cassie method modified by Effendie (1997). The estimation of the size of the first maturity of gonads was analyzed using the Sperman-Karber method (Udupa, 1986) as follows:

$$\log m = X_k + \frac{X_i}{2} - (X \sum p_i)$$

Where:

Xk = logarithm of the last mean value when the fish is 100% cooked;

X = the average difference in the logarithms of the mean class;

Xi = logarithm of the mean class value;

pi = ri / ni; ri = number of cooked gonad fish in class i;

ni = number of fish in class i; qi = 1 – pi

$$\text{Variety} = X^2 \sum \left[\frac{pi * qi}{ni - 1} \right] \quad \text{Interval 95\%: } m \pm Z_{\alpha/2} \sqrt{Variety}$$

In principle, this method is in line with the sigmoid curve method, only in this method the size range is calculated mathematically, so that it is more convincing in determining the reference size. The criteria for gonad maturity are at gonad maturity 3, 4 and 5. (Najamuddin 2004).

III. RESULTS & DISCUSSION

1. Technical Aspects of Catching Scottish Seine

The percentage of the independent variables of the *mesh size* of the finger bags of FADs near FAD, medium FAD, far and (X) to the dependent variable fish catch size (Y) can be seen from the value of the coefficient of determination (R2). From the SPSS output table, it can be seen that the R-Square (R2) value of the regression model formed in this study is 0.581. The coefficient of determination R Square (R2) is 0.170, which means that 17% of the catch size is caused by the variable *mesh size* of the fishing gear bag of close FADs, medium FAD and far FAD and the rest is influenced by other factors.

Based on the results of the F test, it was found that the p-value F was 0,000. Therefore, the p-value F is 0.000 <0.05, so the regression equation can be accepted which means that the mesh size of fishing gear bags used at near, medium FADs, and far FADs together have a significant effect on the size of fish catch.

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	-1.327	10.048		-.132	.896
Near	17.010	11.117	.310	1.530	.010
Medium	14.096	10.600	.279	1.330	.019
Far	1.214	14.978	.017	.081	.130

From the regression model above, the best regression model is obtained, based on the significance value (independent variable), namely the close coefficient of FADs (X1) 17.010 and medium FADs (X2) is positive and it can be concluded that if the addition of the mesh size of the fishing gear bag of Scottish Seine is done, the catch the fish will get bigger. The effect of the size of the fish catch is also influenced by the location of the area where the fish is operated.

Fig 1. Fishing area

Based on research on the catching area for Scottish Seine fishing gear in Majene waters, the operation shows that the FADs close to operate the distance from the fishing base to the fishing ground, namely 1 - 2 miles, while the FADs are between the fishing base to the fishing ground 5 - 8 mill and the remote FADs are 8 - 15 mill. Ministry of Marine and Fishery decision Number 71 concerning fishing routes in 2016 states that Scottish Seine fishing gear can catch fish within a distance of > 4 nautical miles. (Deri et al 2019).

2. Biological Aspect Analysis

A total of 1,170 scortfin scad fish in Majene waters were measured and observed, consisting of 669 males and 504 females. The results of calculations with a 95% confidence interval showed that sortfin scad fish males first matured the gonads at a fork length of 145 mm with a length range of 14.36-15.60 cm. sortfin scad fish mature female gonads with a fork length of 170 mm with a 95% confidence range between 17.18-18.91 cm.

Table 1. Frequency of fork length (cm) and length calculation for the first maturity of male gonads sortfin scad fish (Deapterrus macrosoma)

Class hose	Middle Value	Middle Value Log	Number Of Fish	Mature	Pi*Qi /Ni-1
	Nt	Xi	Ni	Nb	
145 – 150	148	2,170	29	0	0
150 – 155	153	2,184	40	0	0
160 – 165	163	2,212	35	0	0
165 – 170	168	2,225	14	2	0,009
170 – 175	173	2,238	38	6	0,006
175 – 180	178	2,250	17	5	0,012
180 – 185	183	2,262	22	10	0,011
185 – 190	188	2,274	39	12	0,005
190 – 195	193	2,285	49	19	11,39
195 – 200	198	2,296	61	44	12,48
200 – 210	207	2,315	126	80	28,40
210 – 215	213	2,328	76	66	8,569
220 – 225	223	2,348	61	50	7,546
230 – 235	234	2,369	48	42	5,140
235 – 240	238	2,376	14	12	1,591
240 – 245	243	2,385	0	0	0
245 – 250	248	2,394	0	0	0
Total			669	331	75,17
Average					6,264

Table 2. Frequency of fork length (cm) and length calculation for the first maturity of female gonads sortfin scad fish (Decapterrus macrosoma)

Class hose	Middle Value	Middle Value Log	Number Of Fish	Mature	Pi*Qi /Ni-1
	Nt	Xi	Ni	Nb	
145 – 150	148	2,170	20	0	0
150 – 155	153	2,184	8	0	0
160 – 165	163	2,212	28	0	0
165 – 170	168	2,225	17	0	0
170 – 175	173	2,238	22	0	0
175 – 180	178	2,250	33	6	0,013
180 – 185	183	2,262	10	2	0,017
185 – 190	188	2,274	32	7	0,005
190 – 195	193	2,285	18	9	0,014
195 – 200	198	2,296	21	8	0,011
200 – 210	207	2,315	44	19	10,75
210 – 215	213	2,328	57	24	16,39
220 – 225	223	2,348	109	87	24,24
230 – 235	234	2,369	53	49	11,30
235 – 240	238	2,376	34	26	5,937
240 – 245	243	2,385	5	4	0,64
245 – 250	248	2,394	4	3	0,56
Total			504	238	69,89
Average					5,824

The size distribution of male and female sortfin scad fish in Majene waters has the smallest size of 140 mm to the largest size of 250 mm, the size of fish fit to be caught is in the male fish class interval 190-200 mm and the female class interval 210-220 mm. Based on the observation data of male sortfin scad fish with fork length <20.05 mm, 362 of the total 659 male fish were observed, while 287 female kites with fork length <21.01 mm were observed from a total of 504 female fish, namely immature gonads.

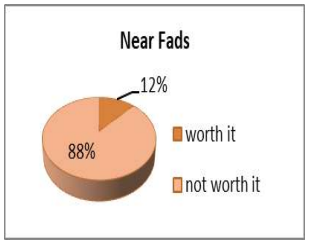

Fig 2. Percentage of FADs Close

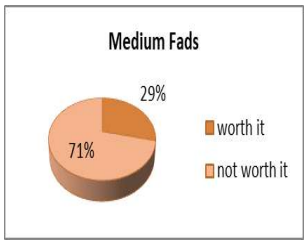

Fig 3. Percentage of FADs Medium

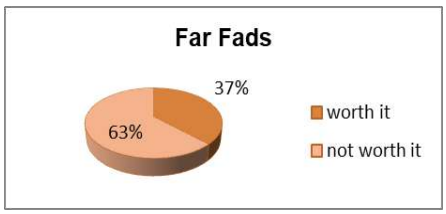

Fig 4. Percentage of distant FADs

The results showed that some sortfin scad fish caught in the FAD area were dominated by small fish (not yet fit to catch). Based on the figure, the percentage of catch size in Majene waters through the morphological approach in medium FAD was 29% feasible and not fit to catch by 71% while sortfin scad fish in distant FADs get a capture size of 37% and not fit to catch 63 %. The area of FAD close to get the size of fish that is fit to catch, as much as 12% of the percentage of fish size fit to be caught in the three FADs are dominated by fish that are not fit to be caught. The results of data analysis of the three FADs were the percentage of fishing that affected the use of FADs carried out. This is because the presence of FADs causes a lot of food around FADs (*phytoplankton*).

Based on the Ministry of Marine Affairs and Fisheries Decree No.2 of 2015 that the Scottish Seine fishing gear is prohibited for catching small fish, the use of *mesh size* nets in Majene waters needs to be enlarged to produce a *catch size* suitable for fishing and in accordance with the provisions of the Minister of Marine Affairs and Fisheries Decree No. 71 The 2016 Fishing Route for the operation of the Scottish Seine fishing gear can be used if the *mesh size* of the net sack is > 1 inch. This needs to be considered because if the size of the mesh used is not changed it will cause the fish resources in the waters to decrease, and the fish resources in coastal waters will be degraded to extinction. (Lorenzon 2016).

IV. CONCLUSION

There are three types of fishing gear operating areas for the Scottish Seine in Majene waters, namely the Scottish Seine which is operated in close FADs, medium FADs and

distant FADs. Based on the technical aspect, statistically the model is suitable for use with an accuracy of> 99%. Biological aspects show that the catch is suitable for fishing, namely 200 mm male sortfin scad fish and 210 mm female sortfin scad fish however the catch of the three FADs is predominantly unfit for catching, so the Scottish Seine fishing gear in Majene waters is in accordance with the regulations Minister of Marine Affairs and Fisheries Regulation No. 2 of 2015, namely producing fish catches that are not fit to be caught. The use of FADs which resulted in the catch of the Scottish Seine's fishing gear produced unsuitable fish, and the use of the relatively small *mesh size* of the Scottish Seine's fishing gear, so it needed to be enlarged, using a mesh size > 1 inch. This needs to be considered because if the size of the mesh used is not changed it will reduce the fish resources in Majene waters.

REFERENCES

[1] Dahlan, M. A., S.A. Omar, J. Tresnati, M.T. Umar & M. Nur. 2015. Sex ratio and size of the first matured fish gonads of Deles (*Decapterus Macrosoma* Bleeker, 1841) in the waters of the Gulf of Bone, South Sulawesi. Makassar, May 2015. Torani (Journal of Marine and Fisheries Sciences). Vol. 25 (1) April 2020: 36-40. ISSN: 0853-4489

[2] Deri Novita , Desi Albert Mamahit , Yusnaldi 2019 Impact of Implementation of Minister of Marine Affairs and Fisheries Regulation Number 71 of 2016 on National Security (Case Study in West Sumatra Province) Maritime Security Study Program, Defense University (Maritime Security Journal) Vol. 5 No: 81 - 95

[3] Effendie, M.I. 1997. Fisheries Biology. Pustaka Nusatama Foundation. Yogyakarta. 163 p.

[4] Ermawati N, Zuliyati. 2015. Social and Economic Impacts of Minister of Marine Affairs and Fisheries Regulation Number 2 / 2015: A Case Study of Juwana District, Pati District. Journal Of Management Of Aquatic Resources. Vol 2 No (3) Page: 197-202.

[5] Farah Ulpa 2006. Composition of Scottish Seine Catch Types by Location of FADs in the Waters of Majene Regency, West Sulawesi. Thesis of Fisheries Resources Utilization, Faculty of Marine and Fisheries Sciences, Hasanuddin University Thesis

[6] Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number PER.02 / MEN / 2015 concerning the Prohibition of Using Trawls and Seine Nets in the Fisheries Management Area of the Republic of Indonesia.

[7] Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 71 / Ministry of Marine and Fishery decision / 2016 concerning Fishing Routes and Placement of Fishing Tools in the Fisheries Management Area of the Republic of Indonesia

[8] Najamudin, Mallawa, A., Budimawan & Indar, M.Y. 2004. Estimation of the Size of the First Ripe Fish Gonads of Deles *(Decapterus Macrosoma Bleeker*). Postgraduate Program. J Science and Technology, Faculty of Marine and Fisheries Sciences, Hasanudin University ,. Makassar. April 2004, Vol. 4 No. 1: 1-8. ISSN 1411-4674

[9] Lorenzen K. 2016 Toward a new paradigm for growth modeling in fisheries stock assesments: embracing plasticity and its consequences. Journal of Fisheries Research. 180 (1): 4-22.

[10] Panggabean, S. A, Suhaidi., Leviza, J, Barus, U. M. (2016). Implementation of Minister of Marine Affairs and Fisheries Regulation No. 2015 concerning the Prohibition of Using Trawls and Seine Nets on Capture Fisheries by Fishermen in Sibolga. USU Law Journal. 4 (4): 40-52

[11] Simbolon D. 2011. Bioecology and Dynamics of Fishing Areas. Bogor (ID). Department of Fisheries Resource Utilization, FPIK, IPB. Journal of Mangrove and Coastal. 10 (1): 42-49

[12] Sutono and Adi Susanto 2016 Utilization of Scottish Seine Fishing Gear Resources in Tegal Beach Waters, Department of Fisheries, Faculty of Agriculture, Sultan Ageng Tirtayasa University Journal of Fisheries and Marine Affairs Volume 6 Number 2 Pages: 104 – 115

[13] Udupa, K. S. 1986. Statistical Methods Of Estimating The Size At First Maturity In Fishes. Fishbyte, 4(2): 8–10.

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Sep-Oct, 2020 | Available: https://ijeab.com/

Performance Analysis of *Purse Seine* with FADs and without FADs at Lappa Fishing Port, Sinjai Regency

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Abstract— *The purposed of this research is to analyze the performance of purse seine fishing gear operated on FADs and purse seines that hunt schools of fish (without FADs) based on four aspects of performance (biological, technical, social, economic) . This research method is a survey method, taking 10 samples of each of the FAD purse seines and without FADs and analyzed using the scoring method through the biological, technical, socio-cultural and economic performance approaches. The results obtained by performed the FAD purse seine and non-FAD purse seine were in good enough criteria, namely ≥ 50 - 75%. In general, the performance of the two fishing gear units did not have a significant difference, because there were similarities and differences that did not greatly differ from each aspect of the performance review. Based on the biological aspects, the performance of purse seine without FADs is better than that of the purse seine using FADs because catch fish with a suitable size and uniform species. whereas based on the economic and technical aspects, the performance of purse seine using FADs is better than purse seine without FADs. This is due to higher catch production and income. Based on the social aspect, the performance of both of them has no difference*.

Keywords— ***Purse Seine, Biological Aspects, Technological Aspects, Economic Aspects, Social Aspects.***

I. INTRODUCTION

Purse seine fishing gear in Sinjai Regency experiencing an average catch production increase 19.4% every year (DKP, 2013). Each purse seine fleet has a variety of factors that will affect the resulting production. This causes fishermen to continue to increase the use of fishing gear technology, one of which is the use of fishing aids, even though their use has had a negative impact on several aspects. The efficient use of technology in fishing operations is necessary so that fishermen can obtain maximum results and income. However, there are several problems faced by purse seine fishermen in maintaining fishing productivity and increasing the efficiency of using fisheries business production factors (Rajagukguk, 2018).

Another problem is that the fishing operation area is moving further away from the coast which increases fishing operational costs. Fishermen very depend on production factors in carrying out their activities. The income of fishermen is very much determined by the size of the production produced considering that the intensive provision for labor (ABK) is not based on the payroll system but with the profit sharing system that is applied. The use of fishing gear that does not pay attention to biological aspects plays a role in reducing catches, which reflects the problems faced by purse seine fishermen in maintaining catch productivity (Aprilla et al., 2013).

Fishing gear technology development, it is necessary to assess the fishing gear performance at the purse seine business unit using FADs or without FADs to know the catch and duration of catching both FAD and non-FAD purse seine, Knowing the production of the catch, the physical effects of the environment, fishing technology and the level of difficulty in operating both FAD and non-FAD trawl fishing gear, Knowing the business unit income and economic feasibility of both FAD and non-FAD purse seines and Knowing the level of technology acceptance, benefits, adaptability and legality of both FAD and non-

FAD business units. So, this research can provide information about the performance of the purse seine fishing gear both using FADs and without FADs so it becomes a reference material for new fishery business actors or capital owners in developing the purse seine fishery business and becomes information and reference for the Fisheries Service in the management and utilization of fish resources and use of fishing gear.

II. RESEARCH AND METHODS

We conducted this research from May to December 2019 at the fishermen's base for catching purse seines who carried out operations in the waters of the Gulf of Bone. Purse seine fishermen comprise fishermen who use FADs as a tool and purse seine fishermen who hunt school of fish (without FADs). Sampling was also carried out at the Lappa Fish Landing Site, Sinjai Regency as the landing site for the fleet. The method used in this research is structured interviews based on four aspects (biological, technical, social and economic) and direct field observation to see the social conditions of the local community, the conditions of existing fishing gear, and the catch as primary data.

2.1 Data Analysis

The performance of the purse seine fishing gear using both FADs and without FADs was analyzed through biological, technical, socio-cultural and economic approaches. The fishing gear performance will be analyzed using the Scoring method used for the assessment criteria. For the lowest score is given 1 to the highest score is given

Table 1. The performance assessor of the ring tine using the scoring method

Variable / sub variable	**The value of the sub variable**	**Weight**	**The value of the variable to - i**	**Value x Weight of the variable to - i**
Biological Aspects				
The size of the fish caught		**0,50**		
1. Small to large size is dominant	1			
2. Small to large size dominant medium size	2			
3 Small to large size dominant large size	3			
4. Medium to large sizes	4			
Selectivity		**0,50**		
1.Catch> 5 species, vary in size	1			
2. Catch> 5 species, even size	2			
3. Catch <5 species, size varies	3			
4. Catch> 5 species, even size	4			
Catching Duration		**0,50**		
1. Catching> 10 months	1			
2. Catching <6 months	2			
3. Catching 8-10 months	3			
4. Catching 6-7 months	4			
Length of peak fishing season		**0,50**		
1. Catching> 10 months	1			
2. Catching <6 months	2			
3. Catching 8-10 months	3			
4. Catching 6-7 months	4			

Technical Aspects		
Effect of physical factors on fishing gear operation		**0,,50**
1. Very influential	1	
2. Influential	2	
3. Less Influential	3	
4. Has no effect	4	
The difficulty level of fishing gear operation		**0,50**
1. Very high	1	
2. High	2	
3. Moderate	3	
4. Low	4	
Technology level		**0,50**
1. Low	1	
2. Moderate	2	
3. High	3	
4. Very high	4	
Average production per trip		**0,50**
1. <1 ton	1	
2.> 1 - 3 tons	2	
3.> 3 - 5 tons	3	
4.> 5 tons	4	
Average production per worker		**0,50**
1. <100 kg	1	
2.> 100 - 300 kg	2	
3.> 300 - 500 kg	3	
4.> 500 kg	4	
Economic Aspects		
The gross income of the business unit per year		**0,50**
1. <250 million	1	
2.> 250 - 500 million	2	
3.> 500 million - 1 billion	3	
4.> 1 billion	4	
Business unit gross income per trip		**0,50**
1. <5 million	1	
2.> 5 - 10 million	2	
3.> 10 - 20 million	3	
4.> 20 million	4	
Business unit income per worker per year		**0,50**

1. <10 million	1	
2.> 10 - 30 million	2	
3.> 30 - 50 million	3	
4.> 50 million	4	
Value of B / C Ratio		**0,25**
1.B / C ratio 1 - 2	1	
2. B / C ratio 3 - 4	2	
3. B / C ratio 4 - 5	3	
4. B / C ratio> 5	4	
NPV Value		**0,25**
1. <200 million	1	
2.> 200 - 300 million	2	
3.> 300 - 500 million	3	
4.> 500 million	4	
IRR Value		**0,25**
1.IRR <50%	1	
2.IRR> 50-75%	2	
3.IRR> 75-100%	3	
4.IRR> 100%	4	
Social Aspects		
The level of technology acceptance by the community of potential users		**0,50**
1. <50% wish	1	
2. > 50 - 65% wish	2	
3. > 65 - 75% wish	3	
4. > 75% wish	4	
Employment		**0,50**
1. <5 workers	1	
2.> 5-10 workers	2	
3.> 10-15 workers	3	
4.> 15 workers	4	
Business benefits for non-fishing communities		**0,50**
1. <25% beneficial	1	
2.> 25 - 50% useful	2	
3.> 50-75% useful	3	
4.> 75% useful	4	
The level of community investment ability in fishing gear		**0,50**
1. <25% capable	1	

2.> 25-50% capable	2			
3.> 50-75% capable	3			
4.> 75% capable	4			
The level of technological adaptability by society		**0,50**		
1. <25% capable	1			
2.> 25-50% capable	2			
3.> 50-75% capable	3			
4.> 75% capable	4			
1. Legal level		**0,50**		
1. contradicting the 3 rules	1			
2. contradicts 2 rules				
3. contrary to 1 rule	2			
4. Not against the rules	3			
	4			
Total Weight Value		**10**	**-**	**-**
Maximum Value				**40**
Acquisition value				∑ (variable value x weight)

Source: Mallawa, 2019

Fishing Gear Performance = (Vp / Vm) x 100%,

Where :

V_p is the historical cost

V_m is the maximum value or full value.

Performance Criteria:

If ≥ 85 - 100% very high or very good

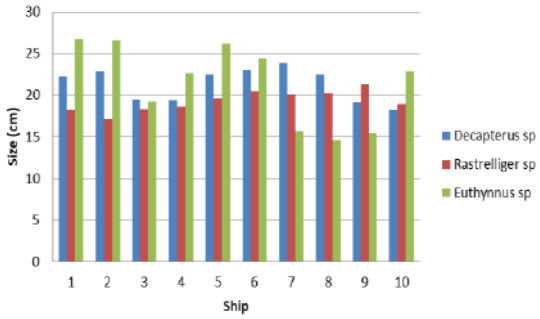
≥ 75 - <85% High or Good

≥ 50 - 75%, high enough or good enough

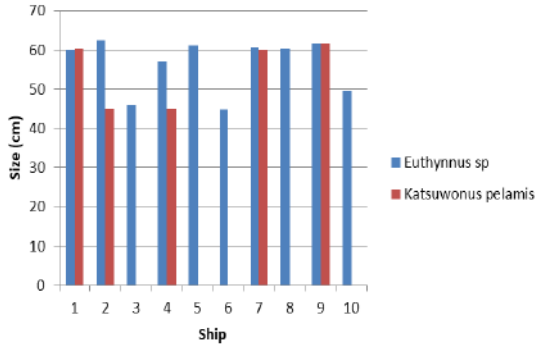
<50%, Low or less good

III. RESULT AND DISCUSSION

3.1 Biological Aspects



(A)



(B)

Fig.1 The size of the fish caught by purse seines: (A) using

FADs (B) without FADs

Based on observations made at the Lappa *Fishing Port* Sinjai by measuring the length of the fish on each purse seine vessel using or without using FADs, it can be seen based on the picture above, namely the average catch size of the dominant fish species in the FAD purse seine ranges at 21.29 cm *Decapterus sp*, 19.33 cm *Rastrelliger sp* size and *Euthynnus sp* size 24.09 cm while in purse seine without FAD the average fish size is 56.36 cm and 54.40 cm for *Euthynnus sp* and *Katsuwonus pelamis*.

Observed from the selectivity of the fishing gear, the purse seine using FADs got catches of up to 5 types of fish with three types of dominant fish which vary in size from small to medium in each catch. The difference in catch size between purse seines using FADs and without FADs shows that there are also differences in fishing methods. Method of catching the FAD ring trawling is by taking a trip operating the fishing gear with the FADs assistive device and some using lights. Using FADs should lure several types of fish to gather in FADs to be caught so that fish species are not the target of being caught. In contrast to purse seines without FADs, operation is carried out by one day fishing and catches by chasing hordes of fish target catch without the aid of fishing tools so that the fish caught is the target fish species and minimize the types of fish that are not the target catch

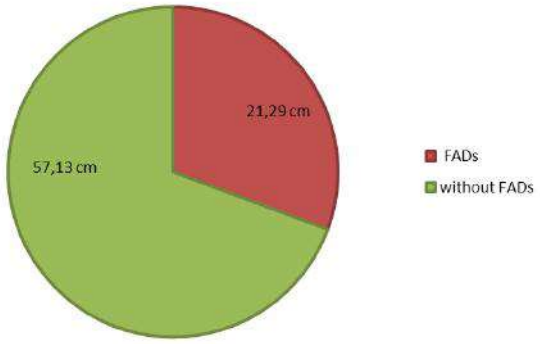


Fig.2 Average Size of Mackerel Tuna (Euthynnus sp) on the

purse seine FADs and without FADs

Purse seines both using and without FADs have the same type of catch in the form of *Euthynnus sp*. The size obtained based on the observation is the average size of 21.29 cm in the purse seine business unit using FADs, while the average *Euthynnus sp* size of 57.13 cm is obtained by the purse seine business unit without using FAD. The picture above shows that the size of the fish up to 57.13 cm is a medium size for *Euthynnus sp* and 21.29 cm is a relatively small size. Wagiyo and Febrianti (2015) conducted research on the biological aspects of *Euthynnus sp* and reported the size of the first time gonad ripe (Lm) was 40.34 cm and the size of the first time caught with purse seines (Lc) was 38.9 cm and was at the optimal exploitation level. This shows that the mackerel tuna in the purse seine FADs is not suitable to be caught, and the mackerel tuna as a non-FAD purse seine catch shows it is suitable to be caught.

The fishing period carried out by purse seine fishermen using or without FADs is all year round. The purse seines with FADs make fishing trips 2 times a month so that 24 fishing trips are obtained throughout the year. Purse seines without FADs are different because the catch is carried out one day fishing or the fishing operation is carried out one day to the fishing area and returns to the fishing base landing on the same day. The operating duration differs from purse seines using FADs are in operation for a maximum of up to 7 days.

3.2 Technical Aspects

The purse seine fishing gear is influenced by the physical factors of the waters, both purse seines using FADs and purse seines without FADs. The current becomes the thing that affects fishing gear operations. This will affect the performance of fishing gear and the ability of ships to determine fishing grounds. Likewise, the wind and waves can trigger the failure of fishing operations carried out by fishermen. According to Akhlak et al. (2015) Flow will affect the movement of fish and fishing gear. Determination of the location to be fishing is very important. Using purse seine fishing gear without FADs is to chase schools of fish as catch targets. Current direction, current speed, wave and wind. The direction and speed of the current affect when fishing is carried out because the target catch is determined by school of fish. The ship will move to change places to chase according to the whereabouts of the catch target. The fishing gear used by fishermen besides having technology capable of supporting the ability of the fishing gear in obtaining maximum fishing results must also be supported by the ability of fishermen to operate. Purse seine fishermen in Sinjai Regency do not experience difficulties in operating the non-FAD purse seine fishing gear. This greatly affects the effectiveness and efficiency of fishing operations. Although fishermen rely more on experience and abilities that are still traditional, the technology in fishing gear can help and make it easier for fishermen to increase their catch productivity. The picture below shows production of purse seine catch using FADs and without FADs.

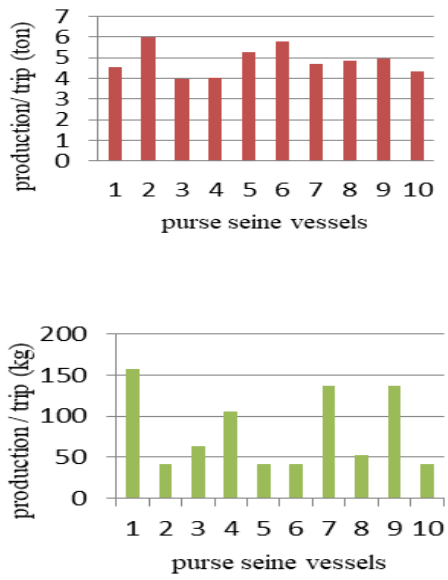


Fig 3. Production of purse seine catches: (A) FAD purse seines (B Non-FAD purse seines

Observations were made on purse seines using FADs or without FADs operating in Bone Bay and landing the caught fish at Pangkalan Pendaratan Ikan (PPI) Lappa. The average catch per trip was 4.8 tons or the equivalent of 4852 kg from 10 purse seines. Purse seines using FADs while purse seines without FADs get an average catch production of 81.9 kg. The production of catches ranges from over 4 to 5 tons in purse seines using FADs while in the production of purse seines without FADs between 42 kg to 152 kg per fishing trip. This difference is because of the different operating times for each business unit. Catching purse seines using FADs lasts for 5 to 7 days on a single fishing trip and makes 2 trips in a month while purse seines without FADs carry out daily fishing operations or one day fishing can last up to 20 trips or more in a month. fishermen productivity is calculated based on the amount of production with the number of workers at a certain time. In the fisheries sub-sector, increasing productivity is directed at the use of production factors as efficiently as possible, including through education, both formal and non-formal education, and increasing fishermen's knowledge and skills. A significant difference is seen because the operating time of the two types of business units is different.

3.3 Economic Aspects

From an economic point of view, these two business units have considerable advantages. Purse seines using FADs as a fishing aid have greater economic advantages than purse seines without using FADs. The gross income per trip obtained by the purse seine business units using FADs is greater than the gross income per trip of the purse seines without using FADs. The difference is very significant. Purse seines without FADs income per trip is Rp. 1,950,000 to Rp. 8,200,000. Meanwhile, the purse seine business unit using FADs earns a gross income per trip is Rp. 55,600,000 to Rp. 77,300,000. This difference shows that the length of fishing operation carried out by these two business units affects the amount of revenue per trip. The purse seines business unit using FADs conducts fishing operations that last over 3 days, while the purse seine without FADs makes only one day catch. This shows that there is a difference in the catch's production per trip and is directly proportional to the income earned per fishing trip. The difference in income per trip for each business unit in purse seines without FADs shows that the purse seine business units without FADs get different production catches. The small income per trip shows that the production per trip is also small and vice versa, if the income per trip is high, the production of the catch is also high. This will then determine the amount of income earned by workers as in the image below.

Table 2. The gross income of the business unit per year

Name	**Purse seine with FADs**	**Name**	**Purse seine Non-FADs**
Mekarsari	1.632.000.000	Putri T	656.000.000
Bintang T	1.856.000.000	Asrianti	234.000.000
Amira 01	1.524.000.000	Hilda 01	628.000.000
Amira 02	1.524.000.000	Hilda 02	522.000.000
Heriani	1.784.000.000	Hilda 03	522.000.000
Arjuna	1.480.000.000	PTK	627.200.000
Minasa M	1.544.000.000	Aldi S	963.200.000
Samudra	1.516.000.000	Askin	708.000.000
Lisna Indah	1.480.000.000	Cahaya 01	723.600.000
Badar	1.336.000.000	Cahaya 02	698.400.000

Source: Primary Data, 2020

Table 3. The gross income of the business unit per trip

Name	Purse seine with FADs	Name	Purse seine Non-FADs
Mekarsari	65.000.000	Putri T	8.200.000
Bintang T	77.300.000	Asrianti	1.950.000
Amira 01	63.500.000	Hilda 01	2.600.000
Amira 02	63.500.000	Hilda 02	4.300.000
Heriani	77.300.000	Hilda 03	4.300.000
Arjuna	61.660.000	PTK	3.700.000
Minasa M	67.300.000	Aldi S	2.800.000
Samudra	63.166.000	Askin	2.950.000
Lisna Indah	61.600.000	Cahaya 01	3.350.000
Badar	55.600.000	Cahaya 02	3.200.000

Source: Primary Data, 2020

Table 4. Business unit income per worker per year

Name	Purse seine with FADs	Name	Purse seine Non-FADs
Mekarsari	48.000.000	Putri T	25.230.769
Bintang T	54.588.235	Asrianti	11.700.000
Amira 01	50.800.000	Hilda 01	31.400.000
Amira 02	50.800.000	Hilda 02	26.100.000
Heriani	55.750.000	Hilda 03	21.750.000
Arjuna	46.250.000	PTK	26.133.333
Minasa M	51.466.000	Aldi S	37.046.153
Samudra	58.307.000	Askin	29.500.000
Lisna Indah	49.333.000	Cahaya 01	27.830.769
Badar	51.384.615	Cahaya 02	29.100.000

Source: Primary Data, 2020

The average value (B / C) of the fishing effort ratio using purse seines without FADs is greater than 1, specifically 1.70, while purse seines using FADs have a value of 2.46. This value shows that the fishing effort can be said to be workable to continue because the B / C value is> 1. The average NPV value in the fishing effort using purse seines without FADs is Rp.1,325,021,457 while purse seines use larger FADs worth Rp.5,798,980,944. The NPV value is positive, which is greater than 0, this indicates that the fishing effort is feasible to continue. The average IRR value of the purse seine fishing effort without using FADs is 31.72% while the purse seine using FADs has a value of 35.15%. This value indicates that the IRR is greater than the interest rate of 12%, so the fishing effort is feasible to continue.

3.4 Social Aspects

The labor required in the purse seine business unit without FADs, at least 10 people and can reach up to 13 people. This also means that people can get work every day in one fishing gear business unit. The purse seines using FADs can absorb a minimum workforce of 13 to 17 people in one fishing trip**.**

Using purse seine fishing gear in Sinjai District provides not only benefits to fishermen. However, the non-fishermen also feel the benefits. From the interviews conducted with the surrounding community, it was said that the existence of the purse seine fishing gear had a good impact on other businesses such as fuel, ice cubes, grocery shops, fish sellers and even snack sellers. Economic activities will go hand in hand with fishing activities. Observed from the technology adaptation by fishermen, the percentage of 70% assessed by the purse seine technology using FADs is lower than the purse seine technology without FADs, which is 80% able to adapt to fishing gear technology. The level of technology adaptability to society is considered capable of being in the middle of society. The fishing gear used by fishermen is fishing gear with adequate technology that supports the fishermen's ability to operate fishing gear. The community can adapt to the existence of this fishing gear, the use of technology accepted by the community, and does not harm it both economically and socially. From the legal point of view of the fishing gear, it is not against the existing regulations, except for administrative matters regarding the completeness of the business unit and fishing gear.

3.5 Performance Analysis of Fishing Tools

In general, if we see from the percentage value of the analysis results between the purse seines of FADs and non-FADs, there is no significant difference, both of them are at a fairly good level of performance. However, when viewed from the aspects that become the assessment study, both FAD and non-FAD purse seines have differences that affect the assessment in the analysis.If averaged, the percentage of performance value of purse seines without FADs is 62.24% and purse seines using FADs are 64.75%. This shows that there is no significant difference between them. Purse seines using FADs had a greater value than purse seines without FADs although they only differed by 3%. From the percentage of 62,245% : 64.75% meets the standard of performance criteria, which is over 50-75%, then the business unit is in the medium or good enough criteria. This means that the business unit is under good

criteria and is not included in the low performance criteria. The use of purse seine fishing gear business units, whether using FADs or not using FADs, means that it is still workable to continue as a business unit with considerations and efforts to improve performance.

Table 5. Performance Assessment of FAD Purse seines

Name	Acquisition value	Performance Value	Final score (%)
Mekarsari	25,5	0,6375	63,75
Bintang T	26,5	0,6625	66,25
Amira 01	26	0,65	65
Amira 02	26	0,65	65
Heriani	26,5	0,6625	66,25
Arjuna	26	0,65	65
Minasa M	26	0,65	65
Samudra	25,5	0,6375	63,75
Lisna Indah	25,5	0,6375	63.75
Badar	25,5	0,6375	63,75
Performance Range			63,75–66,25
Average			64,75
SD			0,98

Source: Primary Data, 2020

Table 6. Performance Assessment of Purse seines without FADs

Name	Acquisition value	Performance Value	Final score (%)
Putri T	25,25	0,6312	63,12
Asrianti	24,75	0,6187	61,87
Hilda 01	25,25	0,6312	63,12
Hilda 02	24,75	0,6187	61,87
Hilda 03	24,75	0,6187	61,87
PTK	24,25	0,6187	61,87
Aldi S	25,25	0,6312	63,12
Askin	24,75	0,6187	61,87
Cahaya 01	24,75	0,6187	61,87
Cahaya 02	24,75	0,6187	61,87
Performance Range			61,87-63,12
Average			62,245
SD			0,60

Source: Primary Data, 2020

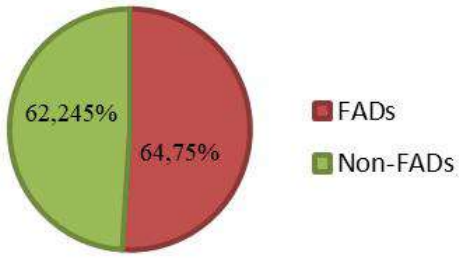


Fig 4. The average value of purse seine performance

IV. CONCLUSION

The performance of FAD purse seines and non-FAD purse seines are in good criteria. Based on the biological aspects, the performance of purse seines without FADs is better than the purse seines using FADs, whereas based on the technical and economic aspects the performance of purse seines using FADs is better than the purse seines without FADs. Based on the social aspects of the performance of the two of them, there is no difference. The things that make both FAD and non-FAD purse seines do not have high performance, specifically the FAD purse seines involve the selectivity and size of the fish while in non-FAD purse seines include production and business unit income which is lower than that of the FAD purse seines. This research will provide information and reference for stakeholders to pay attention to the performance of fishing gear from the biological, technological, social and economic aspects by means of FAD purse seines to increase the productivity of the catch and nonFAD purse seines to pay attention to target fish caught.

REFERENCES

[1] Akhlak MA., Supriharyono., Hartoko, A. 2015. Relationship Of Variables, Sea Surface Temperature, Chlorophy And Results Of Purse Seine Capture Landed At Tpi Bajomulyo Juwana, Pati.

[2] Aprilla RM., Mustaruddin., Wiyono Es., Zulbainarni N. 2013. Efficiency Analysis Of Ring Trawl Catching Unit At Lampulo Beach Fishing Port, Banda Aceh. Journal Of Fisheries And Marine Technology. Vol. 4 No. 1.

[3] Department Of Marine Affairs And Fisheries Of Sinjai Regency. 2013. Marine And Fisheries Statistics Of Sinjai Regency. South Sulawesi. Indonesia.

[4] Mallawa, A. 2019. Performance Appraisal Analysis Using Scoring Method. Faculty Of Marine And Fisheries Sciences. Hasanuddin University. Makassar.

ISSN: 2456-1878
https://dx.doi.org/10.22161/ijeab.55.24

[5] Rajagukguk, K. 2018. Productivity Of Purse Seine Capture Fisheries In Pekalongan Archipelago Fishery Port, Pekalongan City, Central Java Province. Faculty Of Fisheries, University Of Riau.
[6] Wagiyo K And Febrianti E. 2015. Biological Aspect And Population Parameters Of Longtail Tuna *(Thunnus Tonggol)* In Langsa And Adjacent Waters. Research Institute For Marine Fisheries, Jakarta.

International Journal of Environment, Agriculture and Biotechnology, 5(5)
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Identification, Phenology, Ecological Habitat and Damage Caused by Loranthaceae in Plantations of Rural Area of Daloa, Côte d'Ivoire

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Abstract*— *Loranthaceae are parasitic vascular plants that live and thrive at the expense of other woody plants. They proliferate on various woody plants and pose a threat to the host. It seemed important to know the pest species implicated in plantations. The target of this study is to identify Loranthaceae in plantations in periurban areas of Daloa to determine their phenology, to know their ecological habitat and to identify the damage caused to hosts, in order to raise the alarm bell the destructive impact of this plant biodiversity on other woody plants. Surveys and botanical inventory carried out on 25 plantations made it possible to identify three species divided into two (2) genera of which the most distributed on all the plantations prospected was Tapinanthus bangwensis (100% presence). The results of the phenophase observations of the three species showed that they overlap in duration and are not independent of each other. Five major damage was observed. Complete defoliating of host branches (45%) and drying of parasitized branches (32.7%) were the predominant damage observed. Knowledge of the phenology of these parasitic species could be used to develop strategies for the effective control of their spreading at favorable times.

***Keywords*— *Periurban plantations, Loranthaceae, phenophase, damage, targeted control*.**

I. INTRODUCTION

Loranthaceae are hemiparasitic vascular plants that live at the expense of other woody plants cultivated or not. Sometimes unrecognized, this plant biodiversity is in recent decades an agronomic problem in some plantations in sub-saharan Africa (Salle, 2004). Today, due to poor climatic conditions resulting from excessive deforestation, these parasitic plants have found favored hosts in other woody species (Amon, 2014). In Côte d'Ivoire, by traversing fields and plantations in the countryside, they invade in large numbers the plant of crops and other associated woody plants (Soro, 2010). The main question is how to eradicate them. But, how to eradicate them within plantations without a better prior knowledge of the parasite species involved and their biology? In Côte d'Ivoire, studies on this plant biodiversity have been carried out by several authors (Traoré *et al*., 2003, Soro, 2006, Soro, 2010), however, many aspects relating to their distribution and their biology remain deepen to better fight (Salle and Aber, 1986). In the Daloa plantations, where no specific Loranthaceae study has yet been carried out, it seemed important to better understand these phytoparasites. In order to do this, the overall target of this study is to inventory, identify the species of Loranthaceae in plantations in the periurban areas of Daloa and determine their phenology. Specifically, this will involve: (1) identifying Loranthaceae species and determining their vegetative phases; (2) know their ecological habitat and their position on the host; (3) to identify the possible damage caused to the hosts and to specify the means of struggle used by the by peasants.

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II. MATERIAL AND METHODS

2.1. Study area

The study was carried out in plantations in the periurban areas of Daloa, a Department of the Haut-Sassandra region, in west-central Côte d'Ivoire, with geographical coordinates of 6º53 N Latitude and 6º27 N Longitude. The climate of the study area is of the equatorial type of transition with two rainy seasons (from march to july and from september to november) which alternate with two dry seasons (from december to february and in august). The average annual rainfall is 1500 mm and an average annual temperature of 26°C. Its vegetation consists of forest islands and farms.

2.2. Equipment

Plant material is composed of woody species from plantations and Loranthaceae. The technical material includes a geographic positioning device (GPS), a digital camera, a pair of binoculars, a survey sheet and a plastic cover.

2.3. Methods

Surveys were carried out in 25 plantations in periurban areas of Daloa aged 15 to 35 years. These plantations were chosen at random and visited after exchange with the peasants who owned the fields. It consisted of recording, using a leaflet in each plantation visited, the name of the parasite species encountered, the number of clumps per parasite, their different phenophases (flowering, fruiting and vegetative growth), their ecological habitat, position on host and damage to parasitized plants. In the plantations, direct observations were made two to three times per month from may 2017 to april 2018, using an experimental system consisting of plastic cover placed underneath some clumps of randomly listed parasitic species (Amon, 2014). In total, two (2) devices per parasite species and by plantations were laid. This process allowed to collect and to determine from the fall or not of the flowers and the fruits of the clumps of the data, the phenological stages of each species of Loranthaceae met in the plantations prospected.

III. RESULTS AND DISCUSSION

3.1. RESULTS

3.1.1. Inventory of Loranthaceae species from peri-urban plantations in Daloa

Three (3) species of Loranthaceae were identified on all the plantations surveyed. They are *Phragmanthera capitata* (Spreng.) Ballé (Fig. 2), a species recognizable by its opposite or sub-opposite leaves with a petiole, shaggy at first, then glabrous, is canaliculate. The inflorescence is an axillary umbel of 3 to 4 flowers. The corolla 3.5 cm long at 6.5 cm is yellow with a reddish tip. *Tapinanthus bangwensis* (Engl. And K. Krause) Dancing (Fig. 3), a shrub with twigs up to 75 cm long. This plant has leaves are simple whole or wavy, oval elliptical, glabrous and shortly petiolate, sub-opposite or whorled. The inflorescence is an umbel. The corolla is red, streaked, darker towards the summit. The fruits are berries of red color when ripe. With regard to *T. sessilifolius* (P. Beauv.) Van Tiegh. (Fig. 4) is an entirely hairless plant with branches up to 40 cm long. Its leaves are opposite and subopposite, sessile or subsessile. It has 4 to 8 reddish flowers, grouped into axillary umbels, solitary then fasciculate.

Fig. 2: Flowering branch of Phragmanthera capitata

Fig. 3: Flowering twig of Tapinanthus bangwensis

Fig. 4: Fruiting branches of *T. sessifilolius*

3.1.2. Phenology of Loranthaceae species encountered

The phenological stages (vegetative

growth, flowering and fruiting) of Loranthaceae species identified in the prospected plantations are observed and determined (Table 1). The phenophases of the three parasite species observed are not independent of each other. They overlap during the year in the plantations visited. *Tapinanthus bangwensis* begins its fruiting phase from mid-november to mid-February in periurban plantations. It marks a 2nd phase of fruiting between may and mid-June. Regarding the vegetative growth phase of this species, it occurs between mid-february and march, and from mid-June to mid-august. Its flowering phase is observed in april, then from mid-august to mid-november. At *Tapinanthus sessilifolius*, the fruiting phase takes place between december and february, and from June to mid-July in periurban plantations surveyed. Then from mid-August to mid-november. At *Tapinanthus sessilifolius*, the fruiting phase takes place between december and february, and from June to mid-july in periurban plantations surveyed. The vegetative growth phase of this plant is observed from mid-July to August, then in march. It performs its flowering phase between september and november, and from april to may. As for *Phragmanthera capitata*, its fructification phases are only observed between mid-november and february, then in may. It begins its vegetative growth phase between june and august and ends in march. The flowering phase this plant usually takes place between september to mid-november, then in april in the suburban plantations visited.

3.1.3. Distribution and ecological habitat of pests in plantations

Figure 5 shows that the three species of Loranthaceae inventoried are variously distributed over all plantations periurban areas prospected. *Tapinanthus bangwensis* is observed in 25 prospected periurban plantations, either 100% presence. This species recorded the highest average number of tufts (11,404 tufts) on the host 76,14% of the total tufts.

Table 1. Phenological stages of Loranthaceae species identified in plantations

Parasitic species	Month											
	J	F	Ms	A	Mi	Jn	Jt	At	S	O	N	D
Tapinanthus bangwensis												
Tapinanthus sessilifolius												
Phragmanthera capitata												

Vegetative growth Flowering Fructification

It is heliophilus and usually attaches around the crown of its hosts (Table 2). As for *Phragmantera capitata*, it is only found in 11 of the 25 plantations surveyed (44%). It is moderately distributed (2,468 tufts), or 16.48% of the total recorded tufts, unlike *T. sessilifolius* (1,106 tufts), which is very poorly distributed over all the plantations surveyed (Fig. 5). This parasitic plant is observed only in 7 plantations (28 %). *Phragmantera capitata* is present in several humid and ventilated locations of the prospected plantations. This species is helio- sciaphile unlike *T. sessilifolius* which is heliophilus and inhabits aerated media (Table 2).

Indeed, it is fixed both outside and inside the crown of its guests encountered.

3.1.4. Damage to guests in plantations in periurban areas of Daloa

In this study, a number of Loranthaceae related damages were observed on woody host plants in the periurban areas of Daloa. Five major damage was observed. These are: totally invading the hosts by the

parasites (12.3 %) Fig. 6A, the defoliation or complete defoliation of branches of the host subjects (45b%), the desiccation of the parasitized branches (32.7%) Fig. 6B, bulge formation at the point of insertion of the parasite, often with gaping cavities sometimes serving as ants ant (9%) Fig. 6C,

and death of the infested subject (1%), Fig. 6D. Of all the damage recorded, the complete defoliating of twigs of parasitized individuals and the drying up of the parasitized branches were the most commonly observed damages on all plantations in periurban areas surveyed.

3.1.5. Fight against Loranthaceae

The control method (25% of responses) used against the Loranthaceae by farmers encountered on plantations is still traditional and not very constant. Indeed, some of them admit to practice a few times the method of mechanical control (9% of responses).

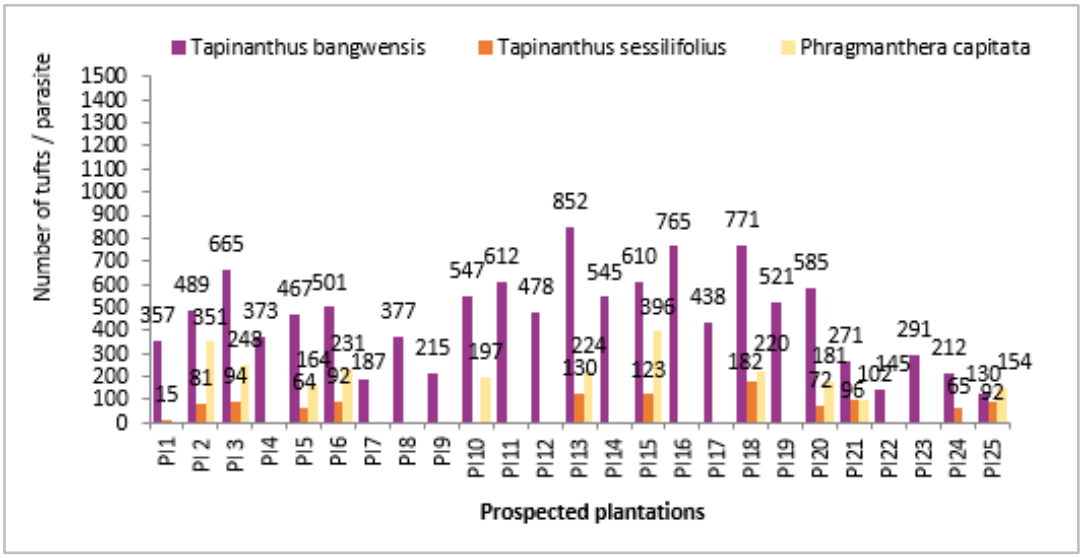

Fig. 5. Distribution of Loranthaceae species in prospected periurban plantations

Fig. 6. Loranthaceae attack damage: total invasion (A), dehydration of infested branches (B), formation of anthill (C) and death of a host subject (D)

Table 2. Habitat and ecological position of Loranthaceae species encountered

Parasitic species	***Characteristics***
Phragmanthera capitata	*Present in many wet and aerated places (Helio-sciaphile), lives both outside and inside the crown of the host.*
Tapinanthus bangwensis	*Heliophilus, present in many stations, lives especially around the crown of its hosts*
T. sessilifolius	*Heliophilus, inhabits aerated biotopes and usually develops from the crown of parasitized subjects.*

3.2. DISCUSSION

3.2.1. Phenology of Loranthaceae species

Observations of the phenology of the different species of Loranthaceae made show dependence on each other. They overlap and vary little from one species to another. Concurrently, flowers and fruits of different stages of growth are found in the clumps of the Loranthaceae. This situation, which is not new, has already been reported

by Soro (2010). According to Boussim *et al*.

(1993b), only late, early or prolonged flowering of parasite species during the year could explain this condition. Also, for these authors, the knowledge of the vegetative phases of parasitic plants better explains the abundance and distribution of this plant biodiversity in all the tropical zones of Africa.

3.2.2. Distribution of Loranthaceae species in plantations

The botanical inventory of parasitic plants made it possible to inventory three species of Loranthaceae in plantations in peri-urban areas of Daloa. *Tapinanthus bangwensis* is abundant and more distributed with 100 % presence in the plantations surveyed. It is followed by *Phragmanthera capitata* (44 % presence). These results reflect the health profile of plantations in the periurban areas of Daloa strongly dominated by *Tapinanthus bangwensis* and *Phragmanthera capitata*. In Côte d'Ivoire, there are no woody species that are not parasitized by this species (Amon, 2006). Traoré and Da (1996), Soro *et al*. (2004b) Soro (2006) revealed a predominance of *Tapinanthus bangwensis* in Shea and Neré plantations in the north of the country. In other African countries, Boussim *et al*. (1993b) in Burkina Faso and Ahamide *et al*. (2015) in Benin report a predominance of the species *Tapinanthus bangwensis* respectively on shea and colatier. The predominance of this plant in periurban plantations is worrying, given the enormous damage that the genus *Tapinanthus* causes to shea in Africa (Boussim *et al*., 1993b). Indeed, according to Salle (2004), the damage of the genus *Tapinanthus* on trees in the Sahelian zone, would have a more destructive impact than the famous desert locusts, because it can even lead to the death of the parasitized subjects.

3.2.3. Damage to guests encountered

Several damages such as completely invade the host, the defoliation or complete defoliation of branches, the drying of the branches, formations of beads at the point of insertion of the parasite, presence of gaping cavities in the beads serving as anthills and death of the Infested subject are observed in plantations in Daloa during the study. The same damage, the complete defoliating of branches, the drying out of the branches, damages very often cause the slowing down of parasitized plants and in the long term, the death of certain parasitized plants (Houenon *et al*., 2012). Deformations or bulge formations at the point of attachment of the parasite on the host were observed. These observations are confirmed by Aké-Assi (1984) who reported that these disturbances are the consequence of the host's reaction to the penetration of the haustorium of the parasite into the tissues.

IV. CONCLUSION

Periurban plantations are parasitized by two parasitic species of the family Loranthaceae. The presence of these two species in all the plantations surveyed of the study sites constitutes a threat to consider considering the damage they cause on the infested subjects. Also, the present study could bring real information on the phenology of each identified pest species, as well as the damage due to their attacks. Knowledge of the phenological stages of plant pests may allow the development of a targeted and effective control program at appropriate times.

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REFERENCES

[1] Innocent, D.Y., Ahamide, Monique, G., Tossou, Aristide, C., Adomou. Janvier, G., Houenon, Hounnankpon Yedomonhan et Akpovi Akoegninou, (2015). Diversité, impact et usage des Loranthaceae parasites de *Cola nitida* (Vent.) Schott. & Endl. Au Sud-Benin.*International Journal of Biological and Chemical Sciences*. 9 (6): 2859-2870

[2] Aké-Assi, L. (1984). Flore de Côte d'Ivoire: Étude descriptive et biogéographique avec quelques notes ethnobotaniques. Thèse de Doctorat, Université d'Abidjan, 1206p.

[3] Amon, ADE. (2006). Les plantes vasculaires parasites de la famille des Loranthaceae rencontrées dans le département de Grand-Bassam, au Sud de la Côte d'Ivoire. Mémoire de D.E.A. de Botanique, Université de Cocody, U.F.R. Biosciences Abidjan, Côte d'Ivoire, 57p.

[4] Amon, A.D.E. (2014). Les Loranthaceae (guis), hémiparasites vasculaires des arbres et des arbustes des agroécosystèmes de la région du Sud-Comoé, en zone de forêt dense sempervirente de la Côte d'Ivoire. Mémoire de Thèse de l'Université Félix Houphouët-Boigny, option Agroforesterie : 213p.

[5] Boussim, I.J., Sallé G., et Guinkio, S. (1993b). *Tapinanthus* du karité au Burkina Faso, 2ème partie: Phénologie, biologie et dégâts. *Bois et Forêt des Tropiques*, 238: 53-65.

[6] Houenon (1998). Premier rapport sur la connaissance des Loranthaceae en République du Bénin. Identification, distribution et dégâts, Cotonou. Document de IITA Benin, 13 p.
[7] Houenon, G.J, Yedomonhan, H., Adomou A.C., Tossou G.M., Akoegninou A., et Traoré (2012). Diversité Spécifique des Loranthaceae Parasites des Agrumes et Leurs Impacts Sur la Production Agrumicole au Sud du Bénin. *European Journal of Scientific Research*: 527-538.
[8] Salle, G., et Aber M. (1986). Les phanérogames parasites: biologie et stratégies de lutte. Revue de Cytologie et Biologie Végétales. France, Lettre botanique 3: 235-263.
[9] Salle, G. (2004). Les plantes parasites, 14p. http://www.futurasciences.com/magazines/botanique plantes parasites [Consulté le 4/11/2019]
[10] Soro, D., N'Da, Soro D., Ouattara D., P.K., Da et D., Traoré (2004b). Efficacité de l'émondage contre les Loranthaceae ou guis du karité : cas du parc naturel à karité de Tengrela dans le Nord de la Côte d'Ivoire. *Annales de Botanique de l'Afrique de l'Ouest* 3 : 87-95
[11] Soro D. (2006). Le karité, *Vitellaria paradoxa* Gaertn. f. (Sapotaceae). Variabilité de quelques caractères morphologiques, production en fruits et moyen de lutte par émondage contre les Loranthaceae parasites. Le cas du parc naturel à karité de Tengrela, Nord de la Côte d'Ivoire. Mém. de thèse, UFR Biosciences, Université de Cocody (Côte d'Ivoire), 142p.
[12] Soro, K. (2010). Les Loranthaceae (guis) des agroécosystèmes dans l'Ouest de la Côte d'Ivoire: flore, parasitisme et usages dans les Départements de Oumé, de Gagnoa et de Soubré. Mémoire de Thèse de l'Université de Cocody-Abidjan, option Agroforesterie : 183p.
[13] Traoré, D., et Da K. (1996). Lutte contre les plantes vasculaires parasites du karité et du néré dans le Nord de la Côte d'Ivoire. Cas des Départements de Korhogo, Boundiali, Ferkessédougou et Tengréla. Rapport annuel de PEP/A.I.S.A.CI., 97p.
[14] Traoré D., Da K.P. et Soro D. (2003). Lutte contre les plantes vasculaires parasites du karité, dans le Nord de la Côte d'Ivoire. Cas du parc naturel à karités de Tengrela, Universités de Cocody, U.F.R. Biosciences, Laboratoire de Botanique Rapport de P.E .P/A.I.S.A. CI., 116p.

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Relay-planting of Peanuts between Double or Triple Rows at different dates Increases Growth, Nitrogen content, and Yield of Red Rice under Aerobic Irrigation Systems

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Abstract— *Previous studies reported that intercropping rice with legume crops such as soybean, peanut and mungbean increased nutrient uptake and yield of rice plants. This study aimed to examine the effects of relay-planting peanuts between double or triple rows of rice at different dates on growth, nitrogen content, and yield of red rice in aerobic irrigation systems on raised beds. The experiment was conducted in Narmada (West Lombok, Indonesia), arranged according to Split Plot design with two treatment factors, i.e. rice row patterns as the main plots (P1= double, P2= triple rows) and relay-planting dates of peanut as the subplots (T0= without peanut; T1= relay-planting peanut 1 week, T2= 2 weeks, T3= 3 weeks after seeding pre-germinated red rice seeds). Results indicated that between the treatment factors, relay-planting peanut at different dates resulted in significant effects on more variables compared with the patterns of rice rows. However, there were significant interaction effects between the treatment factors on tiller and panicle numbers per clump, and higher panicle number supported by higher leaf N content and higher harvest index resulted in significantly higher grain yield of the red rice intercropped with peanuts, especially when peanut was relay-planted at three or two weeks after seeding the pre-germinated rice seeds on raised-beds in aerobic irrigation systems. Although there was no significant effect of row patterns, the highest grain yield average (75.96 g/clump) was on T3 treatment under triple-row and the lowest average (33.29 g/clump) was on T0 treatment under double-row pattern.*

Keywords— ***Peanuts, red rice, intercropping, aerobic irrigation systems, row patterns.***

I. INTRODUCTION

Rice (*Oryza sativa* L.) is grown in at least 114 countries of the world, and together with maize and wheat, these crops produce staple food, but rice becomes the most important among these three food crops with respect to human nutrition and caloric intake. In addition, rice is an extremely versatile crop, which can grow in various different environmental conditions, i.e. from dry to flooded condition, and from low to high altitudes [1]. However, rice is not just staple food. Rice has a lot of advantages for human health because rice contains various biomolecules capable of health-promotion and therapeutic activity, especially the colored grain rice [2].

Rice has been traditionally grown under flooded conditions (conventional technique), and this has been practiced for a long time due to some advantages, such as weed suppression and ease of plowing. However, this conventional technique of growing rice is highly inefficient in using irrigation water [1]. In addition, growing rice under flooded condition makes rice as the most inefficient use of nutrients, especially N, because flooded conditions increase N losses through leaching, denitrification, and volatilization, while grain yield is low under conventional techniques with a world average of 5 ton/ha [3]. The majority of the N loss from Urea applied was through ammonia volatilization, which reached up to 88% of the total N loss [4]. In addition, conventional technique of rice production is also a source of P leaching, which causes pollution of the downstream areas [5].

There have been some non-conventional techniques developed elsewhere. One of which is the system of rice intensification (SRI), which applied intermittent irrigation

water during vegetative growth stages and thin flooding during the reproductive stages of rice growth. From the results of practicing the SRI technique in Madagascar, where this technique was initially developed, it was reported that the maximum rice yield was up to 21 ton/ha with a maximum average of 13.9 ton/ha, while under conventional technique on comparable land, rice yield ranged from only 1.5 to 3.6 ton/ha [6].

Another non-conventional technique of growing rice recently developed is aerobic rice system (ARS), in which rice is grown on non-flooded, non-saturated and non-puddled soil conditions [7], [8]. One of the advantages of growing rice under aerobic irrigation system is aerobic conditions of the soil. Since the soil is not flooded, then it is possible to grow rice in intercropping with legume crops for better nitrogen nutrition. Chu et al. [9] reported that under rice-peanut intercropping, there was significant N transfer from peanut to rice plants. Wangiyana et al. [10] also reported that inoculation of arbuscular mycorrhizal fungi (AMF) on rice plants grown together in pot culture with peanut significantly increased grain yield of red rice under aerobic irrigation systems.

This study aimed to examine the effects of relay planting peanut at different dates between double or triple rows of red rice on growth, leaf nitrogen content, and yield of a promising line of red rice grown on raised-beds under aerobic irrigation systems.

II. MATERIALS AND METHODS

The field experiment in this study was conducted on paddy field in the Experimental Farm of the Faculty of Agriculture, University of Mataram, located in Narmada (Lombok, Indonesia) from June to October 2016. The experiment was arranged according to Split Plot design, testing two treatment factors, namely: the patterns of rice rows (P) as the main plots (P1= double row, P2= triple row), and intercropping (T) with peanut plants relay-planted between the double or triple rows of rice plants at various ages of the rice plants on the raised-beds (T0 = without intercropping, T1= relay planting peanut 1, T2= 2, T3=3 weeks after planting (WAP) pre-germinated rice seeds) as the subplots. Each treatment combination was made on three blocks. The details of the treatments and the implementation of the experiment ware as described in Farida et al. [11].

The observation variables include plant height, leaf number and tiller number at 12 WAP, panicle number, total N concentration in the rice leaves, dry straw weight and grain yield per clump, weight of 100 grains, and harvest index. For leaf N content, oven-dried samples of rice leaves taken during anthesis were sent to the Analytical Laboratory of Mataram University for quantification of total N content. Harvest index was calculated from percentage of grain yield of the total harvested above-ground rice plant biomass including the grains, after being dried. Data were analyzed with analysis of variance (ANOVA) and Tukey's HSD at 5% level of significance, using the statistical software CoStat for Windows ver. 6.303.

III. RESULTS AND DISCUSSION

The summary of ANOVA results in Table 1 shows that between the two treatment factors tested, relay-planting or additive intercropping with peanuts shows significant effects on more variables, especially on grain yield per clump, compared with row patterns of the rice plants. However, there were significant interaction effects between relay-planting of peanut at different dates and row patterns of rice plants on tiller number per clump (Figure 1), and panicle number per clump of the red rice (Figure 2).

In addition to significant interaction effects, relay-planting of peanut and row patterns of rice plants also show significant main effects both on tiller number and panicle number, as it can be seen from Table 1, that relay-planting peanuts at two or three weeks after seeding the pre-germinated red rice seeds significantly increased tiller and panicle number per clump. However, there were interaction effects between the two treatment factors, as can be seen from Figure 1 for tiller number and Figure 2 for panicle number.

It can be seen from Figure 1 that the highest tiller number per clump of red rice plants grown under triple-row pattern was on the red rice plants intercropped with peanut relay-planted at two weeks after seeding the pre-germinated rice seeds, while under double-row pattern, the highest tiller number was on the red rice plants intercropped with peanut relay-planted at three weeks after seeding the pre-germinated rice seeds. The trend was also very similar on panicle number per clump, as can be seen from Figure 2.

This means that the peak N contribution of relay-planting peanut plants on highest tiller number per clump will be achieved when pre-germinated seeds of peanuts were relay-planted between two and three weeks after seeding the pre-germinated red rice seeds. According to the results reported by Chu et al. [9], the highest contribution of N transferred from peanut to rice was up to

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11.9% of the rice N, and they relay-planted peanut seeds at four weeks after seeding rice.

Table.1: Summary of ANOVA results of the effects of intercropping with peanut and row patterns of red rice on growth, nitrogen content, and yield components of red rice on raised-beds under aerobic irrigation systems

Treatments:	Plant height 12 WAP (cm)	Leaf number 12 WAP	Tiller number 12 WAP	Panicle number per clump	Leaf total N concentra-tion (%)	Dry straw weight (g/clump)	Weight of 100 grains (g)	Grain yield (g/clump)	Harvest index (%)
Intercropping:									
T0: monocrop	112.50 a	55.17 b	17.50 c	16.17 c	2.67 b	60.04 b	2.45 a	33.98 c	35.99 b[1)]
T1: 1 week	107.50 a	60.43 ab	24.17 b	23.33 b	2.72 b	80.00 a	2.44 a	57.89 b	41.94 a
T2: 2 weeks	113.83 a	61.83 a	27.17 a	25.83 a	2.82 ab	90.11 a	2.57 a	69.14 a	43.56 a
T3: 3 weeks	114.00 a	65.67 a	28.33 a	26.67 a	2.93 a	90.34 a	2.41 a	70.80 a	43.90 a
HSD 5%	ns	6.59	2.56	2.08	0.15	15.28	ns	7.92	5.40
Row patterns:									
P1:double-row	110.08 a	56.42 a	22.92 b	21.67 b	2.78 a	78.74 a	2.48 a	55.89 a	40.84 a
P2:triple-row	113.83 a	65.13 a	25.67 a	24.33 a	2.89 a	81.51 a	2.46 a	60.02 a	41.86 a
HSD 5%	ns	ns	2.48	2.59	ns	ns	ns	ns	ns
Interactions	ns	ns	s	s	ns	ns	ns	ns	ns

[1)] Mean in each column with same letters indicates non-significant differences between levels of a treatment factor
Note on ANOVA results: ns = non-significant; s = significant (*p-value* < 0.05)

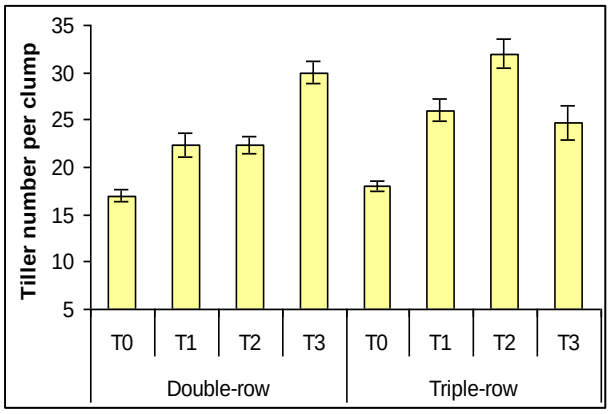

Fig.1: Interaction effects of the treatments on tiller number per clump

In relation to leaf total N content of the red rice plants, although there was no interaction effect of the treatment factor, it can be seen from Table 1 that the highest concentration of N in the rice leaves was on the red rice plants intercropped with peanuts relay-planted at three weeks after seeding the pre-germinated red rice seeds, and leaf N concentration was not significantly different between the patterns of rice rows. These averages of leaf total-N contents were in good correlation with average grain yield per clump with an R^2 = 64.11% (p-value = 0.055). In addition, panicle number per clump also highly correlated with average grain yield per clump, with an R^2 = 98.11% (p-value < 0.001).

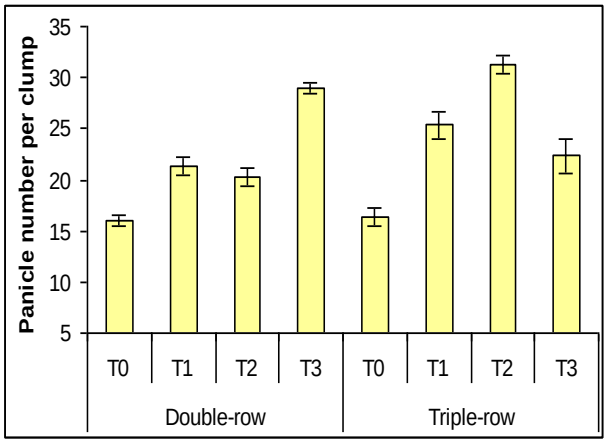

Fig.2: Interaction effects of the treatments on panicle number per clump

With higher averages of panicle number of the red rice plants in the T3 and T2 treatments compared with those in the T1 and T0 treatments supported with higher content of total N in the leaves, these will ensure the seed-filling process to run well to produce higher averages of grain yield under T3 and T2 treatments compared with under T1 and T0 treatments (Table 1). According to results reported by Sinclair and de Wit [12], seed plants require sufficient concentration of leaf N during seed-filling stage for sufficiently high photosynthetic rates during the seed-filling stages, otherwise the plants will remobilize their leaf N to the growing seeds resulting in acceleration of leaf senescence, especially in legume crops, such as soybean, due to the high N requirement of legume crops for the seed protein content.

Although there was no significant interaction effect between the treatment factors on grain yield of the red rice in this study, it can be seen from Figure 3 that the highest average of grain yield was different between different patterns of rice rows. Under double-row pattern, the highest average of grain yield was in the red rice plants intercropped with peanut relay-planted at two weeks after seeding rice (T2), and under relay-planting peanut at three weeks after seeding rice (T3), average grain yield was lower in T3 than in T2. In the double-row pattern, the row distance between the double-rows was 30 cm while in the triple-row pattern it was 35 cm. It was highly possible that peanut plants whose seeds were relay-planted three weeks after seeding rice was more quickly shaded by the higher rice plants in the double-row pattern at three weeks after rice seeding compared with those on the double-row pattern at two weeks after seeding rice. Therefore, peanut growth in the double-row pattern of rice plants was possibly better when relay-planted at two weeks after seeding rice compared with relay-planting at three weeks after rice seeding, so that N contribution to rice could be higher from the peanut plants relay-planted two weeks compared with three weeks after seeding rice. In contrast, in triple-row pattern, the space between triple-rows, where peanut plants were relay-planted was wider than in double-row pattern, so that relay planting peanut three weeks after seeding rice could contribute more N due to closer timing of maximum N-fixation rates and highest N requirement of the red rice plants. Chu et al. [9] conducted relay-planting of peanut seeds at four weeks after seeding rice seeds in an intercropping system.

In relation to harvest index, it can be seen from Table 1 that intercropping the red rice plants with peanut resulted in significantly higher harvest index compared with monocropped red rice plants. This could mean that higher harvest indices in the red rice plants under T3 and T2 compared with under T1 or T0 was most probably due to higher leaf N content of the red rice plants under T3 and T2 compared with under T1 and T0. As has been reported by Sinclair and de Wit [12], sufficiently higher leaf N content is required to ensure sufficiently high rate of photosynthesis during the grain-filling stages. If leaf N content is very low then the photosynthetic rates during the seed-filling stage will be insufficient for the growing seeds even though the average panicle number per clump is high, and this will result in lower harvest index compared in the rice plants containing sufficient leaf N.

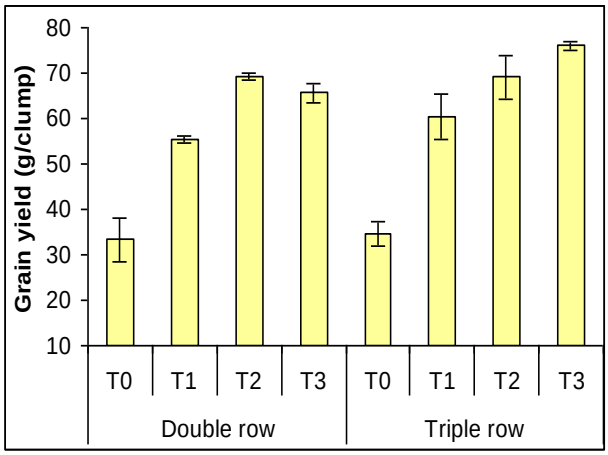

Fig.3: Average (Mean ± SE) grain yield (g/clump) of red rice as affected by relay-planting peanut at different dates between double and triple rows of rice

According to the results reported by Inal et al. [13], intercropping maize with peanut increased the availability of the nutrients in the rhizosphere of the intercropped plants compared with its monocrop, and this makes nutrient contents in the plants grown under intercropping system compared with under monocropping system. Therefore, it is clear why the red rice plants intercropped with peanut relay-planted at one, two or three weeks after seeding pre-germinated seeds of the red rice, which was probably due to the higher N contents of the red rice plants intercropped with peanut, especially when peanut was relay planted three weeks after seeding rice. Arifuddin et al. [14] also reported that relay-planting legume crops, including peanut of Hypoma-3 variety, mungbean of Kenari variety, and soybean of Dering-1 variety, at three weeks after seeding red rice seeds was found to result in the highest tiller number, panicle number, filled grain number, and grain yield per clump of red rice plants grown together with those legume crops in pot culture under aerobic irrigation systems.

IV. CONCLUSION

It can be concluded that intercropping red rice plants with peanuts significantly increased grain yield of the red rice plants due to higher panicle number per clump supported by higher leaf N contents and higher harvest index of the rice plants intercropped with peanut, especially when peanut was relay-planted at three or two weeks after seeding the pre-germinated seeds of the red rice.

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REFERENCES

[1] Datta, A., Ullah, A., and Ferdous, Z. 2017. Water Management in Rice. **In:** B.S. Chauhan et al. (eds.), *Rice Production Worldwide*. Springer International Publishing AG, Cham, Switzerland, pp. 255-277.

[2] Sen, S., Chakraborty, R., and Kalita, P. 2020. Rice - not just a staple food: A comprehensive review on its phytochemicals and therapeutic potential. *Trends in Food Science & Technology*, 7: 265-285.

[3] Singh, B., and Singh, V.K. 2017. Fertilizer Management in Rice. **In:** B.S. Chauhan et al. (eds.), *Rice Production Worldwide*. Springer International Publishing AG, Cham, Switzerland, pp. 217-253.

[4] De Datta, S.K., Buresh, R.J., Samson, M.I., Obcemea, W.N., and Real, J.G. 1991. Direct Measurement of Ammonia and Denitrification Fluxes from Urea Applied to Rice. *Soil Sci. Soc. Am. J.*, 55: 543-548.

[5] Peng, S.Z., Yang, S.H., Xu, J.Z., Luo, Y.F., and Hou, H.J. 2011. Nitrogen and phosphorus leaching losses from paddy fields with different water and nitrogen managements. *Paddy and Water Environ*., 9: 333–342.

[6] Uphoff, N. 2003. Higher Yields with Fewer External Inputs? The System of Rice Intensification and Potential Contributions to Agricultural Sustainability. *International Journal of Agricultural Sustainability*, 1(1): 38-50.

[7] Bouman, B.A.M. 2001. Water efficient management strategies in rice production. *International Rice Research Notes*, 26(2): 17–22.

[8] Prasad, R. 2011. Aerobic Rice Systems. *Advances in Agronomy*, 111: 207-247.

[9] Chu, G.X., Shen, Q.R., and Cao, J.L. 2004. Nitrogen fixation and N transfer from peanut to rice cultivated in aerobic soil in an intercropping system and its effect on soil N fertility. *Plant and Soil*, 263: 17-27.

[10] Wangiyana, W., Aryana, I.G.P.M., Gunartha, I.G.E. and Dulur, N.W.D. 2017. Effects of Inoculation with Arbuscular Mycorrhizal Fungi on Growth and Yield of Promising Line of Red Rice Grown together with Several Peanut Varieties. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, Vol. 10 Issue 9 Ver. II: 18-23.

[11] Farida, N., Abdurrachman, H., Budianto, V.F.A., and Wangiyana, W. 2016. Growth Performance of Red Rice as Affected by Insertion of Peanut Row between Double and Triple-Rows of Rice in Aerobic System on Raised-Beds. *Proceedings of the First International Conference on Sciences and Technology, 1-2 December, 2016, Mataram, Lombok-NTB, Indonesia.* pp. 191-196. http://lppm.unram.ac.id/wp-content/uploads/2019/03/16.-PROSIDING-FIRST-ICST-TAHUN-2016-Lengkap.pdf.

[12] Sinclair, T.R., and de Wit, C.T. 1975. Photosynthate and nitrogen requirements for seed production by various crops. *Science*, 189: 565-567.

[13] Inal, A., Gunes, A., Zhang, F., and Cakmak, I. 2007. Peanut/maize intercropping induced changes in rhizosphere and nutrient concentrations in shoots. *Plant Physiology and Biochemistry*, 45: 350-356.

[14] Arifuddin, Wangiyana, W., and Aryana, I.G.P.M. 2019. Effect of Relay-Planting Several Legume Species at Various Ages of Rice on Growth and Yield of Red Rice Grown Together with Legume Crops under Aerobic Irrigation System. *International Journal of Environment, Agriculture and Biotechnology*, 4(6): 1704-1710.

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Effect of Arbuscular Mycorrhizal inoculation on Biomass, Nutrient Uptake, Root Infectivity and Soil Colonization of Papaya (*Carica papaya* L.) Seedlings

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Abstract— *The effect of Arbuscular mycorrhiza (AM) fungi on biomass accumulation, nutrient uptake, mycorrhizal root infectivity and soil colonization was determined in Papaya (Carica papaya) seedlings raised under four phosphorus regimes in sand culture and also in 1:1 sand/soil media under sterile and unsterile conditions. Inoculation with AM fungi increased the plant height, leaf number, and stem girth in relation to un-inoculated seedlings grown under equivalent P concentrations. An increase in plant height, leaf number and stem girth also occurred in both inoculated sterile and un-sterile 1:1 sand/soil media in relation to un-inoculated sterile and unsterile media. Arbuscular mycorrhiza also increased the leaf area and the root, leaf and stem fresh and dry weights and also caused an increase in the uptake of phosphorus and potassium in the leaf tissues. It also favoured mycorrhizal infectivity of roots, soil mycorrhizal spore colonization and increased the root absorptive surface area. This study indicates that AM fungi improves the capacity of papaya seedlings to absorb and utilize plant nutrients possibly by increasing the effective root surface area from which available form of nutrients are absorbed and also by increasing access of roots by bridging the depletion zones. As a low cost technology, arbuscular mycorrhizal inoculation is recommended as part of the regular practise into nursery media used for papaya seedling propagation.*

Keywords— ***passion fruit, papaya, phosphorus, potassium.***

I. INTRODUCTION

A major problem that faces fruit as well as other agricultural sectors in many tropical countries is the gradual and adverse change in the soil biological, physical and chemical characteristics. Major soil factors that constraint crop production include soil moisture stress, low nutrient capital, soil erosion and degradation, low pH with aluminum toxicity, high phosphorus fixation, low levels of organic matter and loss of soil biodiversity (Cardoso and Kuyper, 2006). Other adverse changes that have occurred include increased natural resource degradation and a build-up of harmful microbes and pests paralleled by a reduction of beneficial soil organisms. Land degradation and soil fertility depletion are considered the major threats to food security and natural resource conservation in sub-Saharan Africa (Cardoso and Kuyper, 2006, Chebet et al., 2020).

Under tropical conditions, AM fungi could be highly beneficial to perennial crops, which require nursery production before transplanting to the field. However, although arbuscular mycorrhiza associations, and their fungal propagules (spores, mycelium and infected roots) are widespread in the tropics (Sieverding, 1991), propagules can be lost or their species changed through site disturbance, inhibiting the renewal of vegetation cover, or changing its composition (Mason and Wilson, 1994). In fruit orchards in Kenya, the AM fungal spores and the mycorrhizal infection of fruit tree roots are low (Wamocho, 1998). Likewise, naturally occurring mycorrhiza formation in fruit/tree

nurseries are sparse, even in unsterilized soils, leading to poorly mycorrhizal or potentially-poorly performing seedlings being transplanted (Michelson, 1992).

Mycorrhizal spores can be found in a wide diversity of habitats in the tropics. For example, studies in Lake Victoria basin in Kenya showed significant differences in richness and relative abundance of indigenous arbuscular mycorrhizal fungi. Undisturbed soils (Lambwe Valley) had the highest total spore count (12.59 per gram root dry weight) while farmed areas (represented by Kibos) had the lowest (4.23 per gram root dry weight) (Othira *et al*. 2014). *Glomus* was the dominant AMF in all soils (49.74%) followed by *Scutellospora* (29.60%) and *Gigaspora* (15.80%) (Othira *et al*. 2014). Lambwe soils also showed a higher degree of AMF diversity (H = 1.21) while Njoro had the least diversity (H = 1.08) (Othira *et al*. 2014).

In Haryana Agricultural University Hisar, India (longitude of 75° 46' E), the number of spores per 50 grams of soil ranged from 0 to 925 in spring-summer season crops and 25 to 1150 in winter season crops (Bansal *et al.*, 2012). Maximum AM fungi spores were found in the rhizospheric soil of sorghum with 925 spores per 50 gram of soil and minimum in cotton with 25 spores per 50 gram of soil, while no spores were found in pigeon pea and urdbean field soils (Bansal *et al.*, 2012).

Limited research have been undertaken on the role of AM fungi on the growth, nutrient uptake and root infectivity of tropical fruit species, unlike in temperate fruit species. To meet this objective, this experiment was undertaken to determine the role of AM fungi in papaya (*Carica papaya* var Mountain) in Kenya.

II. MATERIALS AND METHODS

Treatments and experimental design

Papaya seeds were germinated in sterile sand and uniform seedlings selected and transplanted to polythene pots (20 cm in diameter and 25 cm depth) in a polyethylene-covered greenhouse. An experiment was also laid out in low nutrient soil and sand media (1:1 vol/vol) as a 2 x 2 factorial design consisting of 2 kinds of AM inoculation (AM inoculated and un-inoculated) and 2 media conditions (sterile and non-sterile) with 6 replicates per treatment. The AM inoculum contained approximately 200 spores of a mixture of *Glomus caledonium, G. etunicatum, Gigaspora magarita* and *Scutellospora sp* (Plantworks Inc., UK). To ensure uniformity, similar quantities of autoclaved inoculum were added to the non-mycorrhizal pots.

Plant growth measurements

Weekly measurements were taken on plant height, leaf number and stem girth, starting two weeks after inoculation.

Biomass and nutrient analysis

At seedling harvest, measurements were taken on leaf area and leaf, stem and root fresh and dry weights. Oven-dried shoots were then ground and 1 gram from each seedling weighed and dry-ashed by heating for 5 hours at 550ºC in a muffle furnace. The ash was taken up in 20% HCl and the solution made up to 20 mls with distilled water. Two hundred microliter aliquots from these solutions were further distilled to 10 mls before analyzing for Ca, Mg and K by atomic absorption spectrophotometry. Phosphorus, as molybdate-reactive P was measured by blue colorimetry at 730 nm using a spectrophotometer.

Evaluation of root infection levels

At seedling harvest, root tips (1 ± 0.2 cm) were excised and cleared by autoclaving in 10% KOH followed by staining in 0.05% tryphan blue, glycerol and lactic acid (1:1:1) solution. The frequency of mycorrhizal infection was noted per field (10 grids) for 10 fields, using the grid intersect method (Giovannetti and Mosse, 1980). To convert the data into percent infection, the frequency of infection as a fraction of the total number of grids observed was multiplied by 100 (Wamocho, 1998).

Statistical analysis

The data obtained was subjected to ANOVA, using Genstat software. All treatment means were tested for LSD and the means separated by Duncan's multiple range test (Little and Hills, 1978).

III. RESULTS

Plant Height

Arbuscular mycorrhizal papaya seedlings had higher plant height than non-mycorrhizal seedlings in both sterilized and unsterilized media. There was no significant difference in plant height between the mycorrhizal treatments, whether in sterilized or un-sterilized media. Non-mycorrhizal seedlings raised in sterilized media had significantly higher plant height than non-mycorrhizal seedlings raised in unsterilized media in papaya and lemon seedlings (Figure 1.0).

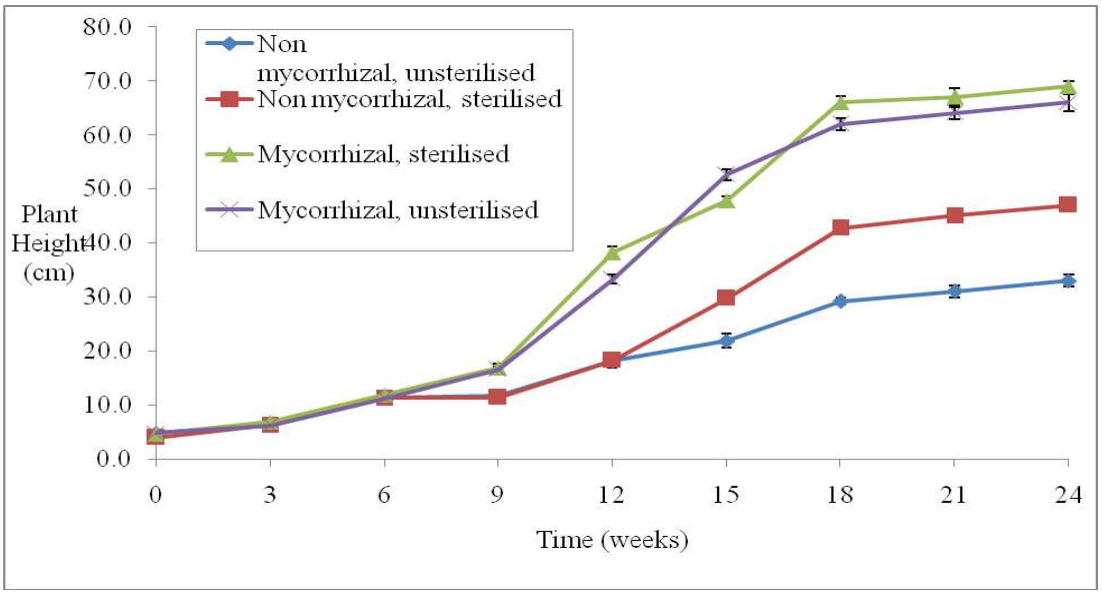

Fig.1: Effect of arbuscular mycorrhiza fungi and media condition on plant height (cm) of papaya (Carica papaya var mountain) seedlings

Biomass measures

Mycorrhizal papaya seedlings raised in both sterilized and unsterilized media had significantly higher stem and root fresh weight, root dry weight and leaf area than non-mycorrhizal plants under both sterilized and unsterilized media. There was no significant difference between all papaya treatments in leaf number, leaf fresh and dry weight and stem dry weight (Table 4.13). There was no significant difference in all parameters between mycorrhizal plants raised in either sterilized or unsterilized media. Non mycorrhizal plants raised in sterilized media had significantly higher root fresh and dry weight and leaf area compared to non-mycorrhizal plants raised in unsterilized media (Table 1.0).

Table 1.0 Effect of arbuscular mycorrhiza fungi and media condition on the leaf number, fresh and dry weight and leaf area of papaya (Carica papaya var mountain) seedlings

Treatments	Leaf dry weight (g)			Dry Weight (g)				Leaf
	No.	Leaf	Stem	Root	Leaf	Stem	Root	Area (cm2)
Non mycorrhizal, unsterilised	7.8a	5.5a	7.3b	13.6c	1.2a	0.8a	4.2c	117.4c
Non mycorrhizal, sterilized	8a	5.6a	7.3b	15.4b	1.3a	0.8a	4.7b	160.3b
Mycorrhizal, unsterilised	7.6a	5.8a	7.9a	19.9a	1.2a	0.8a	6.2a	226.1a
Mycorrhizal, sterilised	7.8a	5.7a	8.2a	20.5a	1.3a	0.8a	6.0a	244.3a
LSD (p≤0.05)	0.5	0.4	0.5	1.4	0.2	0.2	0.4	34.8
CV (%)	10	14.4	9.7	11.5	10.8	14.4	7.8	9.1

[z]Column values followed by different letters are significantly different at p<0.05 (n=6)

Mycorrhizal Root Colonisation

Mycorrhizal seedlings had significantly higher root colonisation than non-mycorrhizalseedlings. There was no significant difference in % root colonisation between mycorrhizal seedlings held in both sterilized and non-sterilized media. Non-mycorrhizal plants held in unsterilized media had low mycorrhizal colonisation % while that held in sterilized media did not have any root colonisation (Table 2.0).

Table 2.0: Effect of arbuscular mycorrhizafungi and planting media on the mycorrhizal root colonisation (%) of papaya (Carica papaya var mountain) seedlings raised in sterilized and unsterilized media

Treatment	Infectivity (%)
Non Mycorrhizal, unsterilised media	8.7 ± 3.2
Non Mycorrhizal, sterilised media	0
Mycorrhizal, unsterilised media	43.2 ± 3.9
Mycorrhizal, sterilised media	45.3 ± 1.5

[z]Means ±SE (N=6)

Mycorrhiza Spore colonization

At the start of the experiment, sterilized media did not have any mycorrhizal spores while unsterilized media had a low spore count. At the end of the experiment period, mycorrhizal inoculation caused a significantly higher spore count in both sterilized and unsterilized media (Table 3.0).

Table 3.0: Effect of media sterilization on mycorrhiza spore number at the beginning and at the end of the experiment period

Treatments	Spores per 25 gram soil sample	
	Beginning	End
Mycorrhizal, sterilised media	0	676 ± 29
Mycorrhizal, unsterilised media	68 ± 8[z]	777 ± 36
Non Mycorrhizal, sterilised media	0	0
Non Mycorrhizal, unsterilised media	57 ± 17	158 ± 16

[z]Means ±SE (N=6)

Leaf Nutrient content

Mycorrhizal seedlings had significantly higher P and K% compared to non mycorrhizal seedlings. There was no significant difference in N, Ca and Mg% between all treatments (Table 4.0).

Table 4.0: Effect of arbuscular mycorrhiza fungi and planting media on the % leaf nutrient content of papaya seedlings

	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Non Mycorrhizal, unsterilised media	1.9±0.1[z]	0.2 ± 0.1	2.3 ± 0.1	1.9 ± 0.2	0.8 ± 0.1
Non Mycorrhizal, sterilised media	1.9±0.1	0.2 ± 0.1	2.2 ± 0.2	2.1 ± 0.1	0.9 ± 0.1
Mycorrhizal, unsterilised media	2.0±0.1	0.4 ± 0.1	2.9 ± 0.1	2.0 ± 0.2	0.9 ± 0.1
Mycorrhizal, sterilised media	2.0±0.1	0.4 ± 0.1	2.9 ± 0.2	2.1 ± 0.1	0.8 ± 0.1

[z]Means ±SE (N=6)

IV. DISCUSSION

Results from this study indicate that AM fungal inoculation improves growth of papaya seedlings. The improvement occurred through increase in plant height, leaf number and leaf area, increased biomass accumulation (fresh and dry weights) and improved nutrient uptake. Many researchers have also reported the benefits of arbuscular mycorrhiza on growth and biomass accumulation in plants. Mycorrhiza inoculation was found to increase the plant height, stem diameter and leaf number of sweet corn in USA (Tas, 2014). Similar observations were made by Al-Karaki (2013) in sour oranges and Suri and Choudhary (2013) in soybeans.

The improved performance of mycorrhizal seedlings can be attributed to improved efficiency of phosphorus uptake as evidenced by increased phosphorus accumulation in the leaves. In papaya study in India, leaf petiole of mycorrhizal plants recorded higher total phosphorus (0.42 – 0.63%) as compared to control (0.35%) plants (Kadhe and Rodrigues, 2009). A significant increase in shoot P concentration was also observed when *L. usitatissimum* was inoculated with *Glommus mosseae* or *G. intraradices* and their combination (Rydlová *et al*., 2011).

In this study, mycorrhizal seedlings had greater root mass compared to un-inoculated seedlings, as indicated by greater root fresh weight. Likewise, the extent of mycorrhizal root infection was significantly greater in inoculated seedlings than in un-inoculated seedlings. It is expected that this greater mass of mycorrhizal roots corresponded to greater absorptive surface area for nutrients and water.

In this study potassium uptake was increased in papaya seedlings. This is consistent with pawpaw study in India which showed that total potassium content of leaf petiole was higher in mycorrhizal plants and ranged from 2.68 - 4.39% as compared to non-mycorrhizal plants (2.26%) (Kadhe and Rodrigues 2009). Uptake of K was also increased by AMF inoculation in cowpea and sorghum (Bagayoko *et al*., 2000). This can be attributed to greater soil exploration and increasing supply to host roots. Further increased K levels in mycorrhizal plants may be attributed to the fact that AM fungi binding soil particles to each other and to the roots, which is beneficial for the nutrient uptake (Estrada-Luna *et al*., 2000).

In the study in sand: soil media, mycorrhizal plants did not differ significantly, in all measured parameters, whether in sterilized or unsterilized media. This indicates that mycorrhizal inoculation played a greater role in the observed plant performance than media sterilization. Un-inoculated seedlings in this study performed poorly in both sterilized and un-sterilized media. However, un-inoculated seedlings held in sterilized media performed better that those held in unsterilized media. This could be attributed to elimination of all organisms in the media by sterilization. This can be an advantage through elimination of harmful micro-organisms in the media and could have contributed to the improved performance of un-inoculated seedlings in sterilized media.

On the other hand, lack of media sterilization can be an advantage because beneficial micro-organisms are not eliminated. In the un-sterilized seedlings, a small percentage of mycorrhizal root infection was observed. This was expected to have proved beneficial by antagonizing against harmful microbes in the media as reported by Elsen *et al.*, (2003).

The presence of mycorrhizal infection in the roots of un-inoculated seedlings raised in un-sterilized media suggests the availability of AM fungi in native soils in the tropics. In this study, unsterilized media had a small quantity of mycorrhizal spores at the beginning of the experiment. This is an indication of the low level of mycorrhization of native soils in Kenya and explains why non mycorrhizal seedlings performed poorly This confirms the report by Wamocho (1998) that in fruit orchards in Kenya, AM fungal spores and the mycorrhizal infection of fruit tree roots are low. Likewise, evidence from a survey of 41 tree species in five nurseries in Ethiopia and Somalia suggest that naturally mycorrhizal formation, even in unsterilized soils can be sparse (Michelson, 1992).

REFERENCES

[1] Al-Karaki, G.N. 2013. The effect of arbuscular mycorrhizal fungi on the establishment of sour orange (*Citrus aurantium*) under different levels of phosphorus. VII. International symposium on mineral nutrition of fruit crops book series. *Acta Horticulturae*, *984*, 103-108.

[2] Bagayoko, M., George, E. Römheld, V. and Buerkert, A. (2000). Effects of mycorrhizae and phosphorus on growth and nutrient uptake of millet, cowpea and sorghum on a West African soil. Journal of Agricultural Science, 135: 399-407

[3] Bansal, M., Kukreja, K. and Dudeja, SS. 2012. Diversity of *Arbuscular mycorrhizal* fungi, prevalent in rhizosphere of different crops grown in the university farm. African Journal of Microbiology Research 6(21): 455-456.

[4] Cardoso, I.M. and Kuyper, TW. 2006. Mycorrhizas and tropical soil fertility: nutrient management in tropical

agroecosystems. Agriculture Ecosystem Environment, 116: 72-84.

[5] Chebet D. Kariuki W., Wamocho L. and Rimberia F. 2020. Effect of Arbuscular mycorrhizal inoculation on growth, biochemical characteristics and nutrient uptake of passion fruit seedlings under flooding stress. International Journal of Agronomy and Agricultural Research (IJAAR) 16 (4): 24-31.

[6] Elsen, A., Baimey, H., Swennen, R. and De Waele D. 2003. Relative mycorrhizal dependency and mycorrhiza-nematode interaction in banana cultivars differing in nematode susceptibility. Plant and Soil 256: 303-313.

[7] Estrada, B.E., Aroca, R. Barea, JM. and Ruiz-Lozano, JM. (2013). Native arbuscular mycorrhizal fungi isolated from a saline habitat improved maize antioxidant systems and plant tolerance to salinity. Plant Science 201: 43–51.

[8] Giovannetti, M. and Mosse, B. 1980. An evaluation of techniques for measuring vesicular–arbuscular infection in roots. New Phytology, 84:489-500.

[9] Khade S.W and B. F. Rodrigues 2009.Studies on Effects of Arbuscular Mycorrhizal (Am.) Fungi on Mineral Nutrition of *Carica papaya* L. Notingham Botanicaland Horticulture Agrobot. Cluj, 37(1): 183-186.

[10] Little, T.M. and Hills, LJ. 1978. *Agricultural Experimentation: Design and Analysis*, New Jersey: John Wiley.

[11] Mason, P.A. and Wilson J. 1994. Harnessing symbiotic associations: vesicular-arbuscular mycorrhizas, p 165-175 In: Leakey, R.R.B., Newton, A.C. (Eds.), Tropical trees: potential for domestication and the rebuilding of forest resources. HMSO, London,.

[12] Michelson, A. 1992. Mycorrhiza and root nodulation in tree seedlings from five nurseries in Ethiopia and Somalia. For. Ecol. Manage. 48: 335-344.

[13] Othira, J.O., Omolo, JO. Kiruki, S. Onek LA. and Wachira, WC. 2014. Molecular diversity of arbuscular mycorrhizal fungi (AMF) in Lake Victoria Basin of Kenya. Journal of Ecology and Natural Environment, 6(4): 145-152

[14] Rydlová, J., Püschel, D. Sudová, R. Gryndler, M. Mikanová, O and Vosátka, M. 2011. Interaction of arbuscular mycorrhizal fungi and rhizobia: Effects on flax yield in spoil-bank clay. Journal of Plant Nutrition and Soil Science, 174: 128-134.

[15] Suri, V.K and Choudhary, A.K. 2013. Effects of vesicular arbuscular mycorrhizae and applied phosphorus through targeted yield precision model on root morphology, productivity, and nutrient dynamics in soybean in an acid alfisol. Comm Soil Science Plant Analysis *17*, 2587-2604.

[16] Tas, B. 2014. Effect of the Mycorrhiza Application on the Agronomical Properties of Sweet Corn Varieties. Journal of Agriculture and Allied Sciences *3*(2): 41.47.

[17] Wamocho, L.S. 1998. Studies on the use of vesicular arbuscular mycorrhizal fungi for fruit production in Kenya. PhD Thesis, Jomo Kenyatta University of Agriculture and Technology.

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Generation Means Analysis of three Seeds antinutrients in Cowpea (*Vigna unguiculata* (L.) Walp.)

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Abstract— *Cowpea seeds are recognized to contain some anti-nutritional factors that reduce their nutritional values. The objective of this work was to evaluate the content of tannins, flavonoids and phytic acid of cowpea seeds and to study their genetic control by using generation's means analysis (GMA). F_1 and F_2 generations as well as backcross populations (BC_1 and BC_2) were produced in three hybrid combinations by crossing six selected lines. Variation among tested varieties was from 55.12 mg GAE/100 g dw (24-125B) to 233.92 mg GAE/100 g dw (IT97K-573-1-1) for tannins, 60.90 mg/100 g dw (24-125B) to 557.91 mg/100 g dw (BR_1) for phytates and 363.64 mg RE/100 g dw (24-125B) to 453.93 mg RE/100 g dw (BR_1) for flavonoids. Broad-sense heritability values (0.86 to 0.99), narrow-sense heritability values (0.06 to 0.50) and analysis of gene effects suggested that the antinutrients studied were controlled by additive and non-additive genes. Significant epistatic effects were found in several crosses and a duplicate type of epistasis was observed. These results suggested that breeding for increased tannins, flavonoids and phytates contents in cowpea seeds would be quite efficient through recurrent selection and selection in advanced generations.*

Keywords— ***GMA, Cowpea, Tannins, Phytates, Flavonoids, Sudano-sahelian zone, Cameroon.***

I. INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is an annual self-pollinated plant (2n = 22 small chromosomes) (Maréchal, 1970). Africans consume the young leaves, immature pods, immature seeds, and the mature dried seeds. It is often eaten in the form of steamed cake called *koki* and *kosai* or *akara* donut (Kaptso *et al.*, 2007). Seeds are also used in the formulation of simple weaning foods for children (Mensa-Wilmot *et al.*, 2001, Egounlety 2002, Magda and Dalia 2013).

Nutritionally, cowpea seeds provide large amounts of protein, vitamins and essential minerals for human nutrition in many countries (Hall *et al.*, 2003, Vasconcelos *et al.*, 2010, Sreerama *et al.*, 2012). However, its wide consumption is limited by the presence of indigestible oligosaccharides (raffinose and stachyose) that induce flatulence (Phillips *et al.*, 2003) and some anti-nutritional factors such as tannins, phytates and digestive enzyme inhibitors (Towo *et al.*, 2003, Giami 2005, Ileke 2014). These are mostly derived from the secondary metabolism of plants and limit and / or reduce the nutritional value of food (Makkar *et al.*, 2007, Martins *et al.*, 2011). They interfere with the bioavailability of minerals and the digestibility of essential nutrients, rendering them unavailable to cells once consumed (Jeroch *et al.*, 1993). It is therefore necessary to eliminate or reduce these inhibitors to make the nutrients bioavailable to the body.

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Anti-nutritional substances can be eliminated or reduced by soaking, dehulling, fermentation, cooking (Egounlety and Aworth, 2003); also by soaking, grilling (Adekanmi *et al.*, 2009); or by soaking, germinating and cooking (Ramadan, 2012). Despite their effectiveness, these methods require extra energy for households and cause a reduction of some nutrients by leaching. Some antinutrients are thermostable and their destruction by some processes is difficult. Therefore, selection of cowpea cultivars with low concentrations of these elements may be the simplest and most effective method for improving the nutritional and technological value and acceptability of cowpea (Preet and Punia, 2000; Giami, 2005). For this purpose, the evaluation of genetic variability and heritability of traits is essential for a breeding program (Noubissié *et al.*, 2011). Thus, Adeyemi and Olorunsanya (2012), Apea-Bah *et al.* (2014) and Salawu *et al.* (2014) report some information on the genetic variability of large groups of phenolic compounds.

Genetic analyses are carried out according to several models including diallel analysis and generation's means analysis (GMA) of Mather and Jinks (1982). GMA provides information on epistasis interactions, gain from selection and heritability of traits (Allard 1960, Gamble 1962, Mather and Jinks, 1982). Compared to diallel method, it requires few controlled hybridization operations, and provides more information about genetic model (by detailing effects of various genic interactions) but requires analysis of a large number of samples for each generation. In the best of our knowledge, only Nzaramba *et al.* (2005) and Noubissié *et al.* (2012) evaluated, in cowpea, the genetic variability and heritability of phenolic compounds and antioxidant activity by 2,2-diphenyl-2-picrylhydraxyl hydrate (DPPH) method. Diallel analysis and a GMA involving only four pure lines of cowpea were carried out by these researchers. In the Sudano-Sahelian zone of Cameroon, there is a dearth of information regarding the genetic analyses of biochemical characters of cowpea genotypes. Thus, this study was designed to evaluate tannins, flavonoids and phytates contents of cowpea genotypes, and to determine their genetic model heritability in the Sudano-Sahelian zone of Cameroon.

II. MATERIAL AND METHODS

Plant materials and field experiments

Field experiments were conducted from 2011 to 2014 at the Institute of Agricultural Research for Development (IRAD) farm of Giring-Maroua (09°30′ N, 10°32′ E) located in the Sudano-Sahelian zone of Cameroon.

The study was carried out on 15 cowpea genotypes (Nassourou *et al.*, 2015) including two local landraces and 13 improved lines developed by IRAD and the International Institute of Tropical Agriculture (IITA). Generation means analysis (GMA) was based on six populations (P_1 and P_2 parents, F_1 hybrids, F_2 generations, and BC_1 and BC_2 backcrosses) obtained from three combinations: IT97K-573-1-1 x 24-125B, B301 x BR_1 and CRSP x Lori.

Preliminary trials were conducted during the rainy season in 2011 and 2012 to ensure purity of genotypes and to assess their variability for tannins, phytates and flavonoids. Experimentations were conducted in a randomized complete block design (RCBD) with three replications. Seeds of selected parents were sown during the 2013 rainy season for crossings (Nassourou *et al.*, 2015). Parents of respective crosses were used as male parent and F_1 hybrids as female parent to produce BC_1 and BC_2 (F_1 backcrossed to P_1 and P_2 respectively) seeds, and F_1 hybrids were selfed to obtain F_2 seeds. All 15 pure lines and hybrids obtained were planted in a RCBD with three replications during the 2014 rainy season. The number of plants sampled is 10 for P_1, P_2 and F_1; 25 for F_2; and 15 in BC_1 and BC_2.

Biochemical analysis

Extraction of tannins was done by adding 100 mg of polyvinyl polypyrrolidone (PVPP) to 1.0 mL of distilled water and 1.0 mL of the methanolic extract of total polyphenols (Makkar *et al.*, 1993; Nassourou *et al.*, 2015). Tannins get bound to PVPP, and then the clear supernatant contained only non-tannin phenolics.

Non-tannin phenolics were determined using the Folin-Ciocalteu method (Gao *et al.*, 2000). Absorbance was read at 725 nm against a blank reagent. Results were expressed as mg gallic acid equivalent (GAE) per 100 g dry weight (dw). Tannins content of the sample was evaluated by difference between non-tannin phenolics and total polyphenols contents (Nassourou *et al.*, 2015).

Total flavonoid content was determined following Noudeh *et al.* (2010) based on the flavonoid–aluminum complex with maximum absorption at 430 nm. A calibration curve was prepared with a 1 mg mL^{-1} solution of rutin (Miyase *et al.*, 1992), and results were expressed as mg rutin equivalent (RE) on a dry matter basis.

Phytic acid was determined according to Wade reagent's method (30 mg of $FeCl_3.6H_2O$ and 300 mg of sulfosalicylic acid dissolve in approximately 70 mL distilled water, and volume completed to 100 mL with distilled water) described by Vaintraub and Lapteva (1988). The absorbance was read at 500 nm against a

blank reagent. Phytate concentration was calculated from the difference between control absorbance (3 mL of water + 1 mL Wade reagent) and sample absorbance. Calibration curve was drawn using a solution of sodium phytate diluted to obtain 5 to 40 µg of phytic acid. Results were expressed in mg per 100 g dry matter basis.

Statistical analysis

Studied antinutrients data were subjected to analysis of variance (ANOVA) using STATGRAPHICS Plus 5.0 (Manugistics, 1997).

Three scaling tests A, B and C were performed to test the adequacy of the additive-dominance model (Mather and Jinks, 1982) as follows:

$$A = 2\overline{BC_1} - \overline{P_1} - \overline{F_1}$$

$$VA = 4V(\overline{BC_1}) + V(\overline{P_1}) + V(\overline{F_1})$$

$$B = 2\overline{BC_2} - \overline{P_2} - \overline{F_1}$$

$$VB = 4V(\overline{BC_2}) + V(\overline{P_2}) + V(\overline{F_1})$$

$$C = 4\overline{F_2} - 2\overline{F_1} - \overline{P_1} - \overline{P_2}$$

$$VC = 16V(\overline{F_2}) + 4V(\overline{F_1}) + V(\overline{P_1}) + V(\overline{P_2})$$

$$SE(A) = (VA)^{\frac{1}{2}} \qquad t(A) = A/SE(A)$$

$$SE(B) = (VB)^{\frac{1}{2}} \qquad t(B) = B/SE(B)$$

$$SE(C) = (VC)^{\frac{1}{2}} \qquad t(C) = C/SE(C)$$

Where, *A*, *B* and *C* are scaling test parameters,

SE = standard error,

V = variance, $\overline{P_1}, \overline{P_2}, \overline{F_1}, \overline{F_2}, \overline{BC_1}$ and $\overline{BC_1}$ are means of parent 1, parent 2, F_1 hybrids, F_2 progenies, and backcrosses generations BC_1 and BC_2, respectively.

In case of proven inadequacy of additive-dominance model, the model of six-parameter generation analysis proposed by Gamble (1962) was used. Various genetic parameters i.e., mid-parent values [*m*], additive gene effects [*d*], dominance deviation [*h*] and the three non-allelic interactions (additive x additive [*i*], additive x dominance [*j*] and dominance x dominance [*l*]) were defined as follows:

$$m = \overline{F_2}$$

$$d = \overline{B_1} - \overline{B_2}$$

$$h = -1/2\,\overline{P_1} - 1/2\,\overline{P_2} + \overline{F_1} - 4\overline{F_2} + 2\overline{B_1} + 2\overline{B_2}$$

$$i = -4\overline{F_2} + 2\overline{B_1} + 2\overline{B_2}$$

$$j = -1/2\,\overline{P_1} + 1/2\,\overline{P_2} + \overline{B_1} - \overline{B_2}$$

$$l = \overline{P_1} + \overline{P_2} + 2\overline{F_1} + 4\overline{F_2} - 4\overline{B_1} - 4\overline{B_2}$$

Student's t-test was used to test scaling test parameters and genetic parameters at 5%, 1% and 0.1% level of significance. In each test, degrees of freedom are the sum of degrees of freedom of various generations involved (Mather, 1949).

Broad-sense heritability (h^2) and narrow-sense heritability (h_n^2) were calculated using the backcross method (Warner, 1952; Mather and Jinks, 1982):

$$h^2 = {s^2}_g/{s^2}_p \text{ and } {h_n}^2 = {s^2}_A/{s^2}_p$$

Where, additive variance $({s^2}_A) = 2{s^2}_{F2} - ({s^2}_{BC1} + {s^2}_{BC2})$; phenotypic variances $(\sigma^2{}_p) = ({s^2}_{F2})$; environmental variances in F_2 $({s^2}_E) = 1/4(2\,{s^2}_{F1} + {s^2}_{P1} + {s^2}_{P2})$ and genetic variance $({s^2}_g) = {s^2}_p - {s^2}_E$ (Wright, 1968).

III. RESULTS

Generation's means

Significant difference was noted between the six evaluated generations for tannin, phytate and flavonoid contents (Table 1). Significant transgressive forms were observed and F_2 population had higher values than better parents. This was the case of tannins for BR_1 x B301, phytates and flavonoids for IT97K-573-1-1 x 24-125B and flavonoids for CRSP x Lori.

Table 1. Mean and standard error of six generations with three crosses for tannins, phytates and flavonoids in cowpea seeds

Traits and generations	BR_1 x B301	IT97K-573-1-1 x 24-125B	CRSP x Lori
Tannins			
P_1	84.19±3.76^{d}	233.92±9.22^{f}	216.00±9.17^{e}
P_2	73.57±5.00^{c}	55.12±6.45^{a}	105.04±8.17^{a}
F_1	94.12±0.76^{e}	85.56±9.59^{c}	144.07±9.29^{c}
F_2	85.45±32.85^{d}	149.84±69.72^{e}	200.56±27.79^{d}
BC_1	70.12±33.44^{b}	140.92±87.43^{d}	144.70±23.08^{b}
BC_2	61.19±28.20^{a}	65.36±31.12^{b}	104.41±25.31^{a}
Phytates			
P_1	557.91±1.46^{c}	94.94±6.16^{b}	419.31±26.14^{f}
P_2	266.38±9.10^{a}	60.90±4.87^{a}	138.03±9.00^{a}
F_1	1044.67±28.36^{f}	160.15±11.49^{e}	383.13±16.06^{d}
F_2	491.53±114.17^{b}	145.23±50.32^{d}	331.72±82.72^{c}
BC_1	888.03±115.66^{e}	186.14±47.19^{f}	387.51±77.12^{e}
BC_2	628.99±108.91^{d}	125.33±44.36^{c}	296.05±74.79^{b}
Flavonoids			
P_1	453.93±20.01^{e}	436.42±17.39^{c}	409.73±11.73^{d}
P_2	400.78±22.71^{b}	363.64±14.37^{a}	386.87±8.86^{c}
F_1	380.63±5.52^{a}	462.70±11.65^{e}	381.03±4.19^{b}
F_2	406.41±52.68^{c}	445.04±37.59^{d}	433.98±27.96^{f}
BC_1	430.54±44.23^{d}	406.28±39.29^{b}	425.87±26.21^{e}
BC_2	494.42±51.49^{f}	476.51±31.36^{f}	362.16±22.01^{a}

Tannins (mg GAE/100 g dw); Phytates (mg/100 g dw); Flavonoids (mg RE/100 g dw);means followed by same letters in a cross for a trait, are not significantly different at 5% probability level

Variance components and heritability

Different components of phenotypic variance for tannin, phytate and flavonoid contents are shown in Table 2. Genetic variance was higher than environmental variance for all traits and variance due to dominance effects was the largest component of genetic variance. CRSP x Lori cross revealed a slight superiority of additive variance for tannins and flavonoids. Broad and narrow sense heritability ranged from 0.86 to 0.99 and from 0.06 to 0.50 respectively (Table 3) depending on the parameters studied (tannins, phytates or flavonoids) and combination. The large difference observed between broad sense heritability and narrow sense heritability was an indicator of dominance effects of genes.

Table 2. Means ± standard error, scaling test and genetic effects for tannins, phytates and flavonoids in cowpea seeds

Cross	A	B	C	Mean [*m*]	Additive [*d*]	Dominance [*h*]	Additive x Additive [*i*]	Additive x Dominance [*j*]	Dominance x Dominance [*l*]	Type of epistasis
Tannins										
C_1	*	*	ns	85.45±32.85**	8.93±43.74	-63.93±157.89*	-79.17±157.86*	3.62±43.85	162.56±218.91***	D
C_2	ns	ns	ns	149.84±69.72***	75.56±92.80*	-245.77±335.18***	/	/	/	D
C_3	ns	ns	**	200.56±27.79***	40.29±34.25*	-320.55±131.05***	-304.02±130.57***	-15.27±34.80	415.14±177.83***	D
Phytates										
C_1	ns	ns	***	491.53±114.17**	258.36±158.87**	1699.12±557.08***	1066.60±506.50***	112.60±158.93*	-1185.68±784.65***	D
C_2	**	ns	ns	145.23±50.32***	60.31±64.77*	125.25±239.67*	43.02±239.35	43.29±64.89*	-190.82±328.97**	D
C_3	ns	ns	ns	331.72±82.72*	91.46±107.43	108.46±395.09	/	/	/	D
Flavonoids										
C_1	ns	ns	*	406.41±52.68***	-63.88±67.88*	177.54±251.18**	224.27±250.67**	-37.30±69.55	-458.21±345.20***	D
C_2	*	*	ns	445.04±37.59***	-70.23±50.27**	48.12±181.60	-14.56±180.88	-106.63±51.52***	-25.56±253.17	D
C_3	*	ns	**	433.98±27.96***	63.72±34.23*	-177.12±131.40***	-159.85±131.13*	75.15±35.01***	142.44±177.59**	D

C1 = BR_1 x B301; C2 = IT97K-573-1-1 x 24-125B; C3 = CRSP x Lori; Tannins (mg GAE/100 g dw); Phytates (mg/100 g dw); Flavonoids (mg RE/100 g dw);

m = mid-parent values; [*d*] = additive; [*h*] = dominance; [*i*] = additive x additive; [*j*] = additive x dominance; [*l*] = dominance x dominance.

*, **, ***: Significance at $P \leq 0.05$, 0.01 or 0.001 respectively

Table 3. Estimates of heritability for tannins, phytates and flavonoids in cowpea seeds

Trait	BR_1 x B301		IT97K-573-1-1 x 24-125B		CRSP x Lori	
	h^2	h_n^2	h^2	h_n^2	h^2	h_n^2
Tannins	0.99	0.23	0.98	0.23	0.90	0.48
Phytates	0.97	0.06	0.97	0.34	0.95	0.31
Flavonoids	0.91	0.34	0.86	0.21	0.92	0.50

h^2: Broad-sense heritability; h_n^2: Narrow-sense heritability.

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Scaling joint tests and gene effects

Means values for the scaling joint tests are presented in Table 2. These tests were carried out for tannins, phytates and flavonoids and indicated the presence of non-allelic interactions in some cases. A and B scaling tests provided evidence for the presence of additive x additive (*i*), additive x dominance (*j*) and dominance x dominance (*l*) type gene interactions. Thus, we observed significant A and B tests for tannins in cross C1 and flavonoids in cross C2; exhibiting presence of non-allelic or epistatic interactions for studied traits. The C scaling test provided a test for type *l* epistasis. Significant C test was observed in almost all traits according to crosses involved.

Additive (*d*) and dominance (*h*) effects are significant, and dominance seems to be more important for these traits, except for tannins (all combinations) and flavonoids (CRSP x Lori). Additive and dominance effects as well as additive-additive (*i*), additive-dominance (*j*) and dominance-dominance (*l*) interactions were also significant for all traits and combinations. Gene effects are all positive for phytates apart from dominance-dominance (*l*) interaction that showed negative values. On the other hand, for all parameters, significant *h* and *l* effects were noted and had different signs indicating a double epistasis type for these characters.

IV. DISCUSSION

Gene actions of some secondary metabolites (tannins, phytates and flavonoids) have been clarified through generation means analysis. Specifically, flavonoids content is known to be dominantly influenced by both genotype and environment (Dwivedi *et al.*, 2016). High values of broad sense heritability were noted in all combinations (BR_1 x B301, IT97K-573-1-1 x 24-125B and CRSP x Lori) for antinutrients. Thus, their levels can be improved genetically under the experimental conditions of Sudano-Sahelian zone. Narrow sense heritability showed values of 50% or less suggesting that these characters are predominantly under the control of non-additive genes effects. In previous work, Noubissié *et al.* (2012) concluded that phenols (tannin-related group) are highly heritable and predominantly controlled by additive genes. Overall, values of broad sense heritability were very high and showed that tannins, phytates and flavonoids are inherited from parents to offspring. In addition, genes involved were mainly non-additive effects and the choice of complementary parents is therefore more appropriate to improve these characters. In previous work, Nassourou *et al.* (2016) have noted that both additive and non-additive gene effects controlled flavonoids and antioxidant properties with a preponderance of non-additive gene effects.

Apart from additive and dominance, which were the main factors controlling the studied antinutrients, epistatic interactions were also significant. Significant epistasis has been previously reported for total phenols content in cowpea using a generation's means analysis (Noubissié *et al.*, 2012); also by using a diallel analysis (Nassourou *et al.*, 2015; 2016). Indeed, epistasis is usually due to a high level of homozygosity in self-pollinated species (Volis *et al.*, 2010). According to Kearsey and Pooni (1996), the type of epistasis is determined only when dominance (*h*) and dominance x dominance (*l*) effects are significant, when these effects have the same sign; effects are complementary while different signs indicated duplicate epistasis. For all these, dominance and dominance x dominance (*l*) interactions are always of opposite sign; which refers to a case of duplicate epistasis. The same conclusion was reported for phenol content of *Solanum melongena* by Sabolu *et al.* (2014). This type of epistasis generally hinders improvement by selection and therefore, significant effects of dominance and dominance x dominance interaction would not be desirable. Overall, for tannins and flavonoids, additive-additive (*i*) interaction is negative, showing a dispersion of parental alleles for these traits.

Genetic improvement of nutritional value of cowpea seeds by reducing antinutrient levels is possible by exploiting the wide genetic variability and using appropriate breeding techniques. Due to significant epistasis observed, selection for these traits would be most effective at latter generations by using pedigree method and recurrent selection (Allard, 1960; Santos *et al.*, 2012). For the pedigree method, selection would be postponed in F_6 generations and operated in bulk or by single-seed or single-pod descent (Demarly, 1977, Bernado, 2003). These methods being particularly expensive, time consuming and laborious, marker assisted selection would also be recommended for more efficiency.

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REFERENCES

[1] **Adekanmi O.K., Oluwatooyin O.F. & Yemisi A.A., 2009.** Influence of processing techniques on the nutrients and antinutrients of tigernut (*Cyperus esculentus* L.). *World J. Dairy Food Sci.*, 4(2): 88-93.

[2] **Adeyemi K.D. & Olorunsanya A.O., 2012.** Comparative analysis of phenolic composition and antioxidant effect of seed coat extracts of four cowpea (*Vigna unguiculata*) varieties on broiler meat. *Iranian J. Appl. Anim. Sci.*, 4(2): 343-349.

[3] **Allard R.W., 1960.** *Principles of plant breeding.* John Wiley and Sons, Inc., New-York. USA, 512 p.

[4] **Apea-Bah F., Minnaar A., Bester M.J. & Duodu K.G., 2014.** Does a sorghum-cowpea composite porridge hold promise for contributing to alleviating oxidative stress? *Food Chem.*, 157: 157-166.

[5] **Bernado R., 2003.** On the effectiveness of early selection in self-pollinated crops. *Crop Sci.*, 43: 1558-1560.

[6] **Demarly Y., 1977.** *Génétique et amélioration des plantes.*Ed. Masson, Paris VI, 287 p.

[7] **Dwivedi S.L., Upadhyaya H.D., Chung I.-M., De Vita P., García-Lara S., Guajardo-Flores D., Gutiérrez-Uribe J.A., Serna-Saldívar S.O., Rajakumar G., Sahrawat K.L., Kumar J.& Ortiz R., 2016.** Exploiting phenylpropanoid derivatives to enhance the nutraceutical values of cereals and legumes. *Front. Plant Sci.*, 7:763.

[8] **Egounlety M. & Aworh O.C., 2003.** Effect of soaking, dehulling, cooking and fermentation with *Rhizopus oligosporus* on the oligosaccharides, trypsin inhibitor, phytic acid and tannins of soybean (*Glycine max* Merr.), cowpea (*Vigna unguiculata* L. Walp.) and groundbean (*Macrotyloma geocarpa* Harms). *J. Food Eng.*, 56: 249-254.

[9] **Egounlety M., 2002.** Production of legume-fortified weaning foods. *Food Res. Int.*,35: 233-237.

[10] **Gamble E.E., 1962.** Gene effects in corn (*Zea mays* L.): separation and relative importance of gene effects for yield. *Can. J. Plant Sci.*,42: 339-348.

[11] **Gao X., Ohlander M., Jeppsson N., Björk L. & Trajkovski V., 2000.** Changes in antioxidant effects and their relationship to phytonutrients in fruits of sea buckthorn (*Hippophae rhamnoides* L.) during maturation. *J. Agric. Food Chem.*, 48: 1485-1490.

[12] **Giami S.Y., 2005.** Compositional and nutritional properties of selected newly developed lines of cowpea (*Vigna unguiculata L. Walp.*). *J. Food Compos. Anal.*, 18: 665-673.

[13] **Hall E.A., Cissé N., Thiaw S., Elawad H.O.A., Ehlers J.D., Ismail A.M., Fery R.L., Roberts P.A., Kitch L.W., Murdock L.L., Boukar O., Phillips R.D. & Mc Watters K.H., 2003.** Development of cowpea cultivars and germplasm by the Bean/Cowpea CRSP. *Field Crops Res.*, 82: 103-134.

[14] **Ileke K.D., 2014.** Anti-nutritional factors in cowpea cultivars and their effects on susceptibility to *Callosobruchus maculatus* (Fab.) [Coleoptera: Bruchidae] infestation. *Biosci. Methods*, 5(2): 1-8.

[15] **Jeroch H., Flachowsky G. & Weißbach F., 1993.** Futtermittelkunde (Handbook of Feed Ingredients), Gustav-Fisher-Verlag Jena, Stuttgart, 510 p.

[16] **Kaptso K.G., Njintang N.Y., Hounhouigan J.D., Scher J., Mbofung C.M.F., 2007.** Production of Bambara groundnut (*Voandzeia subterranea*) flour for use in the preparation of koki (a steamed cooked paste): effect of pH and salt concentration on the physicochemical properties of flour, *Int. J. Food Eng.*,3(3): 1-20.

[17] **Kearsey M.J.& Pooni H.S., 1996.** The genetic analysis of quantitative traits. 1st edition. Chapman and Hall, London.

[18] **Magda S.M. & Dalia M.E-N., 2013.** Nutritional evaluation of weaning food blends fortified with some carotenoids-rich vegetables. *J. Appl. Sci. Res.*, 9(3): 1573-1582.

[19] **Makkar H.P.S., Blummel M., Borowy N.K. & Becker, 1993.** Gravimetric determination of tannins and their correlations with chemical and protein precipitation methods. *J. Sci. Food Agric.*, 61: 161-165.

[20] **Makkar H.P.S., Siddhuraju P. & Becker K., 2007.** Plant Secondary Metabolites. In: Walker J.M. (eds.), *Methods in Molecular Biology*, Humana Press Inc., Totowa, New Jersey, vol. 393, 130 p.

[21] **Manugistics, 1997.** Statgraphics Plus 5.0 for Windows. Manugistics Inc., Rockville, Maryland.

[22] **Martins S., Mussatto S.I., Martínez-Avila G., Montañez-Saenz J., Aguilar C.N. & Teixeira J.A., 2011.** Bioactive phenolic compounds: production and extraction by solid-state fermentation. A review. *Biotechnol. Adv.*, 29: 365-373.

[23] **Mather K.& Jinks J.L., 1982.** Biometrical Genetics: The study of continuous variation, 3rd ed. Chapman and Hall, London, New York.

[24] **Mather K., 1949.** Biometrical Genetics. Dover publication, Inc. New York.

[25] **Mensa-Wilmot Y., Phillips R.D. & Hargrove J.L., 2001.** Protein quality evaluation of cowpea-based extrusion cooked cereal/legume weaning mixtures. *Nutr. Res.*, 21: 849-857.

[26] **Miyase T., Kohsaka H. & Ueno A., 1992.** Tragopogonosids A-I, oleanane saponins from *Tragopogon pratensis*. *Phytochemistry*31: 2087–2091.

[27] **Nassourou M.A., Noubissié T.J-B., Gonne S., Hamadama Y., Bell J.M. & Njintang Y.N., 2015.** Diallel analysis of polyphenols and phytates content in cowpea (*Vigna unguiculata* L. Walp.). *Scientia Agriculturae*, 12(1): 46-51.

[28] **Noubissié T.J-B., Bell J.M., Nassourou M.A., Njintang Y.N. & Youmbi E., 2011.** Genetic analysis of seed proteins contents in cowpea (*Vigna unguiculata* (L.) Walp.). *Afr. J.Biotechnol.*, 10(16): 3077-3086.

[29] **Noubissié T.J-B., Youmbi E., Njintang Y.N., Aladji Abatchoua M., Nguimbou R.M. & Bell J.M., 2012.** Inheritance of phenolic contents and antioxidant capacity of dehulled seeds in cowpea (*Vigna unguiculata* L. Walp.). *Int. J. Agr. Agri. Res.*, 2(3): 7-18.

[30] **Noudeh G.D., Sharififar F., Khatib M., Behravan E. & Afzadi M.A., 2010.** Study of aqueous extract of three medicinal plants on cell membrane-permeabilizing and their surface properties. *Afr. J.Biotechn.*, 9: 110-116.

[31] **Nzaramba M.N., Hale A.L., Schewing D.C. & Miller J.C., 2005.** Inheritance of antioxidant activity and its association with seed coat colour in cowpea. *J. Am. Soc. Hort. Sci.*, 130(3): 386-391.

[32] **Phillips R.D., McWatters K.H., Chinnan M.S., Hung Y.C., Beuchat L.R., Sefa-Dedeh S., Sakyi-Dawson L., Ngoddy P., Nnanyelugo D., Enwere J., Komey N.S., Liu K., Mensa-Wilmot Y., Nnanna I.A., Okeke C., Prinyawiwatkul W. & Saalia F.K., 2003.** Utilization of cowpeas for human food. *Field Crops Res.*, 82: 193-213.

[33] **Preet K. & Punia D., 2000.** Proximate composition, phytic acid, polyphenols and digestibility (*in vitro*) of four brown cowpea varieties. *Int. J. Food Sci. Nutr.*, 51: 189-193.

[34] **Ramadan E.A., 2012.** Effect of processing and cooking methods on the chemical composition, sugars and phytic acid of soybeans. *Food and Public Health*, 2(1): 11-15.

[35] **Sabolu S., Kathiria K.B., Mistry C.R. & Kumar S., 2014.** Generation mean analysis of fruit quality traits in eggplant (*Solanum melongena* L.). *AJCS*, 8(2): 243-250.

[36] **Salawu O.S., Oluwafemi I.E., Oladipupo D. & Bukola B.O.S., 2014.** Effect of *Callosobruchus maculatus* infestation on the nutrient-antinutrient composition, phenolic composition and antioxidant activities of some varieties of cowpeas (*Vigna unguiculata*). *Adv. J. Food Sci. Technol.*, 6(3): 322-332.

[37] **Santos C.A.F., da Costa D.C.C. & da Silva W.R., 2012.** Genetic analysis of total seed protein content in two cowpea crosses. *Crop Sci.*, 52: 2501-2506.

[38] **Sreerama Y.N., Sashikala V.B., Pratape V.M. & Singh V., 2012.** Nutrients and antinutrients in cowpea and horse gram flours in comparison to chickpea flour: evaluation of their flour functionality. *Food Chem.*, 131: 462-468.

[39] **Towo E., Svanberg U. & Kamala A., 2003.** Phenolic compounds, phytate, citric acid and the in-vitro iron accessibility of cowpeas, mungbeans and four varieties of kidney beans. *Afr. J. Food Agric. Nutr. Dev.*, 3(1): 53-59.

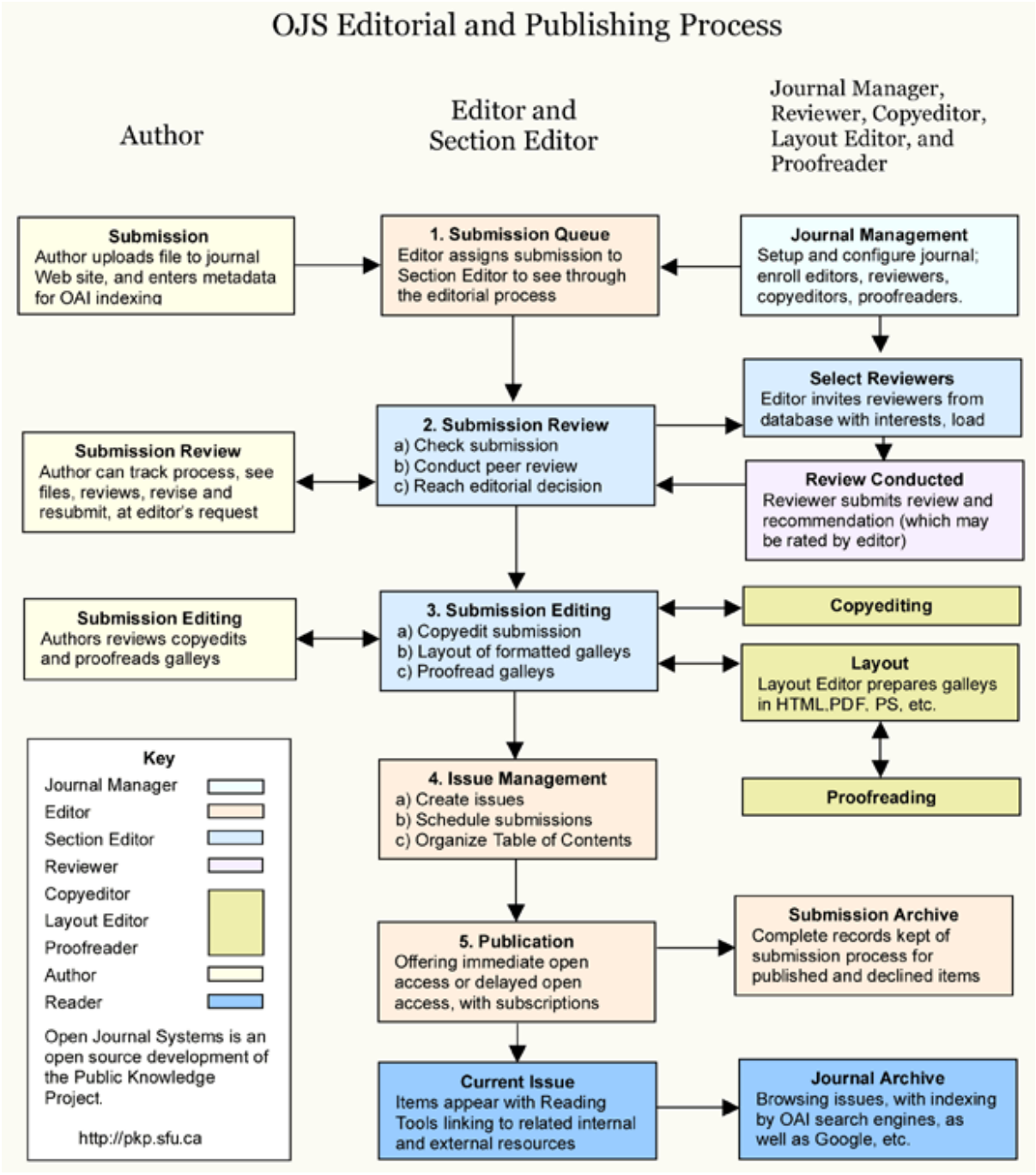
[40] **Vaintraub I.A. & Lapteva N.A., 1988.** Colorimetric determination of phytate in unpurified extracts of seeds and the products of their processing. *Anal of Biochemistry*,175: 227-230.

[41] **Vasconcelos I.M., Maia F.M.M., Farias D.F., Campello C.C., Carvalho A.F.O., Moreira R.A. & Abreu de Oliveira J.T., 2010.** Protein fractions, amino acid composition and antinutritional constituents of high-yielding cowpea cultivars. *J. Food Compos. Anal.*, 23: 54-60.

[42] **Volis S., Shulgina I., Zaretsky M.& Koren O., 2010.** Epistasis in natural populations of a predominantly selfing plant. *Heredity*,106: 300-309.

[43] **Warner J.N., 1952.** A method for estimating heritability. *Agron. J.*, 44: 427-430.

[44] **Wright S., 1968.** The genetics of qualitative variability. In: Wright S., (Ed.), Evolution and genetics of populations. Vol. I. Genetic and biometric foundations. University of Chicago Press, Chicago, III.



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