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FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-4: July-August 2021 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: September, 2021

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Physicochemical property of rubber nursery plants biochar and its effect on the growth of *Hevea brasiliensis* seedlings

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Abstract**—***In order to improve the reutilization rate of rubber seedling-stock shoots waste and minimize the burden on the ecological environment, we investigated physicochemical property of rubber nursery plants biochar and its effect on growth of Hevea seedlings. The results showed that sand bed seedlings biochar had the smaller stem diameter, the more N and P content but the less K content and soluble sugar, in comparison with polybag budding biochar and polybag seedling biochar. Stem of polybag budding plants as nutrient medium had less pH value and more electrical conductivity than that of seedling plants biochar. Medium in N and K nutrient were negatively correlated (P<0.05) with plant height, stem diameter and leaf whorls of rubber seedlings. Taken together, stem biochar as nutrient medium was better than leaf tissue powder as nutrient medium for the growth of rubber seedlings.*

Keywords**—** ***Hevea brasiliensis, Rubber nursery plants, Biochar, Physicochemical property, Growth.***

I. INTRODUCTION

Rubber buddings in polybags nursery with surface soils are the main maintenance of nursery. The seedling stocks are green-budded at six to eight months old. The stocks of successful buddings are cut-back. Rubber nursery production for polybag-buddings normally consume 600 ton surface soil and accompany with 756.8 ton seedling-stock shoots every year in our rubber nursery, and 34,400 ton seedling-stock shoots during the 13th Five-Year (2016-2020) Plan Period in rubber planting areas of China. Those seedling-stock shoots were burn or thrown away in the past, which has caused a burden on the ecological environment. In order to improve the reutilization rate of agricultural waste and minimize the burden on the ecological environment, crop production biochar has been introduced since last two decades (Laird., 2008). Biochar, a carbon rich source application ameliorates drought stress by increasing the plant growth, biomass, nutrient uptake and improves gaseous exchange in drought stress. Application of biochar reduces drought stress by increasing water holding capacity of soil through modification of soil physio-chemical properties that in turn increases water availability to plants and also enhances mineral uptake and regulation of stomatal conductance. Biochar mediates the retention of moisture, nutrients, inhibits harmful bacteria, absorbs heavy metals, pesticides, prevents soil erosion, increases soil pH, improves cationic exchange and boosts soil fertility (Mansoor *et al*., 2021). Biochar addition can significantly improve the growth and physiology of *Phragmites australis*, increase soil organic carbon content and decrease soil $NH4^+$-N content due to the N uptake by *Phragmites australis* (Liang *et al*., 2021). The combination of biochar and chemical fertilizer dissolved organic carbon and shaped soil bacterial community by pH, total nitrogen and available potassium for the improvements of tea growth and low nutrients acidic tea orchard soil (Yang et al, 2021). Wood carbonization increased soil pH, soil exchangeable P and

K (Chidumayo,1994).

For the research reported herein, we investigated physicochemical property of rubber nursery plants biochar and its effect on growth of *Hevea* seedlings, and further explore the feasibility of using it as a seedling-raising substrate.

II. MATERIAL AND METHODS

Rubber Nursery Plants Biochar

The experiment was conducted from October 2017 to November 2020 in the nursery base of natural rubber of Rubber Research Institute of Chinese Academy of Tropical Agricultural Sciences(19°49′22″N, 109°49′27″E), Danzhou City, Hainan Province, China. Sand bed seedlings, polybag seedlings (rootstock-plants), polybag buddings (scion-plants) were harvested, with leaves sundried and with stem girth measured, and pyrolyzed at 500℃for 96 hours (Table1), and then ground, respectively. Each treatment contained 50 plants, three replications.

Analytical Methods

The plants biochar volume weight, total porosity, aeration porosity, water-holding porosity and gas-water ratio were measured according to Liu (2001). The plants biochar EC value was determined with a Electrical Conductivity Meter (DDS-307A, Shanghai, China) according to by mixing plants biochar and water to a mass ratio of 1:5. The plants biochar pH was determined with a pH Meter (Mettler Toledo, SevenCompact S210, Zuirich, Switzerland) by mixing plants biochar and water to a mass ratio of 1:25. The plants biochar total nitrogen content was measured by the alkali-diffusion method, the plants biochar total phosphorus was determined with the molybdenum antimony resistance spectrophotometric method, and the plants biochar total potassium was estimated with a flame photometer (Jingke-F6410, Shaihai Yidian Analytical Instrument Co., Shanghai, China). Soluble Sugar content were measured according to Li (2000).

Rubber Seedlings Growth Experiment

Rubber seedlings with one leaf whorl at leaf-expansion stage were transplanted into root-container with 6cm upper diameter, 2cm lower diameter and 37cm high. The nursery medium were rubber leaves tissue powder and stem biochar (Table1), respectively. At 2-3 mature leaf whorls stage of rubber seedling, plant height, stem diameter, and leaf whorls were measured, respectively.

Statistical Analyses

Statistical analyses were performed with Data Processing System (DPS) statistical software package version 16.5 using one-way ANOVA followed by the Duncan's Multiple Range Test (SSR) to evaluate significant difference among seedlings from different rubber plants biochar as nursery medium and seedlings growth parameters. All data were shown in the mean ± SD of three biological replicates (each replication contained 50 plants).

III. RESULT AND DISCUSSION

Characteristic of rubber nursery plants biochar

As shown in Table1, dried leaves and stem pyrolyzed at 500℃ for 96 hours were ground into different colors. Stem girth of stem3 (polybag seedling stem) was 92.10% more ($P<0.01$) and 401% more ($P<0.01$) than that of stem2 (polybag budding stem) and stem1 (sand bed seedling stem), respectively. Stem girth of stem2 (polybag budding stem) was 161% more ($P<0.01$) than stem1 (sand bed seedling stem).

Table1 Characteristic of rubber nursery plants biochar

Samples	Leaves	Stem1	Stem2	Stem3
Stem girth(mm)	-	15.47±2.01cC	40.36±5.15bB	77.53±8.89aA
Dried samples				
Powdered samples				

Notes: Leaves, dried leaves. Stem1-3, stem pyrolyzed at 500℃ for 96 hours. Stem1, sand bed seedling stem. Stem2, polybag budding stem. Stem3, polybag seedling stem. Data are means and SD, n=3.

Nutrient content of rubber nursery plants biochar As shown in Table2, N content of leaf1, was 22.69% more (P<0.01) and 19.18% more (P<0.01) than that of leaf2 and leaf3, respectively. N content of stem1 was 155% more (P<0.01) and 286% more (P<0.01) than that of stem2 and stem3, respectively. There were no significant difference in N content between leaf 2 and leaf 3, between stem2 and stem3, respectively. P content of leaf1, was 75% more (P<0.01) than that of leaf2. Leaf1 and leaf3 gave no significant difference in P content. P content of stem1 was 200% more (P<0.01) and 300% more (P<0.01) than that of stem2 and stem3, respectively. While P content of stem2 was 33.33% more (P<0.05) than that of stem3. K content of leaf1, was 16.19% less (P<0.01) and 22.12% less (P<0.01) than that of leaf2 and leaf3, respectively. K content of leaf2 was 7.08% less (P<0.01) than that of leaf 3. K content of stem1 was 22.39% more (P<0.01) and 78.26% more (P<0.01) than that of stem2 and stem3, respectively. K content of stem2 was 45.65% less (P<0.01) than that of stem3. Soluble sugar content of leaf1 was 46.73% less (P<0.01) and 36.85% less (P<0.01) than that of leaf2 and leaf3, respectively. There were no significant difference in soluble sugar content between leaf2 and leaf 3, among stem1, stem2 and stem3, respectively. C/N ratio of stem1 was 45.28% less (P<0.01) and 64.33% less (P<0.01) than that of stem2 and stem3, respectively. C/N ratio of stem2 was 34.82% less (P<0.01) than that of stem3. These results showed that leaves had more nutrients than stem, seedling plants had more nutrients than budding plants, and the nutrient of sand bed seedlings had more N than polybag seedling. It is necessary that the reuse of rubber nursery wastes in rubber nursery is an appropriate method for environment management and nutrients provider to raise the rubber nursery seedlings and budding plants.

Table2 Nutrient content of rubber nursery plants biochar

Parameters	Leaf1	Leaf 2	Leaf 3	Stem1	Stem2	Stem3
N%	2.92±0.19aA	2.38±0.04bB	2.45±0.15bB	1.43±0.1cC	0.56±0.06dD	0.37±0.03dD
P%	0.21±0.01bAB	0.12±0.01cC	0.2±0.01bB	0.24±0.02aA	0.08±0dD	0.06±0eD
K%	0.88±0.02cC	1.05±0.02bB	1.13±0.01aA	0.82±0.06dC	0.67±0.01eD	0.46±0.02fE
Soluble sugar content(mg.g^{-1})	144.29±12.39aA	98.34±6.82bB	105.44±2.71bB	27.74±0.97cC	19.9±0.95cC	20.02±1.37cC
C/N ratio	49.65±6.06abAB	41.41±2.93bcBC	43.18±3.84bcABC	19.47±2.01dD	35.58±4.46cC	54.59±6.51aA

Notes: Leaf1, dried leaves of Stem1, Leaf 2, dried leaves of Stem2, Leaf 3, dried leaves of Stem3. Stem1-3, stem pyrolyzed at 500℃ for 96 hours. Stem1, sand bed seedling stem. Stem2, polybag budding stem. Stem3, polybag seedling stem. Data are means and SD, n=3. Lowercase and uppercase indicate significant difference at 0.05 and 0.01 levels, respectively.

Physicochemical property of rubber nursery plants biochar as nutrient medium As shown in Table3, volume weight of leaf3 was 58.97% more (p<0.01) and 58.97% more (p<0.01) than that of leaf1 and leaf2, respectively. There were no significant difference in volume weight between leaf1 and leaf2, among stem1, stem2 and stem3, respectively. Total porosity, aeration porosity, water-holding porosity and gas-water ratio gave no significant difference among leaves and stem. There were no significant difference in pH value among leaf1, leaf2 and leaf3, among stem1, stem2 and stem3, respectively. However, stem1 and stem2 had less pH value than leaves at 0.05 and 0.01 level, respectively. Electrical conductivity of leaf1 was 59.69% more and 56.22% than that of leaf2 and leaf3, respectively. Electrical conductivity of leaf2 and leaf3 had no significant difference. Electrical conductivity of stem1 was 48.35% more and 80.33% more than that of stem2 and stem3, respectively. Electrical conductivity of stem2 and stem3 had no significant difference. The results showed that stem of budding plants as nutrient medium had less pH value and more electrical conductivity than that of seedling plants. Physio-chemical analysis (N, P, K, pH, EC) were best in the growing media comprising biochar + peat moss + leaf compost for flower production

(Altaf *et al*, 2021), which might indicate that different plants have various nutrient medium with biochar.

Table3 Physicochemical property of rubber nursery plants biochar as nutrient medium

Parameters	Leaf1	Leaf 2	Leaf 3	Stem1	Stem2	Stem3
Volume Weight (g/cm^3)	0.39±0.02cB	0.39±0.05cB	0.62±0.07aA	0.55±0.13abAB	0.49±0.01bcAB	0.44±0bcB
Total porosity(%)	7.93±0.02aA	7.93±0.07aA	8±0.01aA	7.99±0.02aA	7.93±0.04aA	7.96±0.02aA
Aeration porosity %	7.48±0.18aA	7.82±0.07aA	7.82±0.57aA	7.99±0.32aA	7.61±0.35aA	8.08±0.37aA
Water-holding porosity %	6.81±0.14aA	6.45±0.09aA	6.09±0.55aA	6.26±0.28aA	6.53±0.27aA	6.09±0.73aA
Gas-water Ratio	1.1±aA	1.21±aA	1.3±aA	1.28±aA	1.17±aA	1.34±aA
pH value	5.55±0.02abA	5.56±0.3abA	5.63±0.08aA	5.12±0.02cAB	4.94±0.02cB	5.21±0.38bcAB
Electrical conductivity	1342±77.9aA	840.36±178.08bcBC	859.04±132.65bcBC	633.56±174.83cdBC	939.8±60.11bB	521.16±95.63dC

Notes: Leaf1, dried leaves of Stem1, Leaf 2, dried leaves of Stem2, Leaf 3, dried leaves of Stem3. Stem1-3, stem pyrolyzed at 500℃ for 96 hours. Stem1, sand bed seedling stem. Stem2, polybag budding stem. Stem3, polybag seedling stem. Data are means and SD, n=3. Lowercase and uppercase indicate significant difference at 0.05 and 0.01 levels, respectively.

Effect of rubber nursery plants biochar as nutrient medium on rubber seedling growth As shown in Table4, plant height of rubber seedlings grown in stem1 as nutrient medium was 10.83% lower ($p<0.01$) and 13.93% lower ($p<0.01$) than that of stem2 and stem3, respectively. There were no significant difference in plant height between stem2 and stem3, among leaves as nutrient medium, respectively. Stem diameter of rubber seedlings grown in leaf3 as nutrient medium was 7.09% smaller ($p<0.01$) and 4.83% smaller ($p<0.05$) than that of leaf2 and leaf1, respectively. There were no significant difference in stem diameter between leaf1 and leaf2, among stem as nutrient medium, respectively. Leaf whorls of rubber seedlings grown in leaf2 as nutrient medium was 10.68% less ($p<0.05$) and 15.73% less ($p<0.01$) than that of leaf1 and leaf3, respectively. Leaf whorls of rubber seedlings grown in stem1 as nutrient medium was 15.84% less ($p<0.01$) and 15% less ($p<0.01$) than that of stem2 and stem3, respectively. There were no significant difference in leaf whorls between leaf1 and leaf3, between stem2 and stem3 as nutrient medium, respectively. Stem diameter of rubber seedlings grown in leaf3 as nutrient medium was 4.84% lower($p<0.05$) and 7.09% smaller ($p<0.01$) than that of leaf1 and leaf2, respectively. There were no significant difference in stem diameter between leaf1 and leaf2, among stem as nutrient medium, respectively. Leaf whorls of rubber seedlings grown in leaf2 as nutrient medium was 10.68% less ($p<0.05$) and 15.73% lower ($p<0.01$) than that of leaf1 and leaf3, respectively. Leaf whorls of rubber seedlings grown in stem1 as nutrient medium was 15.84% less ($p<0.01$) and 15% lower ($p<0.01$) than that of stem2 and stem3, respectively. There were no significant difference in leaf whorls between leaf1 and leaf3, between stem2 and stem3 as nutrient medium, respectively. These results suggested that stem as nutrient medium was better than leaf as nutrient medium for the growth of rubber seedlings. Considering the cost of river sand, availability and germination capacity, leached coir pith is considered as an ideal seed germination medium for rubber (Joseph and Jessy, 2005), while the tomato seedlings grew on the pure wheat straw decomposed matter showed the worst performance(Yang et al., 2020), which showed that different plants had their own suitable medium.

Table4 Effect of rubber nursery plants biochar as nutrient medium on rubber seedling growth

Medium composition	Plant height (cm)	Stem diameter (mm)	Leaf whorls
Leaf1	35.11±4.22cBC	3.72±0.38bBC	2.34±0.48bBC
Leaf2	35.57±3.69cBC	3.81±0.26bAB	2.09±0.29cC
Leaf3	34.35±4.14cC	3.54±0.31cC	2.48±0.51bB
Stem1	37.87±5.66bB	3.86±0.44abAB	2.55±0.51bB
Stem2	42.47±4.91aA	4.01±0.31aA	3.03±0.45aA
Stem3	44±3.95aA	4.03±0.27aA	3±0.27aA

Notes: Leaf1, dried leaves of Stem1, Leaf 2, dried leaves of Stem2, Leaf 3, dried leaves of Stem3. Stem1-3, stem pyrolyzed at 500℃ for 96 hours. Stem1, sand bed seedling stem. Stem2, polybag budding stem. Stem3, polybag seedling stem. Data are means and SD, n=3. Lowercase and uppercase indicate significant difference at 0.05 and 0.01 levels, respectively.

Correlation analysis of rubber nursery plants biochar as nutrient medium on rubber seedling growth As shown in Table 5, plant height was significantly positive correlation with stem diameter (p= 0.0118), leaf whorls (p= 0.0162) and stem girth of rubber nursery plants as medium nutrient (p= 0.0245), respectively. However, plant height was significantly negative correlation with N (p= 0.0035), K (p= 0.0224), soluble sugar (p= 0.0247) content and pH value (p= 0.0174) of rubber nursery plants biochar as nutrient medium, respectively. Stem diameter was significantly negative correlation with N (p= 0.0298), K (p= 0.0259) content and pH value (p= 0.0349) of rubber nursery plants biochar as nutrient medium, respectively. Leaf whorls were significantly negative correlation with N (p= 0.0158), K (p= 0.037) content and stem girth (p= 0.0208) of rubber nursery plants biochar as nutrient medium, respectively. N content of rubber nursery plants biochar as nutrient medium was significantly positive correlation with K (p= 0.0321), soluble sugar (p= 0.0021) content and pH value (p= 0.0246), but significantly negative correlation with stem girth (p= 0.0122), respectively. K content of rubber nursery plants biochar as nutrient medium was significantly negative correlation with stem girth (p= 0.0069). Soluble sugar content of rubber nursery plants biochar as nutrient medium was significantly positive correlation with pH value (p= 0.0154). These results showed that high nutrients of rubber nursery medium was not good for the growth of rubber seedlings due to the existence of seed nutrient at the initial growth stage.

IV. CONCLUSION

In summary, sand bed seedlings as rubber nursery plants biochar had the smaller stem diameter, the more N and P content but the less K content and soluble sugar, in comparison with polybag budding and polybag seedling. Stem of polybag budding plants as nutrient medium had less pH value and more electrical conductivity than that of seedling plants. Stem as nutrient medium was better than leaf as nutrient medium for the growth of rubber seedlings.

Table5 Correlation analysis of rubber nursery plants biochar as nutrient medium on rubber seedling growth

Factors	Plant height	Stem diameter	Leaf whorls	N%	P%	K%	Soluble sugar	pH	Stem girth
Plant height		0.0118	0.0162	0.0035	0.1053	0.0224	0.0247	0.0174	0.0245
Stem diameter	0.91		0.1487	0.0298	0.1305	0.0259	0.0588	0.0349	0.0622
Leaf whorls	0.8943	0.666		0.0158	0.2632	0.037	0.0557	0.0737	0.0208
N%	-0.9515	-0.8556	-0.8956		0.1507	0.0321	0.0021	0.0246	0.0122
P%	-0.7219	-0.6884	-0.5452	0.6636		0.2279	0.3101	0.4649	0.1026
K%	-0.8751	-0.8655	-0.8384	0.85	0.5797		0.0987	0.0899	0.0069
soluble sugar	-0.8687	-0.7948	-0.8006	0.9627	0.5022	0.7312		0.0154	0.0645

pH	-0.8903	-0.8433	-0.7693	0.869	0.3742	0.744	0.8969		0.1619
Stem girth	0.8695	0.7888	0.8797	-0.9082	-0.7256	-0.9313	-0.7848	-0.6505	

Notes: Correlation coefficients on the lower left, p-value on the upper right.

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Orphaned and Abandoned Fruit Species from Panama, A Brief Thematic Review

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Abstract— *The richness of Panama's biological heritage is highly significant. However, the scarce research work on its own national plant genetic resources focuses on a limited number of agricultural crops with high local consumption levels (grains, tubers, traditional tropical fruits) or on exportable items such as cucurbits (watermelon, melon), musaceae (banana, plantain) or bromeliads (pineapple), considered "priority species" by the Panamanian government. Non-traditional fruit species, considered "orphan" or in a clear state of abandonment, do not fall within the priorities already mentioned, which explains, to a large extent, their situation as native fruits practically not studied or not preserved and that have been steadily disappearing from the local consumption. We will review the status of these species and discuss possible actions for their recovery and enhancement.*

Keywords— ***Tropical fruit growing, plant genetic resources, tropical fruit trees, orphan species, tropical agriculture, Panama.***

I. INTRODUCTION

The Mexican researcher Francisco Zavala defines tropical fruit growing as: "The economic activity that takes place in all the tropical areas of the world, areas that are located between the tropics of Cancer and Capricorn, this part of the planet is located at 23 ° 27 North latitude and 23 ° 27 'South latitude. The tropical zone is characterized by the uniformity of warm temperatures, a favorable factor for the productive development of several species of fruit trees… Tropical fruit growing is defined as an activity that grows edible fruits, which are consumed either fresh or processed. This (practice) is conducted in developing countries, considering that its geographical location is in the tropical zone, a factor that limits the development of research in these fruit trees, since most of the research has been carried out in fruit trees with a temperate climate, by developed countries that are located in temperate zones"(1).

This work focuses on the general state of Panamanian fruit growing and, above all, on the study of our native species, analyzing factors that determine their interest as food species and their potential for expanding their propagation and consumption, enriching the diet of the Panamanian people, helping to guarantee the conservation of these fruit species and to ensure our food security, based on our phytogenetic resources.

II. STATUS OF THE PANAMANIAN FLORA

The richness of the Panamanian national biological heritage is highly significant. The Fifth National Biodiversity Report clearly sums it up: "Panama is located in the region with the greatest biodiversity on the planet, among the six known centers of global biodiversity, with high altitude variations that, under tropical climate conditions, favor a diversity of ecosystems containing 12 of the 30 Holdridge Life Zones on the planet ... in addition to the 24 categories of vegetation proposed by UNESCO and the 7 additional categories that were included for the country that host an extensive variability of ecosystems and habitats that allow the establishment of many species "(2).

In terms of vegetation, as this report mentions, "Panama has 21 times more plant species per km^2 than Brazil… 3.5% flowering plants and 7.3% ferns and the like in the world… there are between 1,300 and 1,900 species of plants… that they are endemic or unique to the country" (Ibidem).

The Fourth National Biodiversity Report of Panama (3) stated that "Panama has a published Catalog of Vascular Plants (2004), where 9,520 species of vascular plants distributed in 255 families were recorded; 8,560 Angiosperms, 22 Gymnosperms, and 938 Pteridophytes (ferns and allies). Of that total, 1,144 are endemic, until now they have only been registered in Panama".

Fig. 1. Samples of the rich Panamanian flora (image from La Estrella De Panamá journal)

The Database of Indigenous Plants of Panama maintained by the Center for Tropical Forest Sciences (CTFS) of the Smithsonian Tropical Research Institute (STRI), contains descriptions of 1,213 trees, shrubs and palms and 278 species of lianas, all species present at throughout the country's geography (4).

According to the Fourth National Report on Panamanian Biodiversity, prepared in July 2010, there is a degree of scientific management and use of plant genetic resources in the country, when it states that: "Panama is a Contracting Party to the International Treaty on Plant Genetic Resources for Agriculture and Food. A National Commission of Plant Genetic Resources of Panama has been operating since 1999. Inventory studies and collections of wild species that are relatives of tropical crops are carried out (several institutions participating, including the Faculty of Natural, Exact and Technology Sciences of the University of Panama , Instituto de Investigaciones Agropecuarias de Panamá (IDIAP), STRI, among others). Working collections and germplasm banks exist in the Faculty of Agricultural Sciences of the University of Panama, and in the IDIAP. The use of Phytogenetic resources is wide, focused mainly on genetic improvement (Faculty of Agricultural Sciences of the University of Panama, Institute of Agricultural Research of Panama, and the Corporación Azucarera la Estrella, SA (CALESA). ANAM (2009) has contributed to the establishment of 29 nurseries of native forest species, 20 community nurseries and 115 private nurseries (Op.Cit) ".

Curiously, the Fifth National Report on Biodiversity (Op.Cit.) shows that much of the above has not been translated into serious and significant progress in terms of preserving our biodiversity. The tenth meeting of the Conference of the Parties (COP10) held at the Nagoya summit, created the Aichi targets on Biodiversity 2011-2020. The Aichi Goals make up a set of 20 goals grouped around five Strategic Objectives, which the signatory countries should achieve by 2020. As the aforementioned Fifth Report recognizes, in Panama, in 2018, significant progress had only been made in 2 of the 20 goals and with some initial progress, only in 6 of the 20 strategic goals by the end of the second decade of this century. Something very worrying, due to its high level of non-compliance and its consequences on our biodiversity.

Fig. 2. Panama's National Biodiversity Strategy and Action Plan 2018-2050 (Image from UNDP-Panamá).

Even worse: of the 26 actions listed in the National Biodiversity Strategy and Action Plan 2018-2050, only one has direct relevance, as an implicit derivation, with the research and development of our plant genetic resources: Line 3.3. Promotion of Research on Biodiversity, Action 3.3.1. Promote specialized research on biodiversity and associated issues (5).

Today, it is an indisputable fact that the richness of the world's plant biodiversity (and above all, that of the tropics, including Panama) is in serious risk and in many cases, is suffering dangerous setbacks. The Food and Agriculture Organization of the United Nations (FAO), in its global report "The state of biodiversity for food and agriculture in

the world", published in 2019, calls the alarm about the state of critical deterioration of biodiversity in the world.

On plant species, this document clearly states that "Of some 6,000 species of plants that are grown for food, less than 200 contribute substantially to world food production, and only nine represent 66% of the total production. agricultural ... 24% of nearly 4,000 wild food species - mostly plants, fish and mammals - are declining in number ... the proportion of wild foods in decline is likely to be even higher, as the status of more than half is unknown of the existing wild food species… The largest number of wild food species in decline is found in Latin American and Caribbean countries" (6).

The scarce research work on our national plant genetic resources focuses on a limited number of agricultural crops with high local consumption (grains, tubers, traditional tropical fruit trees) or on exportable items such as cucurbits (watermelon, melon), musaceae (banana, plantain) or bromeliads (pineapple). In other words, species defined by the determining entities of agricultural public policies as "priority species". A huge part of our plant genetic wealth, edible or not, is neglected.

III. THE PRODUCTION AND CONSUMPTION OF FRUITS IN PANAMA, TODAY

Fruit growing centered on traditional species is an important economic activity for certain sectors, although its net contribution to Gross Domestic Product (GDP) is relatively small, falling from 25% 40 years ago to less than 3% today. According to the Ministry of Agricultural Development (MIDA): "9,775 producers are dedicated to planting and harvesting fruits on 39,788 hectares of land… The commercialization of Panamanian fruits such as pineapple, watermelon, lemon, papaya melon and avocado contribute more than US$ 175 million annually to the GDP of Panama" (13).

Regarding Panamanian fruit production, MIDA states that: "Fruit production has increased in the last decade, especially that of cucurbits (melon and watermelon) and we must also mention the famous "chorrerana" pineapple, which are exported to American countries. and even Europeans… One of the points to be highlighted is that fruit production has been concentrated in Azuero and Panama Oeste regions, thus boosting the economies of these areas and boosting agricultural growth, with which many families subsist Panamanians, without forgetting to mention the other provinces that day by day do their job to produce the fruits that we consume.

Fig. 3: Panama's National Fruit Production figures (Infographics by La Prensa journal, based on FAO 2019 data).

Crop yield is increasing, indicating that growers achieve greater efficiency each season. However, national demand is increasing (as well), making this market more attractive ... In most Panamanian households, fruits are consumed fresh, as a dessert or as a snack for children and for people with special diets; They are also used in the preparation of drinks and smoothies to accompany meals. The highest consumption occurs in restaurants and hotels, where fresh fruits and juices are offered for breakfast, as light lunches, in salads and smoothies, or used in the preparation of desserts for lunches and dinners" (14).

But, on the contrary, the national press reflects many divergent opinions. For example, the nutritionist of the Caja de Seguro Social (Panama's social security agency), Mr. José Ramiro López, stated that "The consumption of this food in Panama is quite low compared to the recommendation of three times a day" (15). According to dietitian Ms. Karla Díaz: "In the Panamanian diet, the least consumed nutritional sources are vitamins and minerals, which are found in all the variety of fruits and vegetables available" (16). Likewise, according to the Panamanian Association of Nutritionists-Dietitians and the Ministry of Health, "studies show that the average consumption of fruits, legumes and vegetables is much lower than the minimum necessary for health protection" (17).

Panamanian fruit production focuses, as has already been stated, on some traditional tropical species for export to certain developed markets (United States, European Union, China) and to a lesser extent, on some tropical species for local consumption.

In the first group we could point to a series of species that are mass-produced and that are in high demand in the mentioned markets. For this reason, they are species that have been highly studied (even by large food multinationals such as Nestlé, Dole, Del Monte, Tropicana, Chiquita, etc.) from the agronomic point of view and that have been the subject of much research for their genetic improvement, seeking to modify its organoleptic aspects and its nutritional content.

Among this first list (or "A" list) are species such as: Mango, Banana, Plantain, Pineapple, Melon, Watermelon, Passion Fruit, Avocado, Papaya, Citrus (Oranges, Grapefruits, Lemons, Limes, Tangerines), Cocoa, Coffee and Tea (18).

A second list (or "B" list) gathers species of great consumption within the Latin American region and that have a market share in developed countries, such as "exotic" fruit trees. Even these species (some tropical and others introduced and established for a long time) have different degrees of agro-industrial transformation, which is why they have been the subject of agrotechnical studies at an important level. In this list we have species such as: Soursop or Guanábana, Pineapple Guava or Feijoa, Dragon Fruit or Pitahaya, Goldenberry or Uchuva, Tamarillo or Tree Tomato, Guava or Guayaba, Tamarind, Peach Palm or Pixbae, Cashew or Marañón, Star Fruit or Carambola, Coconut, Rambutan, Mangosteen, Macadamia and even Nopal (Íbidem), among others.

Fig. 4. Panamanian Exotic Fruits (Image from La Prensa journal).

IV. THE FRUIT WEALTH OF THE COUNTRY

There is little specific information on Panamanian non-traditional fruits, listing and / or describing the relevant species.

About 70 years ago, Dr. Robert Harris, a scientist at the Massachusetts Institute of Technology (MIT), mentioned just over 230 native species of edible plants with high nutritional content, in Central America and Panama (7), many of which are species fruit trees.

In 2009, the National Institute of Biodiversity (InBio) of Costa Rica published a book called "Edible Plants of Central America", which includes Panama. In its introductory section, this text indicates that: “The floristic richness and the cultural development of Central America have made important contributions to the food security of humanity. Corn, cocoa, beans, and chili peppers are just a few examples. In addition to these plants widely cultivated throughout the world, the region has a large number of edible species, many of which lack extensive cultivation technologies or are still collected directly from their natural environment, through artisanal practices” (8).

This book has technical data sheets on 103 edible species, the vast majority of which are fruits and of which just over 80% are present in Panama. On the other hand, this study leaves out several important orphan Panamanian fruit species.

The author Oris J. Donoso, in her work "Some plants used by the native groups of Panama" reviews 22 non-traditional and 4 traditional fruit species (9), based mainly on the text of Chizmar et al. (Op. Cit.).

In 2011, Carolina Reyes Acosta, a student from the Pontificia Universidad Javeriana de Bogotá, Colombia, with the support of the Center for Environmental and Human Development (CENDAH-Facilitadores) conducted a field study within communities of the San Blas islands, which generated, as a final product, the book "Plants of traditional use in the indigenous region of Guna Yala". The text lists and describes plant species for private consumption in the original Guna population (10), some of which are non-traditional tropical fruit species.

As already mentioned, for a few years, the CTFS-STRI has maintained an important “digital repository of trees, shrubs and common palms of Panama” called “Tree Atlas of Panama”, with information on almost 1,500 Panamanian plant species, including a good part of the fruit species, known or unknown, in the country (11).

In 2017, the book "Catalog of native plants with potential for biotrade and bioprospecting of the private natural reserve Punta Patiño, Darién, Panama" was published, which examines 22 plant species, many of them oleaginous fruit spices (12).

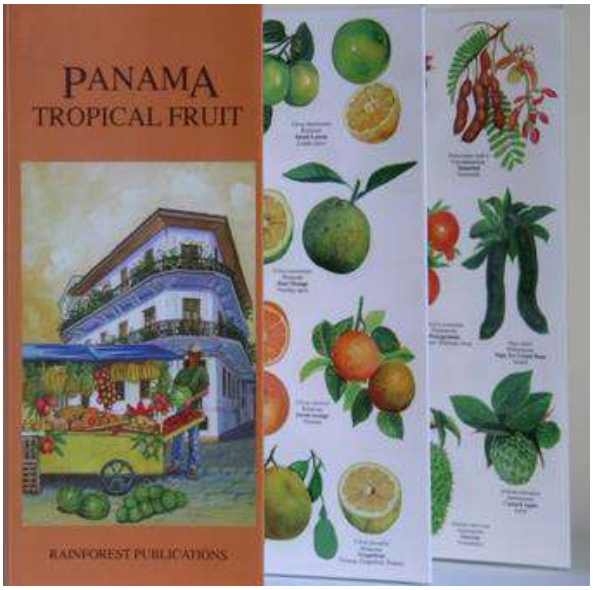

Fig. 5: “Panama Tropical Fruits”, published in the Netherlands by Rainforest Publications (ISBN 1888538-796-1).

V. OUR ORPHAN SPECIES

As the International Plant Genetic Resources Institute (IPGRI) points out: “Abandoned, forgotten, orphaned, neglected or traditional crops are those that are grown only in their centers of origin in a traditional way and that are important for the subsistence of families. rural ... Underutilized crops are products that were of commercial importance and today their popular presence in local markets has diminished and they are no longer appreciated” (19). They are increasingly unknown by consumers.

As already mentioned, both the agricultural and environmental Panamanian authorities have defined priorities regarding the preservation of plant genetic biodiversity, including those that have agri-food use or potential. For example, in 2009, the Panama’s Ministry of Agricultural Development launched the initiative called "Promotion and Competitiveness of the Fruit Subsector", which established that: "The direct beneficiaries of the actions to be carried out by the project will be approximately 1,150 producers for an incremental surface of 3,500 hectares of new plantations in the first 5 years of execution (an average of 3 hectares per producer) prioritizing eight fruits: avocado, passion fruit, papaya, banana, mango, cashew, guava and orange juice ”(20). This criterion and those “priorities” continue to this day.

Obviously, the fruit species considered "orphan" or in a state of abandonment, do not fall within the priorities already mentioned, which explains, to a large extent, their situation as native fruits that have been disappearing from local consumption.

However, there is awareness in a part of the population regarding the gradual loss of many of these species. In the report "The Fruits that were lost", the local newspaper La Prensa describes that, previously, "they did not have to go very far to find algarrobas, higo, jobo, cañafístula, grosella, guinda, piro, toreta, uvita de parra, cuate, guabita cansaboca, piñuela, níspero, corozo, pomarrosa and caimito, fruits that were abundant in almost all the fields of the interior countryside ... But today these fruits have practically disappeared, so they are unknown to new generations ... Curiously, the country has a high consumption of fruits from a temperate climate, such as apple, grape and pear" (21).

In an interesting journalistic work from a few years ago, Mr. Ángel Carril, fruit growing coordinator of the National Directorate of Agriculture of the Ministry of Agricultural Development (MIDA) in Santiago, Veraguas, pointed out that: "many tropical fruits native to Panama do not They are found with the same frequency as several decades ago ... Some of them are: la fruta de pan, el caimito, zapote, mamey, chirimoya, mangotín, guaba, guabita cansaboca, corozo, nance, níspero, jobo, pomarrosa, ciruela, guayaba criolla, toreto and borojó... This is a list of fruits that we have identified. As lately we have been working at the field level, we have observed that many of the producers have emphasized to us that these fruits have been disappearing ... These fruits are no longer seen as frequently due to factors such as: rapid population growth, environmental effects such as drought and floods, invasive species, overgrazing, burning, deforestation, among others… Before, people used to sow in the backyard. Now it cannot, as today's typical urbanization model does not allow people to plant; suddenly yes a rose and some palm trees, but the physical residential space that was traditionally wide before has now been reduced, and that means that people do not plant, and if they plant, they do it in small quantities ... so that these fruits are not lost , at least rescue their genetic material, because that is where the future of fruit growing practically lies, and create community nurseries to try to maintain them "(22).

Our "C" list is the list of our native orphan fruits and includes, for the most part, abandoned native species, but also some introduced species that have been largely lost. It includes species of primary consumption by our native peoples, for example: white cacao and pataste (Ngäbe-Buglé and Bokotá nations), jagua and guásima (Emberá-Wounaan nation), membrillo and piro (Guna nation). Also, many native fruits that were cultivated and consumed in the Panamanian countryside but that today are practically not found in markets and hardly in our fields.

Some of these species were introduced during the Spanish colony era or during major events of foreign presence (arrival of foreigners for the construction of the intercontinental railroad, the French canal or the interoceanic canal by the North Americans, with the consequent immigration of various human groups of various ethnicities). Species such as pomegranate, sarsaparilla, Curaçao cashew or rose apple, were introduced this way. Also, species that were brought by the Afro-Antilleans, such as akee, sorrel and breadfruit. All were consumed significantly during the late nineteenth century and a good part of the twentieth century.

All these introduced species and those of many of our native fruit trees, for various reasons (such as the strong influence of American culture, the relatively fast urbanization, the cosmopolitanism in terminal cities, the commercial opening towards food staples imports), began to stop being propagated and, therefore, to gradually disappear from the local fruit supply to the point that, at present, they are practically inaccessible and the last generations of Panamanians are even unaware of the existence of these species.

Table.1: Panamanian Orphan Fruit species

Spanish (Panamanian) common name	English common name	Scientific name	Bothanical Family
Akí or Fruto de Huevo	Akee	Blighia sapida	Sapindaceae
Algarrobo	Carob	Hymenaea courbaril	Fabaceae
Almendra tropical	Indian almond	Terminalia catappa	Combretaceae
Anón	Sugar apple	Annona squamosa	Annonaceae
Borojó	Borojo	Borojoa patinoi	Rubiaceae
Cacao blanco	Capuassu	Theobroma grandiflorum	Malvaceae
Caimito	Star apple	Chrysoplillum caimito	Sapotaceae
Canistel or Nisperillo	Canistel	Pouteria campechiana	Sapotaceae

Cañafístula	Golden shower, purging cassia, Indian laburnum, or pudding-pipe tree	Cassia fistula	Fabaceae
Cereza or Acerola	Barbados Cherry	Malpighia emarginata	Malpighiaceae
Chirimoya	Cherimoya	Annona cherimola	Annonacea
Ciruela Traqueadora or Mercoya	Red Mombin, Purple Mombin	Spondias purpurea	Anacardiaceae
Corozo or Palma de Pacora	N/A	Acrocomia panamensis	Arecaceae
Fruta de Pan	Bread Fruit	Artocarpus altilis	Moraceae
Granada	Pomegranate	Punica granatum	Lythraceae
Granadilla	Sweet Granadilla	Passiflora ligularis	Passifloraceae
Grosella	Otaheite Gooseberry, Malay Gooseberry	Phyllanthus acidus	Phyllanthaceae
Guaba	Ice Cream Bean	Inga edulis	Fabaceae
Guabita Cansaboca	N/A	Inga laurina	Fabaceae
Guásima	West Indian Elm or Bay Cedar	Guazuma ulmifolia	Malvaceae
Guayabita sabanera	Brazilian Guava, Castilian Guava, Sour Guava	Psidium guineense	Myrtaceae
Guinda	Black Cherry, Wild Black Cherry	Prunus salicifolia	Rosaceae
Guineo manzano	Dwarf banana	Musa sapientum	Musaceae
Icaco	Cocoplum	Chrysobalanus icaco	Chrysobalanaceae
Jagua	Genipap	Genipa americana	Rubiaceae
Jobo	Yellow Mombin, Hog Plum	Spondias mombin	Anacardiaceae
Madroño	N/A	Rheedia madrunno	Clusiaceae
Majaguillo or Capulín	Puan	Muntingia calabura	Muntingiaceae
Mamey	Mammee, Mammee Apple	Mammea americana	Calophyllaceae
Mamón, Mamoncillo	Genip, Kenep	Melicoccus bijugatus	Sapindaceae
Mangotín	June Plum	Spondias cytherea	Anacardiaceae
Maquenca	N/A	Coccoloba lasseri	Polygonaceae
Marañón Curazao, Manzana de Agua	Malay Apple, Otaheite Apple	Syzygium malaccense	Myrtaceae
Membrillo	Sachamango, Heaven Lotus	Gustavia superba	Lecythidaceae
Nance	Savanna Serret, Golden Spoon, Hogberry	Byrsonima crassifolia	Malpighiaceae
Naranjilla, Lulo	Naranjilla	Solanum quitoense	Solanaceae

Nonita	Custard Apple, Wild Sweetsop	Annona reticulata	Annonaceae
Pataste, Mocambo	Mocambo tree	Theobroma bicolor	Malvaceae
Piñuela	N/A	Bromelia pinguin	Bromeliaceae
Piro	N/A	Bromelia karatas	Bromeliaceae
Pomarrosa	Rose Apple	Syzygium jambos	Myrtaceae
Sapote, Mamey de tierra	Sapodilla, Nooseberry	Pouteria zapota	Sapotaceae
Saril, Flor de Jamaica	Sorrel, Roselle	Hibiscus sabdariffa	Malvaceae
Toreta	Soncoya, Sincuya	Annona purpurea	Annonaceae
Uva de playa	Sea Grape, Bay Grape	Coccoloba uvifera	Polygonaceae
Uvita	N/A	Bactris maraja	Arecaceae
Zapote	Sapodilla	Manilkara zapota	Sapotaceae
Zapote Teta de Chola	Chupa	Quararibea cordata	Malvaceae
Zarzamora	Blackberry	Rubus fruticosus or Rubus ulmifolius	Rosaceae

(Infographics by the author).

VI. FINAL CONSIDERATIONS

Regarding ideas to reverse this situation, there should be a reorientation of agricultural public policies in many areas, including the issue of native species, which should receive much more attention from the sectoral governing bodies. This should lead to a redefinition and expansion of what is understood as a priority species. Consequently, towards the agrotechnological study, preservation, propagation and sustainable use of more native plants, including orphan fruit species. This also implies their inclusion in the group of plant species with potential for agricultural exportation and their rational exploitation and promotion towards internal and external markets.

From an environmental and conservation perspective, firm actions must be taken for their management and conservation. It is not enough to preserve samples in herbaria. Inventories should be made targeting these particular species, as well as the establishment of one or more national genebanks for orphan species, as preliminary steps for their massive propagation and reintroduction in the field (community nurseries and gardens, individual farmers) and into their ecological niches.

The biotechnological study (especially through plant tissue culture techniques) of these species would be much valuable, from a botanical and agronomic perspective. Much of this would add new and useful scientific knowledge and would represent a significant contribution to the care of our plant genetic heritage and to the diversification of our national fruit production, based on state-of-the-art agrotechnologies.

From a cultural and health perspective, they should be studied, revalued and included in programs that rescue foods form former times, for the current Panamanian daily diet and to integrate them as valuable elements of the Panamanian gastronomic-cultural heritage, typical of the country.

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Assessment of the contribution of home garden and its component on household income and home garden income of disadvantaged groups (DAGs) in Jhapa district of Nepal

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Abstract— *Nepalese agriculture is subsistence based and furthermore, farms are getting smaller and subsistence farm families are on the rise.Home garden, traditional land use system around a homestead, where several species of plants are grown along with livestock. Home garden provides fruits and vegetables to the household with direct access to important nutrients that may not be readily available or within their economic reach. A study was conducted in three VDCs of Jhapa namely; Dharampur, Dangibari and Dhaijan to assess the contribution of home garden to total household income. The study reveled that among the three VDCs total own land, total plant species, were found significant and others were not significant. Mean of total plant species was found 42 and significant (P=0.5) among the VDCs. The home garden contribution on annual household income was 19.23% and livestock component was identified as most profitable component as it contributes 50.92% of home garden incomes followed by vegetable component (25.02%). The total household income was found higher in home garden practitioner compared to the non-practitioner household but it was not statistically significant. It was found that the mean annual income from home garden was NRs 37697.24 in practitioner household and significant (P=0.05). Among the home garden components the annual income was found highest in livestock component (NRs. 19197.77) followed by vegetable component (NRs. 9434.44). The annual income from home garden components such as vegetables, fruits and livestock components were found significant and higher in practitioner household whereas annual income from poultry and other component was not significant and higher in non-practitioner household The research suggested to promote home garden in order to increase the food security situation and income of the farmers.*

Keywords— ***Agriculture, Home Garden, Income, Practitioner, Food security.***

I. INTRODUCTION

Agriculture is the largest economic sector employing 65.7 percent of economically active population and sharing 35.1 percent in the GDP (MoAD, 2013).Nepalese agriculture is subsistence based and furthermore, farms are getting smaller and subsistence farm families are on the rise. Three types of interventions are commonly employed to improve micronutrient status, namely: capsule and tablet supplementation, fortification of commonly consumed foods, and diet diversification. Diet diversification is arguably the most sustainable and affordable strategy to improve nutrition for the majority of the population particularly the poor. For poor households, vegetables and fruits are often the only source of micronutrients in the family diet. Home garden, traditional land use system around a homestead, where several species of plants are grown along with livestock and maintained by household members and their products are primarily intended for the family consumption (HKI, 2001; Mictchell and Hanstad, 2003). Home garden provides fruits and vegetables to the household with direct access to important nutrients that

may not be readily available or within their economic reach. Home garden is one of the most complex and diverse agro-ecosystems worldwide. Home garden systems have existed for millennia (Kumar and Nair, 2004; Soemarwoto and Conway, 1992) in many tropical regions, where they played an important role towards the development of early agriculture and domestication of crops and fruit trees, a still ongoing process (Kimber, 1978; Miller and Nair, 2006; Ninez, 1987; Smith, 1996).

Therefore, home gardening would be a good means to improve household food security. Equally important, home gardening has been shown to be a source of additional income, because the household can sell a portion of the garden's produce. The home garden, literally known in Nepali as *GharBagaincha*, refers to the traditional land use system around a homestead, where several species of plants are grown along with livestock and maintained by household members and their products are primarily intended for the family consumption (Shrestha *et al.*, 2002). In Nepal, 72% of households have home gardens of an area 2-11% of the total land holdings (Gautam *et al.*, 2004).The current research highlights the contribution of home garden to total household economy.

II. MATERIALS AND METHODS

Home garden approach is a group based inclusive intervention which intends to contribute household food security and family nutrition through homestead agro-biodiversity management. The study was conducted in three VDCs of Jhapa district to analyze the effectiveness of home garden approach for household food security and socio-economic empowerment of disadvantaged people. Both descriptive and analytical survey design was used for this study. Altogether 120 respondents (40 respondents from each VDC) were randomly chosen. Descriptive statistics, one way ANOVA test, chi-square tests were employed to address the objectives set forth.

III. RESULTS AND DISCUSSION

Distribution of home garden practitioners by family type

Home garden practitioners were classified on the basis of the family type such as joint and nuclear. The study revealed that majority of the household was under joint family system (55.6%). Among the three VDCs, Dhaijan had the highest percentage of joint family (23.3%) followed by Dharampur (12.2%). Nuclear family type was found highest in Dangibari VDC (21.1%) followed by Dharampur VDC (13.3%). The distribution of home garden practitioners by family type is statistically significant (p=0.029) across the VDCs (Table 1).

Table 1. Distribution of the home garden practitioners by family type

Type of family	Name of VDCs			Total (N=90)
	Dharampur (n=30)	Dangibari (n=30)	Dhaijan (n=30)	
Joint	18(20.0)	11(12.2)	21(23.3)	50(55.6)
Nuclear	12(13.3)	19(21.1)	9(10.0)	40(44.4)
Total	30(33.3)	30(33.3)	30(33.3)	90(100.0)

Source: Field survey, 2013

Figures in parenthesis indicate percentage

$\chi 2$- value 7.110 at 2 df (p=0.029)

Land holding characteristics

The mean size of land holdings of the home garden practitioners was higher in Dangibari (23.61 kattha) followed by Dharampur (10.13 kattha), whereas the mean land holding under home garden was also higher in Dangibari (2.25 kattha) followed by Dhaijan (2.12 kattha). The maximum land holding was 60 kattha whereas the minimum was found 0.5 kattha: moreover, the maximum land holdings under home garden were 8 kattha and minimum 0.2 kattha in the study area (Table 2).

Table 2. Distribution of home garden practitioner based on land holdings in the study district

Name of VDCs	Mean	St. Deviation	Maximum	Minimum
Dharampur				
Total own land (Kattha)	10.13	9.81	40	1
Home garden size (Kattha)	1.64	1.12	6.0	0.2
Dangibari				
Total own land (Kattha)	23.61	15.35	60	0.5
Home garden size (Kattha)	2.25	1.67	8.0	0.5
Dhaijan				
Total own land (Kattha)	7.15	5.54	20.0	1.0
Home garden size (Kattha)	2.06	1.08	6.0	1.0
Total				
Total own land (Kattha)	13.63	13.04	60.0	0.5
Home garden size (Kattha)	1.98	1.32	8.0	0.2

Source: Field survey, 2013

From this study it was evident that average home garden size was 14.52 % of average total land holdings which is slightly higher than the findings of Gautam *et al.*, 2004 i.e. 72% of households have home gardens of an area 2-11% of the total land holdings and smaller than the findings, it occupies 20% of the total arable land (Jensen, 1993). The variation in such result may due to differential socioeconomic character.

One-way ANNOVA analysis of socioeconomic characteristics and income distribution ofhome garden practitioners

Different socio-economic parameters were analyzed among three VDCs using one way ANNOVA test. The variables such as total own land, area under home garden, total plant species, years of schooling, income from different components, annual household income were analyzed. Among the three VDCs total own land, total plant species, were found significant and others were not significant. The value from Duncan's test helps in the determination of homogeneity of the variables. Mean total own land was found 13.63 kattha and significant (P=0.01) among the VDCs, and on homogeneity test total own land of Dharampur and Dhaijan fall in same category, whereas total own land of Dangibari falls on other category. Mean of total plant species was found 42 and significant (P=0.5) among the VDCs. Further, on homogeneity test total plant species of Dangibari and Dhaijan fall under one category, whereas total plant species of Dharampur falls under another group. Although, there is variation of income across the VDCs, but was not significantly differ (Table 3).

Table 3. VDC wise socioeconomic characteristics and income distribution of home garden practitioner using one way ANNOVA

Variables	Total Average (N=90)	Dharampur (n=30)	Dangibari (n=30)	Dhaijan (n=30)	F- value
Total own land (kattha)	13.6333	10.1333[a]	23.6167[b]	7.1500[a]	19.100***
Total own land under home garden (kattha)	1.98	1.642	2.250	2.067	1.678
Total plant species	42	47[a]	45[b]	34[b]	3.55**
Year of schooling	7.04	7.4	7.4	6.26	.931
Income from poultry component (NRs)	5465.9	6500	4850	4428.6	.472

Income from fruit component (NRs)	4200	2370.6	3156.2	5907.1	2.017
Income from livestock component (NRs)	21597	13260	22607	28270	2.372
Income from other component (NRs)	8183.4	8370.6	13706	4115.5	.601
Income from vegetable component (NRs)	9873.3	7976.7	10115.4	11560	0.834
Home garden annual income (NRs)	37697.24	29446.67	37278.36	46366.7	1.778
HH annual Income (NRs)	195419.1	193579	169116.7	223500.0	1.109

Source: Field survey, 2013

*** Significant at 1% level, ** significant at 5 % level

Home garden and its component contribution to income

Contribution of home garden and its components on annual household income

As different components are integrated on home garden, its profitability in terms of income generation is worthwhile to be noted. In this perspectives attempt was made to identify the most profitable component. From the study it was evident that the home garden contribution on annual household income was 19.23% and livestock component was identified as most profitable component as it contributes 50.92% of home garden incomes followed by vegetable component (25.02%) (Table 4).

Table 4. Contribution of home garden and its component on household income and home garden income

Particulars	Annual income (NRs)						
	Household	Home garden	Vegetable	Fruit	Livestock	Poultry	Other
Mean	196025.56	37697.20	9434.44	2846.60	19197.70	2672.22	3546.10
St. Dev.	141182.24	35082.10	10737.80	5553.40	24927.40	5257.50	13682.10
Percentage contribution		19.23#	25.02##	7.55##	50.92##	7.08##	9.40##

Source: Field survey, 2013

Home garden contribution on annual household income

Component contribution on home garden annual income

Home garden and its contribution on household income

The total annual household income; income from home garden and income from home garden components were analyzed in home garden practitioner and non practitioner household and mean was compared.

The total household income was found higher in-home garden practitioner compared to the non practitioner household but it was not statistically significant. It was found that the mean annual income from home garden was NRs 37697.24 in practitioner household and significant (P=0.05). Among the home garden components the annual income was found highest in livestock component (NRs. 19197.77) followed by vegetable component (NRs. 9434.44). The annual income from home garden components such as vegetables, fruits and livestock components were found significant and higher in practitioner household whereas annual income from poultry and other component was not significant and higher in non practitioner household (Table 5).

Table 5. Annual household incomes from different sources

Annual HH income	Home garden practitioner (n=90)	Non practitioner (n=30)	Mean Difference	t-value
Total HH income (NRs.)	196025.56	168873.33	27152.22	0.987
Home garden annual income (NRs)	37697.24	19463.34	18233.91**	2.593
Annual home garden income from vegetable (NRs)	9434.44	2723.33	6711.11***	3.375
Annual home garden income from fruit (NRs)	2846.66	1166.66	12297.77*	1.631
Annual home garden income from livestock (NRs)	19197.77	6900.0	12297.77***	2.660
Annual home garden income from poultry component (NRs)	2672.22	3033.33	-361.11	-0.289
Income from other component (NRs)	3546.13	5640.0	-2093.86	-0.550

Source: Field survey, 2013

*** Significant at 1% level, ** significant at 5 % level, * significant at 10%

Study revealed that home gardens adoption had positively contributed to income generation which is similar to the findings of Calvet*et al.* 2012 and Vassey, 1985 that is home garden contribute to income generation, improved livelihoods, and household economic welfare as well as promoting entrepreneurship and rural development.

Sufficiency of home garden products on household requirement

Home gardens, with their intensive and multiple uses, provide a safety net for households when food is scarce. To analyze duration of food supply by home garden, duration of time was categorized as year round, 9-12 months, 6-9 months, 3-6 months and 0-3 months. On study, 85.6% home garden practitioner responded that a vegetable produced under home garden was sufficient for more than 6 months. Furthermore, 71.1% and 48.9 % respondent agreed that fruit produced under home garden and animal protein derived from home garden is sufficient for only 0-3 months.

Table 16. Sufficiency of home garden components on household requirement

Components	Sufficiency				
	Year round	9-12 months	6-9 months	3-6 months	0-3 months
Vegetable	23(25.6)	27(30.0)	27(30.0)	11(12.2)	2(2.2)
Fruit	2(2.2)	6(6.7)	9(10.0)	9(10.0)	60(71.1)
Animal protein requirement	6(6.7)	7(7.8)	19(21.1)	14(15.6)	44(48.9)

Source Field survey, 2013

Figures in the parenthesis indicate percentage

From the study it was found that home garden plays important role on year round supply of food particularly vegetables which is consistent with the finding of (Budowski, 1990; Eibl*et al.*, 2000). According to Budowski, 1990 and Eibl*et al*. 2000 home gardens are very important for supplying the household with food products year-round.

IV. SUMMARY AND CONCLUSION

The distribution of home garden practitioners by family type is statistically significant. The mean size of land holdings of the home garden practitioners was higher in Dangibari (23.61 kattha) followed by Dharampur (10.13 kattha), whereas the mean land holding under home garden was also higher in Dangibari (2.25 kattha) followed by

Dhaijan (2.12 kattha). From this study it was evident that average home garden size was 14.52 % of average total land holdings. Mean total own land was found 13.63 kattha and significant (P=0.01) among the VDCs, and on homogeneity test total own land of Dharampur and Dhaijan fall in same category, whereas total own land of Dangibari falls on other category. Mean of total plant species was found 42 and significant (P=0.5) among the VDCs.From the study it was evident that the home garden contribution on annual household income was 19.23% and livestock component was identified as most profitable component as it contributes 50.92% of home garden incomes followed by vegetable component (25.02%). The total household income was found higher in home garden practitioner compared to the non-practitioner household but it was not statistically significant. Mean annual income from home garden was NRs 37697.24 in practitioner household and significant (P=0.05). Home garden plays important role on year round supply of food particularly vegetables

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AUTHORS' CONTRIBUTIONS

B. Prasai conducted research and wrote the paper. D. Devkot, K.K. Pant, and R.H. Timilsina revised and finalized the paper.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding publication of this manuscript.

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Utilization of Biogas Sources from Pig Waste as an Effort to Minimize Environmental Pollution

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Abstract**—** *Livestock was one of the subsectors that play an important role in human resource development. One of the livestock commodities that had an important role as a source of animal protein was pigs. North Sulawesi had prospects in the development of pigs in terms of livestock resources and the availability of local consumers. The problem was that pig farms were developed in residential areas so that this condition had a negative impact on the environment of the community. This research was conducted with the aim of analyzing the potential for biogas production from pig waste. The research method used was a survey method with a case study approach to pig farming. The location of pig farms was determined by purposive sampling, namely pig farms managed in residential areas. Respondents were the Maesa pig farmer group in Tempok Village. Analysis of the data used was descriptive analysis through the analysis of biogas production potential.The results showed that the number of pigs in the pen was 13 tails, consisting of adult and grower phases, each of which was 4, and the starter was 5. The total weight of pigs was 753 kg which produces 56.59 kg of manure per day. The results of this study had the potential to produce 1.53 kg of gas per day. Based on the results of the study, it can be concluded that the biogas produced was beneficial for minimizing environmental pollution and substituting the use of LPG gas and firewood. Suggestions, biogas reactors need to be socialized to other farmers who develop pig farming businesses in residential areas and need government intervention to introduce biogas reactors because they require investment funds.*

Keywords**— biogas, waste, pigs.**

I. INTRODUCTION

Agricultural development is currently carried out with a sustainable orientation. Sustainable agriculture was a policy that was very much needed in development. The concept of a sustainable agricultural system was a concept that became a global issue that emerged in the eighties. Some evidence shows that agriculture as a production system was in fact also a polluter. Agriculture in a broad sense also includes the livestock sub-sector which was claimed to be a polluter. The livestock waste produced has an impact on increasing greenhouse gas emissions.

Livestock in North Sulawesi was generally a producer of animal protein food with high nutritional value to improve the quality of human resources. Livestock development in this case has good prospects in the future. This is because the current demand for livestock products continues to increase, along with the increase in population, income and public awareness to consume highly nutritious food. The indications are that livestock development needs to be encouraged in order to fulfill the demand of the population which tends to increase. The commodity of concern as a source of animal protein from livestock in North Sulawesi was pigs.

Pigs were one of the livestock commodities that were relied on by some people of North Sulawesi as a source of animal protein as well as their source of income. This pig farming business had market prospects considering that the people of North Sulawesi province were potential consumers. Pig products in this area were liked and consumed by most people. This was supported by social and religious factors that support the community in consuming pork products so that the demand for pork was quite high.

The prospects described above were very supportive of the development of pigs which were supported by a very open market potential. The characteristics and abilities of these pigs provide benefits (Gobai et al, 2013), and their business development was very potential (Aku et al, 2013). This phenomenon shows that pigs were easy to sell at the age of 8-9 months with body weights reaching 100 kg live weight, balanced with fast growth, prolific nature (many births) and good ration efficiency. Pigs and or their processed products were quite potential as a national export commodity (Ministry of Agriculture, 2012). The market for pork commodities is even still wide open to various countries such as Singapore and Hong Kong. The advantage of pigs over chickens was that the volume of imports can be said to be zero (Ministry of Agriculture, 2012). Pigs based on several studies can be used as an alternative business for farmers because of the fairly high contribution of these businesses (Sobang and Paulus, 2017).

The production and population of pigs need to be encouraged in balancing their potential and development prospects. Based on the potential and prospects for the development of pig farming, the business can be increased to a commercial direction. Consequently, the increase in population and production of pigs had an impact on increasing pig waste.The increasing waste of pigs had the opportunity to pollute the environment. The production process of pig farming can cause environmental problems (Putra et al. 2015).Based on this problem, one way that can be done is to process pig manure into biogas. Biogas was a technology for the formation of energy (Wahyuni, 2011).he stages of the biogas process begin with building a biogas reactor to accommodate pig farm waste, which is very important in internalizing environmental pollution. Based on this background and thoughts, a research was conducted on the utilization of biogas from pig manure. The purpose of this study was to analyze the potential of biogas production and its benefits to pig farmers and society in general.

II. RESEARCH METHODS

The research method used was a survey method with a case study approach to pig farming. The data collected were primary data and secondary data. The location of the pig farm was determined by purposive sampling, namely the pig farm that was managed in a residential area. Respondents were the Maesa Pig Farmer Group in Tempok Village. The data analysis used was descriptive analysis through the analysis of biogas production potential using the formula (Wahyuni, 2015):

Biogas Production Potential = BK x Production Rate (m^3/kg BK)

Explanation :

BK : Dry Weight

Production Rate : 0.30 m^3/kg BK at 25^0C

III. RESULTS AND DISCUSSION

North Sulawesi as a potential area for the development of pigs can be seen from its population which was increasing every year. The pig population in 2018 was 411,753 heads to 427,777 in 2019 or an increase of 3.89 percent (BPS North Sulawesi, 2020). The increase in population was the impact of the increasing number of pig farming businesses, one of which was due to the potential of abundant natural resources and had not been fully utilized (Wea et al. 2020). The increase in the pig farming business was supported by the development of restaurants using pork as raw materials (Saroinsong et al. 2019).

Consequently, the increase in the population of pigs had an impact on environmental pollution. This was because the increasing population of pigs causes an increase in the amount of waste produced.The waste had an impact on environmental pollution of water, soil and air because it is not managed properly. Pig farm waste that was managed properly can had a positive impact, because the abundant livestock waste has the potential to be a source of energy that is very beneficial for farmers in particular and humans in general. The current condition of pig waste has been used as a source of biogas.

The results show that 100 percent of farmers develop pig farming as a source of income that is used to support the lives of farmers. However, livestock development was carried out in residential areas so that it was very disturbing to the surrounding community. Whereas farmers can benefit from the pig business (Suryadi et al. 2014).The pig business also has opportunities to compete in the MEA market (Suarna and Suryani, 2015). Pig farming has an impact on increasing income and employment opportunities if the management

is carried out in accordance with the recommended and sustainable (Tulak et al. 2018).

The results showed that 75 percent of farmers graduated from junior high school and 25 percent graduated from high school. Farmers do not receive education about biogas and the use of biogas reactors. The lack of knowledge and low background of pig farmers cause environmental awareness has not been a concern. Pig farm waste was channeled into the yard and public drains. A biogas reactor was introduced in the research area in 2017 which was used as an example (Salendu et al. 2017). Pig farm waste had been channeled to a biogas reactor so that pollution can be minimized. In fact, the introduction of the biogas reactor had not been well received by other farmers and even by the government in the research area. Farmers and the government in general do not have knowledge about the benefits of building a biogas reactor. In addition, the construction of a biogas reactor requires investment funds so that it has not become the attention of farmers and various parties.

The results showed that the number of pigs managed by the Maesa group was 13, consisting of 4 adult pigs, 4 growers and 5 starters. After weaning (aged 10 weeks), 36 pigs were immediately sold. Adult pigs belonging to farmers were used as broodstock. There were 13 pigs in the pen, which produce waste which was directly distributed to the biogas reactor. The biogas introduced in the research area was in the Maesa group farm (Salendu et al. 2017). The body weight of each pig was presented in Table 1.

Table 1.Body Weight and Number of Pigs

Body Weight (Kg)	Pigs(Ekor)	Amount (Kg)
100	2	200
90	2	180
70	1	70
65	2	130
50	1	50
25	2	50
20	2	40
15	1	15
Total	13	735

There were 13 pigs with a total body weight of 735 kg (Table 1) which produce manure which was a potential source of biogas. The number of pigs totaling 36 heads in this case was considered not to affect biogas production because it had been sold.Making biogas can be done by farmers who had 6 pigs (Dewi and Kholik, 2018). The waste produced by breeder pigs with a body weight of 90-120 kg can reach 5.30 kg per day (Takarenguang et al. 2016). The biogas potential according to the research results can be seen in Table 2.

Table 2.Biogas Production Potential

No.	Description	Value
1.	Total Body Weight of Pigs (Kg/Day)	
2.	Waste Produced (Kg/Day)	
3.	Dry Weight (Kg/Day)	
4.	Gas Production (m^3/kg BK)	

The total body weight of pigs according to the results of the study was 753 kg which produced 56.59 kg of waste per day (Table 2). This condition has the potential to produce 1.53 kg of gas per day. Pig feces was very good to use as stuffing material in the process of producing biogas because it has a feces CN ratio of 25, meaning that the development and activity of methane-forming microorganisms is very good.Pigs are not only a producer of meat, organic fertilizer, but also biogas (Seseray et al. 2012). The biogas reactor was successfully constructed starting with pig manure (Adl et al. 2012). The implication was that pig farmers were able to substitute firewood and LPG gas with biogas produced from pig manure. Furthermore, the comparison of research biogas with other fuels was presented in Table 3.

Table 3.Comparison of Biogas from Research Results with Other Fuels

No	Other Fuels	Production of1m^3 Biogas*	Production of 1,53
1.	LPG (kg)	0.46	
2.	Kerosene (Liter)	0.62	
3.	Firewood (Kg)	3.50	
4.	Diesel Oil (Liter)	0.52	
5.	Gasoline (Liter)	0.80	
6.	City Gas (Cubiv)	1.50	

Keterangan : *) Wahyuni (2015)

**) Research Result Data (Processed)

The results showed that the fuel used by farmers for their daily needs was LPG, kerosene and firewood. The data in Table 3 shows that the biogas production according to the research results was 1.53 m3 equivalent to LPG of

0.704 kg per day.The use of kerosene per day can be substituted by utilizing biogas, biogas production was 1.53 m^3 equivalent to kerosene of 0.949 liters. Furthermore, the use of firewood per day can be substituted by utilizing biogas, biogas production of 1.53 m^3 was equivalent to firewood of 5.355 kg. The indication was that the cost of purchasing LPG gas and kerosene can be reduced if farmers use biogas from pig manure. Farmers can also reduce their use of firewood in the forest if they use biogas.

Household scale biogas technology was used as fuel for cooking instead of firewood and improves human health and the environment (Barnhart, 2012). Biogas was one type of energy and sustainable development that was important for energy and environmental planning. Biogas was one of the renewable energy sources that can answer the need for energy as well as provide soil nutrient needs in a sustainable agricultural system. The benefits obtained from making biogas were reducing expenditure on kerosene, reducing dependence on fuel from wood, making the yard clean, pleasing to the eye and reducing odors (Elly, 2012).The management of pig waste into alternative energy was very beneficial for various parties (Mariawan, 2012). Several studies had shown that biogas technology can be applied to household, commercial or village scale. Utilization of biogas as an energy source in small industries based on agricultural product processing can provide multiple effects and become a driving force for the dynamics of rural development.Biogas can also be used to increase added value by giving green labeling to processed products that were processed using green energy. Biogas as an alternative solution to overcome the energy crisis solution (Yahya et al. 2017).

IV. CONCLUSIONS AND SUGGESTIONS

Based on the results of the study, it can be concluded that the biogas produced is beneficial for minimizing environmental pollution and substituting the use of LPG gas and firewood.Suggestions, biogas reactors need to be socialized to other farmers who develop pig farming businesses in residential areas and need government intervention to introduce biogas reactors because they require investment funds.

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Improvement of fungal cellulolytic and xylanolytic enzymes production by new formulation of culture medium using wastes

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Abstract— *The use of the I-Optimal mixture design technique of agro-industrial residues in cultivation submerged at 28°C for 15 days with Trichoderma reesei QM 9414, complemented with nutrients, was used to optimize the mixture for the production of fibrolytic enzymes. The results demonstrated that the use of 100% (m/v) of brewer's spent grain was promising for the production of total cellulases (0.42 FPU/mL) and xylanase (39.60 U/mL), as well as the use of 33.3% citrus pulp and 66.7% brewer's spent grain for the production of xylanase (40.2 U/mL). The combination of 16.67% wheat bran, 16.67% citrus pulp, and 66.7% brewer's spent grain was the most promising for the production of endoglucanase (2.03 U/mL), exoglucanase (3.20 U/mL), and β-glycosidase (0.12 U/mL). The study on the demand for minerals, sucrose, and yeast extract (as a vitamin and amino acid source) revealed that 0.1% yeast extract, 0.11% dibasic potassium phosphate, 0.0028% zinc, and 1% of sucrose in 12 days of culture were sufficient to maximize the production of cellulases, increasing by 2.38 times (1.0 FPU/mL) compared to the initial culture (0.42 FPU/mL). Cellulolytic production remained the same with the use of 0.01% tween 80 in citrus pulp (0.40 FPU/mL) compared to that obtained in the design with a brewer's spent grain without tween 80, however it reduced substantially (from 15 to 9 days) the cultivation time. On the other hand, the use of tween 80 dramatically inhibited the fungal production of xylanases (2.96 U/mL). The best combination of salts was combined with tween 80 to obtain 1.12 FPU / mL in 9 days of fermentation. An enzymatic hydrolysis of cassava bagasse was carried out by combining cellulases and amylases, reaching 48 g / L of reducing sugar. Thus, this work shows that by studying the influence of residues, kind of salts and concentration of tween 80, a more efficient and economical bioprocess was possible to obtain, as well as the association between fibrolytic enzymes.*

Keywords— ***Agro-industrial residues, cellulases, submerged fermentation, Trichoderma reesei QM 9414, xylanase.***

I. INTRODUCTION

According to the United Nations data (2019), it is estimated that the world population will reach 9.7 billion by 2050. Such a population growth induces an increase in the consumption of natural resources and, in turn, an increase in the production of agro-industrial waste. The reuse of these residues is an option to reduce pollution of the environment and to add value to such a waste.

Nowadays, the main agro-industrial residues are wheat bran, sugar cane straw, cassava bagasse, citrus pulp, and brewer's spent grain, just to mention a few examples. The brewer's spent grain is also known as spent grain or malt bagasse. Beer production generates 20 kg of brewer's

spent grain for every 100 liters produced. (Aboukila *et al.*, 2018). Considering the annual production of 14 billion liters of beer, a generation of 2.8 million tons of brewer's spent grain can be estimated annually (Cervbrasil 2016). Brewer's spent grains are considered as a fibrous material containing about 19-30% protein, 12-25% of cellulose, 20-25% of hemicellulose, and 12-28% of lignin. The nutritional composition varies according to the process used by the brewery and the origin of the products (Lynch *et al.*, 2016). Regarding the orange pomace, also called the citrus pulp, a fibrous residue composed of peel, seed, and pulp, which representing about 50% of the discarded fruit. The use of these residues is an alternative to add value to the fiber-rich material, making the bioprocess more viable in terms of production costs (Cypriano *et al.*, 2017). The lignocellulosic residues have a rich biochemical composition and a high potential for energy generation, in addition to not interfering with food production (Magalhães *et al.*, 2019). Such residues are an option for the production of second-generation ethanol. The use of orange pomace has shown to be promising in the production of xylanolytic and cellulolytic enzymes (Cypriano *et al.*, 2017). The residues, brewer's spent grain and citrus pulp, are also used as food for dairy cattle because they have high nutritional value, good digestibility, and degradability (Ikram *et al.*, 2017).

Brazil, together with the United States, represent the countries that invest the most in bioethanol production, both accounting for 85% of the world production (Azhar *et al.*, 2017; Spyridon *et al.*, 2016). Investments in second-generation ethanol are growing, as well as the studies to optimize the process of production. However, even though the production of second-generation ethanol is very promising, it is still limited by the high cost of producing cellulolytic enzymes. These productions consist of an enzymatic complex that includes exoglucanases, endoglucanases, and β-glycosidases. The synergistic action of cellulases degrades cellulose polymers present in plant material to release fermentable sugars that can be converted into ethanol (Devi and Kumar 2012).

Several companies are investing in this segment as Danisco / DuPont (Denmark), Basf (Germany), Genencor (USA), Roche (Switzerland), Novozymes (*Denmark*), among others (Li *et al.*, 2012). In particular, cellulases due to their broad spectrum of application encompass the second place regarding industrial interest, being directly related to the viability of second-generation ethanol production. The cost of the enzyme can reach 48% of the minimum sale price of cellulosic ethanol (Liu *et al.*, 2016). The reduction of the production costs is an alternative to support the future development of biorefineries and viable production of second-generation ethanol, which depends not only on the large quantities of lignocellulosic residues generated annually, but also on the production costs of cellulolytic enzymes (Rastegari *et al.*, 2019). In addition to the production of second-generation ethanol, there are other interesting applications that use enzymes such as processes in the textile industry, juice clarification, glucose syrup production, among others. Thus, this work aims to develop an economic bioprocess in order to produce fibrolytic enzymes (cellulase and xylanase enzymes) from the use of agro-industrial wastes.

II. MATERIAL AND METHOD

In order to optimize a bioprocess for the production of cellulase and xylanase enzymes, studies were carried out in five stages: (i) preparation of the inoculum of the microorganism, (ii) preparation of an experimental design to study fermentations, (iii) fermentation stage, (iv) extraction stage and (v) enzymatic analyzes. The IBM SPSS software was used to perform statistical analyzes. Significance level of 0.05%.

2.1 Inoculum preparation

The inoculum of the microorganism culture was prepared using *Trichoderma reesei* QM 9414 strain in petri dishes containing 30 mL of PDA medium (39 g/L - Potato Dextrose Agar - Difco, Detroit, USA) incubated for five days (120 hours) at 28 °C in order to produce spores. The inoculum consisted of transferring a 10 mm diameter circle of PDA containing the fungus *T. reesei* QM 9414. The culture was maintained in mineral oil and PDA medium for preservation. Before each fermentation, two replications were carried out in the PDA medium to activate the fungus.

2.2 Experimental design applied to optimize the mixture of agro-industrial residues used in the culture medium of *T. reesei*

Agricultural residues, citrus pulp (Citrovita Agroindustry, Catanduva-SP), wheat bran (Moinho Nacional, Assis - SP) and brewer's spent grain (Cervejaria Malta, Assis - SP) were used in order to select the most suitable combination of substrates for the production of cellulases and xylanases. The residues were previously crushed in an industrial crusher (SPL-048, Spolu, Itajobi, Brazil) and then sieved so that the particle size selected for the experiment (between 1 mm and 2.8 mm) reducing the variations caused by lack of homogeneity of the substrates and facilitating the access of microorganisms to nutrients. Then, an I-Optimal mix design was designed with a sufficient number of experimental combinations to fit a model to determine the influence of the proportions of three substrates on the production of enzymes. The

modeling and statistical optimization were performed using Design-Expert software version 10 (Design-Expert®, StatEase Inc. Minneapolis, USA) with a 5% significance level, with response variables being the enzymatic activities of xylanases (U/mL), total cellulase (FPU/mL), endoglucanase (U/mL), exoglucanase (U/mL) and β-glycosidase (U/mL).

2.3 Cultivation tests with *T. reesei* QM 9414

The fermentation media were prepared in a 250 mL Erlenmeyer containing 100 mL of water and combinations of substrates according to the experimental design of item 2.2. A set of salts, sucrose and yeast extract, previously studied in the laboratory, were used to supplement the submerged fermentation medium (formulation: 0.11% K2HPO4, 0.1% (NH4)2SO4, 0.0017% MgSO4.7H2O, 0.0028% ZnSO4.7H2O, 0.1% MAP (NH4H2PO4), 0.06% KCl and supplemented with 1% sucrose and 0.1% yeast extract) (Campioni *et al.*, 2019). Then, the media were sterilized at 121 °C for 20 minutes with subsequent inoculation of the microorganism according to item 2.1. Cultivations took place in a shaker at 28 °C, 150 rpm for 360h (15 days). After the fermentation period, the enzymatic extract was obtained through filtration on filter paper to remove unfermented substrates and mycelium from the fungus. The extract (60 to 70 ml) was centrifuged at 5000 rpm (956xG) for 10 minutes (Heraeus Megafuge 16R, Thermo Scientific, Osterode am Harz, Germany) and stored in a freezer at -18 °C during the analysis process.

2.4 Effect of new formulations of Tween 80, salts and surfactants on the production of xylanases and cellulases

Additional studies to the experimental design of mixtures were carried out with Tween 80 and with the nutrients (salts, sucrose and yeast extract), in order to observe the influence on enzymatic production. Tween 80 was used in concentrations of 0.01%, 0.05% and 0.1% for the cultivation carried out with 10% of brewer's spent grain, salts, sucrose and yeast extract according to the standard formulation. Tests with Tween 80 were also performed with 3% citrus pulp. Cultures were performed at 28 °C, 150 rpm in 15 days, with samples taken during this period. Analyzes of enzymatic activity were performed after cultivation.

The study of the influence of salts, sucrose and yeast extract were carried out in individual cultures, with each specific nutrient together with the brewer's spent grain to perform the cultivation at 28 °C, 50 rpm for 15 days. Samples were taken throughout the cultivation. The eight nutrients were tested at this stage. The best conditions of tween 80 and salts were associated with the carbon source in order to maximize the enzymes production in batch fermentations.

2.5 Enzymatic assays

The activity of total cellulase (EC 3.2.1.4), endoglucanase (EC 3.2.1.4.) and exoglucanase (E.C. 3.2.1.91) of the obtained extracts were determined by the absorbance measurement at 540 nm for the estimation of reducing sugars (especially glucose) released in the hydrolysis of cellulose, carboxymethylcellulose (CMC) and avicel (microcrystalline cellulose) respectively by the aforementioned enzymes, as described by Ghose (1987). The reducing sugar released was quantified by the Miller method (1959). 1 unit of enzymatic activity was defined as the amount of enzyme required to release 1 μmol of reducing sugar, per minute, under the test conditions, using a standard glucose curve.

Xylanolytic activity (EC 3.2.1.8.) was carried out with 0.5% Birchwood xylan substrate (Sigma Aldrich) in acetate buffer pH 5.0 as described by Bailey *et al.*, (1992). The 3,5-dinitrosalicylic acid method (Miller 1959) was used to quantify reducing sugar released from xylan. 1 unit of enzymatic activity is defined as the amount of enzymes required to release 1 μmol of reducing sugar, per minute, under the test conditions, using a standard xylose curve.

β-glucosidase activity (*E.C.* 3.2.1.21) was performed using p-nitrophenyl β-D-glucopyranoside (PNPG) as a substrate, which is hydrolyzed by the enzyme in p-nitrophenyl and D-glucose as described by Grover et al, (1977). 1 unit of enzyme activity is defined as the amount of enzyme needed to form one μmol of p-nitrophenyl per minute under the conditions described. The activities developed in this work are represented in the diagram of Fig 1.

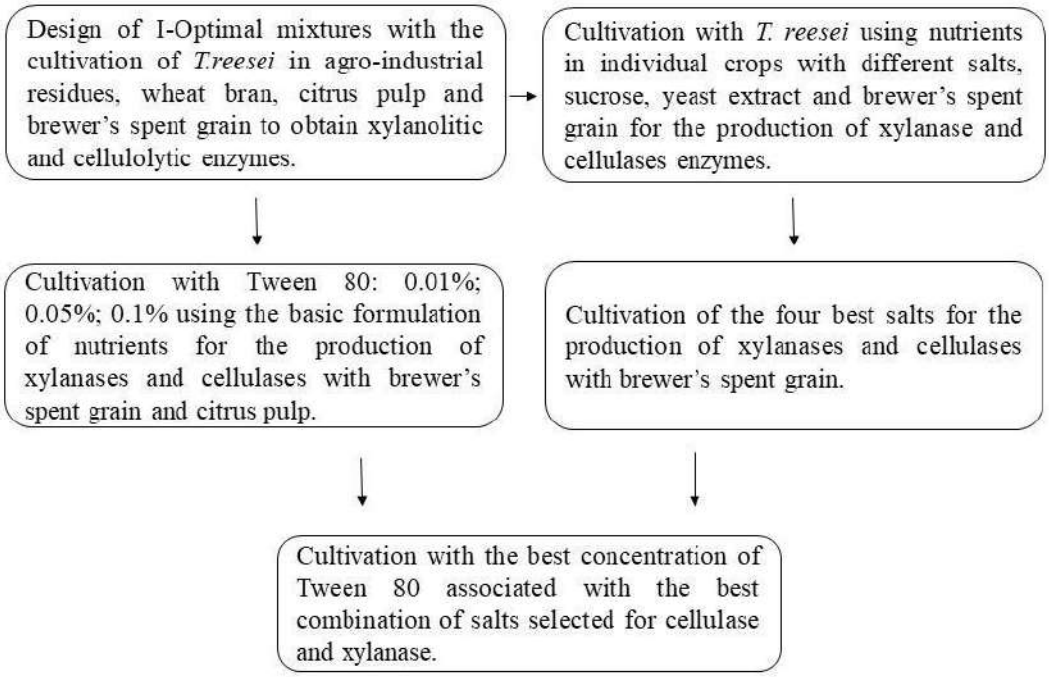

Fig. 1. Summary of the experimental steps to optimize the enzyme activities studied.

2.6. Enzymatic hydrolysis

Enzymatic hydrolysis was performed with 10% (w/v) cassava bagasse in pH 4.5 citrate buffer at 50 °C for 24 hours. The samples were tested with and without previous gelatinization (20 min at 80 °C). The enzymes used were amylase (15 U/mL) and cellulase (15 FPU/mL) added at time zero and time ten hours. At the end of hydrolysis, the enzymes were denatured (5 min at 100 °C) followed by quantification of the reducing sugar (DNS) released. Amylolytic enzymes were produced with *Rhizopus oligosporus* (CCT 3762) according to Escaramboni and Oliva-Neto (2016).

III. RESULTS AND DISCUSSION

3.1. Experimental design of agro-industrial waste mix for optimization of enzyme production

Table 1 presents the experimental matrix of the composition of the fermentation media as well as the results of the output variables for each enzyme studied.

Table 1. Experimental matrix and observed responses of agro-industrial waste mix to optimize the production of xylanases and cellulases.

Samples	Variable Factors			Xylanase	Endo-glucanase	Exo-glucanase	β-glycosidase	Total Cellulase
	A %	B %	C %	U/mL	U/mL	U/mL	U/mL	FPU/ml
1	0.00	66.67	33.33	14.228	0.050	2.381	0.049	0.230
2	0.00	100.0	0.00	1.796	0.025	0.900	0.013	0.096
3	66.67	33.33	0.00	12.712	0.030	1.777	0.036	0.235
4	66.67	0.00	33.33	28.690	0.377	2.218	0.078	0.360
5	0.00	0.00	100.00	**39.607**	1.127	2.634	0.077	**0.427**
6	16.67	16.67	66.70	30.707	**2.030**	**3.202**	**0.126**	0.395
7	33.33	66.67	0.00	7.419	0.010	1.294	0.016	0.000

8	66.67	16.67	16.70	20.328	0.438	2.452	0.070	0.234
9	100.0	0.00	0.00	19.693	0.701	2.888	0.059	0.271
10	33.33	0.00	66.70	36.318	1.092	2.381	0.100	0.400
11	16.67	66.67	16.70	10.426	0.060	1.275	0.034	0.133
12	100.0	0.00	0.00	21.673	1.432	2.599	0.063	0.315
13	0.00	33.33	66.70	**40.206**	1.412	2.563	0.106	0.387
14	0.00	100.00	0.00	2.664	0.025	1.346	0.014	0.070
15	66.67	33.33	0.00	7.431	0.035	1.701	0.023	0.205
16	0.00	0.00	100.00	33.213	0.955	2.523	0.068	0.341
17	33.33	33.33	33.33	23.275	0.742	2.340	0.076	0.334

A – Wheat bran; B – Citrus pulp; C – Brewer's spent grain

As noted in Table 1, responses to enzyme activities varied at different numerical intervals. Generally, when the ratio between the maximum value and the minimum value is greater than 10, a transformation of the response data is necessary for better adjustments of the model. Transformations in these data were performed according to the need and the mathematical modeling for each enzyme was performed prioritizing the models that maximized the values of "Adjusted R^2" and the "Predicted R^2".

Table 2 presents a summary of the transformations used, the adjusted model that best suited each answer, as well as the R^2 statistical data and precision analysis of the modified models, which considers only the significant terms.

Table 2. Statistical data of the models obtained for each enzyme activity studied (U/mL).

Enzyme (U/mL)	Transformation	Adjusted model	R^2	Precision	F - Value	p-value
Xylanase	square root	quadratic	0.9689	31.04	118.78	<0.0001*
Endoglucanase	square root	cubic	0.9758	16.30	31.30	<0.0001*
Exoglucanase	square root	special quartic	0.9580	17.13	29.36	<0.0001*
β-glycosidase	cubic root	cubic	0.9527	20.29	44.36	<0.0001*
Total cellulase	cubic root	cubic	0.9622	14.10	16.93	<0.0002*

*Significant in 5% level

The final equations in terms of the real factors only for the significant terms of each modified model are also presented (1, 2, 3, 4 e 5):

$$\sqrt{Xylanase\ \left(\frac{U}{mL}\right)} = 4.51A + 1.40B + 6.39C + 5.03BC \quad (1)$$

$$3\sqrt{Endoglucanase\ \left(\frac{U}{mL}\right)} = 1.01A + 0.16B + 1.02C - 2.03AB - 0.79AC + 0.49BC + 11.52ABC - 2.59AC(A - C) - 4.74BC(B - C) \quad (2)$$

$$Exoglucanase\ \left(\frac{U}{mL}\right) = 2.74A + 1.15B + 2.56C - 1.85AB - 1.38AC + 2.77BC - 52.57AB^2C + 74.99ABC^2 \quad (3)$$

$$\beta - glycosidase\ \left(\frac{U}{mL}\right) = 0.23A + 0.10B + 0.26C + 0.25AC + 0.42BC - 0.44\ BC(B - C) \quad (4)$$

$$Total\ cellulase\ \left(\frac{U}{mL}\right) = 0.23A + 0.07B + 0.29C + 0.04AB + 0.57AC + 0.48BC + 0.74AB(A - B) - 0.79AC(A - C) \quad (5)$$

The precision analysis presented in Table 2 measures the signal-to-noise ratio, it compares the range of values predicted at the design points with the average forecast error. Ratios greater than 4 are desired and indicates adequate accuracy of the model. Therefore, the equations found can be used to navigate the design space of all optimization experiments. P-values less than 0.0500 indicates that the terms of the model are significant. In this case, the equation in terms of real factors can be used to make predictions about the response for certain levels of each factor. As noted, component C (brewer's spent grain) and the combination BC (citrus pulp/brewer's spent grain) have the greatest impact on the production of the xylanase enzyme.

Trace Chart and 3D Surface graphics were used to compare the effects of all components in the design space (Fig 2 and Fig 3). Through them, it is possible to visualize how sensitive the response to the deviation of the formulation is close to the reference mixture for each model. The x-axis of the plot is in coded units and shows the position relative to the coded scale (0 to 1 for mixtures) and 3D surface located on the right side for the production of xylanase, endoglucanase, exoglucanase, β-glycosidase, and total cellulase.

From Fig 2 and 3, it is possible to observe that the brewer's spent grain (letter C) is good for the highest enzymatic production, presenting a small inhibition of the production of endoglucanase, exoglucanase, β-glycosidase, and total cellulase when in large quantities (trace and 3D graphics). The citrus pulp (letter B) is a good residue for the production of all enzymes when used in small quantities. However, enzyme production is inhibited by increasing the concentration of citrus pulp. Wheat bran (letter A) was the residue that least influenced the enzyme production, demonstrating stability in production regardless of the residue concentration for the enzymes: xylanase, β-glucosidase exoglucanase, and total cellulase demonstrating greater oscillation only in the production of endoglucanase.

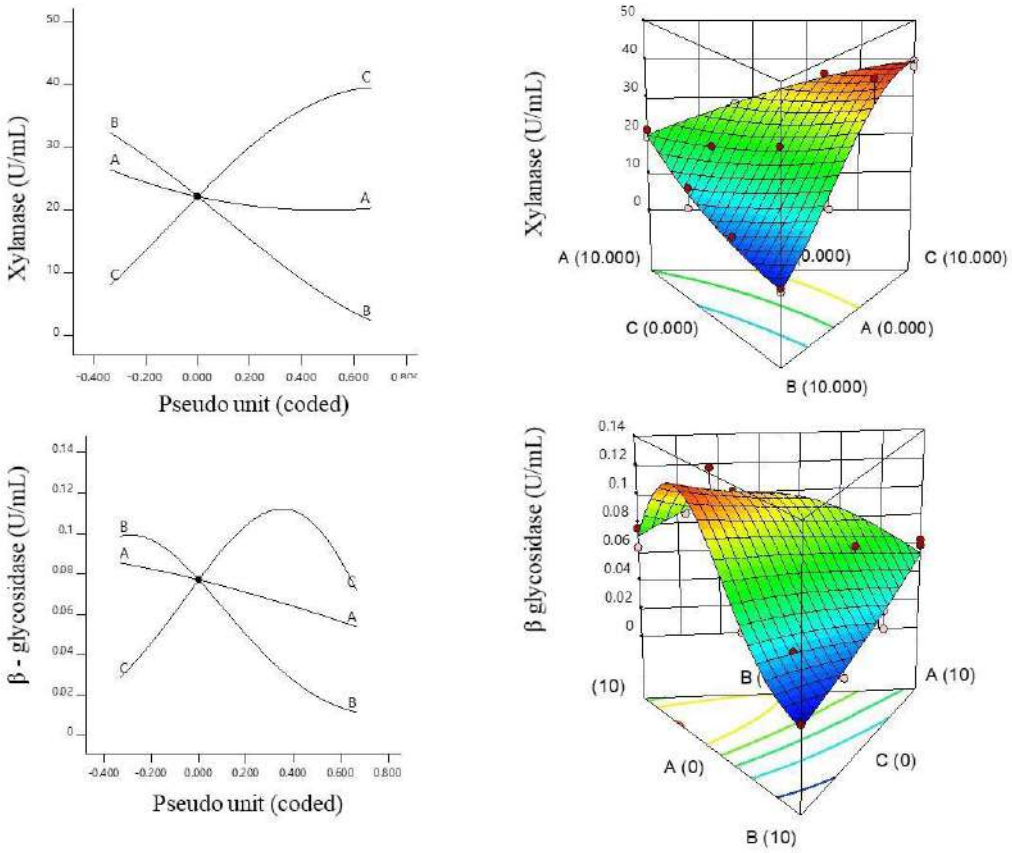

Fig. 2 Optimization of the production of xylanases and β-glycosidase using T. reesei QM 9414 by mixing agro-industrial residues wheat bran (A), citrus pulp (B) and brewer's spent grain (C) in the culture medium in submerged cultivation at 28 °C and 150 rpm for 15 days. The 3D surface graphs are representing the values obtained min max.

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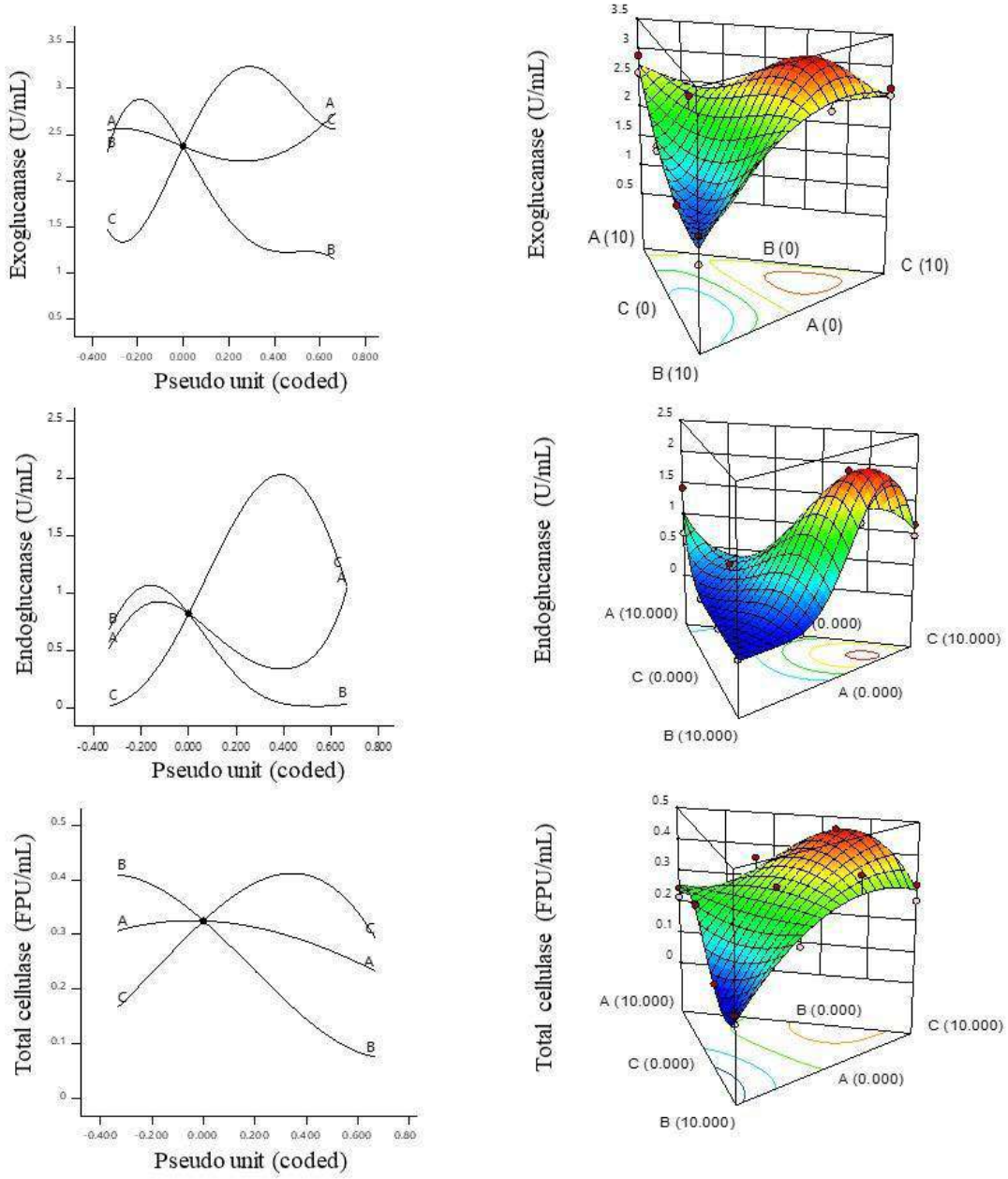

Fig. 3. Optimization of the production of exoglucanase, endoglucanase and total cellulase of T. reesei QM 9414 by mixing agro-industrial residues wheat bran (A), citrus pulp (B) and brewer's spent grain (C) in the culture medium in cultivation submerged at 28 ° C and 150 rpm for 15 days. The 3D surface graphs are representing the values obtained min max.

3.2. Validation of the models obtained through the experimental design of the mixture for the different agro-industrial residues

The validation of the studied models was performed using 6.0% bran, 13.30% citrus pulp, and 79.70% brewer's spent grain as suggested by the program. The verification showed that the model presents an adequate adjustment regarding the production of xylanase and exoglucanase that are within the confidence interval, the other enzymes showed a significant error as foreseen in the model. Table 3 presents the results of the validation of the models obtained by the program.

Table 3. Validation of the models obtained through the experimental design of mixtures for enzymatic activities.

Replies (U/mL)	Predicted averages	Predicted median	Observed	Standard deviation	95% low	95% high
Xylanase	37.712	37.602	**38.012**	4.066	**28.648**	**47.772**
Endoglucanase	2.015	2.002	0.120	0.315	1.226	2.968
Exoglucanase	2.971	2.971	**2.548**	0.176	**2.518**	**3.425**
β- glycosidase	0.111	0.111	0.000	0.009	0.079	0.147
Total cellulase	0.037	0.037	0.260	0.003	0.276	0.476

It was observed through the graphs of traces the great potential of the citrus pulp when used in small quantities and of the brewer's spent grain when in greater proportion. From these results, we sought to use different strategies, such as the use of surfactants, and to unravel the influence of mineral salts, sucrose and yeast extract for residues with greater production potential, in order to increase enzyme production and reduce cultivation time.

3.3. Tween 80 for enzymatic optimization

The search for increased enzyme production is mostly aimed at favoring the best conditions for the development of the microorganism such as the supply of substrates, moisture, pH, supplementation of the medium with salts, yeast extract, among other conditions. Tween is a non-ionic synthetic surfactant that is proving relevant in helping to increase enzyme secretion by microorganisms. Table 4 presents some works in which the authors used the surfactant tween 80 to increase enzyme production.

Table 4. Production of enzymes in the literature using tween 80.

References	Tween 80 concentration studied	Microorganism	Enzymes studied	Best
Reese e Maguire, 1961	0.05 a 0.2%	*Trichoderma viride QM6a, T. viride QM2940*	Cellulase, β-glycosidase	0.1%
Long e Knapp, 1991	0.06 g/L	*Coprinus cinereus*	Cellulases e xylanase	0.06 g/L
Domingues *et al.*, 2000	0.5 g / L	*Trichoderma reesei Rut C-30*	Cellulases	0.5 g /L
Zeng *et al.*, 2006	0.05% e 0.15%	*Penicillium simplicissimum*	CMCase e xylanase	0.15% e 0.05%
Liu *et al.*, 2006	0.05% e 0.15%	*Trichoderma viride*	Cellulase e xylanase	0.15%
Tangnu *et al.*,1981	0.01. 0.02 e 0.1%	*Trichoderma reesei Rut C-30*	Cellulase, β-glycosidase	0.02%

The metabolic mechanism involved by using Tween 80 is not yet fully understood. Studies have shown greater effectiveness of tween 80 compared to other types of tween 60, 40, and 20 (Reese and Manguire 1969; Liu *et al.*, 2006). Surfactants were studied in different concentrations, showing inhibition in large quantities. The concentrations selected for the study were 0.1%, 0.05% and 0.01%. Fig 4 shows the influence of using tween for cultivations with citrus pulp for 15 days. The culture with the surfactant in 0.01% demonstrated an acceleration in the enzymatic production taking 9 days to reach values of 0.4 FPU/mL ± 0.06 (2.4 FPU/g) for cellulase. Xylanase production reached its maximum of 2.9 U/mL (17.4 U/g) in 12 days with 0.05% tween 80. The xylanolytic production was low compared to the previous optimization performed without tween 80 (40.2 U/mL), indicating that tween 80 was not favorable for xylanolytic enzymes.

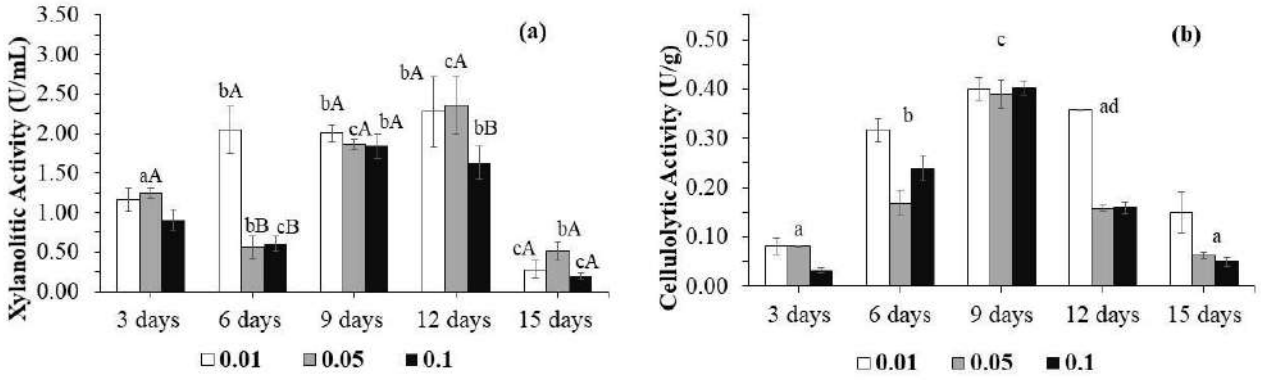

Fig. 4. Cultivation with different concentrations of tween 80 for total cellulase (a) and xylanase (b) activity using T. reesei and citrus pulp in submerged culture at 28 ° C and 150 rpm for up to 15 days. Xylanase: Different letters indicate significant differences between groups according to the Sidak test for different comparisons. Lower case letters indicate comparisons between days of the same concentration. Capital letters indicate comparisons between the different concentrations of Tweeen for each day. Cellulase: No significant difference was observed between the independent variables, only for the variable "days". The Tukey test was used with a significance level of 0.05%.

Long and Knapp (1991) using 0.006% tween did not observe an effect on xylanases when compared to the control, a strategy that was not effective for optimizing xylanases in the present work. Tangnu *et al.*, (1981) using 0.02% tween 80 obtained with *T. viride* QM 9414 5.1 FPU/mL, whereas with *T. reesei* Rut C-30 reached from 7.3 to 14.4 FPU/mL, demonstrating the capacity of *T. reesei*. The authors Liu *et al.*, (2006) used 0.05% and 0.15% of tween 80 and rhamnolipids. The percentages of enzymatic degradation among them were similar, considering only tween 80, the best concentration was 0.15%, with a degradation rate of 14.4% for cellulose and 7.3% for hemicellulose, higher than the control without surfactant, justifying the increased production of cellulases. Finally, Tween 80 cultivation using brewer's spent grain inhibited the production of cellulases and xylanases, with all results very close to zero.

3.4. Influence of mineral salts, sucrose and yeast extract on the formulation of *T. reesei* culture medium for the production of cellulases and xylanases enzymes

The production of xylanase using cultures with each mineral salt, yeast extract, and sucrose in addition to the brewer's spent grain residue is shown in Fig 5. Cultivations with these nutrients demonstrated the importance of each one for enzymatic production. There was no statistical difference between days 9, 12 and 15 of fermentation and six of the nine salts showed no statistical difference. The following additives were chosen as the best nutrients for xylanase production: ZnSO4 0.0028% (21.8 U/mL), MgSO4 0.0017% (20.4 U/mL), (NH4)2SO4 0.1% (20.1 U/mL) and yeast extract 0.1% (21.4 U/mL). The results were three times superior to the control without salt when compared with zinc and magnesium.

Fig 6 shows the influence of nutrients supplementation for the production of total cellulase.

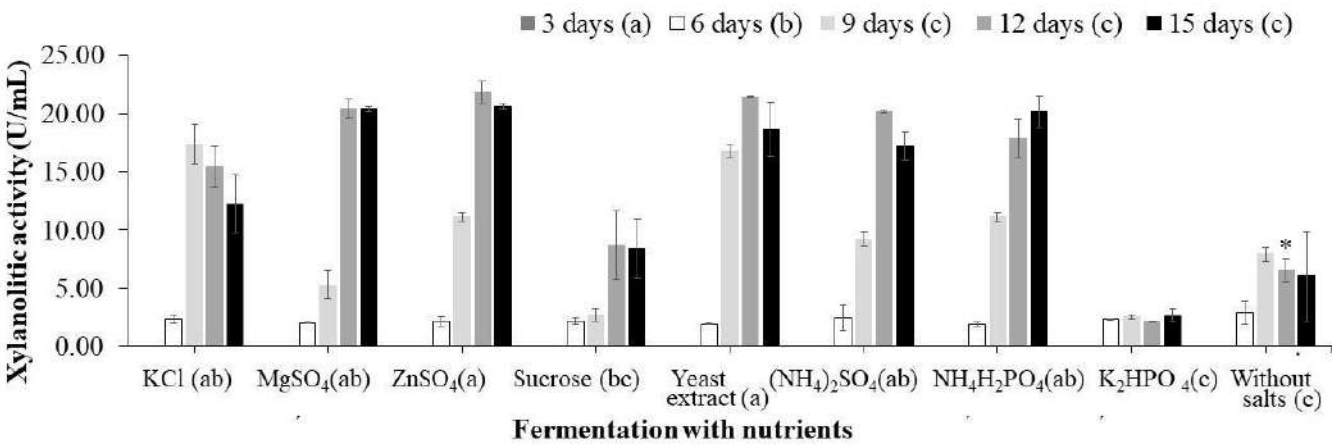

Fig. 5. Submerged cultivation of T. reesei with salts, yeast extract and sucrose at different times to produce xylanases at 28 ° C and 150 rpm for up to 15 days. The Kruskal-Wallis test was used with a significance level of 0.05%. Different letters indicate significant differences between groups.

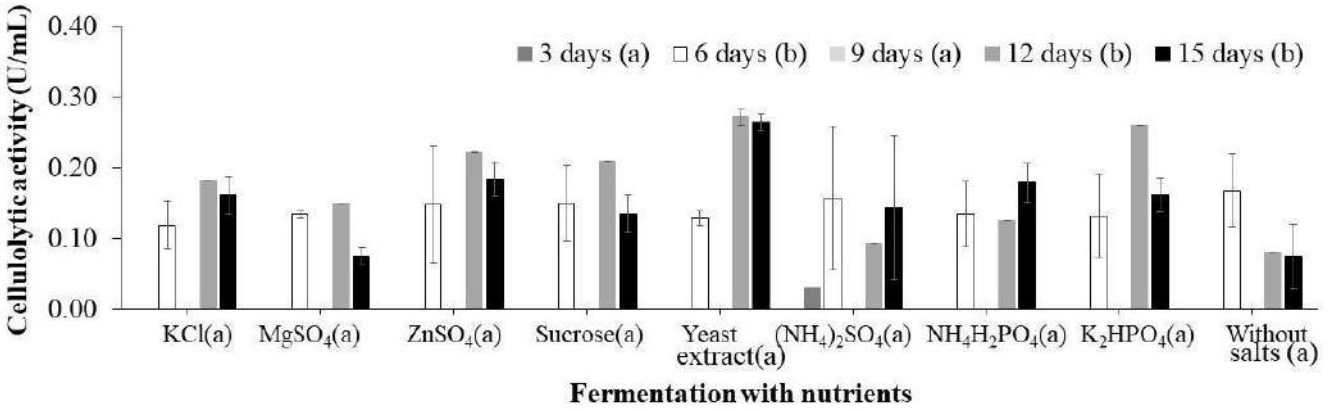

Fig. 6. Submerged cultivation of T. reesei with salts, yeast extract and sucrose at different times to produce cellulases at 28 °C and 150 rpm for up to 15 days. The Kruskal-Wallis test was used with a significance level of 0.05%. Different letters indicate significant differences between groups.

There was no statistical difference between the different salts or between days 6, 12 and 15 of fermentation. The nutrients chosen as the best salts for total cellulase were yeast extract 0.1% (0.27 FPU/mL), K2HPO4 0.11% (0.25 FPU/mL), ZnSO4 0.0028% (0.22 FPU/mL) and sucrose 1% (0.20 FPU/mL). The influence of nutrients was no statistical difference for exoglucanases. Days 12 and 15 were the best fermentation days. Endoglucanases showed no statistical difference between the salts and the best days 12 and 15 of fermentation. The salts ammonium sulfate (0.85 U/mL), potassium phosphate (1.0 U/mL), magnesium sulfate (0.87 U/mL), monobasic ammonium phosphate (0.85 U/mL) and yeast extract (0.78 U/ml) were selected as the best salts. The production of exoglucanase and endoglucanase are represented in Fig 7 and Fig 8. Narasimha *et al.,* (2006) observed 0.52 U/mL for endoglucanase using yeast extract, a result lower than that obtained in the current study. The authors found greater results with the use of 0.82 U/mL urea as a source of nitrogen for endoglucanase.

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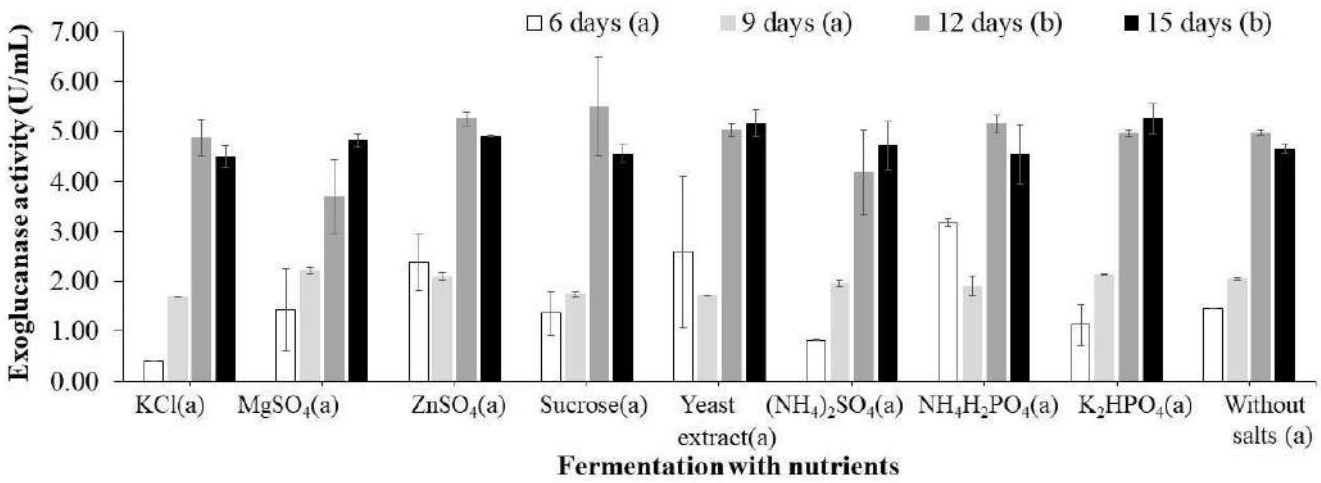

Fig. 7. Submerged cultivation of T. reesei with salts, yeast extract and sucrose at different times to produce exoglucanase at 28 °C and 150 rpm for up to 15 days. The Kruskal-Wallis test was used with a significance level of 0.05%. Different letters indicate significant differences between groups.

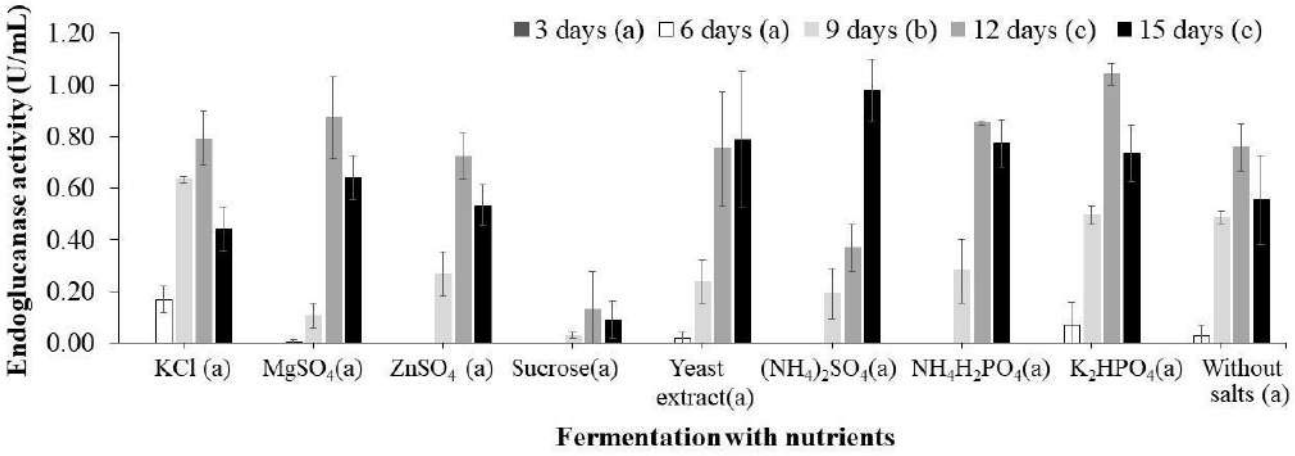

Fig. 8. Submerged cultivation of T. reesei with salts, yeast extract and sucrose at different times for the production of endoglucanase at 28 °C and 150 rpm for up to 15 days. The Kruskal-Wallis test was used with a significance level of 0.05%. Different letters indicate significant differences between groups.

Literature reports indicate increased enzyme production when the media are supplemented with simple carbohydrates, such as sucrose (Delabona *et al.*, 2012). Sucrose has the potential to optimize the production of cellulases, proving to be an inducer of cellulase gene expression (Silva *et al.*, 2018). Chandra *et al.*, (2007) observed a rapid increase in biomass due to the addition of sucrose, the sugar that is easily absorbed together with greater enzyme secretion due to the presence of cellulose. Silva *et al.*, (2018) using citrus pulp and sucrose reached 0.85 ± 0.07 FPU/mL in 10 days of submerged culture, increasing production by 48.1% due to the presence of sucrose compared to the culture without this sugar. The authors also found higher values when using a tank-type bioreactor with 1.76 ± 0.00 FPU/mL using *T. reesei*. Delabona *et al.*, (2012) with *Trichoderma harzianum* obtained 1.21 FPU/mL using pretreated bagasse, dignified with NaOH, and sucrose in a stirred tank bioreactor. However, research also reports that a high concentration of

sugars can inhibit fungal metabolism and consequently enzyme production (Rodrigues- Zúñiga *et al.*, 2011).

Yeast extract appears as a source of nitrogen and vitamins for cultivation. Narasimha *et al.*, (2006) demonstrated the differences in the addition of urea (1.68 FPU/mL), peptone (1.21 FPU/mL), sodium nitrate (1.12 FPU/mL) and yeast extract (0.52 FPU/mL) in the production of cellulolytic enzymes by *A. niger*, the yeast extract being one of the least efficient. Ammonium sulfate was also promising in terms of the production of xylanases in the current research.

The use of essential metal ions such as magnesium, zinc, iron, manganese, among others, is related to the activation of fungal metabolism, proving to be essential for the optimization of enzymatic production (Vale *et al.*, 2011). Microorganisms require different concentrations of minerals showing toxicity when they are in quantities greater than tolerated, inhibiting their growth (Fomina and Karl 2003). Zinc, according to Babich and Stotzky, (1978) is linked to the integrity of ribosomes, biological membranes, and fungal growth. The production of cellulases proved to be efficient regarding the use of the mineral zinc, but not magnesium, in contrast to the xylanase that used the two minerals for enzymatic production.

Rodríguez-Zúñiga et al. (2011) compared four different fermentation media and found that the best enzyme activity inducer was the modified Mandels & Weber medium, with addition of carboxymethylcellulose obtaining 0.4 U/g for total cellulase and 13 U/g for endoglucanase. Mandels & Weber medium contains urea, peptone, yeast extract, ammonium sulfate, and other minerals. Cultivation using sucrose was not efficient, as well as the Czapeck Dox medium composed of carboxymethylcellulose, sodium nitrate, sucrose, and other minerals. Among the nitrogen sources studied, the current study found yeast extract as the most promising for the optimization of total cellulase, in addition to sucrose, in the concentrations used to which they were shown to be favorable.

3.5. Kinetic study of the production of xylanases and cellulases with the combination of the four best mineral salts and combination with Tween 80

The study with nutrients allowed the selection of four different substances based on the statistics or on the value of the enzyme activity observed if the salts did not show statistical difference. From this, the four best nutrients for the production of xylanases (BX) were selected, which were ZnSO4 (0.0028%), MgSO4 (0.0017%), (NH4)2SO4 (0.1%) and yeast extract (0.1%); and the best ones for the production of cellulases (BC), which were yeast extract (0.1%), K2HPO4 (0.11%), ZnSO4 (0.0028%) and sucrose (1%). These were the nutrients that most influenced the biosynthesis of cellulases and xylanases in the previous stage of the research. The new cultivation with the best nutrients provided promising results in terms of increased enzyme production in a shorter cultivation time.

Fig 9 shows the production of xylanase (a) and total cellulase (b) for each set of chosen supplements. The best results for cellulase were in 12 days of fermentation. There was no statistical difference between BX and BC. The cellulases reached 1 FPU/mL (6 FPU/g) with the best nutrients for cellulase (BC), as for the best nutrients for xylanase (BX) the production of cellulases was also optimized reaching values close to the BC, but with greater standard error (0.91 U/ml ± 0.15). The xylanolytic enzymes reached maximum values of 2.9 U/mL (17.4 U/g) in just 3 days with BX. Cultures with BX were not efficient compared to the standard culture, with all components (40.2 U/mL). The individual study of nutrients provides a basis for the needs of the microorganism, but it does not allow observing interactions between nutrients for the metabolism of the fungus, so it can be said that the results were promising. Other combinations can be studied in the future and even their proportions to optimize production.

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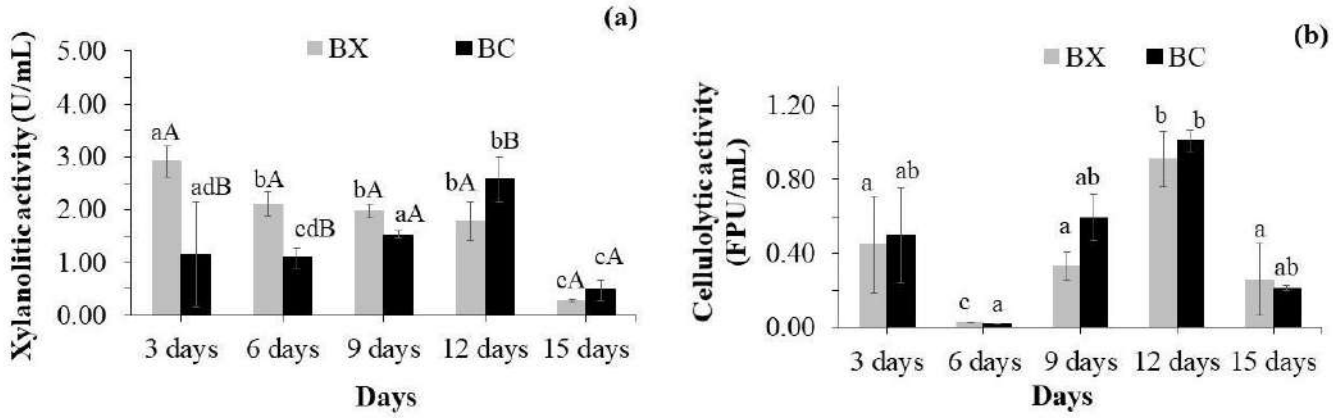

Fig. 9. Enzymatic activity obtained with the combination of brewer's spent grain and the best salts compositions for xylanase (a) and cellulase (b) using T. reesei in submerged culture at 28 °C and 150 rpm for up to 15 days. The Tukey test was used with a significance level of 0.05%. Different letters indicate significant differences between groups. For Xylanase significant differences were observed between samples (BX and BC) and days. Lower case letters indicate differences between the days of the same sample and capital letters indicate differences between samples on the same day. For cellulase BX and BC were compared individually with variable "Days" because no significant differences were observed between samples (BX and BC). BX: best nutrients for xylanase: $ZnSO_4$ (0.0028%), $MgSO_4$ (0.0017%), $(NH_4)_2SO_4$ (0.1%) and yeast extract (0.1%); BC: Best nutrients for cellulase: yeast extract (0.1%), K_2HPO_4 (0.11%), $ZnSO_4$ (0.0028%) and sucrose (1%).

The best concentration of tween 80 and the best selected salts were combined in order to observe the effect on cellulase and xylanase enzymatic activity (Fig 10). The combination, Tween 0.01% associated with MX, allowed to reach values of 1.12 FPU/mL in 9 days of fermentation, no statistical difference was observed between 9 and 12 days (1.32 FPU/mL). The use of Tween 80 proved to be more promising when combining with the best salt for xylanase (MX) compared to the best salt for cellulase (MC). The production of xylanase that was previously inhibited by the use of Tween, reached 26.35 U/mL in 12 days, there was no statistical difference between MX and MC on day 12. The xylanolytic activity found in this step did not exceed the results obtained through the experimental design (40.2 U/mL).

A summary of the best results found in each activity developed is shown in Table 5.

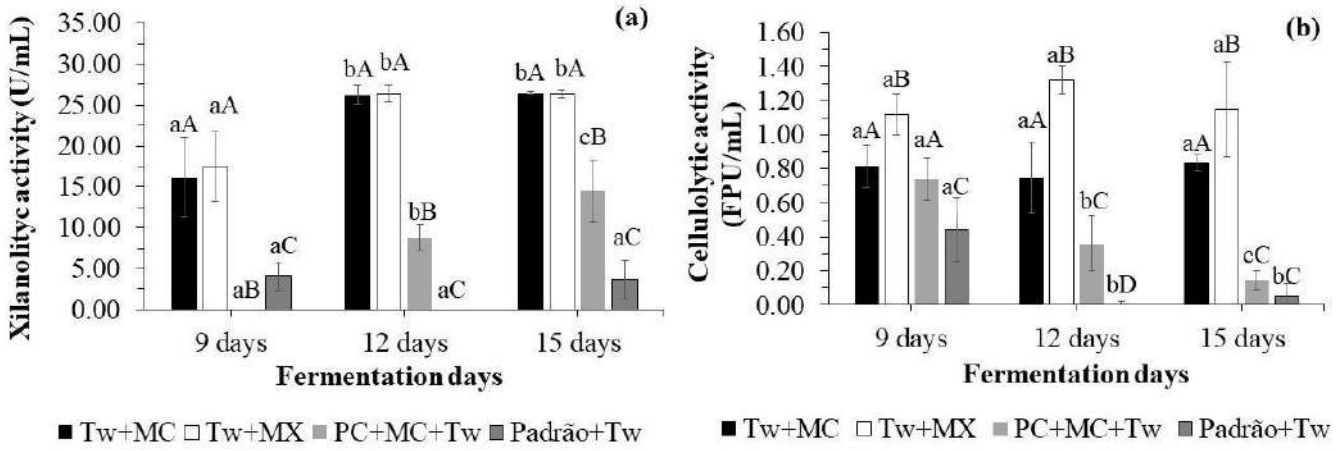

Fig.10. Enzymatic activity obtained with the combination of the best salts compositions for xylanase and cellulase using T. reesei with the best concentration of tween 80 in submerged culture at 28 °C and 150 rpm for up to 15 days. Tw+MC: brewer's spent grain+0,01% of Tween+ best salts for cellulase. Tw+ MX: brewer's spent grain+0,01% of Tween+ best salts for xylanase. PC+MC+Tw: citrus pulp+ best salts for cellulase+0,01% of Tween 80. Padrão+Tw: brewer's spent grain+ initial set of eight salts+0,01% of Tween 80. The Tukey test was used with a significance level of 0.05%. Different letters indicate significant differences between groups. Lower case letters indicate comparisons between days of the same sample. Capital letters indicate comparisons between the different samples for each day.

Table 5. Enzyme activity was obtained at each stage of the study.

Stage	FE days	TC (FPU/mL)	Endo (U/mL)	Exo (U/mL)	β -glyco (U/mL)	Xylan (U/mL)
1) Design with mixed wastes	15	0.42	2.03	3.202	0.126	40.20
2) The best combination of salts, sucrose and yeast extract	12	1	-	-	-	-
3) Presence of Tween 0.01%	9	0.40	-	-	-	-
4) Tween 0,01% and MX	9	1.12	-	-	-	-
5) Tween 0,01% and MX	12	1.32				

FE Days: Fermentation / Cultivation Days. TC: Total Cellulase. Endo: Endoglucanase. Exo: Exoglucanase. β-glyco: β glycosidase. Xylan: Xylanase. 1-Design: for TC: 100% of brewer's spent grain; for Endo, Exo and β-glyco: 16.67% bran and citrus pulp and 66.7% brewer's spent grain; for Xilan: 33.33% citrus pulp and 66.7% brewer's spent grain. The composition described for the design was complemented with a set of salts, yeast extract and sucrose. 2- Best combination of salts for cellulase: 0.1% yeast extract, 0.11% dibasic potassium phosphate, 0.0028% zinc and 1% sucrose + 100% brewer's spent grain. 3- Presence of 0.01% Tween: 33% of brewer's spent grain + 0.01% of tween, salts, yeast extract, and sucrose. 4- Tween 0,01% and MX: 100% of of brewer's spent grain.

The importance of understanding the needs of the microorganism used, as well as the potential of the chosen carbon source, is emphasized, in order to follow more optimistic paths regarding the optimization of enzymatic production. Considering the matrix provided by the design, the greatest cellulolytic production was found using a proportion of 10 g brewer's spent grain, 0 g of citrus pulp and 0 g of wheat bran obtaining a value of 0.42 FPU/ml (2.52 FPU/g, considering 60 mL of extract). This production was optimized during the study with tween 80, which reached 0.4 FPU/mL of cellulolytic activity in 9 days of fermentation, 6 days less compared to the culture performed for the design. The third step aimed at the best combination of nutrients for the production of xylanases

and cellulases surpassed the results obtained previously, reaching 1 FPU/mL of cellulolytic activity in 12 days. The best results found for the concentration of Tween 80 and combination of salts were tested together and allowed to reach 1.12 FPU/mL in 9 days of fermentation.

The research by Campioni *et al.,* (2020) demonstrated by means of a D-optimal experimental design with three agro-industrial residues cane straw, citrus pulp and wheat bran that cane straw is the most influential residue among the three. The design reached the production of 90 U ml of xylanase and 0.5 U/ml of cellulase using 100% cane straw with *T. reesei*. The study by Rodríguez-Zúñiga *et al.,* (2011) using *Aspergillus niger* obtained a maximum of 0.4U/g of cellulase with wheat bran in the solid state after 72 hours, a study that used a little starchy carbon source cultivation time and solid state cultivation reaching a value below that found in the current work. Campioni *et al.,* (2019) obtained 0.3 FPU/mL of total cellulase in 6 days of submerged cultivation with sugar cane straw using *T. reesei* QM 9414, which is also lower compared to the present study, but worked with a shorter cultivation time. On the other hand, Saini *et al.,* (2015) with an isolated strain in the country recognized as *Penicillium oxalicum*, obtained 1.2 FPU/mL in 8 days of submerged cultivation with wheat bran, reaching a value three times higher than that found at this stage of the work and four times greater than Campioni *et al.,* (2019) who also used wheat bran, showing the greater potential of *Penicillium oxalicum* compared to *T. reesei* in wheat bran. Florêncio *et al.,* (2016) obtained 0.7 FPU/g with sugarcane bagasse in solid cultivation for 24 hours, later changed to liquid cultivation (48h) with the *T. reesei* fungus, demonstrating an interesting strategy due to the association between reduced cultivation time and high enzyme activity, but not surpassing current work.

The xylanolytic enzymes showed greater production capacity for the experimental design using 6.66 g of brewer's spent grain, 3.33 g of citrus pulp, and 0 g of wheat bran reaching 40.2 U/mL or 241.23 U/g (402 U/L). The production with 10g of brewer's spent grain was also high (39.6 U/mL). The results of cultivation with tween 80 did not exceed the control (without tween) regarding the biosynthesis of xylanases by the fungus, on the contrary, they proved inhibition of this biosynthesis in the presence of this surfactant during cultivation. The best result with tween 80 for xylanase was 2.96 U/mL using 0.01% tween 80, much lower than that obtained in the design. The combination of selected nutrients such as BX and BC did not favor the production of xylanases.

Regarding the production of xylanases, Gottschalk *et al.,* (2010) produced 0.15 U/mL with *T. reesei* in 5 days of cultivation, while with the fungus *Aspergillus* awamori in 7 days of cultivation they obtained 0.025 U/mL, lower capacity that the optimization of the current study. Campioni *et al.,* (2019) reached 60 U/mL of xylanase using *T. reesei* in 6 days of submerged fermentation with sugar cane straw. Gottschalk *et al.,* (2010) used less cultivation time and obtained values below the current work, in contrast to Campioni *et al.,* (2019) which surpassed the results of the current research in productivity and yield.

The maximum production of endoglucanase in the mix design was found in the proportions of 6.67 g of brewer's spent grain, 1.66 g of citrus pulp, and 1.66 g of wheat bran, obtaining 2.03 U/mL (12,1 U/g). Rodríguez-Zúñiga *et al.,* (2011) found 21.0 U/g for endoglucanase using wheat bran in solid cultivation for 72 hours, values close to the current optimization, already Florêncio et al. (2016) obtained a production of 1.6 U/mL for endoglucanase with *T. reesei* in submerged cultivation with sugarcane bagasse, but it did not exceed the yield studied in this work. Castro *et al.,* (2010) obtained 0.55 U/mL of endoglucanase after 97 hours of cultivation in pyruvate dehydrogenase complex with *Trichoderma harzianum* 30 °C at 200 rpm, lower than that obtained in this work.

The production of exoglucanase in the design was higher using 6.67 g of brewer's spent grain, 1.66 g of citrus pulp, and 1.66 g of wheat bran reaching 3.20 U/mL (19.2 U/g). Silva *et al.,* (2018) reached values of 3.14 U/mL for endoglucanase, 1.25 U/mL for exoglucanase (citrus pulp substrate) and 93.08 U/mL for xylanase (sugarcane bagasse with alkaline pre-treatment), showing a lower value when compared to exoglucanase production, but higher when it comes to endoglucanase and xylanase production.

The production of β-glycosidase in the design of mixtures was higher with proportions of 6.67 g of brewer's spent grain, 1.66 g of citrus pulp, and 1.66 g of wheat bran reaching 0.12 U/mL (0.72 U/mL). Gottschalk *et al.,* (2010) reached 0.15 U/mL with the fungus *T. reesei* in 5 days and with A. awamori 0.018 U/mL in 7 days of cultivation. The authors demonstrated the potential of *T. reesei* in the production of β-glycosidase and found a value close to that of the current study.

From the optimization carried out it was possible to conclude that the fungus *T. reesei* can be used for the production of fibrolytic enzymes with the studied residues, however other strains and other residues are also standing out, mainly regarding the production of total cellulase (FPU) and xylanase, in addition to indicating the capacity of tween 80 for the production of xylanases and the

importance of salts for optimizing enzymatic production, as noted with the increase in total cellulase activity.

3.6 Enzymatic hydrolysis

Thinking of optimizing the production of reducing sugar (glucose syrup), an enzymatic hydrolysis was carried out associating cellulases with amylases. Enzymatic hydrolysis was performed with cassava bagasse (10% w / v) gelatinized or not, combining amylases and cellulases added in zero or ten hours, to obtain a glucose syrup. The highest concentration of reducing sugar was observed in previously gelatinized cassava bagasse (48.6 g / L). There were no significant differences in glucose concentration when adding amylase in zero or ten hours (Fig. 11). Shi et al. (2014) hydrolyzed the cassava bagasse (10% w / v) with more than one type of enzyme, including amylases and cellulases, reaching 44.3 g / L of reducing sugars in 48 hours of reaction, achieving lower concentration of reducing sugar in a longer time of hydrolysis. Chen et al. (2015) using cassava bagasse (10% w / v) carried out enzymatic hydrolysis with commercial cellulase (A1500; 0.2 mL / g) reaching 46.2 g / L of reducing sugar in 48 hours of reaction, a value similar to the present study, however, with a longer reaction time. Gonçalves (2016) observed greater hydrolysis over 10 hours of reaction, stabilizing after this period. Gonçalves (2016) when using amylases and cellulases in 0 and 10 hours of hydrolysis of cassava bagasse obtained 46.1 g / L of reducing sugar in 24 hours, similar to the present study. The synergistic action of the enzymes allowed to reach values similar to those observed in the literature.

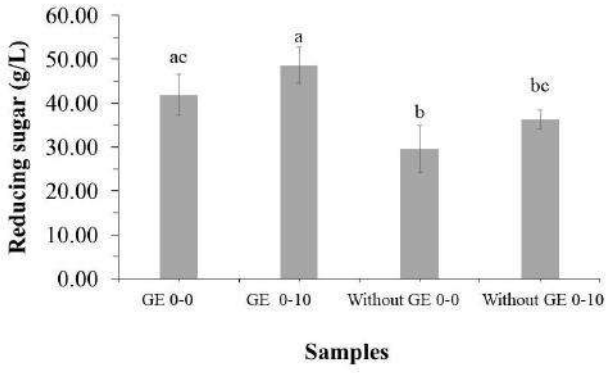

Fig.11. Enzymatic hydrolysis with cassava bagasse (10% w/ v), pH 4.5 at 50 ° C for 24 hours. Enzymes: 15 U / ml amylase and 15 FPU / ml cellulase. GE 0-0: Gelatinization +amylase and cellulase added at time zero. GE 0-10: Gelatinization+ cellulase added at time zero and amylase at time 10 hours. Without GE 0-0: Without gelatinization + amylase and cellulase added at time zero. Without GE 0-10: Without gelatinization+ cellulase added at time zero and amylase at time 10 hours. The Tukey test was used with a significance level of 0.05%. Different letters indicate significant differences between groups

Table 2 presents a summary of the transformations used, the adjusted model that best suited each answer, as well as the R^2 statistical data and precision analysis of the modified models, which considers only the significant terms. The final equations in terms of the real factors only for the significant terms of each modified model are also presented (1, 2, 3, 4 e 5).

IV. CONCLUSION

The use of the I-Optimal mixture design technique of agro-industrial residues in submerged fermentation with *T. reesei* QM 9414, showed that the use of spent grain is promising for the production of cellulases and xylanase, as well as the use of citrus pulp. The study on the demand for minerals and yeast extract (as a vitamin and amino acid source) reveals that is possible to reduce the time of cultivation and increase the enzymatic production as we saw with the cellulase production that increased by 2.38 times. The use of 0.01% tween 80 in the culture medium drastically inhibited the fungal production of xylanases and increased total cellulase productivity, substantially reducing the cultivation time. Through enzymatic hydrolysis we observe the importance of synergistic use of enzymes, reaching significant values of reducing sugar.

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Fisherman Competency Study on Fishing Business Units on Pole and Line Based on SKKNI and STCWF-1995 in Sikka Maumere Regency, East Nusa Tenggara

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Abstract— *One of fishermen's problems is skills and knowledge. The skills and knowledge of fishermen are obtained from a learning process that is hereditary. Fisherman competency standards are important in order to improve work safety and fishing business. This study aims to evaluate the competence of pole and line fishermen based on SKKNI 2013-298 (competence units for operating huhate (pole and line)), SKKNI 2005-191 PRK.NP03002.01, and STCW-F 1995 Resolution 3 in Sikka Maumere Regency, East Nusa Tenggara and the suitability of fishermen's competency standards in SKNNI and STCW-F 1995. Fishermen's competency data were obtained through observation and in-depth interviews with selected respondent fishermen and then analyzed based on these two standards. National fishermen's competency standards are also evaluated for conformity to international standards. The amount of weighting is determined based on the level of importance of each of the existing performance criteria. The assessment criteria for competency elements use a score scale of 1-4. The total value of the weights is 10. The total value of x weights is 40, then multiplied by 100%. Obtaining the suitability value of each performance criterion can show the level of conformity of the fishermen's competence with competency standards. The results showed that (1) the competence of fishermen based on the 2005-191 SKKNI was not suitable (conformity value interval <50%), while based on the 2013-298 SKKNI it was quite appropriate (conformity value interval between 50-75%). (2) Fishermen are still not suitable (conformity value interval <50%) to the implementation of STCW-F 1995 resolution 3. (3) The basic competency units in SKKNI 2005-191 and SKKNI 2013-298 are divided into 7 competency units. Meanwhile, in STCW-F 1995 became an integral part of the competency unit as a basic level safety training for fishermen.*

Keywords— ***SKKNI 2005-191, SKKNI 2013-298, STCW-F 1995, pole and line.***

I. INTRODUCTION

The problem that is often faced by Indonesian fishermen is the lack of knowledge and skills. This can result in the inability of fishermen to access technology, information, and lack of mastery of safety and fishing competencies as well as the ability to handle fish catches. According to Lincoln et al., (2002), fishing vessel safety is an interaction of complex factors, namely human factors (master and crew), machines (ships and safety equipment) and environmental (weather and climate for fishery resource management). . Safety problems or accidents will arise if at least one element of the human factor, machines or environmental factor is not functioning properly. Risk control in the fishing process is carried out by selecting

competent crew members, making plans for fishing/shipping activities, designing safe work procedures, using appropriate equipment, using personal protective equipment and conditioning a healthy work environment, and always coordinating between crew members. . The management of fishermen's work safety needs to be done so that their implementation is synergistic. (Fis Purwangka, 2013).

Mazaheri et al., (2015) stated that many ship accidents occur due to errors by crew members in reading the situation in navigating, resulting in errors in decision making. Errors occur due to weak competence, so it is necessary to draft regulations governing the competence of ship crewing. Hamzens & Sumardjo (2007) stated that the quality of fisherman's human resources is low, characterized by low competencies such as low awareness of safety at sea, low ability to plan business, low ability to catch fish, and low ability to solve business problems. According to Retnowati (2014) stated that the root cause of problems related to fishermen's human resources is education. In addition, the problem of competence contained in the elements of skills and knowledge. These abilities and knowledge, they get from the learning process that is hereditary, so that these competencies can still be improved for the better. Therefore, fisherman competency standards are needed that can improve the safety and fishing effort of fishermen so that the quality and number of fishermen's catches increases.

Monintja (1968) said that in principle the pole and line fishing gear consists of three parts, namely: the rod (pole), line (line) and hook (hookless). Pole and line (huhate) is one type of fishing gear that can be classified as a fishing rod that is usually used in catching skipjack tuna. These tools are used individually, so that one of the factors that influence the success of fishing is the individual skill of the crew, and other factors, such as the availability of live bait and the density of skipjack tuna schools in fishing areas. The success of the operation of the pole and line ship, is very dependent on the condition of the stability of the ship because of the oceanic nature of the operation. Good cooperation by the crew is needed in order to successfully catch fish using pole and line (huhate) fishing gear. Research on the study of fishermen's competence on fishing business units on Pole and line based on SKKNI and STCWF-1995 is expected to provide data and information on fishermen's competence in pole and line fishing business units in the research area. Its utilization can provide material for consideration in determining policies in the field of capture fisheries, especially increasing the ability and skills of fishermen. Fishermen also get legal protection and increase the quality and quantity of their catch.

II. RESEARCH AND METHODS

Data retrieval is done by purposive sampling method (a sampling technique of data sources with certain considerations, namely the data source knows best about what is expected, making it easier for researchers to explore the object or situation being studied (Sugiono, 2010). Data collection is done by: (1) Observation, namely the object of observation that is studied are aspects related to the suitability of fishermen's competence regarding pole and line fishing operations and work safety problems on board with existing standard rules.(2) Interviews, namely direct interaction and communication and observing performances. the work of pole and line fishermen selected to obtain information (3) Literature study, namely studying the rules of national and international competency standards that support research so that it is hoped that with a strong legal basis a good understanding will be obtained.

Data retrieval using a questionnaire containing the units and elements of competence that exist in SKKNI 2005-191 PRK.NP03002.01, SKKNI 2013-298 (competence units for operation of huhate (pole and line)), and STCW-F 1995 Resolution 3. Observations of fishermen's actions during fishing operations using the pole and line are scored on a scale of 1-4. The scoring score is shown in Table 1.

Table 1. Assessment criteria

Score	Assessment criteria	Description
4	Very suitable	Fishermen explain sequentially and in great detail
3	Appropriate	Fishermen explain sequentially and in detail
2	quite appropriate	Fishermen explain sequentially and in less detail
1	Not suitable	Fisherman explains not sequentially

Performance Criteria :

If 4: 85 up to 100%

3: 75 to < 85 %

2: 50 to < 75 %

1: < 50%

The number of competency elements in SKKNI 2005-191 PRK.NP03002.01 is 5 (five), namely: (1) Organizing and implementing regulations on occupational safety and health practices for crew members. (2) Implement FAO/ILO/IMO provisions on fishing vessel crews. (3) Use

and maintain work safety equipment. (4) Precautions for entering enclosed spaces. (5) Take action to prevent accidents on board. The competency units based on the 2013-298 SKKNI are (1) Planning fishing operations. (2) Preparing ship's seaworthiness. (3) Preparing the seaworthiness of fishing operations. (4) Carry out the task of guarding the sea. (5) Assembling huhate. (6) Catching fish in the sea using huhate (pole and line). (7) Perform maintenance on fishing gear made from ropes and fishing rods on land. (8) Perform maintenance on fishing gear made from ropes and fishing rods on the ship. (9) Repairing fishing gear made from ropes and fishing rods. (10) Handling tuna fish on board. The elements of competence that exist in STCW-F 1995 Resolution 3 are as follows: (1) Knowledge and techniques of self-rescue. (2) Fire prevention and suppression. (3) Emergency procedures. (4) The basics of first aid (first aid in an accident). (5) Prevention of pollution of the marine environment. (6) Prevention of ship accidents.

Data analysis used: (1) Content Analysis Method; The analysis used is the content analysis method where descriptive data is often only analyzed according to its content. Therefore, this kind of analysis is also called content analysis (Suryabrata 1983). Charles (2001) means that the content analysis method is carried out by observing the content of the main articles of the policy, in this case the competence of pole and line fishermen. The procedure taken begins with identifying and taking inventory of existing fishermen's competency standards on national and international standards. (2) HTA (Hierarchical Task Analysis); work/activity is broken down into several levels of activity/job. It is also very useful in seeing the activities/workers in interacting with work equipment and aspects of the work environment. Activities/jobs are divided into several levels of activity/work based on the goals to be achieved (Lyons et al., 2004). The approach taken in qualifying with time. The identified activities are overall activities, both from the stages of the preparation, catching, and handling of the catch. Work intensity is researched through quantitative studies using large-scale survey instruments and has been understood as a series of measurements of pace of work and the need to meet strict time targets (Hamilton, 2007). (3) Scoring System Method; according to Wardhani (2005) as a measurement result in the form of numbers (quantitative), the scoring system, which is also known as a scale score, requires a comparison norm so that it can be interpreted qualitatively. Basically, the interpretation of the scale score is always normative, meaning that the meaning of the score is referred to the relative position of the score in a group that has been limited in advance. The scoring method is used to represent the level of proximity, the relationship between the performance of fishermen in the operation of pole and line fishing with national and international standards. The assessment criteria for competency elements use a score scale of 1-4. The total value of the weights is 10. The total value of x weights is 40, then multiplied by 100%. Obtaining the suitability value of each performance criterion can show the level of conformity of the fishermen's competence with competency standards. The assessment of the suitability of competency standards using intervals is shown in Table 2.

Table 2. Conformity Assessment

Value of Conformity	Assessment Criteria Conformity	Assessment Interval
4	Very suitable	85 ≥ 100%
3	Appropriate	75 < 85 %
2	quite appropriate	50 ≤ 75%
1	Not suitable	< 50 %

III. RESULT AND DISCUSSION

Data collection was carried out on 8 (eight) pole and line vessels from 75 vessels or 10% of the number of existing vessels. This number can represent fishing activities carried out because almost all pole and line fishermen operating in florest waters are located in Water Management Areas (WPP-RI) 573, 713, and 714 in the waters of East Nusa Tenggara Province. Fishermen started to participate in fishing operations on pole and line vessels, acting as chefs and preparing live bait in fishing operations. The fishermen, on average, graduated from elementary school or even dropped out of school since elementary school. It was at this young age that they began to learn directly in fishing operations. Beginning as cooks and preparing live bait that will be used by the boys in fishing operations, they then learn directly as anglers, engine guards, helmsmen, compradors, to become ship captains. Pole and line ship data can be seen in Table 3.

Table 3. Data of pole and line ships

Name of Vessel	GT Vessel	LOA (m)	Number of Fishermen	Educational Level Starting from elementary school
KMN. Citra	27	20.72	17	17
KMN. Jabal Sur	30	20.10	16	16
KMN. Indah Baitullah 03	30	23.00	20	20
KMN. Kembali Baitullah	26	22.65	22	22
KMN. Khanza	30	22.09	15	15
KMN. Surya Mas	30	18.35	18	18
KMN. Tujuan Baitullah	30	19.11	17	17
KMN. Darussalam	29	20.15	18	18

Fishermen Competency Suitability Based on SKKNI 2005-191 PRK.NP03.002.01

The suitability value of the competence of pole and line fishermen based on SKKNI 2005-191 PRK.NP03002.01 is presented in Figure 1.

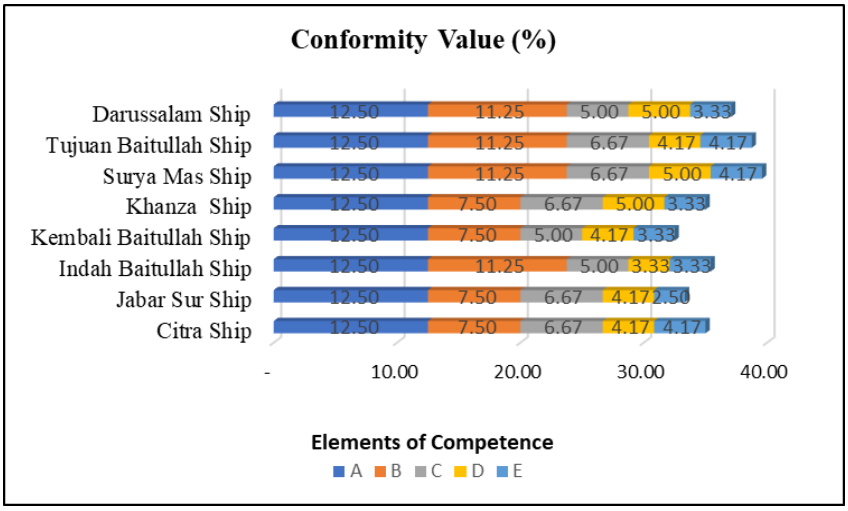

Fig 1. The value of the suitability of the competence of pole and line fishermen with SKKNI 2005-191 PRK.NP03002.01

Description of Competency Elements:

A. Organizing and implementing regulations on occupational safety and health practices for crew members.

B. Apply FAO/ILO/IMO provisions on fishing vessel crews.

C. Use and maintain work safety equipment.

D. Precautions for entering enclosed spaces.

E. Take precautions to prevent accidents on board

In Figure 5, it can be seen that pole and line fishermen are still not suitable (conformity value interval < 50 %) to the implementation of SKKNI 2005-191 PRK.NP03.002.01 concerning Implementing Occupational Safety and Health on Ships. This is because fishermen's knowledge of the importance of occupational safety and health on ships has not been understood.

Learning about work safety is done by going to sea often and obtained from information from generation to generation. It is evident from the number of crew members who have participated and passed the BST (basic safety training) training. The average crew who have followed and passed the BST are only 2 people, namely the captain/captain and the engineer. The other crew members didn't even know about BST.

The first element of competence in the 2005-191 SKKNI is Organizing and implementing regulations on occupational safety and health practices for crew members. The fishermen explained about the use of gloves to avoid injuries to the hands while working on the boat. The action to save the crew is to use life jackets and jump into the sea in the event of a fire. In an effort to maintain health and safety on board, fishermen explained the efforts made to eat on time and get enough sleep. In the second element of competence related to safety measures on fishing vessels

and technical steps for safe fishing operations according to FAO/ILO/IMO provisions concerning fishing vessel crews, fishermen do not yet know the importance of wearing safety clothing on board. The only work safety clothing known to fishermen is gloves, and even then they are used only one-sidedly and are often not used. The process of filling ice blocks and the fishing process can be seen in Figure 2a and Figure 2b.

In the third competency element, namely using and maintaining work safety equipment, from the observations of the fishermen, none of the fishermen used wear packs, work shoes, work helmets, gloves, and protective masks. Only one person uses gloves when fishing and puts ice into the hold, and even then only one side.

Fig 2. (a) The process of filling ice blocks; (b) Fishing process

Maintenance of work safety equipment is not carried out because all ships do not provide complete safety equipment. The precautionary measure to enter a closed room in the fourth element of competence has never been carried out by fishermen. Respiratory protection equipment, protective equipment to help victims, protective equipment to extinguish small fires are not provided on board. Elements of competence take action to prevent accidents on board, fishermen do good ship movement, but understanding of ship motion during an emergency has never been trained. One of According to AP2HI (2015), safety on ships needs to be considered and known by pole and line and handline fishermen. Accidents can occur on ships both during shipping, when making arrests and when loading and unloading is done at the port. Accidents can occur due to lack of knowledge, training and lack of awareness. Lack of awareness such as not using safety equipment on board, even though using safety equipment on ships can reduce the risk of accidents on board. Lack of knowledge and inappropriate attitudes about hygiene and sanitation at sea causes many fishermen to have work accidents (Ratri and Paskarini, 2014).

Fishermen Competency Suitability Based on SKKNI 2013-298 concerning Huhate Operation (pole and line)

In the 2013-298 SKKNI, there are 10 competency units in it related to the competence of pole and line fishermen. The 10 competency units have different boundaries and goals in each type of competency. The explanation regarding the 10 competency units that must be mastered by fishermen can be seen in Table 4.

Table 4. Competency units in SKKNI 2013-298 regarding Huhate Operation (pole and line)

	Competency Unit Code	Competency Description
1	A.031110.001.001	Planning fishing operations
2	A.031110.002.001	Preparing the ship's seaworthiness
3	A.031110.003.001	Preparing the seaworthiness of fishing operations
4	A.031110.004.001	Carry out marine guard duties
5	A.031110.009.001	Assembling huhate (pole and line)
6	A.031110.014.001	Doing fishing in the sea using huhate (pole and line)
7	A.031110.017.001	Perform maintenance on fishing gear made from ropes and fishing rods on land

8	A.031110.018.001	Perform maintenance on fishing gear made from ropes and fishing rods on the ship
9	A.031110.019.001	Repairing fishing gear made from ropes and fishing rods
10	A.031110.020.001	Handling tuna on board

Pole and line fishermen are quite appropriate (interval of suitability value between 50 to < 75 %) to the implementation of SKKNI 2013-298 regarding fishermen's competence in terms of fishing using pole and line in the sea which must be owned and controlled. The actions of fishermen have been sequential in terms of operating the catch using pole and line fishing gear, but the fishermen do not use safety equipment on the boat. The suitability value of the competence of pole and line fishermen based on the 2013-298 SKKNI is shown in Figure 3.

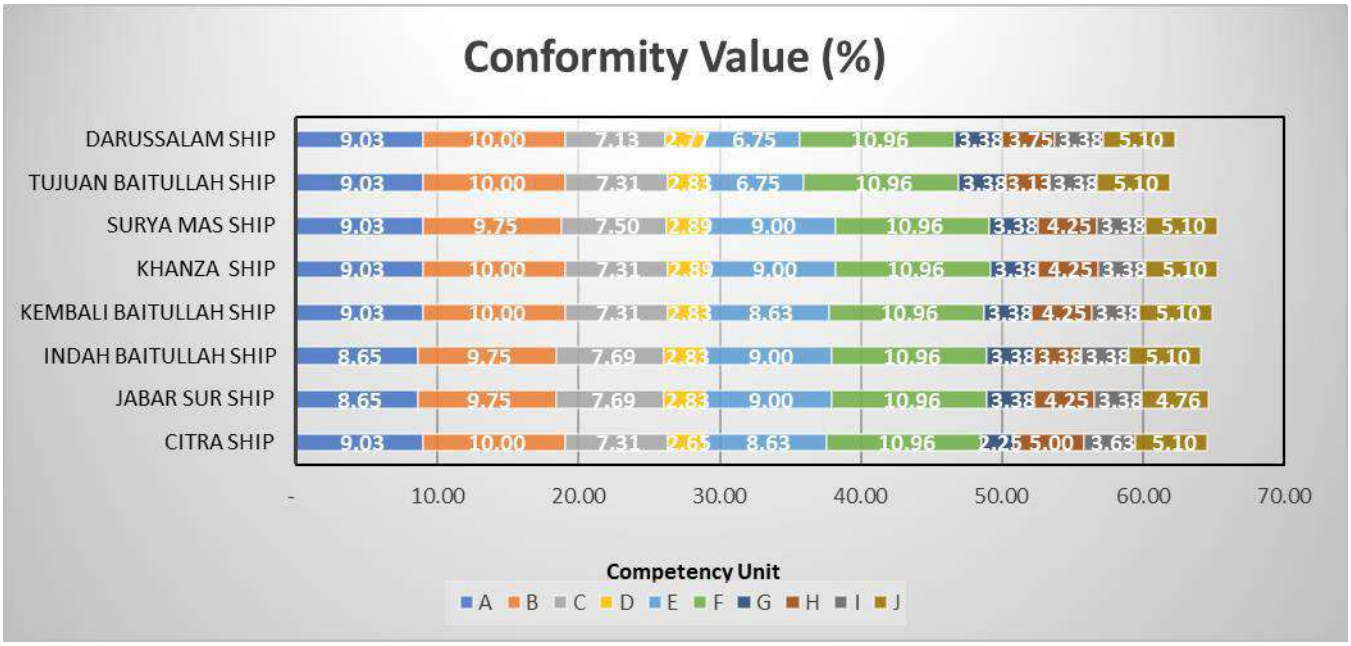

Fig 3. The suitability value of pole and line fishermen's competencies based on the 2013-298 SKKNI concerning fishermen's competencies in terms of catching fish using pole and line in the sea

Description of Competency Unit:

A. Planning a fishing operation plan
B. Preparing the ship's seaworthiness
C. Preparing the feasibility of fishing operations
D. Carry out marine guard service
E. Assemble Huhate
F. Catching fish in the sea using huhate (pole and line)
G. Perform maintenance on fishing gear made from ropes and fishing rods on land
H. Carry out maintenance on fishing gear made from ropes and fishing rods on the ship
I. Repairing fishing gear made from ropes and fishing rods
J. Handling tuna on board

The performance of fishermen's actions in the fishing operation plan is on average the same from 8 vessels. The target fish to be caught are skipjack tuna, fishing gear using pole and line (huhate) fishing gear and fishing grounds. Fishermen predict the weather based on natural conditions. Among them count the dark moon. The terms used by fishermen are dark and light moon nights. The calculation of the time, distance, and route of the capture operation was carried out using an application on a cellphone, namely an offline maps application without using a marine map. Estimated operating time is only done by experience. Fishing is done before sunrise until around noon. 10.00 am and evening before sunset. If the catch is deemed insufficient, it will be carried out the next day, depending on the availability of live bait. Estimated ship logistics and ship crew, prepared for 3 days at sea. The activities of fishermen when going to FADs and looking for schools of fish for fishing can be seen in Figures 4 a and b.

Fig 4. (a) Fishermen's activities when going to FADs for fishing; (b) Looking for schools of fish for fishing

According to Rahmat & Yahya (2015), if the fishing area is carried out outside FADs, there are several clues to find schools of skipjack tuna, for example, it is seen that there are birds swooping down to the sea surface, fish jumping on the surface of the water, fish coming along. roaming with drifting logs or following dolphins or whales and so on.

The average performance of the fishermen's actions in preparing the ship's seaworthiness was fulfilled by 8 of these vessels. The documents required to obtain a sailing approval letter from the harbormaster are always met. Fulfillment of the crew is also fulfilled in accordance with the duties and functions of each crew member. Meanwhile, fishermen tend to pay less attention to the fulfillment of human and ship safety equipment.

In article 5 paragraph 2 Government Regulation no. 51 of 2002 Fulfillment of every ship's seaworthiness requirements is evidenced by a ship's certificate and/or ship's certificate. Shipworthiness requirements include ship building and engine condition in good condition. The captain and fisherman have certificates and experience at sea. Equipment and safety equipment on board are adequate and meet the requirements. Ships must also not pollute the environment while operating at sea.

Documents for fishing vessels consist of: (1) Letter of measurement/gross deed; (2) Nationality certificate (small/big pass); (3) Shipworthiness certificate and fishing vessel manning certificate; (4) Radio communication license (SIKRI) for ships > 35 GT; (5) List of crew members; (6) Sanitation exemption; (7) Fishery business license (SIUP) (photocopy); (8) Original fishing permit (SIPI) or fish transport ship permit (SIKPI); (9) Operation worthiness letter (SLO); (10) sailing approval letter (SPB); (11) Barcode tickets for ships over 30 GT; (12) Re-registration/sign of payment of the original fishery levy; (12) SIPI (photocopy).

The ship before sailing must obtain a sailing approval letter issued by the harbormaster. It is stated in article 219 paragraph 1 of Law Number 17 of 2008. The sailing approval letter is proof that (1) the ship has been inspected. (2) the ship has met the requirements of seaworthiness. (3) has fulfilled other obligations in the shipping sector.

The performance of fishermen's actions in the competency unit in preparing the feasibility of fishing operations is to complete licensing documents related to fishing businesses and prepare fishing gear and equipment. The administrative feasibility document (original SIPI and original fishery levy settlement sign, and barcode) is fulfilled by fishermen. Meanwhile, the completeness of the ship's and crew's needs for supplies tends not to be counted. Like the remaining fuel, lubricants, hydraulic oil, and fresh water during shipping and fishing operations, foodstuffs and medicines are not counted.

The performance of fishermen's actions in the competency unit carrying out the marine guard service is almost all not carried out by fishermen. Fishermen make improvements to the position, bow, speed of the ship. Running manual steering following the cruise track is also controlled. Actions based on important messages from previous marine watch officers or the captain's orders are carried out. The deck diary is not filled in. The handover of the replacement of the guard service at each round of the marine guard service is not carried out.

According to Ramadhan (2021), the implementation of the guard service carried out by the guard on the ship when the ship is sailing or docking has been regulated by the company and the ship in their duties and responsibilities. The guard service is carried out to achieve a safe and controlled situation while the ship is sailing. The purposes and objectives of the implementation of the watch service are: (a) Maintaining the security, safety, orderliness of the ship, cargo, passengers, and the environment. (b) Implement/comply with applicable regulations and provisions (national/international). (c) Carry out orders/instructions from the company or the captain (written orally) of Standing Orders/Bridge Orders.

Almost all of the performance of fishermen's actions in assembling the pole and line is done. Fisherman lays out

the huhate design. The number, type and size of work equipment and material requirements are not prepared. The series of huhate components is always carried out when going to do fishing activities. The activity of assembling pole and line fishing gear is shown in Figure 5.

Fig 5. Activities for assembling pole and line fishing gear

The performance of the actions of fishermen in the competency unit in catching fish at sea using pole and line, which is fulfilled is preparing live bait fish in the hold and fishing. The position of the presence of fish is determined by the location of FADs because fishing is always carried out around FADs and observing schools of fish by looking at signs in the sea. The caught fish are not collected, left to die. Newly caught fish are collected after the fishing process is complete.

Mallawa & Sudirman (2004), the presence of skipjack tuna is marked by the presence of foam or splashes of water, skipping skipjack tuna or flocks of birds flying swooping to the sea surface where schools of fish are located. According to Naamin (2000), the operation of the huhate depends on the availability of bait fish, about 20-40% of the total sea days cannot be carried out because there is no bait, especially in the skipjack season. Artificial bait for huhate is designed with attention to shape and color in order to attract the attention of the target fish. Matching and brighter color settings and fish-like shapes will stimulate fish to grab the hook.

In addition to live bait, artificial bait attached to the fishing line. Almost all of the pole and line fishermen in Sikka district use chicken feathers to disguise their hooks, not using artificial bait. According to Rahmat & Yahya, (2015), this artificial bait is made to cover the fishing line so that it can trick the target fish. The most widely used artificial bait material is lint cloth, but some are made of chicken feathers, neat rope, fish gill petals or shells/mussels which are shiny in color. The activity of assembling chicken feathers on the hook can be seen in Figure 6.

Fig 6. The activity of assembling chicken feathers on the hook

The operation of the huhate depends on the availability of bait fish. The fishing area using huhate is in the waters around FADs or in waters outside FADs. The principle of fishing with the huhate technique is to collect target fish in the fishing area by spreading live bait fish and if the school of fish is already in the fishing area, then fishing/fishing begins. The caught fish lying on the ship's deck are then put into the fish hatch and given bulk ice to maintain the quality of the fish. All types of fish are mixed in their storage in the hold (Rahmat & Yahya, 2015). Good cooperation by the crew is needed in order to successfully catch fish using pole and line (huhate) fishing gear.

The performance of fishermen's actions in the competency unit in carrying out maintenance on fishing equipment made from ropes and fishing rods on land has never been carried out. Fishermen do not prepare for the type of maintenance and prevention of damage to fishing gear, prepare the place, type, material and amount of equipment for maintenance and prevention of damage to fishing gear made from ropes and fishing rods, and carry out maintenance and prevention of damage to fishing gear on land. The fishing gear was left in the open at the bow of the boat, exposed to the sun and rain.

The performance of fishermen's actions in the competency unit in carrying out maintenance of fishing equipment made from ropes and fishing rods on the ship is to provide spare fishing line, spare rod, and chicken feathers for fishing line. While the fishing line maintenance is the responsibility of each angler because each angler brings his own fishing line. The placement and arrangement of fishing gear is not stored in the warehouse but is stored in the open at the bow of the ship. The actions of fishermen in the maintenance of fishing gear on boats are shown in Figure 7.

Fig 7. Actions of fishermen in the maintenance of fishing gear on the boat

The performance of fishermen's actions in the competency unit in repairing fishing gear made from ropes and fishing rods is repairing damaged rigging and replacing other damaged equipment components. The provision of preservatives and dyes on the rigging is not carried out. Likewise, avoiding damage caused by the direct influence of the sun, oil, harmful chemicals and rodents is not done. Fishing gear made from rope is stored in the open at the bow of the boat and fishing gear made from fishing rods is stored by each angler.

The performance of fishermen's actions in the competency unit in handling tuna on ships is to prepare equipment and places for handling tuna caught on board and prepare a storage system. The equipment provided on each ship is a hammer for crushing ice. Equipment for handling tuna is not prepared, the fish caught are left alone until fishing is complete. Fish die by themselves because the handling is waiting for fishing to finish. The storage system uses a stereoform box and some are stored in the hold. The large number of catches affects the storage area. If a lot is stored in the hold, if a little is stored in a steroform box. Fishermen handle fish by spraying seawater and then placing them in a styroform box or hold. The caught fish are arranged in a storage area. The caught fish are not cleaned of spoilage sources.

Fishermen Competency Suitability Based on STCW-F 1995

The knowledge and understanding of fishermen about personal safety equipment when working on ships is still very minimal so that its application is still difficult for fishermen to apply. Fishermen assume that the use of safety clothing can hinder the activities to be carried out. The self-defense technique known to fishermen is using a life jacket and plunging into the sea.

The suitability value of the competence of pole and line fishermen based on the 1995 STCW-F is presented in Figure 8.

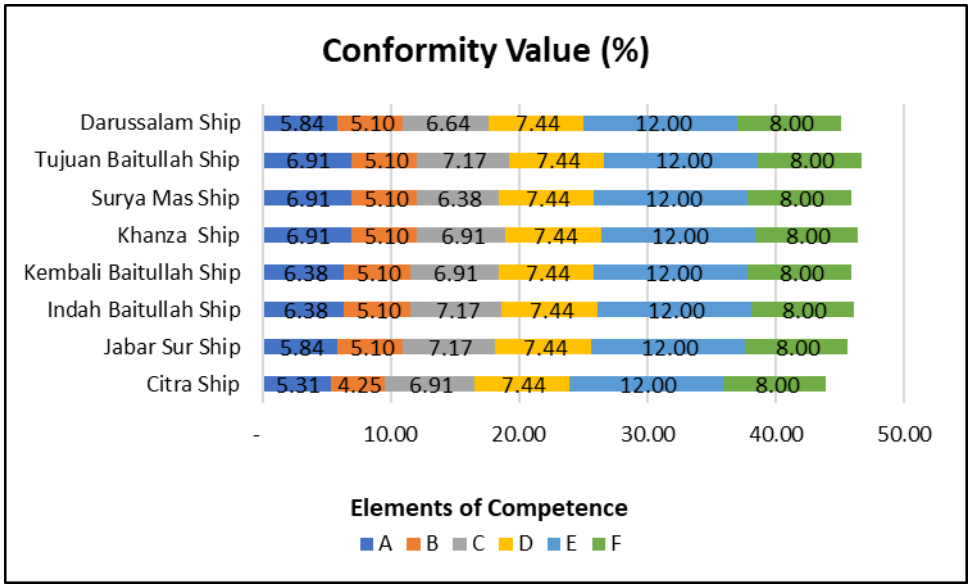

Fig 8. Compatibility of pole and line fishermen with STCW-F 1995

Description of Competency Elements:

A. Knowledge and techniques of self-rescue

B. Fire prevention and suppression

C. Emergency procedures

D. Basics of first aid (first aid in accidents)

E. Marine environment pollution prevention

F. Ship accident prevention

Figure 7 shows that pole and line fishermen are still not suitable (conformity value interval < 50%) to the application of STCW-F 1995 regarding basic level safety competencies for all fishing vessel crews. This is because

fishermen's knowledge of the importance of occupational safety and health on ships has not been understood and applied. Learning about work safety is carried out only with a lot of intensity at sea and information obtained from generation to generation.

The knowledge and understanding of fishermen about personal safety equipment when working on ships is still very minimal so that its application is still difficult for fishermen to apply. Fishermen assume that the use of safety clothing can hinder the activities to be carried out. The self-defense technique known to fishermen is using a life jacket and plunging into the sea.

According to Handayani (2014), human error is the main cause of accidents at sea that lead to death. As many as 80% of marine accidents are caused by human error and other causes are neglect by sea transportation operators and related agencies, as well as inadequate marine transportation safety equipment. Ramli (2010) states that Occupational Health and Safety (K3) is a science and application to prevent work accidents and occupational diseases.

Fishermen's knowledge regarding fire prevention and suppression is still minimal. Fishermen know how to extinguish fires using only water. Exercise The emergency organization of firefighting, chemicals and fire classes, fire extinguishing systems and fire fighting equipment is still unknown to fishermen.

Fire is a disaster caused by a fire. Where the fire disaster certainly causes losses. Fire is a rapid chemical reaction (oxidation) formed from 3 (three) elements, namely: heat, air and fuel that generates or produces heat and light. The fire triangle is the elements that support the occurrence of fire where the elements are heat, fuel and oxygen. However, with these three elements, fires have not occurred and only produce flares (ILO, 2018). APAR is a tube that functions to prevent or help extinguish fires and is also a portable device capable of removing water, foam, gas, or other materials capable of extinguishing fires.

Fishermen's knowledge of emergency procedures is limited to the use of life jackets and large buoys on board. Fishermen's learning relies on information passed down from generation to generation and the intensity of going to sea as experience so that there are no emergency conditions or work accidents on board and ship accidents. Based on the contents of Government Regulation number 5 of 1996 concerning Procedures for Facing Emergency and Disasters, it is stated that every company must have procedures for dealing with emergencies or disasters, which are tested periodically to determine reliability at the time of actual occurrence. Periodic testing of the procedure is carried out by personnel who have work competence, and for installations that have major hazards, they must be coordinated with the relevant authorities. Delivery of the basics of first aid (first aid in accidents) by fishermen, namely the use of minor wound medicine and the use of bandages.

Based on the Law of the Republic of Indonesia Number 1 Year 1970 article 3 paragraph (1), one of the requirements for work safety is to provide first aid for work accidents (P3K). The first aid given must be appropriate and fast because if the treatment given is wrong or inappropriate and fast, the victim's condition will get worse. There are three basic principles that must be carried out by first aid workers. First, action guidelines related to the environmental situation and the patient's condition. Both disorders are common in patients who must be helped. The third is readiness for help in the form of helpers, facilities, and equipment needed (Amarudin et al., 2016).

To prevent pollution of the marine environment, the fishermen explained that they do not throw garbage, oil spills and excess catch into the sea, but instead bury them on land. They realize and understand that if the sea is dirty and polluted, it will result in reduced catches. Income will decrease and affect welfare because their livelihood is obtained from fishing. Fishermen's understanding of the use of small models for the demonstration of signs or lighting, or navigational lighting simulators is also still limited to the use of spotlights or flashlights.

Article 261-265 of the Law of the Republic of Indonesia concerning Shipping explains that the implementation and development of human resources in the shipping sector aims to provide professional, competent, disciplined and responsible human resources and meet national and international standards. Including the management of education/training of human resources in the field of shipping safety and security. The education/training in question can be taken through formal or informal channels. The local government plays a role in providing services and facilities as well as ensuring the implementation of quality education and training in the field of shipping for every citizen without discrimination.

The suitability of the existing fishermen's competency standards in SKNNI (national standards) with international standards (STCW-F 1995)

Basic training and certification in SKKNI 2005-191 and SKKNI 2013-298 regarding the knowledge and competencies that fishermen must have in fishing activities at sea are divided into several competency units, while in STCW-F 1995 the basic competencies that fishermen must have are made into one chapter, namely Chapter III Basic

Safety Training for All Crews of Fishing Vessels. The units and elements of competence in SKKNI 2005-191, SKKNI 2013-298 and STCW-F 1995 are shown in Table 5.

Table 5. Units and elements of competency standards for basic level fishing vessel crew training based on SKKNI 2005-191, SKKNI 2013-298 and STCW-F 1995

Competency Unit	SKKNI 2005-191	Competency Unit	*STCW-F 1995*
1	Application of Rescue Engineering Procedures Self at Sea (PTK.NP02.003.01)	**Resolution 3**	1 Personal survival techniques, including donning of lifejackets and, as appropriate, immersion suits
2	Doing Prevention and Extinguishing Fire (PTK.NP01.008.01)		2 Fire prevention and fire fighting
3	Emergency procedures (PTK.NP01.009.01)		3 Emergency procedures
4	Application of Onboard Medical Services (PRK.NP01.010.01)		4 Elementary first aid
5	Preventing Marine Environmental Pollution (PRK.NP02.013.01)		5 Prevention of marine pollution
6	Manipulating and Controlling the Ship Fisheries (PRK.NP02.007.01)		6 Prevention of shipboard accidents
7	Implementing Occupational Health and Safety onboard (PRK.NP03.002.01)		
	SKKNI 2013-298		
8	Carry out marine guard duties (A.031110.04.01)		

In Table 5, the basic competency units in the 2005-191 SKKNI are divided into 8 competency units. Meanwhile, in 1995 STCW-F became an integral part of the competency unit as a basic level safety training for fishermen. Fishermen in SKKNI must attend 8 trainings to obtain basic level safety knowledge and certificates. Whereas in STCW-F 1995, fishermen only attended 1 training to obtain basic level safety knowledge and certificates.

IV. CONCLUSION

1. Competence of pole and line fishermen based on SKKNI 2005-191 PRK.NP03002.01 concerning Implementing Occupational Safety and Health on Boats in Sikka Regency is not appropriate (conformity value interval < 50 %). This is due to the fact that fishermen's knowledge of the importance of work safety on ships has not been understood. The competence of pole and line fishermen based on the 2013-298 SKKNI concerning the competence of fishermen in terms of catching fish using pole and line in the sea is quite appropriate (interval of suitability value between 50 to < 75 %). The actions of fishermen have been sequential in terms of operating catching using pole and line fishing gear, only fishermen do not use work safety equipment when working on boats.
2. Pole and line fishermen are still not suitable (conformity value interval < 50 %) to the implementation of STCW-F 1995 regarding basic level safety competence for all fishing vessel crews. This is because fishermen's knowledge of the importance of work safety on ships has not been understood and applied.
3. The basic competency units in SKKNI 2005-191 and SKKNI 2013-298 are divided into 8 competency units. Meanwhile, in 1995 STCW-F became an integral part of the competency unit as a basic level safety training.

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Fishing Effectiveness of Fixed Lift Nets with Multi Color LED Combinations

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Abstract— *This study aims to analysis at the composition of fish catches and the fishing effectiveness of fixed lift nets fitted with LED lights of varying color combinations. This research was carried out from May to June 2019, located in the waters of Pangkajene Regency and the Islands. Two fixed lift nets units, 16 white light Emitting Diode (LED) lights and 16 pairs of white blue and yellow combination lights, Global Positioning System (GPS), Stop watch, Digital scale, Digital camera, Logbook, Meter, Current meter, Thermometer, Refractometer, and Lux meter. The research method used in this study is Experimental fishing in fixed lift nets fishing operations using LED lights. Experimental research of white and white combination LED light color (control), and blue, white and yellow LED light color (Treatment) used in 2 fixed lift nets. The fixed lift nets used is 15 meters long and 15 meters wide with a height of 25 meters from the seabed to the top pole with a building height of 10 meters above sea level. The data collection technique was carried out by following directly the catching operation of two fixed lift nets with different color combinations of lights. The data collected is the position of the fishing ground and catch data. Data analysis was carried out qualitatively and quantitatively. Qualitative analysis by looking at the technical aspects of operations on the fixed lift nets and data tabulation. Quantitative analysis was carried out using statistical methods and comparison of fish catches using two treatments using LED light colors. The results show that the composition of fish catches using color combinations (white, blue and yellow) shows higher yields when compared to white. The composition of the catch in the fixed lift nets is divided into three groups, namely the main catch (main catch), bycatch (bycatch) and discarded catch (discard). The use of a combination of LED lights on the fixed lift nets got a catch of 1,347.21 Kg, while the use of white LED lights got a catch of 906.21 Kg. The difference between the catches of the two treatments was 441 kg or 49% of the fish caught using white LEDs. From these results it can be concluded that the use of color combinations of LED lights is more effective than the use of white LED lights.*

Keywords— ***fixed lift nets, use of LED lights, experimental fishing, fishing effectiveness.***

I. INTRODUCTION

The development of the current fishing business in Indonesia can be said to be increasing rapidly, in (Baskoro et. al. 2011) revealed that one of the rapidly increasing developments is in fishing technology using light, fishing technology using a lot of light in Indonesia itself is widely used. in lift net and purse seine fisheries.

In the eastern region of Indonesia, in general, one of the fishing gears that is widely used by fishermen is the lift nets. Lift nets fishing gear is a fishing tool that uses light as a lure to attract fish so they can gather in a place or area from a fixed lift nets for easy catching, generally using light tools on the fixed lift nets is used to catch pelagic fish.

In the classification, the fishing gear is grouped in the category of lifting nets. The main part of the lift nets fishing gear is made of bamboo and has a net that can be raised and lowered during the fishing process. This fishing gear that collects small pelagic fish is a fishing gear that utilizes the positive phototactic properties of fish (BBPPI 2007).

Currently, the development of fixed lift net fisheries by utilizing lights in fishing activities in coastal areas is increasing, it can be seen from the number of fishermen who use this fishing gear. The interest of fishermen in the use of light aids on the fixed lift nets is due to several advantages, namely, (Sudirman and Nessa, 2011): (1) It is technically easy to do (especially fixed lift nets), (2) The investment is affordable by the community, (3) It is a community fishery that has been used by people in coastal areas and around small islands for generations. (3) The catch is always there even though sometimes the amount is small, (4) It absorbs a lot of manpower, and (5) The technology is very simple.

Many studies have been carried out and have developed a lot as in the research conducted by Nadir, 2000, Sudirman et. al. 2001 and 2003. These studies have reached the use of electric light technology, especially the use of mercury lamps.

The use of light aids as a developing technology is generally still very simple. Various efforts to increase the use of light technology, especially in fixed lift nets, have been carried out by many researchers. Among them are the use of 4, 6 and 8 lamp units, the use of petromax lamps which are associated with strong light illumination does not show a significant difference (Herutomo, 1995). In Efendy's (1998) research, there was an effect of increasing catches for each additional number of units on the lift nets operated in the waters of Teluk Awur Jepara, Central Java, but there was no difference between the use of 4 and 5 lamp units, and several studies suggested that there is a difference in the composition of the dominant fish catch for each number of lights used, the use of 2 lamp units produces a dominant catch, namely rebon shrimp, 3 lamp units produce a dominant catch of anchovies, 4 lamp units produce a dominant catch of tembang fish and 5 lamp units produce a dominant catch of layur fish .

Improvements in the use of light technology in fixed lift nets have been carried out as well as further studies conducted by Sudirman et.al 2010 regarding the selectivity performance of fixed lift nets carried out in the Makassar Strait, an environmental friendly research on fixed lift nets fishing gear. And followed by further research that examines the use of several types of lights used in fixed lift nets gear, namely (fluorescent, mercury, and incandescent lamps), in this study it was stated that the most effective lamp in relation to attracting the attention of fish was the use of fluorescent lamps in fixed lifts. net (Sudirman et.al 2013). Science and technology that continues to develop at this time may be an improvement in the use of appropriate technology for sustainable fisheries, especially in fixed lift nets fisheries, which in existing studies and those that have been applied by fishermen should need further development.

II. RESEARCH METHOD

This research was carried out from May – June 2019, located in the waters of Pangkajene Regency and the Archipelago, with the coordinates of the fishing base 04º50'55.7" South Latitude – 119º30'56.4" East Longitude and fishing ground 04º48'21.5" South Latitude – 119º 27'056 and 04º49'22.5" South Latitude – 119º 27'10.5º. Around the fishing ground there are two islands, namely Bangko Island - Bankoang and Kulambing Island, where these two islands are all inhabited as can be seen in Figure 1.

Fig.1: Research site

The tools and materials used in this study are instruments that support the retrieval of research data. The tools and materials used and their uses can be seen in Table 1.

Table 1. The tools and materials

No	Tool	Function
1	Two fixed lift nets	Fish catching tool
2	16 white LEDs and 16 white, blue, and yellow combination LEDs	Fishing aids
3	Global Positioning System (GPS)	Determining the position of the fishing base, fishing ground and the movement of the handline fishing fleet
4	Stop watch	Calculating the effective time of the hand line fishing process

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5	Digital scale	Measuring the weight of the caught fish
6	Digital camera	Documenting research
7	Logbook	Record production and fishing area data
8	Ruler	Measuring the length per fish
9	Current meter	Measuring current speed
10	Thermometer	Measuring seawater temperature
11	Refractometer	Measuring salinity
12	Lux meter	Measuring light intensity

The research method used in this study is Experimental fishing in fixed lift net fishing operations using LED lights. Experimental research of white and white combination LED light color (control), and blue, white and yellow LED light color (Treatment) used in 2 fixed lift nets. The fixed lift net used is 15 meters long and 15 meters wide with a height of 25 meters from the seabed to the top pole with a building height of 10 meters above sea level. The control net lift is installed with 15 white LED lights with a total power of 376 watts white. And the test lift net installed a combination of LED colors with a total power of 376 watts of different color combinations, 4 units of white LED lights with a power of 27 watts, 6 units of blue lights with a power of 27 Watts, and Yellow Lights with a power of 40 watts consisting of of 2 units, the 13 watt Yellow light consists of 2 units. Illustration of the use of Neon and LED lamps used in research. The data collected are catch production and oceanographic data on two fixed lift nets with different color combinations of LED lights.

Data Collection Technique

The data collection technique was carried out by following directly the capture operation of two fixed lift nets with different color combinations of lights. The data collected are as follows:

1. Position of the fishing ground

The position of the fishing area is taken using a GPS (Global positioning system) at each fishing group. Data collection on the position of the fishing ground is done to determine the location of the fixed lift net.

2. Catch data

Counting the number of catches on two fixed lift nets with different color combinations of LED lights. This is done to determine the number and composition of catches in two color combinations of LED lights.

Data Analysis

Data analysis was carried out qualitatively and quantitatively. Qualitative analysis by looking at the technical aspects of operations on the fixed lift net and data tabulation. Quantitative analysis was carried out using statistical methods and comparison of fish catches using two treatments using LED light colors.

III. RESULTS AND DISCUSSION

Composition of Catches

Catches on fixed lift nets that use a combination of LEDs include anchovies (Stolephorus indicus), lemuru (Sardinela fimbriata), peperek (Leiognathus equulus), bilis (Herklotsichthys dispilonotus), kwee (Carangoides dinema), peperek (Leiognathus equulus), squid - squid (Loligo sp), selar (Anodontosoma chacunda), selar kuning (Selaroides leptolepis), selar tengkek (Megalaspis cordyla), and tembang. based on the proportion caught sequentially such as pestle (Sphyraena forsteri), machete (Chirocentrus dorab), jackfruit seed (Upeneus sulphureus), mackerel (Scomberomorus commerson), lencam (Lethrinus lentjan), layur (Trichiurus sp. B), small crab (Portunus pelagicus), gerot-gerot (Pomadasys andamanensis), and balombong (Atherinomorus egibyl), bitter gourd (Arothron manilensis), pufferhead (Lagocephalus sceleratus), stone puffer (Torquigener brevipinnis), chickens (Paramonacanthus), crocodile tong (Syngnathoides biaculeatus), bluncat (Arcygobius baliurus).

Based on the results of the study, the composition of fish catches using a combination of colors (white, blue and yellow) showed higher yields when compared to white. The composition of the catch in the fixed lift net is divided into three groups, namely the main catch (main catch), bycatch (bycatch) and discarded catch (discard). The main catch (main catch) on fixed lift neta that uses LEDs is 1,105 kg on a fixed lift net with white LEDs as much as 722.49, by catch on fixed lift neta that uses LED color combinations as much as 202.24 kg and on fixed White LED lift net is 153.69 Kg, Discarded catch is 39.47 Kg LED color combination on White LED is 30.03 Kg. By-catch is a catch of fish that consists of three types of catch, while discarded catch is a catch that has no economic value or the economic value of the fish is classified as very low, so the fish caught are

usually discarded by fishermen. The limited space for fish storage is also a factor in the fish being discarded. To see the composition of the catch can be seen in Figure below.

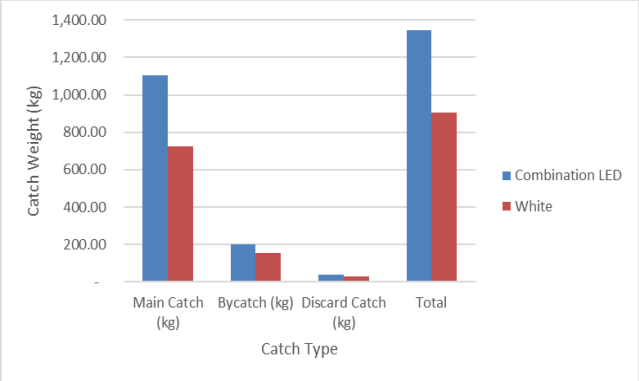
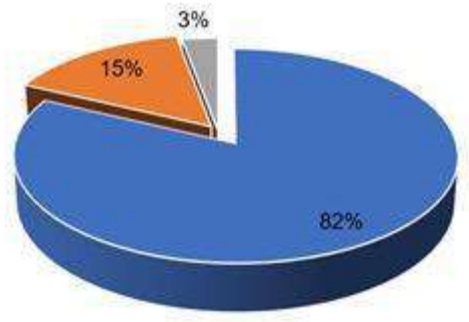
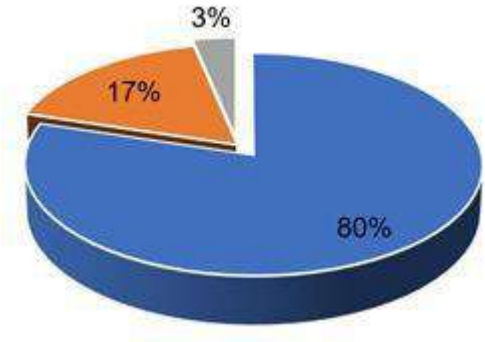


Fig 2: Composition of fish catches using a combination of LED light colors



(a)



(b)

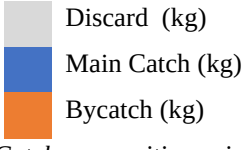


Fig.3: (a) Catch composition using combination color LED (b) catch composition using white LED

The total main catch on the fixed lift net using the LED color combination is more than the percentage of the main catch in the fixed lift net using the White LED. With a total percentage of 82% and on the white LED by 80%. Judging from the bycatch, the percentage of the total catch is greater in lift nets that use White LEDs by 17% and in fixed lift nets with LED color combinations by 15%. Meanwhile, the percentage of catches and discharges between the two lift nets is the same as the total percentage of 3%.

The Effectiveness of Using a Combination of LED Lights

The use of assistive devices in the form of lights is now widely used by fishermen, especially for fixed lift net fishermen in Pangkep Regency. Based on the results of the study, it was reported that it showed that electric lights were effective in attracting the attention of fish around the lift net (Ta'ladin, 2000). In this study, the lamp used is a type of Light Emitting Diode (LED). The effectiveness of catching fish using fixed lift net fishing gear in Pangkep Regency can be seen from the catch produced with two combination treatments of LED and white lights. In the previous discussion, it has been explained that there are significant differences in catches. The use of a combination of LED lights on the fixed lift net got a catch of 1,347.21 Kg, while the use of white LED lights got a catch of 906.21 Kg. The difference between the catches of the two treatments was 441 kg or 49% of the fish caught using white LEDs. From these results it can be concluded that the use of color combinations of LED lights is more effective than the use of white LED lights.

Differences in catches on fixed lift nets that use color combinations, namely the blue color which is suspected to be supporting the number of catches on the step-by-step fixed lift nets that uses color combinations, blue lights have a low wavelength so that their penetrating power in waters is very deep research conducted by Amos, CT (2019) which states that blue light has a low wavelength so that its range is very far in the water. This light is able to attract small pelagic fish and demersal fish. This allows greater opportunities for fish at more distant locations to respond to light to attract and congregate in the catchable area of the fixed lift nets.

In addition, Aliyubi FK et al. (2015) said that the use of light colors on fixed lift nets will certainly affect the fish caught. The theory from several previous studies shows that white and red lights do not provide maximum results compared to other light colors such as blue and yellow.

The next question is whether the use of white LED lights has been effective?. The use of white LED lights is still effective with the catch obtained by 906.21 Kg consisting of the main catch of 722.49 Kg, by-catch of 153.69 Kg and Discard of 30.03 Kg. The use of a combination of LED

lights (White – Blue – Yellow) is more effective in catching fish when compared to the use of white LED lights, this study supports the results of previous studies that specifically examined fixed lift nets that use LEDs, one of which is the use of white LEDs compared with CFL Lamps conducted by Susanto, A (2017). From this study concluded that commercial LED light distribution can penetrate wider and deeper into the catchment area than CFL lamps and is good enough to attract target species of anchovy. The use of LED lights significantly affects the catch of anchovy and saves fuel consumption. LED lamps are a potential light source that is suitable to replace CFL lamps in developing fisheries, in other words the use of LEDs is very good compared to other types of lamps. Through this research, it can be seen that the modification of fixed lift nets using a combination of LED colors is proven to increase fish catches seen from the effectiveness of the fixed lift nets studied.

This study is also in accordance with several previous studies that examined differences in catches on fixed lift nets with different LED colors. Sudirman (2003) said that the color of the light greatly affects the total weight of the fish caught. From the results of research by Gustaman (2012), the use of blue lights has an effect on the catch of some demersal fish. Furthermore, Gustaman said that the distribution of demersal fish such as petek is also the most caught in the use of blue light because the light has a strong penetrating power in the waters. This indicates that the total catch on fixed lift nets with LED color combinations can be caused by the use of blue LED lights in combination to reach fish in deeper waters and collect fish to the fixed lift nets catch area.

IV. CONCLUSION

The composition of fish catches using color combinations (white, blue and yellow) shows higher yields when compared to white. The composition of the catch in the fixed lift nets is divided into three groups, namely the main catch (main catch), bycatch (bycatch) and discarded catch (discard). The use of a combination of LED lights on the fixed lift nets got a catch of 1,347.21 Kg, while the use of white LED lights got a catch of 906.21 Kg. The difference between the catches of the two treatments was 441 kg or 49% of the fish caught using white LEDs. From these results it can be concluded that the use of color combinations of LED lights is more effective than the use of white LED lights.

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Effect of Vermicompost and Terrestrial Isopod (*Porcellio laevis*) Fertilizers on The Yield and Quality of Lettuce (*Lactuca sativa* var. *capitata* cv. Wismar)

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Abstract—*Terrestrial isopods (woodlice) (Isopoda.: Oniscidea) are important members of soil macrofauna in many habitats. Although the role of woodlice in decomposing organic matter and recycling nutrients is well known, there is no available data on the utilization of fertilizer obtained using terrestrial isopods in agricultural production. To evaluate the effects of the addition of vermicompost and the fertilizer obtained using terrestrial isopod species Porcellio laevis Latreille, 1804 in different ratios to plant growing media on nutrient content and yield of lettuce, nine different mixtures containing 1, 5, 10, and 20% of each fertilizer [v/v, including agricultural soil (control)] were used. As result, while the total and head weight of the control plant was 69.66 g and 59.53 g respectively, the highest values were obtained from the mixtures containing 20% vermicompost with 154.33 g and 150.66 g, and this followed by isopod fertilizer (20%). The vitamin C and chlorophyll (SPAD) content of plants grown in all mixtures were higher than control and there were no significant differences in respect to phenolic matter and nitrate. The fertilizer produced by using P. laevis, which can evaluate many kinds of agricultural and household organic wastes can be confidently used or added to media*.

Keywords— ***Lettuce, Porcellio laevis, quality, Terrestrial isopod, vermicompost.***

I. INTRODUCTION

Lettuce, a cool-season crop rich in Vit C, A, and minerals, is the major salad vegetable in many countries of the world also in Turkey (Yamaguchi 1983; Liebster 1990; Krug 1991). It has nutritious properties and important for a balanced diet. Existing (conventional) agricultural production systems are threatening living and environmental health. For instance, the excessive use of nitrogen for high yield is a widespread practice, especially in leafy vegetables like lettuce. This situation not only the soil's ability to produce healthy plants affect, but also causes salinization and pollution in soil and groundwater. Therefore, there is a demand for naturally derived plant nutrient elements and soil conditioners for the sustainability of agriculture and healthy vegetable products. In this context, it is increasing the interest in the use of materials such as vermicompost, especially for the utilization of agricultural wastes and environmentally friendly sustainable production. Vermicompost, processed organic material by earthworm, which is increasingly used in agricultural practices, has high porosity, drainage, water-holding capacity, and microbial activity. It improves absorbability and retention of nutrient due to having a large surface area, and thus contain nutrients in forms that are readily taken up by the plants. There are a number of researches in the literature dealing with the positive influence of vermicompost on growth, productivity and quality of vegetables (Edwards and Burrows 1988; Orozco et al. 1996; Atiyeh et al. 1999; Sharma and Banik 2014).

Terrestrial isopods (Isopoda: Oniscidea), a member of soil macrofauna, are invertebrate species that playing an important role in the decomposition of agriculture and

livestock waste material (Drobne 1997; Odendaal and Reinecke 1999; Hussein et al. 2006; Loureiro et al. 2006). They are identified as an integral part of the decomposition process, which recycles essential nutrients of the soil and maintains its fertility by the fragmentation of organic matter and stimulating and/or ingesting fungi and bacteria. Due to their high physiological adaptation capacity and exhibiting a broad distribution, they have become an important model organism for the monitoring of pollution and to test the hypotheses in global change biology (Kammenga et al. 2000; Zimmer 2002). *Porcellio laevis* is one of the most widely and intensively used woodlice species for this purpose, as it is cosmopolitan and shows plasticity in physiological and life-history traits in response to different geographical climatic condition (Powers and Bliss 1983; Castañeda et al. 2004; Bacigalupe et al. 2007; Lardies and Bozinovic 2008; Folguera et al. 2009; Da Silva Junior et al. 2014).

Nowadays, many ingredients such as vermicompost, perlite, coir, and peat are used to improve the qualifications of growing media in growing seedling and horticultural crops (Tuzel et al. 2020). Furthermore, interest in different resources to be used for this purpose in the production of horticultural crops is increasing due to reasons such as increased environmental awareness, high input cost, and increasing demand for waste recycling. Although many studies have reported the positive impacts of vermicompost on the growth and yield of vegetable crops, to our knowledge, no information is available on the role of woodlice-mediated fertilizer in crop production. The main objective of this study was to evaluate the usability of terrestrial isopod (*Porcellio laevis*) fertilizer added to growing media at different proportions for lettuce production and to compare it with vermicompost.

II. MATERIALS AND METHODS

2.1 Isopod fertilizer and preparing

In this study, agricultural soil, vermicompost, and isopod fertilizer were used as the main media to show the usability potential of woodlice-mediated fertilizer in horticulture through comparative data. The agricultural soil was taken from the vegetable research field of the department of horticulture to prepare growing media had the clay loam texture (35.13% clay, 24.40% silt, 40.47% sand). Cow manure vermicompost, processed by red earthworm (*Eisenia foetida* L.), suitable for vegetable production was provided by a commercial firm. To prepare isopod fertilizer, the plastic pot having dimensions 40x50x40 cm was used. Firstly, three-liter agricultural soil was put into the pot, laid to cover the bottom, soaked with tap water, and compressed to a depth of about 1-2 cm. Then, two kg dry cow manure (old cow dung), lettuce and carrot waste, wheat straw (each one 0.5 kg) were added. The mixture was stirred thoroughly and again was moistened. Three hundred adult *P. laevis* longer than 8 mm were collected from the field, identified morphologically according to the species-specific keys (Hale, 1927-1929), released into the pot, and the container was covered with fine mesh and left at room temperature for three months (Fig. 1a). During this composting period, the studied settlement was regularly checked at intervals of no more than one week. The contents were moistened and mixed gently to allow the isopods to access the different parts of foods, and new food materials were provided when it is necessary. At this point, in order to prevent the excessed food supply from spontaneously decomposing into the fertilizer independently of the isopod effect, food particles that were covered with mold were removed. In all the rearing processes of the isopods, the known data about their environment preferences, moisture requirements, food preferences, daily feed consumption amounts, and other requirements were considered (Warburg 1993; Zimmer 2002; Lardies et al. 2004; Catalán et al. 2008). At the end of the three-month composting period, all the contents were gently sieved (pore size, *ca*. 3x3 mm) to eliminate insufficiently decomposed food pieces and the isopods. Some chemical properties of the agricultural soil, isopod fertilizer) and vermicompost used in the experiments were determined using (Table 1).

By taking into consideration the previous studies (Edwards and Burrows 1988; Ali et al. 2007; Kiran 2019) concerning vermicompost, the following growing media were tested in the experiments:

(1) Agricultural soil (collected from the top 30 cm depth)
(2) Agricultural soil mixed with 1% vermicompost (v/v)
(3) Agricultural soil mixed with 5% vermicompost (v/v)
(4) Agricultural soil mixed with 10% vermicompost (v/v)
(5) Agricultural soil mixed with 20% vermicompost (v/v)
(6) Agricultural soil mixed with 1% isopod fertilizer (v/v)
(7) Agricultural soil mixed with 5% isopod fertilizer (v/v)
(8) Agricultural soil mixed with 10% isopod fertilizer (v/v)
(9) Agricultural soil mixed with 20% isopod fertilizer (v/v)

2.2 Experiment site, plant materials, and growth conditions

The experiments on the lettuce cultivation were carried out at the unheated greenhouse of the experimental field of the Department of Horticulture, Faculty of Agriculture, Tekirdag Namik Kemal University, Turkey (40°59´33´´N, 27°34´43´´E, altitude 18 m). Seedlings of commercial lettuce (*Lactuca sativa* L.), iceberg type, 'Wismar' (Vilmorin-Anadolu Vegetable Seeds, Istanbul, Turkey)

were planted into bags (dimension in 22x40 cm) containing soil and vermicompost or isopod fertilizer at different ratios. Bags were put on benches inside the greenhouse. In order to clearly see the effect of different growing media, no additional fertilization was made during the growing period. Regular watering by hand to keep the soil with adequate water supply was made. Towards the end of the experiment, low tunnels were set up over the plants and covered with shade cloth to protect the plants from high temperatures. (Fig. 1b). Maximum and minimum temperatures and relative humidity were recorded daily during the experiment period (Fig. 2).

Table 1. The basic chemical properties of the agricultural soil, isopod fertilizer (If) and vermicompost (Vc) used in the experiments.

	pH	Salt (%)	Lime (%)	Organic matter (%)	N (%)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)
Soil	7.74	0.13	4.72	1.73	0.025	32.31	95.37	531.41	56.20	0.43	1.37	0.71	16.07
If	7.02	0.74	1.71	6.52	0.33	480.61	9591.45	7763.27	2528.88	6.89	3.18	42.43	21.59
Vc	6.08	0.22	-	42.80	1.40	2619.71	2945.74	4455.50	-	-	-	-	-

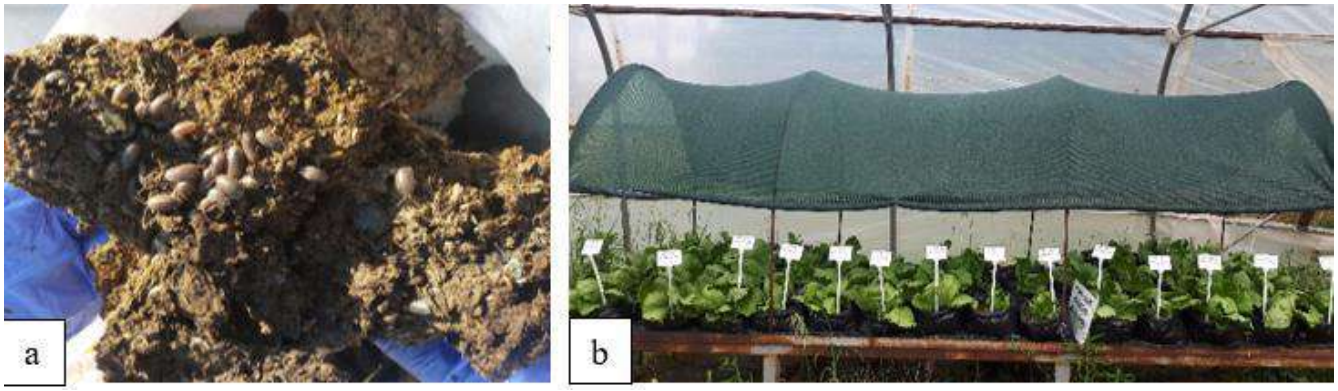

Fig.1. Isopods (Porcellio laevis) (a) and a view of plants grown in a greenhouse (b).

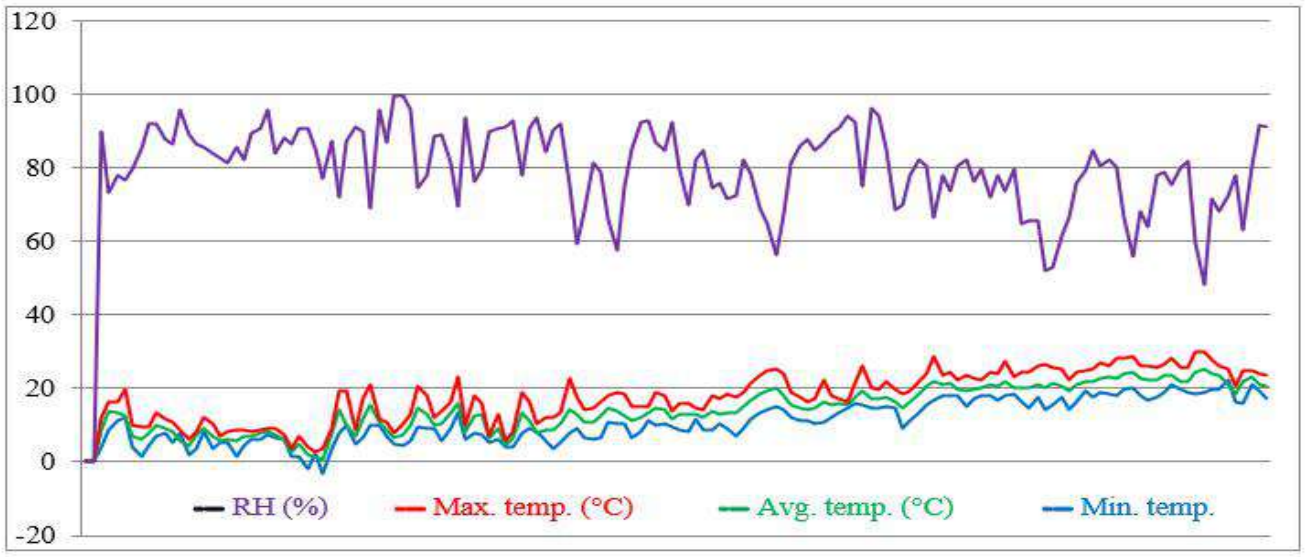

Fig.2: Daily relative humidity (RH, %), minimum, maximum and average temperatures (°C) during the growing period.

2.3 Measurement and analysis of plant

After 60 days from transplanting all plants were harvested by cutting above soil surface using a steel knife, and plant

weight (without roots), head weight, and head circumference were weighed or measured in the samples randomly selected from each plot and application. Vitamin C was determined by using the 2,6, dichlorophenol-indophenol dye titration according to Pearson (1970) and presented as mg/100g fresh weight. Chlorophyll content of leaves was measured nondestructively by Minolta Chlorophyll Meter-SPAD 501 (Ghoname et al. 2017). The content of the total phenolic compounds was determined by Folin-Ciocalteu assay and was expressed as mg gallic acid equivalent/100 g of sample (Leamsomrong et al. 2009). The nitrate content of leaves was determined by salicylic acid method and expressed as ppm (Cataldo et al. 1975). Nitrogen was quantified by micro-Kjeldahl method in dried and ground leaf samples, the determination of mineral content of leaf was used atomic absorption spectrophotometer (Hernandez et al. 2010).

2.4 Statistical analyzes

The experiment design was a randomized complete block with three replications, each including nine different growing media. Data were subjected to analysis of variance (ANOVA), followed by the LSD test at p <0.05 (Montgomery 1991).

III. RESULTS AND DISCUSSION

3.1 Head properties

The addition of vermicompost (Vc) or isopod fertilizer (If) to the growing medium led to an increase in plant and head weight, and this increase showed a linear relationship with the amount of them (Table 2). The highest plant and head weights were obtained from 20% Vc with 154.33 g. and 150.66 g. respectively, this was followed by media containing the same proportion of If with 137.77 g. and 135.00 g. The same situation was also seen in the head circumference and plants growing in medium containing Vc and If had larger heads than the soil (control). The addition of Vc or If to the growing medium may have brought the soil pH closer to neutral. Likewise, the fact that they contain a higher rate of nutrients than the soil may have led to this result. Similar to the results obtained from this experiment, as reported by many authors (e.g., Hernandez et al. 2010; Singh et al. 2010; Sharma and Banik 2014), the addition of vermicompost to the medium increases plant growth. Nagavallemma et al. (2006) stated that the application of vermicompost can directly modify the physicochemical properties of agricultural soil in a way that promotes plant growth. In our previous study that the vermicompost and isopod fertilizers at the same ratio were added to the lettuce seedling growing medium, there was no difference among applications in terms of seedling emergence and seedling characteristics, probably due to the short seedling growing time. However, fresh and dry weights of seedlings in If and Vc media were higher than those grown in soil (Arın and Dinçsoy 2020).

3.2 Nutrient composition and mineral content

The vitamin C and chlorophyll contents of plants grown in media containing vermicompost and isopod fertilizers were higher than the soil (control), and this increase was parallel to the amount of them at media (Table 2). Besides all applications have a higher value than control, the highest SPAD value was recorded at 20% vermicompost with 38.56 (a), followed by 20% isopod fertilizer with 35.91 (ab). A similar case existed in the results regarding the vitamin C content of the leaves. The likely reason for the increase in vitamin C, chlorophyll, with the addition of these to the growing medium, could be that these materials contain higher organic matter and plant nutrient elements compared to the soil (Table 1). Other hand, Kiran (2019) stated that vermicompost increases water uptake of roots due to its capacity of holding water and the microorganisms including mycorrhizal fungi. Ayyobi et al. (2014) reported that the increase in chlorophyll content with organic matter applications such as vermicompost or municipal solid waste compost can be attributed to an increase in photosynthesis and CO assimilation which improve mineral uptake by the plant.

There were no significant differences among the content of phenolic matters of plants grown in different media but, the lowest value with 175.33 mg/100 g was determined in control (soil). Also, in terms of nitrate, the differences of growing media were not statistically important (Table 2). It is known that excess nitrate is harmful to human health. During various processes in the human body, nitrates are converted into nitrites, which causes various diseases, such as blue baby syndrome (methemoglobinemia) and cancer. Leafy vegetables, including lettuce, are plants that accumulate high amounts of nitrate (Mensinga et al. 2003; Colla et al. 2018; Bian et al. 2020; Salehzahed et al. 2020). Gorenjak and Cencic (2013) reported that lettuce takes place in the remarkably high group in the classification made according to the nitrate content of vegetables, Krug (1991) that the nitrate content of lettuce varies 380-3520 mg/kg FW as depending on many factors such as the variety, growing season and fertilization. According to EU Commission regulation (No 1258/2011), concerning with maximum nitrate content for the commercialization of fresh vegetable, the nitrate threshold established for lettuce is 3000-5000 mg/kg FW, and the highest daily nitrate intake 222 mg for a 60 kg individual (Colla et al. 2018). In this study, besides the nitrate content of lettuce leaves was not significantly affected by the addition of vermicompost or isopod fertilizers to growing media, the nitrate levels of the plants

were within the aforementioned values or did not exceed the recommended maximum nitrate intake value per day.

Table 2. The effect of different growing media on the plant weight (g), head weight (g), head circumference (cm), vitamin C (mg/100g), chlorophyll (SPAD), total phenol (mg/100g), nitrate content of lettuce (ppm).

	Plant weight (g)	Head weight (g)	Head circum. (cm)	Vitamin C (mg/100g)	Chlorophyll (SPAD)	Total phenol (mg/100g)	Nitrate (ppm)
Soil	69.66 d	59.53 d	28.7 b	9.47 f	24.37 c	175.3	1064.0
1% Vc*	99.67 bcd	96.33 bcd	37.0 ab	11.90 de	28.35 bc	195.6	1230.5
5% Vc	112.00 abc	108.66 abc	41.3 a	13.97 cd	30.95 abc	248.0	1256.0
10% Vc	128.00 ab	125.33 ab	41.0 a	16.43 ab	31.49 abc	184.6	1070.0
20% Vc	154.33 a	150.66 a	42.0 a	18.68 a	38.56 a	218.7	1433.5
1% If**	79.00 cd	76.33 cd	35.0 ab	11.62 ef	28.99 bc	179.3	2164.5
5% If	93.20 bcd	90.33 bcd	34.0 ab	12.16 de	29.12 bc	230.7	1189.5
10% If	120.33 abc	116.66 abc	33.6 ab	15.46 bc	31.29 abc	254.6	1972.5
20% If	137.77 ab	135.00 ab	39.4 a	16.83 ab	35.91 ab	192.0	1745.5

Within columns, values followed by different letters are significantly different (P<0.05)

**Vc: Vermicompost, **If: Isopod fertilizer*

The differences in the mineral content of the leaves among growing media were not significant except for zinc. With the increase of isopod fertilizer in the mixture, the zinc content of the leave increased regularly and the highest zinc content with 11.58 ppm was determined at 20% If (Table 3). As known well, Zinc has a particularly important role in protein synthesis, membrane stability, and enzyme activation in plants, and it supports and activates the plant immune and resistance system, especially in stressful conditions (Cakmak 2008; Rehman et al. 2019; Farooq et al. 2021).

Table 3. The effect of different growing media on the mineral content of lettuce leaves.

	N (%)	P (ppm)	K (ppm)	Ca (ppm	Mg (ppm)	Na (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)	Fe (ppm)
Soil	0.93	7187.3	8762.6	11105.9	1717.5	1511.5	41.20	8.53 bc	1.33	12.70	650.8
1% Vc*	0.97	5601.2	8213.4	10581.4	1641.5	1524.8	43.26	7.46 bcd	1.32	12.42	872.7
5% Vc	1.10	7329.2	15254.8	10347.7	1441.6	1422.1	39.58	7.03 bcd	1.15	9.63	445.0
10% Vc	1.08	5741.8	6467.4	9295.6	1502.3	1375.1	34.70	6.08 d	1.10	6.53	481.8
20% Vc	1.05	6348.9	11987.3	9554.7	1310.6	1270.1	33.68	6.60 cd	1.23	9.20	597.7
1% If**	0.87	6735.5	13471.2	10566.8	1581.1	1533.2	37.05	8.16 bcd	1.15	7.30	448.7
5% If	0.88	6649.0	5056.8	10128.8	1609.0	1425.5	40.56	8.63 bc	1.27	13.57	794.3
10% If	0.76	8053.7	10908.5	11017.2	1848.8	1574.3	35.75	9.00 b	0.98	11.05	561.0
20% If	1.14	8046.0	6311.0	10222.4	1677.0	1553.3	39.33	11.58 a	1.38	9.80	608.3

Within columns, values followed by different letters are significantly different (P<0.05)

**Vc: Vermicompost, **If: Isopod fertilizer*

3.3 Evaluation of results as deals with health, environment, and agriculture

The use of sustainable organic materials can increase fertility without negative effects on human health and the environment. They maintain quantity and quality of yield and can be less costly than synthetic fertilizers. Vermicompost is widely one of the most used materials for this purpose. However, it should be kept in mind that the content and characteristics of vermicompost vary depending on the raw material, the type of earthworm, the methods of processing, etc. and it has a high cost and can cause salinity when used continuously or at high rates (Atiyeh et al. 2002; Ayyobi et al. 2014; Guiterrez-Miceli et al. 2007). Today is being emphasized the importance of sustainability to protect human life, animals, and plants by cutting pollution. Therefore, within the scope of zero waste, studies are being carried out and the decisions and measures are taking to reach this goal (Marshall and Farahbakhsh 2013; Lim et al. 2015). The European Union, which has focused on environmental and social sustainability issues such as combating climate change, reducing greenhouse gas emissions, and using renewable energy published a new environmental plan called The European Green Deal in November 2019 (EU Commission 2020). All the relevant data indicate that the interest in materials that can be used as plant nutrients and as soil conditioners from waste with natural processes will continue to increase.

This study suggested that woodlice can be a promising alternative that may be utilized in the eco - friendly agricultural practices. Furthermore, our results and observations, and some well-known features of *P. laevis* as follows indicate that this species is a good candidate in this context: i) it can effectively feed on a great variety of fresh or dead plant materials (Warburg 1993) and dry cattle feces, ii) it is able to avoid the foods contaminated with some heavy metal (Odendaal and Reinecke 1999), iii) it ingests more food than some other woodlice species (Dallinger and Wieser 1977; Warburg 1993), iv) the retention time of food in the digestive tract is mostly less than 24 h, depending on some factors such as food quality (Zimmer 2002), v) it is bigger than many other species, and the adults can reach a length of about 13 mm (Amari et al. 2019), vi) during the life span that can be as long as two years (Nair et al. 1976; Amari et al. 2019), each female can breed repeatedly (interoparous), the number of broods per year is usually two under field condition (Warburg 1993), this number is most probably higher under constant proper circumstances, and the number of eggs per female in each brood can exceed 100, depending on the size of individual, food quality, and some other environmental conditions (Amari et al. 2019), vii) it has cosmopolitan distribution over the world and synanthropic feature, is commonly associated with stables, cattle yards, and dung heaps, and can effectively inhabit such indoors (Pierce 1907; Harding 2016), viii) it is predominantly active during the night (nocturnal) or at the shady shelters (Warburg 1993), therefore it does not need direct sunlight, ix) it has obviously higher interest in elevated humidity and lower desiccation resistance compared to most other terrestrial isopods (Warburg 1993; Ghemari et al. 2016), taking advantage of that it is fast (Pierce 1907) and timid species, it is easy to get them to gather at a humidified focus in the rearing container, and x) its integument characteristics are different from most of the other woodlice species (Warburg 1993), in shiny and fine appearance, and possibly the content of the chitin is less than some other species such as *Armadillo officinalis* and *Porcellio dilatatus*. Furthermore, we are also of the opinion that most of these characteristics indicate that *P. laevis* reared for fertilizer production has the potential to be used as animal feed additive.

IV. CONCLUSION

Results show that the tested vermicompost and terrestrial isopod fertilizer in the present study can improve the yield and quality of lettuce, and the isopod fertilizer was as effective as the vermicompost. Considering that vermicompost production is a high cost and technical method, and knowledge for producing are required, isopod fertilizer may be preferred due to it is a cheap, simple, eco - friendly method that does not require highly equipped facility. Moreover, by this way, agricultural and household organic wastes will be evaluated, and useful recycling will be provided through isopod fertilizer production.

DECLARATION OF INTEREST

The authors declare that they have no competing interests.

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Varietal screening of Cucumber in Sundarharaicha Municipality, Morang, Nepal

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Abstract— *Varietal screening of cucumber in the Eastern Terai of Nepal by using nine different varieties of cucumber i.e., F1-leader, Malini, Kangana, NS-404, Kamini, F1-solar, Encounter-962, Syngeta glossy and Bhaktapur local was conducted in Sundarharaicha, Morang during the month of February to June (2020) to find the best yielding variety. The experimental setup was designed on randomized complete block design having three replications and nine treatments. There was a significant difference among the varieties in terms of yield. NS-404 gave the highest yield (5468.66gm/harvest), highest number of harvest (8.80 harvests) and highest number of fruits/harvest (14.53 fruits/harvest). Encounter-962 gave the lowest yield (2689.73 gm/harvest). This study showed NS-404 as high yield variety and should be recommended in Sundarharaicha, Morang.*

Keywords— ***Varietal screening, Cucumber, Fruit, Variety, Yield.***

I. INTRODUCTION

Cucumber (*Cucumis sativus L.*) belongs to family Cucurbitaceae which is used as vegetable crop (Shinde et al., 2018). Cucumber is 4th most important cultivated vegetable after cabbage, onion and tomatoes in the world (Fareed et al., 2017). It is cylindrical in shape and size varies according to varieties(Christopher, 2020).Cucurbits are tropical in origin and are mainly cultivated in Africa, central America,and south east Asia (Maharjan et al., 2015). People consume cucumber in the form of salad, pickle, and vegetable. More than 90% of cucumber content is water. Besides its low caloric value, cucumber and other cucurbits are well served by potassium and folic acid but low in sodium (Akbar et al., 2015).

Globally, cucurbits are grown on an area of 8.5 million hectares with production of 17.9 million tons(Akbar et al., 2015). Agriculture is the backbone of Nepalese economy. Agriculture contributes on an average 33 percent to GDP and employs 65.7 Percent of the labor force in Nepal (Pandey et al., 2017). There are two major lean periods for the cucumber supply in Nepal. The first lean period extends from May to October and characterized by high temperature and long day photoperiodic condition and the second lean period is November-February, which is demonstrated by low temperature and short day photo period (Sharma et al., 2005).Due to lack of systematically organized planting the production of this vegetable is low. The nation has to invest heavy amount on the annual import of cucumber(Tripathy & Behera, 2019). In Nepal, to date, very little research work have been performed on varietal screening of cucumber in Eastern Terai, due to which very few farmers are known about the cultivation practices of cucumber. Thus, the current investigation is aimed to assessing the performance of some promising varieties of cucumber in Gothgaun, Morang.

II. MATERIALS AND METHODS

2.1 EXPERIMENTAL SITE

The experiment was conducted at G.P Koirala College of Agriculture and Research Centre Gothgaun; Morang. It lies at 26º40'2.56" latitude and 87º20'59.64" longitude and 135 meter above sea level. It also lies in the tropical region of Nepal. The research was conducted during the month of February to June (2020).

2.2 EXPERIMENTAL MATERIAL

The experiment was conducted under open field condition using nine different varieties of cucumber including one Bhaktapur local and eight hybrid varieties.

2.3 EXPERIMENTAL DESIGN

The experiment was conducted in Completely Randomized Block Design (RCBD), consisting three replications of each having nine treatments.Spacing between replications was 100cm and between treatments was 50cm. Border gap was 100cm around the experimental field. Total field size for research was 33 m × 16 m consisting of 27 plots each of size 4m × 3 m. Each plot consisted of 12 plants each, with spacing 100cm × 100 cm. Out of 12 plants, centered 2 plant including other 3 were selected in random way from each plot as sample plants.

TREATMENT DETAILS

Total 9 variety of cucumber were selected as treatment in experimental setup.

T1= Cucumber F1 leader

T2=Malini

T3= Kangana

T4= NS-404

T5= Kamini 017 F1

T6= F1-solar

T7= Encounter 962 F1

T8= Syngeta glossy cucumber

T9= Bhaktapur local

2.4 SEEDLING PREPARATION FOR TRANSPLANTATION

Seeds were soaked in water for 20 hrs and were sown under protected conditions in polybags of size 15 × 8 cm on 15th February 2020.Two seeds per polybag were sown and kept inside the polyhouse with regular watering. Media used for seed germination was soil: sand: vermicompost in the ratio of 2:1:1 based on volume. Seed germination percentage of all varieties was >85 % except Bhaktapur local <70 %.After complete germination of the seed and seed being ready for transplantation, the seedlings were transplanted with spacing of 100 cm × 100 cm P-P × R-R., keeping 12 plants per plot and 5 plants were sampled to document various observations. Transplantation was done on 5thMarch 2020. Re transplantation was also done in case of damaged plants due to heavy rain and wind.

2.5 FIELD PREPARATION, MANURE, FERTILIZATION, AND IRRIGATION

Two plough one after another was done to make soil fine and porous on 19th and 20th February, respectively. Weeding was also done to remove weeds manually. Recommended dose of FYM 20 ton/ha was applied on field 7 days before seedling transplantation. Recommended dose of NPK = 120:60:50 kg/ha was applied in the field about 4 hours before seedling transplantation. Urea was applied under four split doses at 15 days of interval. First irrigation was given on day of transplanting after transplanting of seedling then depending upon soil moisture condition irrigation was done and on days of application of fertilizer slight irrigation was done. The water requirement was almost met by natural rainfall. Trellis method of staking was done with bamboo stakes and bamboo sticks were used for training cucumber vines.

2.6 DATA COLLLECTION TECHNIQUES

Vegetative characteristics and flowering behaviors were recorded. 5 plants were selected from each plot as sample plant to record for different observations. Height of main stem (cm), numbers of primary branches per vine were observed and average was calculated. Height was measured by using measuring tape. Fruit lengths (cm), fruit circumference (cm), were also measured by measuring tape and average was calculated. Number of fruits per plant, Marketable andNonmarketable fruits were observed, and average was calculated.

2.7 FLORAL MEASUREMENTS

Days to first female flower emergence after transplanting was on 23rdMarch 2020 and days to first male flower emergence after transplanting was on 24thMarch 2020.Number of female flowers per plant and number of male flowers per plant were observed and average was calculated.

2.8 DATA ANALYSIS

All the recorded data were arranged systematically. A simple correlation and regression were established among the selected parameters with reference to Gomez and Gomez (1984). Different statistical tools as R and MS-EXCEL were used for the analysis of variance and other data.

III. RESULTS AND DISCUSSION

3.1 PLANT HEIGHT (40 DAT)

Among nine different varieties if cucumber, Bhaktapur local is the local variety and remaining are hybrid varieties. The plant height of different varieties was in range of 96.34 to 54.30 cm. The highest plant height was found in Bhaktapur local i.e., 96.34cm followed by NS 404(81.78cm), Malini (77.02cm), F1-solar (70.28cm), kamini (67.56cm0, kangana (63.33cm), syngeta glossy (59.72cm) and F1 leader (59.32cm). The lowest plant height was found in Encounter- 962 i.e., 54.30cm. The average plant height was found to be 69.98cm (Table 1).

It has been reported that the highest plant height was observed in Kathmandu local (203cm) and the lowest plant height in kasinda (148.70) with average plant height 177.45cm (Maharjan et al., 2015). There was a nonsignificant difference among different varieties on plant height.

3.2 NUMBER OF BRANCH AT FINAL STAGE

Among nine different varieties of cucumber, the greater number of branches was found in Bhaktapur local (5.26 branch) and the smaller number of branches was found in Encounter-962 (1.20 branch). Average number of branches was found to be 2.48 in every varieties of cucumber (Table 1). It has been found that the more number of branches was observed in Kathmandu local (primary branches 57.33/plant and secondary branches 56.33/plant) and the less number of primary branches was observed in Malini (43.83/plant)(Maharjan et al., 2015). Also maximum number of branches per vine was recorded in genotype CUCUVAR-6 (11.26) while the lowest number of branches per vine was recorded in Supriya-100 (7.20) (Arunachalam, 2020). There was a highly significant difference among different varieties on number of branches at final stage.

3.3 NUMBER OF FEMALE FLOWERS/PLANT

The highest number of female flower (142.6 flowers/plant) was found in syngeta glossy followed by NS 404 (126 flowers/plant), Malini (108.33 flowers/plant), F1 leader (98.33 flowers/plant), kamini (98 flowers/plant), kangana (90 flowers/plant), F1-solar (86 flowers/plant), Encounter-962 (83.33 flowers/plant). The lowest number of female flower (69.33flowers/plant) was found in Bhaktapur local. The average number of female flowers per plant was found to be 99.33 (Table 1).

It has been also reported that the highest number of female flower (27.33 flowers/plant) was recorded in Kamini and the lowest (7.83 flowers/plant) in Kusle at maximum flowering stage of plant ((Maharjan et al., 2015). Maximum number of female flowers in genotype CUCUVAR- 6 (28.53), followed by Prasad-100 (24.80) and minimum female flowers per vine was found in HY-512 (14.00) (Arunachalam, 2020). There was a significant difference among different varieties on number of female flowers per plant.

Table 1: -Morphological character of different varieties cucumber in varietal screening Gothgaun, Morang, Nepal -2020

Varieties	Plant height (cm)	Number of branches at final	Number of female flowers/plants
F1-leader	59.52^{bc}	1.93^{c}	98.33^{bc}
Malini	77.02^{abc}	1.73^{c}	108.33^{bc}
Kangana	63.33^{bc}	1.46^{c}	90.00^{bc}
NS-404	81.78^{ab}	3.80^{ab}	126.00^{ab}
Kamini	67.56^{bc}	2.13^{bc}	98.00^{bc}
F1-solar	70.28^{bc}	2.26^{bc}	86.00^{bc}
Encounter-962	54.30^{c}	1.20^{c}	83.33^{c}
Syngenta glossy	59.72^{bc}	2.53^{bc}	142.66^{a}
Bhaktapur local	96.34^{abc}	5.26^{a}	69.33^{c}
Mean	69.98	2.48	99.33
SEM	216.1	0.579	579.5
LSD	25.44(NS)	1.71**	41.66*
CV	21.00%	39.87%	24.23%
F test	NS	**	*

SEM: Standard error of mean; LSD: Least significant difference; CV: Coefficient of variation.

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*: Significant at 5% level of significance; **: Significant at 1% level of significance; ***: Significant at 0.1% level of significance; NS: Not significant.

3.4 FRUIT LENGTH, DIAMETER AND WEIGHT

Among nine different varieties of cucumber, the highest fruit length was found in Bhaktapur local (26.51cm) followed by NS 404 (24.32 cm), syngeta glossy (24.02cm), F1- solar (23.99cm), Encounter-962 (20.87cm), kamini (20.85cm), kangana (20.63cm) and Malini (20.10cm). The lowest fruit length was found in F1-leader (19.97cm). Average fruit length was found to be22.36cm (Table 2).

Similarly, the highest fruit diameter was found in Bhaktapur local (6.32cm) followed by kamini (5.35cm), syngeta glossy (5.33cm), NS-404 (5.14cm), kangana (5.06cm), Encounter-962 (5.02cm) and Malini and F1-solar (4.98cm). The lowest fruit diameter was found in F1-solar (4.95cm). Average fruit diameter was found to be 5.23cm (Table 2).

Also, the highest fruit weight was found in Bhaktapur local (635.75gm/fruit) followed by NS-404 (384.84gm/fruit), syngeta glossy (369.80gm/fruit), F1-solar (340.09gm/fruit), Kamini (311.85gm/fruit), Encounter-962 (292.05gm/fruit), kangana (288.64gm/fruit) and Malini (275.58gm/fruit). The lowest fruit weight was found in F1-leader (267.46gm/fruit). Average fruit weight was found to be 351.89 gm/fruit (Table 2).

It has been also reported that the maximum fruit diameter was found in KARAN (4.19 cm) and the minimum fruit diameter was found in CUCUVAR-1 (3.17 cm). The maximum fruit length was found with CUCUVAR-6 (19.33 cm) and the minimum fruit length was recorded with CUCUVAR-5 (12.38 cm). The highest fruit weight were recorded in CUCUVAR-6 (177.60 gm) and the lowest fruit weight was recorded with AK-47 (139.20 gm) (Arunachalam, 2020). Fruit length, diameter and weight have been also differ by the use of chemicals like ethephon(Dhakal et al., 2019). There was a highly significant difference among the varieties on fruit length, fruit diameter and fruit weight. It has been also reported that the fruit length, diameter and weight of different varieties of cucumber depends on heredity and genetic variability (Kumar et al., 2013).

3.5 YIELD PER HARVEST

There was a significant difference among the varieties on yield. Among nine different varieties of cucumber, the highest yield per harvest was found in NS-404 (5468.66gm/harvest) followed by syngeta glossy (5442.73gm/harvest), Malini (3295.86gm/harvest), Kamini (3284gm/harvest), Bhaktapur local (3229.33gm/harvest), kangana (2806.13gm/harvest), F1-solar (2790.13gm/harvest) and F1-leader (2740.13gm/harvest). The lowest yield per harvest was found in Encounter-962 (2689.73gm/harvest). Average yield per harvest was found to be 3527.41gm (Table 2).

In this research, we found NS-404 as the best yield giving varieties. It has been shown that the Kamini variety was found superior as compared to the other varieties in terms of yield(Maharjan et al., 2015). It has been also shown that the maximum yield (tones/ hectare) was recorded in CUCUVAR-6 (35.99 t/ ha) and the lowest yield was found in HY-512 (19.55 t /ha)(Arunachalam, 2020). The experiment was conducted in the farmers' field conditions at Yampaphant, Tanahun, Nepal during April - July 2000 included one commercial cultivar namely Bhaktapur Local and the four exotic cultivars and hybrids namely Malini, Korean White, Japanese Green and Green Long. The hybrid Malini was found significantly more vigor and earlier (first picking at 42 days) and produced significantly higher number of fruits (252 thousands/ha) and significantly higher yield (69.6 t/ha) (Shakya et al., 2006). Also, the research conducted in owerri area of southeastern Nigeria having four different varieties if cucumber CU99, OHE/CU, MURANOF1 and AOA/CU, CU99 gives the highest yield (18840 kg/ha) (Umeh, 2018).

Table 2: Yield attributing traits of different varieties of cucumber in varietal screening, Gothgaun, Morang, Nepal -2020

Varieties	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	Yield/harvest (gm)
F1- leader	19.97c	4.98b	267.46^{b}	2740.13^{b}
Malini	20.10^{c}	4.98^{b}	276.58^{b}	3295.86^{b}
Kangana	20.63^{c}	5.06^{b}	288.64^{b}	2806.13^{b}

NS 404	24.32[ab]	5.14[b]	384.84[b]	5468.66[a]
Kamini	20.85[c]	5.35[b]	311.85[b]	3284.00[b]
F1- solar	23.99[b]	4.95[b]	340.09[b]	2790.13[b]
Encounter 962	20.87[c]	5.02[b]	292.05[b]	2689.73[b]
Syngeta glossy	24.02[b]	5.33[b]	369.80[b]	5442.73[a]
Bhaktapur local	26.51[a]	6.32a	635.75[a]	3229.33[b]
Mean	22.36	5.23	351.89	3527.41
SEM	1.76	0.0554	5393	984121
LSD	2.30***	0.40***	127.11***	1717.09*
CV	5.94%	4.49%	20.86%	28.12%
F test	***	***	***	*

SEM: Standard error of mean; LSD: Least significant difference; CV: Coefficient of variation.

*: Significant at 5% level of significance; **: Significant at 1% level of significance; ***: Significant at 0.1% level of significance; NS: Not significant.

3.6 MARKETABLE FRUITS AND NON-MARKETABLE FRUITS PER HARVEST

There was a significant difference among the varieties on the total number of marketable fruits per harvest. Among nine different varieties of cucumber, the highest number of marketable fruits per harvest was found in syngeta glossy (12.26 fruits/harvest) followed by NS-404 (12.06 fruits/harvest), Malini (8.33 fruits/harvest), F1-leader (7.80 fruits/harvest), Kamini (7.46 fruits/harvest), Kangana (7.20 fruits/harvest), Encounter-962 (6.66 fruits/harvest) and F1-solar (6.40 fruits/harvest). The lowest number of marketable fruit per harvest was found in Bhaktapur local (3.73fruits/harvest). Average number of marketable fruits per harvest from each variety was found to be 7.99 fruits/harvest (Table 3).

Similarly, the highest number of nonmarketable fruits per harvest was found in Malini (3.40 fruits/harvest) followed by Kamini (3.06 fruits/harvest), NS-404 (2.46 fruits/harvest), kangana, F1-leader, Encounter-962 (2.33 fruits/harvest), syngeta glossy (2.20 fruits/harvest) and F1-solar (1.93 fruits/harvest). The lowest number of nonmarketable fruits per harvest was found in Bhaktapur local (1.46 fruits/harvest). Average number of nonmarketable fruits per harvest from each variety was found to be 2.39 fruits/harvest (Table 3).

It has been reported that the total number of marketable fruit per plant was higher in Kamini (13.10 fruits/plant), whereas it was the lowest in Kusle (2.30 fruits/plant) (Maharjan et al., 2015). There was a nonsignificant difference among the varieties on the total number of nonmarketable fruits per harvest. Syngeta glossy and NS-404 have almost produced same marketable fruit per harvest. Production of marketable fruit per harvest in syngeta glossy and NS-404 was almost four times double than Bhaktapur local.

3.7 TOTAL NUMBER OF FRUITS PER HARVEST

Among nine different varieties of cucumber, the highest number of fruits harvested was found in syngeta glossy (132 fruits) followed by NS404 (119.33 fruits), Malini (98.66 fruit), Kamini (91.33 fruits), F1-leader (89.33 fruits), Kangana (85.33 fruits), F1-solar (82.33 fruits) and Encounter-962 (78 fruits). The lowest number of fruits harvested was found in Bhaktapur local i.e., 66 fruits. Average number of fruits harvested was found to be 93.59 fruits (Table 3).

There was not a significant difference among the varieties on total number of fruits harvested. Late season planting may be the reason for Bhaktapur local having the lowest total number of fruits harvested. It has been also reported that kamini has the highest number of total fruit harvested (21.23 fruits) and Kusle has the lowest number of total fruit harvested (4.60 fruits) (Maharjan et al., 2015).

Table 3: -Marketable fruit, non-marketable fruit, and total number of fruits of different varieties of cucumber in varietal screening, Gothgaun, Morang, Nepal -2020

Varieties	Marketable fruit/harvest	Nonmarketable fruit/harvest	Total number of fruit/harvests
Cucumber F1leader	7.80^{b}	2.33^{ab}	89.33^{bc}
Malini	8.33^{b}	3.40^{a}	98.66^{abc}
Kangana	7.20^{b}	2.33^{ab}	85.33^{bc}
NS 404	12.06^{a}	2.46^{ab}	119.33^{ab}
Kamini 017 F1	7.46^{b}	3.06^{ab}	91.33^{bc}
F1 solar	6.40^{bc}	1.93^{ab}	82.33^{bc}
Encounter 962 F1	6.66^{bc}	2.33^{ab}	78.00^{c}
Syngeta glossy	12.26^{a}	2.20^{ab}	132.00^{a}
Bhaktapur local	3.73^{c}	1.46^{b}	66.00^{c}
Mean	7.99	2.39	93.59
SEM	3.41	0.8909	504.6
LSD	3.19***	1.63 NS	38.88 NS
CV	23.10%	39.44%	24%
F test	***	NS	NS

SEM: Standard error of mean; LSD: Least significant difference; CV: Coefficient of variation.

*: Significant at 5% level of significance; **: Significant at 1% level of significance; ***: Significant at 0.1% level of significance; NS: Not significant.

3.8 NUMBER OF HARVEST

Among nine different varieties of cucumber, the highest number of harvesting was found in NS-404 (8.80 harvest) followed by Malini (8.46 harvest), syngeta glossy (8.06 harvest), F1-leader (7.33 harvest), kamini (6.93 harvest), kangana, Encounter-962 (6.66 harvest) and F1-solar (6.06 harvest). The lowest number of harvesting was found in Bhaktapur local (4 harvest). Average number of harvesting was found to be 7. There was a highly significant difference among the varieties on total number of harvesting per plant (Table 4).

3.9 NUMBER OF FRUITS PER HARVEST

The total number of highest fruits per harvest was found in NS-404 (14.53 fruits/harvest) followed by syngeta glossy (14.46 fruits/harvest), Malini (11.46 fruits/harvest), Kamini (10.53 fruits/harvest), F1-leader (10.13 fruits/harvest), kangana (9.53 fruits/harvest), Encounter-962 F1 (9 fruits/harvest) and F1-solar (8.33 fruits/harvest). The lowest number of fruits per harvest was found in Bhaktapur local (5.20 fruits/harvest). Average number of fruits per harvest was found to be 10.35. There was a highly significant difference among the varieties on total number of fruits per harvest (Table 4).

3.10BIOMASS YIELD

There was a highly significant difference among the varieties on biomass yield. The highest biomass yield was found in Bhaktapur local (341.60gm) and the lowest biomass yield was found in F1-solar (75.33gm). Average biomass yield of cucumber variety was found to be 136.20gm. There was a long gap in between Bhaktapur Local and other remaining varieties in case of biomass yield (Table 4).

Table 4: Number of harvesting per plant, number of fruits per harvest and biomass yield of different varieties of cucumber in varietal screening, Gothgaun, Morang, Nepal -2020

Varieties	Number of harvesting	Number of fruits per harvest	Biomass yield (gm)
Cucumber F1leader	7.33^{d}	10.13^{c}	77.60^{c}
Malini	8.46^{ab}	11.46^{abc}	85.86^{c}
Kangana	6.66^{cd}	9.53^{c}	76.13^{c}
NS 404	8.80^{a}	14.53^{a}	196.40^{b}
Kamini 017 F1	6.93^{bcd}	10.53^{bc}	113.20^{bc}
F1 solar	6.06^{d}	8.33^{cd}	75.33^{c}
Encounter 962 F1	6.66^{cd}	9.00^{cd}	98.93^{bc}
Syngeta glossy	8.06^{abc}	14.46^{ab}	160.80^{bc}
Bhaktapur local	4.00^{e}	5.20^{d}	341.60^{a}
Mean	7	10.35	136.20
SEM	1.054	5.25	3410
LSD	1.77**	3.96**	101.07***
CV	14.66%	22.14%	12.87%
F test	**	**	***

SEM: Standard error of mean; LSD: Least significant difference; CV: Coefficient of variation.

*: Significant at 5% level of significance; **: Significant at 1% level of significance; ***: Significant at 0.1% level of significance; NS: Not significant.

IV. CONCLUSION

Among nine different varieties of cucumber, NS-404 was found to be the best yield giving variety and could be the best one for cultivation in Sundarharaicha municipality. Syngeta glossy is also the best yield giving variety after NS-404. All the varieties were damaged by cucurbits fruit fly. Malini and kamini gives highest number of non-marketable fruits.

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Ethnobotanical Study of Wild Edible Plants in Pyuthan, Nepal

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Abstract**—** *Wild edible plants are those plants that are not domesticated and often neglected but have nutritional and medicinal value and can be used as a good source of diet. The study discusses and depicts the availability of wild edible plants, their taxonomical categories, species richness, distribution, preference, and their threat in the Gaumukhi area. Data were collected from 60 randomly selected wild edible plant consumers of Puja and Khung village using a semi-structured interview schedule. The study showed that 37 different species of wild plants are frequently used by respondents. It was found that the majority of the WEP's used were trees followed by herbs and shrubs. It was found that majority of WEP's used were trees followed by herbs and shrubs. Regarding the plant parts used, most of the respondents (54%) use WEP's in the form of vegetables followed by raw fruits (28%) users. The study revealed that the majority of WEP's consumers (39%) were from other caste categories like Giri, Puri, Malla, etc. followed by Dalits (36%). Research indicated that most of the WEPs were collected from the forest area having an altitude of (1300-1500) masl. The major threat to wild edible plants was fuel wood collection followed by uncontrolled fire. Study preference of WEP's among the respondents showed that* Polystichumsquarrosum *(Daude) was the highly preferred one followed by* Diplaziumesculentum *(Neuro) and* Dendrocalamushamiltoni *(Tama).*

Keywords**— WEP, Gaumukhi, Ethnicity, Habitat, Threat.**

I. INTRODUCTION

Nepal, being a small country, occupying just 0.1% of the global area is rich in its biodiversity, both in plant and animal diversity and cultural diversity (MoFSC, 2014). The country is bestowed with climatic variation and unique geography which provides diversified topography. The ecologically rich environment and the multi-ethnic population is a unique and attractive attribute of the country. Biodiversity and cultural diversity come together as we know; different ethnic groups depend on biodiversity for their food security. Nepal is rich in wild edible plants growing in different ecosystems and such plants along with their wild relatives enrich the genetic diversity in the country.

About 1500 species of plants found in Nepal are considered to be useful (Manandhar, 2002). Out of these, 651 species are economically useful including 440 species as wild food plants. Total 394 wild plants are recorded to be in use in different purposes such as vegetables (246 spp), fruits (125 spp), pickle (44 spp), jam (11 spp), spices and condiments (10 spp), oil (6 spp) and other uses (Dangol*et.al* 2017). During food scarcity, people from both, urban and rural communities highly depend on natural habitats to gather edible fruits and vegetables (Manandhar, 1982). Although many agricultural societies

depend on conventional crop plants, the tradition of eating wild edible plants has not been completely abandoned (Lockett*et.al* 2000). Gathering the indigenous edible plants for both, self-consumption and sales is usually common in Nepal in most of the rural communities.

Wild edible plants (WEP) are those plant species that are not domesticated but are available through natural habitation and are used as food (Bhatia, 2018). They are the source of nutrients, medicine, fuel, fodder, and spices. Also, its fresh, aromatic taste, pollution-free growing environment, and strong vitality are favorable for people to utilize the WEPs (Yilin*et.al*2020). Even though the world is modernized, there are still poor and marginalized populations in the rural areas who are highly dependent on wild edible plants. These neglected groups of food plants can absolutely contribute their part in ensuring food security, increasing agricultural diversification, income generation, and poverty reduction (Ashagre*et.al* 2016). In many developing countries, millions of people do not have enough food supply to meet their requirements and in such cases, rural communities depend on wild resources to meet their need of food (K & F, 2006). Rural area people not only use wild plants as their source of food and medicine but also help in its conservation. WEP is used as a staple food for indigenous people, complementary food for non-indigenous people, and offers alternative cash-generating sources (Uprety*et.al* 2012). Household harvesting of wild plants and value addition to it can boost rural employment and bring profit to local communities (Gautam*et.al* 2020).

Despite being important to food security and livelihood, these plants are still in wild forms. Many valuable wild plants are familiar to certain groups and communities but unnoticed and unknown by others as they are in a wild state. Also, the rapid reduction in usage of wild plants and reliance on processed food makes it crucial to have information on the status of WEP (Uprety*et.al* 2012). The information and utilization of WEP is majorly confined to local people so many scientists are interested to understand and disseminate it on various platforms. Many researches and studies were focused on wild edible fruit plants (Gautam*et.al* 2020) and some research were on wild edible plants in various other districts like Palpa, Rupandehi, etc[(Acharya&Acharya, 2010), (Mahato, 2014)]. No research has been found to be studied on WEP in Pyuthan district. This paper has attempted to compile and analyze the information on wild edible plants along with their plant parts, uses, the local and scientific names which are available, utilized, and unutilized in the Pyuthan district.

II. METHODOLOGY

2.1 Study site

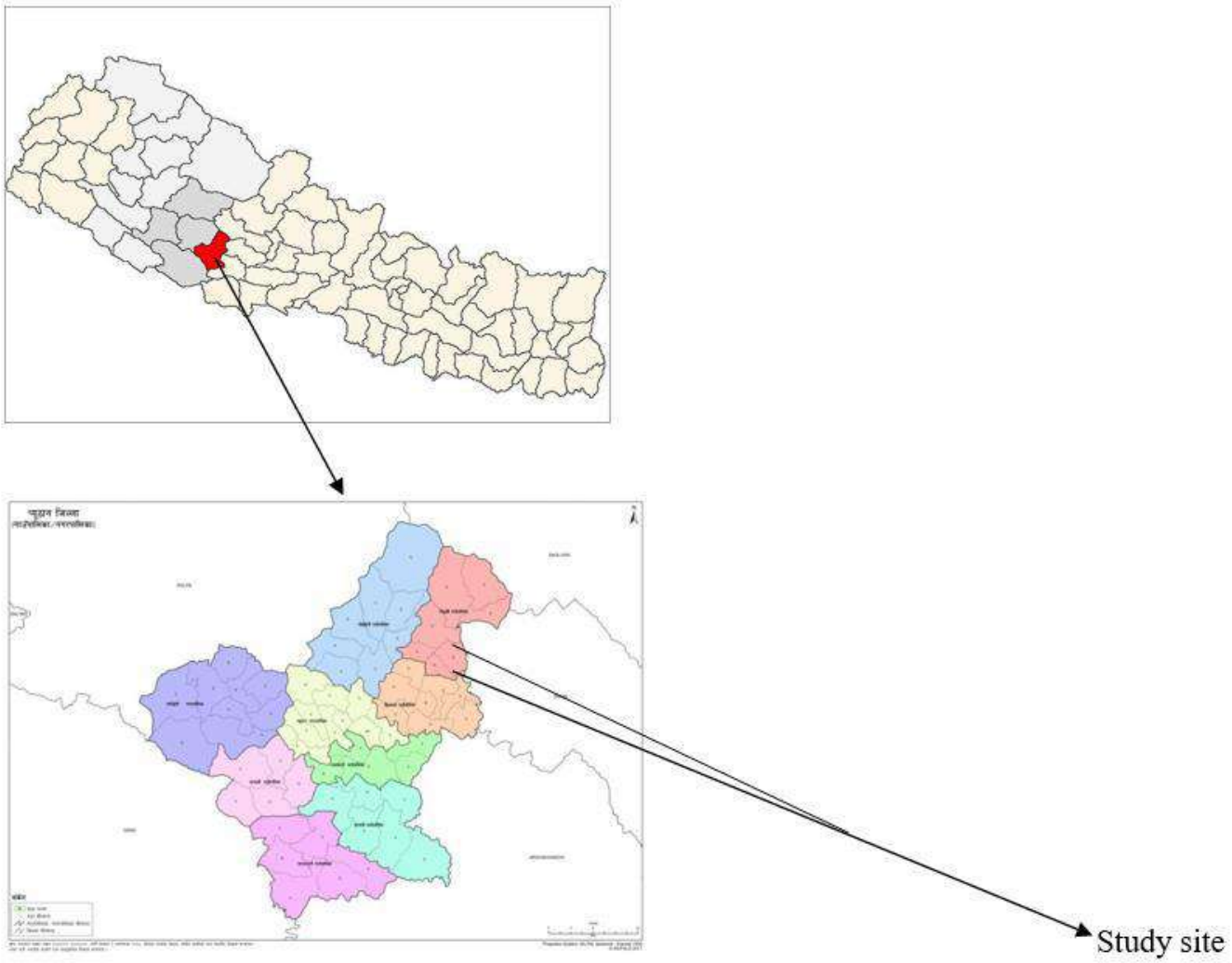
Pyuthan district was selected purposively for the study site as it is well known as the home of various indigenous wild plants for a long time. The study was carried out in Ward no.5 (Khung) and ward no.4 (Puja) of Gaumukhi Rural municipality in Pyuthan, Nepal. The reason behind the selection is that people around those areas mostly depend on wild plants as a source of their living. Among the consumers, 30 sampling population from each ward was selected randomly using simple random sampling techniques.

2.2 Ethnobotanical Survey

Before conducting the Ethnobotanical survey in both the village, we had a meeting with the leader of the village explaining our research objective. After getting verbal consent from the authority figure, the survey was conducted on the villages, and the respondents were categorized based on ethnic group. A total of 60 informants were interviewed and asked the 5W+H questions (viz. what, who, why, when, where, and how the respondents are utilizing the wild edible plants) to gain information on local name, usage, availability, species richness, threats, and opportunities of WEP. The informants freely stated their information and knowledge regarding the WEP available in the study area without being interfered.

2.3 Research Instrument and design

The pre-tested interview schedule was used to collect primary information. In addition, one focus group discussion and two key informant interviews were performed. Furthermore, secondary data were collected from various relevant journals, literature, and publications of different organizations. After data collection, it was thoroughly checked, coded, and entered for analysis.



2.4 Data Analysis

After the data collection process, it was analyzed using both quantitative and qualitative analytical tools. Microsoft Excel sheet was used to organize the collected ethnobotanical data. The collected data was thoroughly checked, tabulated, and analyzed by SPSS software and RStudio.

Preference ranking was performed by Henry Garrett ranking method to analyze the most popular wild edible plants based on respondent's daily consumption. The percent position of each rank was obtained by the formula and then converted to the score from the table given by Henry Garrett.

Percentage position = $\frac{(100(Rij-0.5)}{Nj}$

where,

R_{ij}= Rank given for i^{th} item j^{th} individual

N_j= Number of items ranked by j^{th} individual

III. RESULTS AND DISCUSSIONS

3.1 List of WEP with its Local name, English name and Scientific name

The local people of the study area mentioned about availability of various wild fruits, vegetables, and medicinal plants in the study area. Table 1 shows the list of local edible plants along with their English name and the scientific name which are majorly available and utilized by the respondents of the study area.

Table 1: Name of Wild edible plants available in study area

S.N	Local Name	English Name	Scientific Name
1	Neuro	Fiddlehead fern	*Diplaziumesculentum*
2	Tama	Tufted bamboo	*Dendrocalamushamiltoni*
3	Sisnu	Stinging nettle	*Nasturtium officinale*
4	Pudina	Mint	*Mentha Spp.*
5	Silam	Perilla	*Perillafrutescense*
6	Gurjo	Heart leaved moonseed	*Tinosporacordifolia*
7	Ghodtapre		*Centellaasiatica*
8	Jaluka	Hitchhiker elephant ear	*Remusatia vivipara*
9	Simesaag	Water cress	*Nasturtium microphyllum*
10	Daude	Basket fern	*Polystichumsquarrosum*
11	Khanayo	Drooping fig	*Ficussemicordata*
12	Kabro	Java fig	*Ficuslacor*
13	Koiralo	Mountain ebony	*Bauhinia variegate*
14	Aiselu	Raspberry	*Rubusellipticus*
15	Chutro	Rasanjan	*Berberisaristata*
16	Teeju	Coromandel ebony	*Diospyrosmelanoxylon*
17	Harro	Chebulicmyrobalan	*Terminaliachebula*
18	Barro	Baheda	*Terminaliabellerica*
19	Chiuri	Nepal butter tree	*Diploknemabutyraceae*
20	Bidaulo	Cluster fig	*Ficusracemosa*
21	Timilo	Common fig	*Ficuscarica*
22	Bhakimlo	Macassar kernels	*BruceajavanicaL.merr*
23	Ghanggaru	Nepalese firethorn	*Pyracantharenulata*
24	Sil-timur	Mountain pepper	*Litseacitrale*
24	Kaulo	Fragrant baytree	*Perseaodoratissima*
25	Ban keraa	Wild banana	*Musa balbisianacolla*
26	Ban tarul	Wild edible yam	*Dioscoreabulbifera L.*
27	Mayal	Wild pear	*Pyruspyraster*
28	Bhuikafal	False strawberry	*Duehesneaindica*
29	Bhyakur	Deltoid kam	*Dioscoranepalensis*
30	Amaro	Wild mango	*Spondiaspinnata*
31	KadeDhania	Wild Coriander	*Eryngiumfoetidium*
32	Paiyu	Wild cherry	*Prunusnepalensis*
33	Salleuchyau	Wild Mushroom	*Amanita chepangiana*
34	Bagalechyau	Wild Mushroom	*Schizophyllum commune*
35	Phutuki	Wild Mushroom	*Scleroderma texense*

36	Gobrechyau	Parasol mushroom	*Macreolepiotaprocera*
37	Jharichyau	Deceiver mushroom	*Laccarialaccata*

3.2 Taxonomical categories of WEP

The figure 1 shows the categories of the wild edible plants that are available in the study site. According to the study, out of total wild plants mentioned by the 60 respondents, 27(45%) were trees followed by 16(26%) herbs, 13(22%) shrubs and 4(7%) climbers.

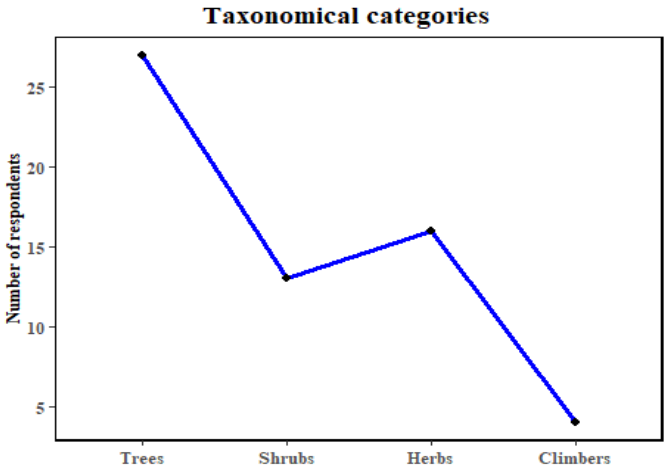


Fig 1: Taxonomical categories of WEPs

Source: Field survey

3.3 Plant parts used as food

Wild edible plants are used in various forms by the people in the study area. The figure1 shows that majority of the wild edible plants (WEP) are used in the form of vegetables (54%) followed by raw fruits (28%) and pickle (12%), oil (3%) and spices (3%).

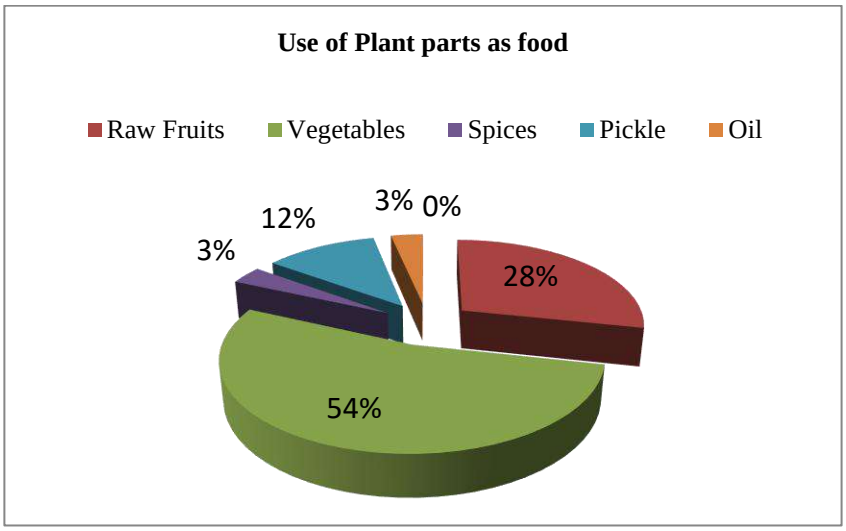


Fig 2: Parts of Plants used as food

Source: Field survey

3.4 Distribution of WEP in different habitat

Research shows that, mostly, the respondents collect wild edible plants from (60%) forest area followed by (15%) grazing land, (12%) riverside, (8%) roadside and (5%) crop fields. (Fig 3)

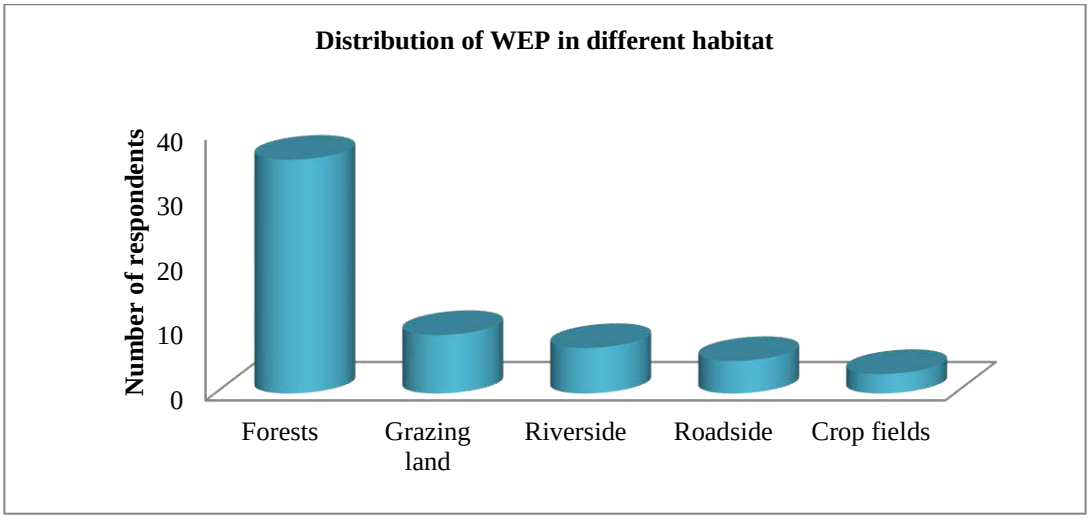


Fig 3: Distribution of Wild Edible Plants

Source: Field Survey

3.5 Dependence on WEPs based on Ethnicity

The respondents were categorized in four major ethnic groups; Brahmin, Chhetri, Dalits and Others. The others category in the study area includes Giri, Puri, etc.Fig 4 shows the findings of the study made to know and understand the dependence of respondents on wild edible plants on the basis of their ethnicity. The others category (39%) was found to depend more on wild plants comparing to Dalits (36%), Chhetri (15%) and Brahmin (10%).

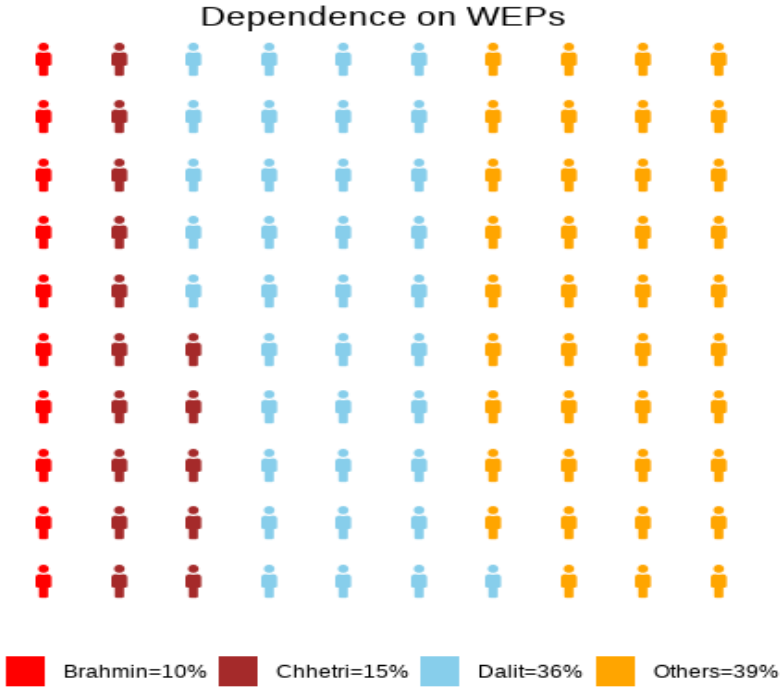


Fig 4: Dependence on WEPs based on ethnicity

Source: Field survey

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3.6 Species richness of WEP along the elevation gradient

On studying the species richness of WEP's in the Gaumukhi area, the highest diversity of the plants were found in the altitude range of (1300-1500)masl and the lowest diversity of the plants was found at the altitude of 2250 masl. The fig 5 shows the result of this study - species richness of wild plants along with its elevation gradient. It is in line with the research paper(Babu Ram Nepali, 2020) conducted in Arghakhachi district of Nepal.

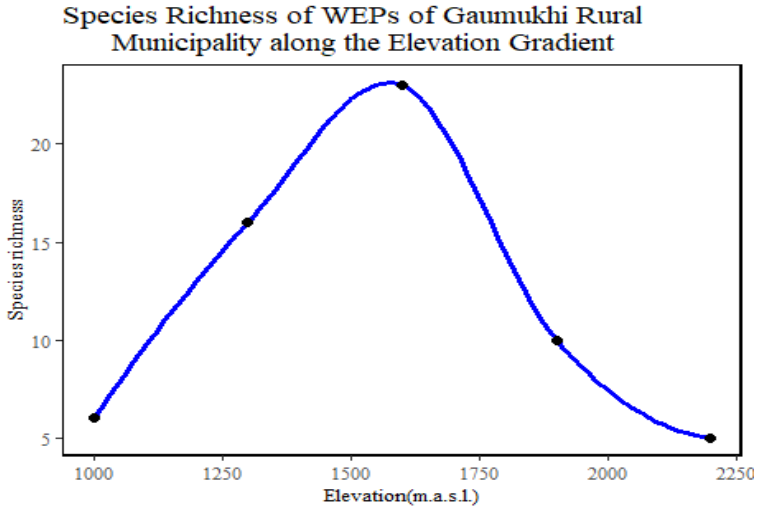

Fig 5: Species richness along the elevation gradient

Source: Field survey

3.7 Threat to wild edible plants

On studying the several threats to wild edible plants available in study area, research shows that fuel wood collection was found to be the major problem to conserve the wild plants followed by uncontrolled fire and problem of over grazing (Fig 6).

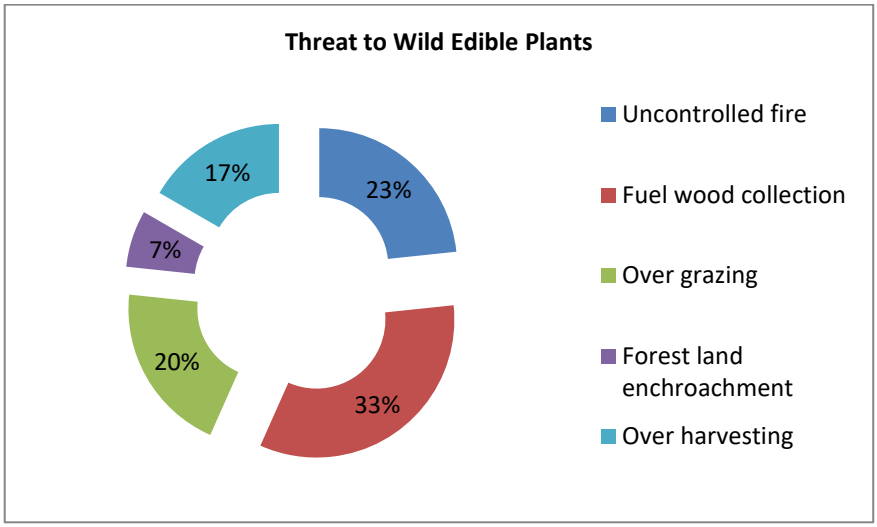

Fig 6: Threats to Wild Edible Plants

Source: Field survey

3.8 Preference of WEP in study area

Based on daily consumption by the respondents of study area, the preference of WEP is ranked by Henry Garrett ranking method. Among the different crops listed by respondents, Dauderanked first followed by Neuro, Tama, Sisnu and Simesaag.

Table 2: Preference of wild edible plants

Wild Edible Plant Species	Average Score	Ranking

Polystichumsquarrosum(Daude)	64.5	I
Diplaziumesculentum (Neuro)	60	II
Dendrocalamushamiltoni(Tama)	46.4	III
Nasturtium officinale(Sisnu)	37.6	IV
Nasturtium microphyllum(Simesaag)	35.6	V

IV. CONCLUSION

Most of the wild plants available in the study area were found to be edible. The objective of our study was to understand and record the local knowledge on indigenous plants which are available in the Gaumukhi area of the Pyuthan district. The study was focused to promote the neglected plants which have high value in terms of nutrients and medicine. The result of our research survey shows that the WEP are not only a good source of nutrients and food to local communities but also, can be used as means of income generation by the local population. The study highlights the ethnicity of the people in the study area and their dependence on wild plants. The study revealed information about edibility, natural habitat, and plant parts used as food. These multi-valued plants are in threat by causes such as fuelwood collection, uncontrolled fire, overgrazing, forest land encroachment, and over-harvesting. Conservation and sustainable management of these resources could be a great contribution to local communities as well as biodiversity. Encouraging the youth of communities rather than consulting elders for the information and knowledge on wild plants could be helpful to conserve these valuable resources. The study we made on ethnobotanical research on wild plants from different ethnic groups located in the study area could be the key data to promote the importance of wild edible plants and conservation of cultural traditional value among the youngsters. The wild plants, if conserved, could turn into a profitable crop and also contribute to the sustainable use of natural resources by safeguarding the endangered species.

Fig.7: DaudeFig: Ghanggaru

(*Polystichumsquarrosum*)(*Pyracantharenulata)*

Fig.8: SisnuFig: Teeju

(*Nasturtium officinale*) (*Diospyrosmelanoxylon)*

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Estimation of Genetic Variability, Heritability and Genetic Advance for Yield and Yield Attributing Traits in Dolichos Bean (*Lablab Purpureus* L.)

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Abstract**—** *The present experiment was conducted to determine the genetic variability, heritability, genetic advance for yield and yield-related traits in dolichos bean at UAS, Bengaluru, during rabi 2020. The experimental material comprises six bush-type dolichos bean genotypes with two local checks were evaluated for 12 morpho-metric characters in randomized block design with three replications. The mean performance of all the characters analyzed was found significant. The genotype DOLBVAR-4 (52.80cm) recorded the maximum plant height and the minimum recorded for DOLBVAR-6 (49.30cm). The genotype DOLBVAR-2 (60.80g) recorded the highest pods plant^{-1}, followed by HA 5 (60.60g) and DOLBVAR-4 (49.26g). The green pod yield hectare^{-1}was maximum for genotype DOLBVAR-2 (3.90 t/ha) followed by HA 5 (3.60 t/ha) and DOLBVAR-3 (2.74 t/ha). In contrast, DOLBVAR-5 (2.00 t/ha) yielded the lowest among all the genotypes. High PCV and GCV were observed for the number of pods plant^{-1}, pod length (cm), and pod width (cm), indicating the higher magnitude of variability for these traits and consequently more scope for their improvement through selection. High heritability coupled with high genetic advance as percent of mean was recorded for all the characters except for days to 50% flowering, primary branches plant^{-1} and plant height (cm). These results indicate these characters are under the influence of additive gene action; hence simple selection based on the phenotypic performance of these traits would be more effective.*

Keywords**— Dolichos, PCV (Phenotypic coefficient of variation), GCV (Genotypic coefficient of variation), Heritability, GAM (Genetic advance as percent of mean).**

I. INTRODUCTION

Dolichos bean (*Lablab purpureus* L.), also known as Indian bean, it is a self-pollinated, leguminous crop grown throughout the country. It is commonly known as sem, avare, seim, bean, lablab bean, Egyptian kidney bean, Indian bean, bataw, and Australian pea in a different part of the world**.** It is cultivated as an annual crop but potentially an herbaceous perennial, erect, bushy, or climbing race type. Dolichos is primarily grown as green pods, and the dried seed are being used for vegetable purposes. It is a rich source of protein, minerals and vitamins (Golani *et al*., 2007). Its leguminous nature allows for food, forage, soil improvement, soil protection, and weed control (Maass, 2006). Due to the presence of therapeutic agents in Dolichos, it is used for traditional medicine systems and modern design (Morris 2009).

In India the young green pods and tender beans are used as vegetables and dry seeds used to prepare curry and dal. It is also well known for its use as green manure and produces edible young pods, leaves, and flowers (Morris 2003). India being the center of origin for dolichos there is an excellent range of variability for plant and pod characters of pole and bush types dolichos bean. We can exploit this variability for the development of high-

yielding dolichos genotypes. Dolichos bean had been controlling due to its photosensitive nature, irregular flowering pattern, growth habit, consumer preferences based on pod shape, size, color, the aroma of pods, and mainly low productivity (Mishra *et al.*,2019).

The evaluation of the potentialities of the existing varieties is essential because it is the genetic diversity of the initial parental material, which depends on the promise for further crop improvement. Breeding for yield and its contributing characters for any crop is controlled by environmental influence, polygenes and determined by the magnitude and nature of their genetic variability.

The exploitation of genetic variability in Dolichos bean in germplasm is a prerequisite for selecting and developing potential high-yielding genotypes. The extent of variability is measured by Genotypic coefficient of variance (GCV) and Phenotypic coefficient of variance (PCV), which also provides information about relative variation in different characters. Hence, to have a rigorous, comprehensive idea, it is necessary to have an analytical assessment of yield components.

The estimation of heritability indicates the extent to which a character is transmitted from parent to progeny. Lesser degree environment interactions influence highly heritable characters associated with yield and yield-related traits and an output indicator in the selection program. Heritability gives information on the magnitude of inheritance of quantitative characteristics, while genetic advance aids in formulating suitable selection procedures. When heritability is studied along with genetic advances, it increases the selection intensity. Considering the actual prospect, acquired the present investigation to estimate the extent of genetic variability, heritability, genetic advance for different characters in 6 Dolichos bean genotypes, and two local checks.

II. MATERIAL AND METHODS

The research work was conducted at UAS, GKVK, Bengaluru, during *rabi* 2020 to identify high-yielding Dolichos bean genotypes. The experimental material comprised six genotypes obtained from AICRP on vegetable crops, Varanasi, and two check varieties collected from UAS, Bengaluru (Table 1). The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. Selected healthy and bold seeds were sown in 4m × 4m plots with 30 cm plant to plant and 45 cm row to row spacing. Followed all recommended agronomic practices to raise a good uniform crop. Five random plants were selected from each plot to record the morphometric traits *viz* days to 50% flowering, plant height (cm), branches plant^{-1}, petiole length (cm), leaf length (cm), leaf width (cm), pod length (cm), pod width (cm), number of pod plant-1, number of seeds pod-1, green pod yield plant^{-1} (cm) and green pod yield (t/ha).

Recorded a morphological observation like plant type, leaf shape, leaf color, pod characters, and purpose of green pods and seeds use during maturity stage were also recorded from 5 random plants selected from each plot.

Analysis of variance was done to partition the total variation into variation due to treatments and replications according to the procedure given by Panse and Sukhatme (1953). Phenotypic and genotypic variance was done according to the formula given by Burton and Devane (1953). Heritability and genetic advance as *percentage* of mean were obtained by the formula given by Johnson *et al*. (1955). Statistical analysis was performed with SPSS Version 11.0 statistic software package.

Table.1 Sources of Dolichos bean genotypes used for the study

Sl. No.	GENOTYPES	SOURCE
1	DOLBVAR-2	AICRP, Varanasi
2	DOLBVAR-3	AICRP, Varanasi
3	DOLBVAR-4	AICRP, Varanasi
4	DOLBVAR-5	AICRP, Varanasi
5	DOLBVAR-6	AICRP, Varanasi
6	HA 5	UAS, Bengaluru
7	HA 3*	UAS, Bengaluru
8	HA 4*	UAS, Bengaluru

*Local checks used for the study

III. RESULT AND DISCUSSION

In the present study analysis of variance (ANOVA) for the six genotypes and 2 local checks of dolichos beangenotypes were evaluated and remarkable significant variation was observed for all 12 yield and yield attributing traits under trial (Table 2).Based on the mean performance of thegenotypes and checks, days to 50% flowering ranged from 36.50- 39.00 days with mean value 37.50 days. Earlier flowering was observed for the check variety HA 4 (36.50 days) while maximum days of 50% flowering recorded for DOLBVAR-5 (39.0 days). The genotype DOLBVAR-4 (52.80cm) was recorded the longest plant height and DOLBVAR-3 (47.20 cm) was found to be the shortest plant among all genotypes. Maximum branches plant^{-1} was recorded in DOLBVAR-3 (4.70) followed by DOLBVAR-2 (4.60). Highest number

of pods plant^{-1} was identified in the check variety HA 4 (68.73 g) followed by DOLOVAR-2 (60.80 g) and HA 5 (60.60 g). Genotype DOLBVAR-2 recorded maximum number of seeds pod^{-1} (5.8) followed by DOLBVAR-4 (5.6). Among all genotypes DOLBVAR-2 (138.73g) recorded highest green pod yield plant^{-1}followed by DOLBVAR-4 (126.13g) and HA 5 (124.33g).Green pod yield tons hectare^{-1} was maximum for genotype DOLBVAR-2 (3.90 t/ha) followed by HA 5 (3.60 t/ha) and DOLBVAR-3 (2.74 t/ha). Whereas DOLBVAR-5 (2.00 t/ha) yielded lowest among all the genotypes.

Longest petiole length was observed for DOLBVAR-5 (15.0cm) followed by HA 3 (13.0 cm), DOLBVAR-6 and HA 3 (11.0 cm) recorded the shortest petiole. Leaf length was maximum for DOLBVAR-4 and HA 5 (9.83cm) and short leaf was observed in check variety HA 3 (6.16 cm) followed by DOLBVAR-6. Broad shape leaf was observed for the genotypeDOLBVAR-4 (8.66cm) followed by HA 5 (7.69 cm).Longest pod was observed for DOLBVAR-4 (12.08cm) and DOLBVAR-3 (4.72cm) recorded the shortest pod among all genotypes and checks. The genotype DOLBVAR-2 (3.62 cm) had maximum pod width while minimum was observed for DOLBVAR-3 (1.4cm).

Fig 1: Genotype DOLBVAR-2

Genetic variability, heritability and genetic advance

The genetic parameters *viz*. mean, range, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), heritability estimates, and predicted genetic advance as *percent* of mean for characters studied are presented in Table 3 and fig 2. The trait shows a more negligible difference between PCV and GCV values was minimum, indicating that these traits are less influenced by the environment and demonstrates a high degree of genetic variability present in these characters and thus a greater scope for selection based on those characters. The estimates of various genetic parameters are given in table 3. High PCV and GCV were observed for a number of pods plant^{-1}, pod length (cm), and pod width (cm), indicating the higher magnitude of variability for these traits and consequently more scope for their improvement through selection.

Present findings were confirmed with Singh *et al.*,2015 for number of pods per plant and pod yield in 24 genotypes of Dolichos bean; Dewangan *et al*. 2017 also reported high GCV and PCV for pod width, pod weight, pod length, and green pod yield plant^{-1} in 38 Dolichos genotype. Shilpa *et al.*, 2020 also reported the same findings for pod length and pod width in 30 Dolichos genotypes.

PCV and GCV estimates were moderate for grain yield plant^{-1}(g), petiole length (cm), leaf length (cm), leaf width (cm), and a number of seeds plant^{-1}. This implied equal importance of additive and non-additive gene action for the traits recorded. These results were confirmed with the findings of Chaitanya *et al.*, 2014; Verma *et al.*, 2015; Hadavani *et al*. 2018; Susant and Bahadur, 2018; for a number of seeds pod-1 in Dolichos bean.

Low GCV and PCV were recorded for days to 50% flowering, number of primary branches plant-1, and plant height (cm). These results confirmed the findings of Chaitanya *et al*., 2015 for days to 50% flowering and plant height in 34 pole

type Dolichos bean genotypes. Savithiri *et al.*, 2018 also reported similar findings for days to first flowering and days to 50 percent flowering in 60 genotypes of Yard Longbean.

In the present study, high heritability coupled with high genetic advance as *percent* of mean was recorded for all the characters except for days to 50% flowering, number of primary branches plant-1, and for plant height (cm). The results indicate these characters are under the influence of additive gene action; hence simple selection based on the phenotypic performance of these traits would be more effective. Present results were similar to the findings of Rai *et al*. 2006 and Savitha (2008) for pod length, pod width, number of seeds pods^{-1}; Magalingam *et al*., 2014 reported similar result for pod length (cm) and pod width (cm), pod weight (g) in Dolichos bean genotypes and Kujur *et al.*, (2017 for days to first flowering, pod length (cm) and pod width (cm) in Dolichos bean.

High heritability with low genetic advance as *percent* mean values were observed for the characters days to 50% flowering, number of primary branches plant^{-1} and plant height (cm); this indicates the influence of non-additive gene action considerable influence of environment on the expression of these traits. These traits could be exploited through the manifestation of dominance and epistatic components through heterosis.

Study of plant type, leaf, and pod characters for the eight Dolichos genotypes

A detailed morphological study for plant type, leaf, and pod characters was done, and findings were recorded and represented in table 4 and figure 3. All the entries used for the experiment were the bush type with ovate-shaped green-colored leaves. Genotype DOLBVAR-2 and DOLBVAR-4 exhibited flat and long dark green pods, among which the pod DOLBVAR-2 was the longest. The pods were fleshy, and the whole pod could be eaten as a vegetable. Among all the DOLBVAR genotype, DOLBVAR-3 had whitish pods and smaller in size. The pods were dried to be used for seed purposes. DOLBVAR-4 and DOLBVAR-6 were tall and slender in shape, as their width was less. The pods of these genotypes could be eaten as a whole green vegetable.

Table 2. Mean performance for yield and yield attributing traits in 6 genotypes and two check varieties of Dolichos bean

S.No.	Genotypes	Days to 50% flowering (Days)	Plant height (cm)	Branches/plant	Petiole length (cm)	Leaf length (cm)	Leaf width (cm)	Pod length (cm)	Pod width ( )	No. of pods/plant	No. of seed/ pod	Green pod yield/ plant (g)	Green pod yield (t/ha)
1	DOLBVAR-2	37.50	50.70	4.60	13.1	8.0	6.13	12.08	3.62	60.80	5.8	138.73	3.90
2	DOLBVAR-3	36.50	47.20	4.70	12.3	9.33	5.40	4.72	1.40	47.20	5.0	121.33	2.74
3	DOLBVAR-4	38.50	52.80	4.50	12.0	9.83	8.66	11.22	1.90	49.26	5.6	126.13	2.80
4	DOLBVAR-5	39.00	51.80	4.40	15.0	8.12	7.02	8.10	2.04	44.93	5.0	106.20	2.00
5	DOLBVAR-6	37.50	49.30	4.55	11.0	6.33	6.64	8.20	1.86	47.46	3.8	119.26	2.64
6	HA 5	37.00	50.80	4.20	13.0	8.89	7.69	6.00	1.90	60.60	4.4	124.33	3.60
7	HA 3*	37.50	49.30	4.30	11.0	6.16	6.43	6.20	1.88	60.26	4.4	103.40	2.18
8	HA 4*	36.50	51.30	4.00	10.42	9.83	6.96	4.60	1.72	68.73	4.2	112.80	4.00
	MEAN	37.50	50.40	4.41	12.22	8.31	6.87	7.64	2.04	54.91	4.78	119.02	2.98
	SE m ±	0.38	2.61	0.15	0.47	0.47	0.14	0.26	0.13	2.59	0.11	3.57	0.16
	CD @ 5%	1.24	8.73	0.50	1.56	1.56	0.47	0.88	0.43	8.67	0.36	11.93	0.52
	CV (%)	1.44	7.33	4.81	5.20	5.20	2.79	4.64	8.72	6.69	3.16	4.12	8.04

Table 3. Estimation of genetic parameters for 12 characters in 6 Dolichos bean genotypes and check varieties

Characters	Mean	Range	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	Genetic advance as % of mean
Days to 50% flowering (Days)	37.5	34.5-39.0	3.58	3.86	86.09	2.54	6.85
Plant height (cm)	50.4	47.20-52.80	5.38	6.71	64.28	4.53	8.88
No. of branches/plant	4.41	4.00-4.70	3.98	6.24	40.61	0.23	5.22
Petiole length (cm)	12.2	11-12.3	12.81	13.83	85.86	3.10	24.46
Leaf length (cm)	8.31	6.16-9.83	13.78	16.22	72.11	2.04	24.10
Leaf width (cm)	6.87	5.4-8.66	14.52	14.79	96.44	2.09	29.38
Pod length (cm)	7.64	6.0-12.08	36.04	36.34	98.37	5.88	73.64
Pod width (cm)	2.04	1.4-3.42	27.21	28.58	90.69	1.12	53.39
No. of pods/plant	59.2	42.25-76.30	23.38	24.32	92.43	25.39	46.31
No. of seed	4.78	3.8-5.8	14.59	14.93	95.53	1.42	29.38
Green pod yield/ plant (g)	82.9	97.45-168.00	19.79	20.22	95.85	48.86	39.92
Green pod yield (t/Ha)	2.75	1.45-4.32	39.6	40.41	96.04	2.20	79.94

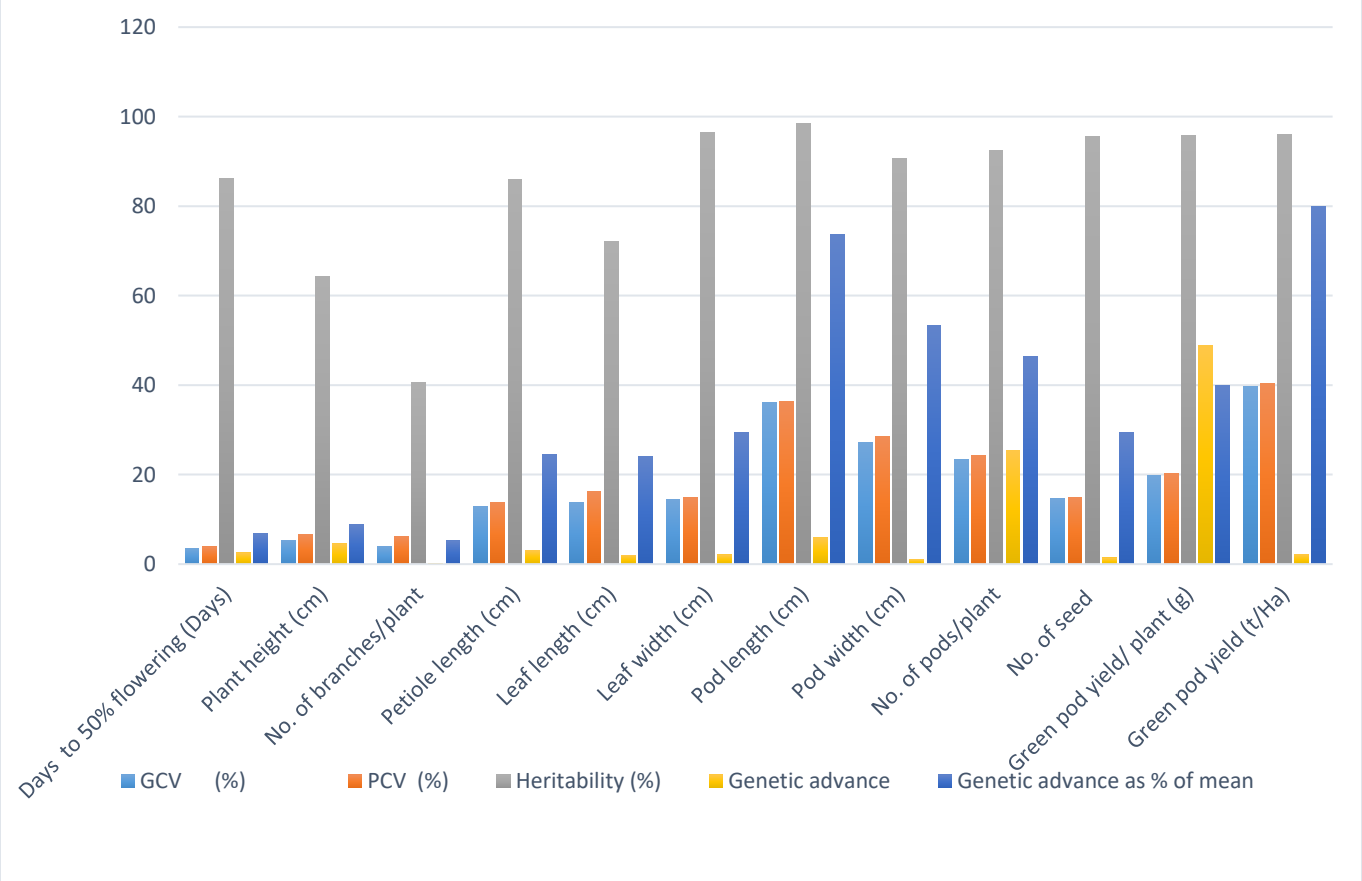

Fig 2: Graphical representation of genetic parameters for 12 characters in 6 Dolichos bean genotypes and check varieties

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Table.4: Leaf and pod characteristics of Dolichos bean genotypes and checks

Genotype name	Bean type	Leaf shape	Leaf color	Pod character	Purpose
DOLBVAR-2	Bush	Ovate	Green	Flat and long, Dark green	Used as whole for vegetable purpose
DOLBVAR-3	Bush	Ovate	Green	Flat and short, whitish green	Used as seed purpose
DOLBVAR-4	Bush	Ovate	Green	Flat and long, dark green	Used as whole for vegetable purpose
DOLBVAR-5	Bush	Ovate	Green	Medium flat, green in color	Used as whole for vegetable purpose
DOLBVAR-6	Bush	Ovate	Green	Medium flat, green in color	Used as whole for vegetable purpose
HA 5	Bush	Ovate	Green	Light green in color	Used as seed purpose
HA 3*	Bush	Ovate	Green	Dark green on the ridges	Used as seed purpose
HA 4*	Bush	Ovate	Green	Light green and dark green on the ridges	Used as seed purpose

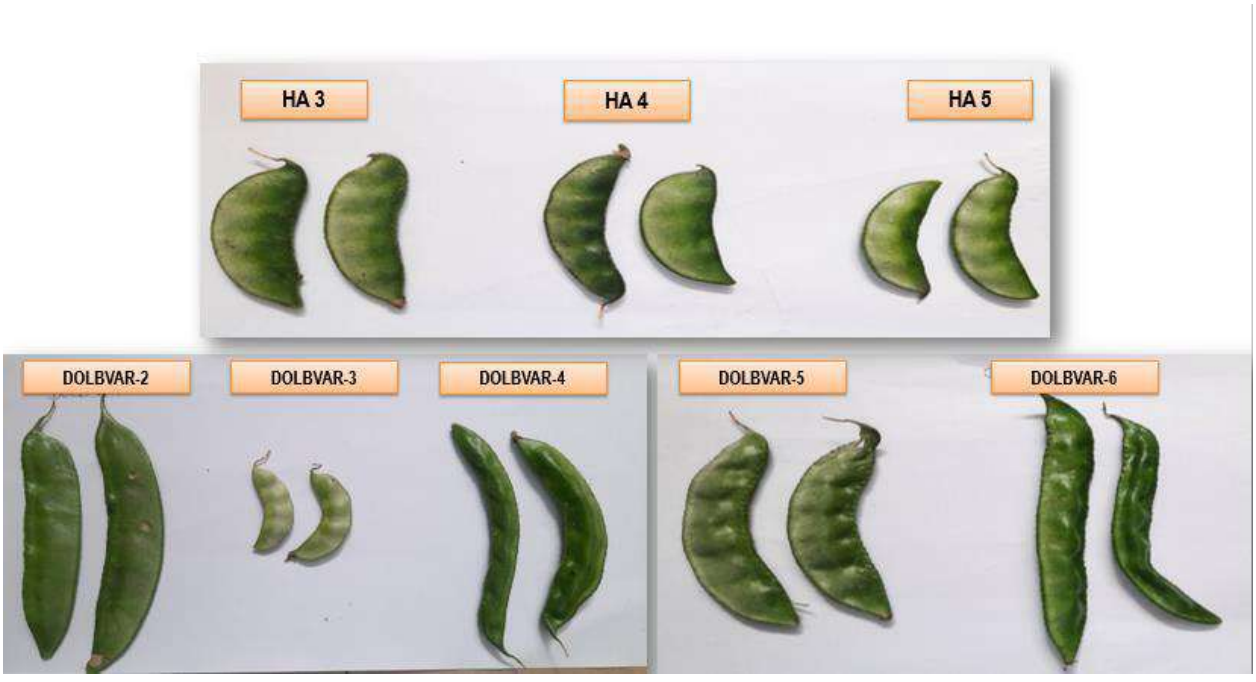

Fig 3: Pod characteristics of 6 genotypes and 2 checks of dolichos bean

DOLBVAR-2 recorded the maximum number of green pods *per* plant, green pod yield plant-1, and green pod yield hec^{-1}. Even the check variety HA 4 (4.00 t/ha) is on par with DOLBVAR-2 (3.90 t/ha) for green pod yield *per* hectare at 5% CD value. The genotypes HA 5 (60.60) and DOLBVAR-2 (60.8) were also on par with the local checks with respect to a number of green pods *per* plant. So, it can be concluded that DOLBVAR-2

is the best performing Dolichos genotype among taken up for trial.

The genotype DOLBVAR-2 was found with the tallest pods among all the genotypes, and pods could be used as whole green vegetables.

In conclusion, based on genetic variability estimates that individual plant could be carried out selection for characters *viz*., pod yield plant^{-1}, pod length (cm), pod weight (cm) as they recorded high values of heritability coupled with high genetic advance Hence, the breeder should adopt a suitable breeding methodology to utilize both additive and non-additive gene effects simultaneously since varietal and hybrid development will go a long way in the breeding programs, especially in the case of Dolichos bean

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Changes in properties of tropical ferruginous soils under long-term fertility management and continuous cultivation

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Abstract**—***Soil fertility is an important resource to enhance crop productivity and meet global food demand. The present work investigated the impact of long-term fertility management and continuous cultivation on selected soil properties of ferruginous soils. 8 plots of the experimental research plot situated behind the Agricultural Extension Research and Liaison Services (AERLS) building in Samaru, Zaria, Nigeria,were subjected to different fertility treatment for over 50 years. These treatment were: control (C); nitrogen (N); nitrogen & potassium (NK); nitrogen & phosphorus (NP); nitrogen & phosphorus & potassium (NPK); dung & potassium (DP); dung & nitrogen (DN); and dung & nitrogen & phosphorus (DNP). Using a completely randomized design (CRD) sampling technique, triplicate soil samples were collected from each fertility plot from the first 300 mm of the soil surface and analysed for selected properties. Results showed that the soils were majorly sandy loam. Sand component of the fertility plots was significantly ($P<0.05$) higher compared to the Control, while silt was observed to have reduced in the experimental plots. Soil organic carbon (SOC) was significantly ($P<0.05$) higher in the Control. Soils with dung as part of its fertilizer treatment showed slightly higher organic carbon content, with the DNP treatment having the highest value (0.76%), while lowest OC (0.36%) was recorded in the soils treated with inorganic fertilizer of NPK combinations. The OC content (0.35%-0.78%) recorded in soils of the various fertility plots was well below the 2% critical level required to guarantee soil structural stability. The pH values of treated soils were from 5.1–6.1 and significantly ($P<0.05$) higher in the Control. Bulk density was highest (1620 kg/m^3) in the Control, while the plot under DP showed the least value of 1520 kg/m^3. The different fertility treatments were observed to have reduced the plasticity of the soils from highly plastic recorded in Control to medium plastic observed in most of the other treatments. It is suggested that measures to enhance the soil OC be implemented as that will not only enhance the soil aggregate stability, but reduce the risk of soil erosion.*

Keywords**—*Long-term, fertility management, soil quality, ferruginous, aggregate stability***

I. INTRODUCTION

The need to sustain agricultural systems has become a concern of global dimension due to the rising decline in soil productivity. Soil quality and fertility are important resource to enhance crop productivity in order to meet the food required for the current and future population, particularly in the developing countries whose economy mainly depends on agriculture [1]–[4]. Soil quality means the capacity of the soil to deliver the intended functions for both biomass and yield production [5], [6].

When an agricultural land is under intense cultivation and use, there is the need to maintain soil fertility, soil sustainability and soil erosion control. Various methods have been adopted to achieve this. These include better land use management, continuous cultivation, crop rotation and fertility management programmes. Fertility management programmes refer to the various techniques adopted to enhance and ensure that essential plant nutrients are not depleted to undesirable levels. Fertility management is important to maintain crop yield and

protect the land from the depletion of important soil nutrients.

In much of sub-Saharan Africa, the lack of organic soil amendments constitute one of the principal causes for declining soil fertility in intensifying farming systems. The challenge, therefore, remains to increase the availability of organic inputs and to develop recommendations for their combination with inorganic fertilizers [7].

Continuous and judicious application of manure has been shown to improve the physical and chemical properties of the soil, especially those that are coarse textured, or have low organic matter, thus reducing the potential for degradation of the quality of soil [7]. Interest in organic farming has increased following the determination that use of green manure and other organic matter can improve soil structure, improve nutrient exchange, and maintain soil health [8], [9].

The application of chemical fertilizers and organic manure to the soil has both positive and negative effects on plant growth and the soil properties. Though chemical fertilizers are relatively inexpensive, and have high nutrient contents which are rapidly absorbed by plants, applying them in excess can lead to a number of problems. Such problems may include loss of nutrient, contamination of surface water and groundwater, soil acidification, reductions in population of useful microbial communities, as well as increased sensitivity to harmful insects. On the other hand, use of organic manure is reported to have a number of deficiencies including slow decomposition and low nutrient in comparison to chemical fertilizers [10]. Despite the deficiencies in the use of organic fertilizer, it is reported to have multiple benefits due to the balanced supply of nutrients, increase in soil nutrient availability as a result of increased soil microbial activity, the decomposition of harmful elements, improvements in soil structure and root development, and increased soil water availability [10]. According to the authors, organic manure that generated from animal byproducts has been used to overcome environmental contamination and plant productivity reductions which are the results of prolonged application chemical fertilizers to the soil. The combined application of both chemical fertilizer and organic manure has shown diverse results in soil characteristic and plant yield.

Continuous cultivation and long-term fertility management programmes have direct bearing on soil structure and some other properties such as pH, infiltration rates and erodibility; and if not properly managed, it may cause adverse effect on the soil. Understanding variability of soil fertility, its distribution and the causes of the observed variability are important to improve sustainable land use strategies [11]. This work was therefore designed to investigate changes in properties of Samaru soils in Zaria, Nigeria under long-term fertility management and continuous cultivation.

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II. MATERIALS AND METHODS

Location

The experimental research plot for this study was situated behind the Agricultural Extension Research and Liaison Services (**AERLS)** building in Samaru, Zaria, Nigeria. Samaru (11º 11' N, 07 º 38' E, on altitude of 686 m above mean sea level) is situated in the Northern guinea savanna zone. Annual rainfall is about 1100 mm (May–September). The soils of the study area are classified as are ferruginous (a soil that is of or contains iron or iron rust) tropical soils formed from drift material, and are largely representative of the loess plain soil unit.

Plot layout

The plots behind the Agricultural Extension Research and Liaison Services building in Samaru were originally established to study and compare the effectiveness of inorganic fertilizers and dung (farmyard manure) in maintaining crop yield under continuous cultivation. It is a research project monitored by the Institute of Agricultural Research (IAR), Samaru. The soils were from the same parent body prior to commencement of the fertilizer treatment. A section of the research plots was thus selected for the purpose of this experiment. Eight (8) different blocks of the research plot were subjected to different fertilizer treatment. These treatment were: control (C); nitrogen (N); nitrogen & potassium (NK); nitrogen & phosphorus (NP), nitrogen & phosphorus & potassium (NPK). Other treatments were dung & potassium (DP); dung & nitrogen (DN); and dung & nitrogen & phosphorus (DNP). Source of nitrogen fertilizer used was ammonium sulphate; while single superphosphate and muriate of potash were used as source for P and K respectively. Fertilizer treatments were applied in two levels (Level 1 & Level 2), and all plots were subjected to uniform continuous cultivation for a period of thirty-three (33) years. Treatment level 1 comprised supplying a specific amount of fertilizer for the first 22 years of the experiment, while treatment level 2 involved supplying another level of fertilizer for the remaining 13 years of the experiment. The application rate and total amount of fertilizer treatment received by respective plots during the period of the experiment is shown in Table 1.

Table 1. Amount of fertilizer for Level 1 and Level 2

Fertilizer type	Treatment Level (kg/ha)				Total amount of Fertilizer received in 33 yrs. (tonnes/ha) = Total for 22 yrs. + Total for 13 yrs.
	Level 1		Level 2		
	Application Per yr.	Total for in yrs.	Application Per yr.	Total in 13 yrs.	
Control	-		-		-
N	**36**	**792**	**74.5**	**968.5**	**1.761**
P	**14**	**308**	**48**	**624**	**0.932**
K	**22.5**	**495**	**69**	**897**	**1.392**
Dung (D)	**5000**	**110000**	**5000**	**65000**	**175**

Table 2. Total fertilizer treatment received by individual plots in 33 yrs.

Plot no	Treatment combination	Total amount of Fertilizer received in 33 yrs. (tonnes/ha)			
		Dung (D)	N	P	K
1	**Control**	**-**	**-**	**-**	**-**
2	**N**	**-**	**1.761**	**-**	**-**
3	**NK**	**-**	**1.761**	**-**	**1.392**
4	**NP**	**-**	**1.761**	**0.932**	**-**
5	**NPK**	**-**	**1.761**	**0.932**	**1.392**
6	**DP**	**175**	**-**	**0.932**	**-**
7	**DN**	**175**	**1.761**	**-**	**-**
8	**DNP**	**175**	**1.761**	**0.932**	

Soil sample collection

This research adopted a completely randomized design (CRD) sampling technique. Triplicate soil samples were collected from each soil fertility treatment plot. Samples were collected from the first 300 mm of the soil surface using a soil auger. Samples were placed in black properly labeled polythene bags, and transported to the laboratory for analysis. Samples for bulk density were collected using a core sampler. Each soil sample was analyzed for pH, organic carbon, bulk density, consistency limits, and particle size distribution (PSD).

III. LABORATORY ANALYSIS

Determination of selected soil chemical and physical properties

The bulk density of each soil sample was measured by determined by core sampler method [12], soil pH value was determined using a 1:2.5 soil to water paste and the glass electrode pH meter, organic carbon by Walkely and Black's oxidation method as described by Jackson et al. [13].

Particle size analysis using sedimentation method

The hydrometer test was carried out to determine the percentage of sand, silt and clay in the soil samples from the various fertility plots. Percentage of sand, silt and clay were determine by hydrometer method [14] and the textural class was determined using the USDA textural triangle.

$$\% \text{ sand} = \frac{Sample\ weight - 40\ seconds\ reding}{Sample\ weight} \quad (1)$$

$$\% \text{ clay} = \frac{8\ hour\ reading}{Sample\ weight}\ x\ 100 \quad (2)$$

$$\% \ silt = 100\ \% - (100\% + clay) \quad (3)$$

Determination of consistency limits

The liquid limit was determined using the standard cup and grove method. This was carried out following the standard laboratory methods (ASTM standard test method D 4318). The plastic limit was determined by the method of rolling a 3mm thread of the soil until the thread crumbles. The plasticity index was calculated as the difference between the value of the liquid and plastic limit of the soil.

IV. RESULTS AND DISCUSSION

Particle size distribution

Table 3 shows the textural compositions, organic carbon, and pH of the soils under different fertility treatments. The results show that Samaru soils are basically Sandy loam with the exception of the Plot no 4 and 5 under NP and NPK treatments, respectively, which fall in the Loamy sand category.

Table 3. Effect of fertility treatment on selected soil properties

Plot no.	Soil Treatment	Sand (%)	Silt (%)	Clay (%)	Textural class	OC (%)	pH
1	Control	59	37	4	Sandy loam	0.78	6.2
2	N	54	40	6	Sandy loam	0.49	6.1
3	NK	64	31	5	Sandy loam	0.35	5.4
4	NP	77	20	3	Loamy sand	0.45	5.5
5	NPK	75	21	4	Loamy sand	0.36	5.7
6	DP	66	30	4	Sandy loam	0.70	5.8
7	DN	72	24	4	Sandy loam	0.64	5.4
8	DNP	66	30	4	Sandy loam	0.76	5.1
LSD 5%		1.413	1.322	NS		0.030	0.166

The sand content of the soils was significantly influenced by the fertility treatment. The sand content (54–77%) dominated the textures, followed by silt (20–40%) and clay contents (3–6%) respectively. The sand fractions are mainly the fine sand fraction (0.06mm – 0.2mm). These are very erodible fractions indicating that these soils are actually susceptible to erosion.

However, sand component of the various fertility treatment plots was observed to be significantly ($P<0.05$) higher compared to the Control, while silt was observed to have reduced in the experimental plots. No noticeable change in level was observed for clay fraction of the soil before and after the fertility treatment. Highest variation in sand and silt fractions relative to the Control plot was observed in the NP treatment plot with sand and silt percentages of 77% and 20% respectively, against 59% and 37% sand and silt percentages in the Control plot. The relative increase in the proportion of fines in the treatment plots could be the result of frequent mixing of the fertilizers and soil by machines used in the farm. According to Toy *et al.* [15], soils having more sand and silt components at the surface cap facilitates runoff, and are susceptible to water erosion. Compared to the Control plot, the results show that long-term fertility treatment did not cause any major change in the textural properties of the soils, though there were variations in the individual soil components.

Soil organic carbon

Soil OC was significantly ($P<0.05$) higher in the Control plot compared with the various treatments. Soils with dung as part of its main treatment treatment showed slightly higher organic carbon content, with the DNP treatment having the highest value (0.76%), while lowest OC was recorded in the soils treated with inorganic fertilizer of NPK combinations. The result agrees with the findings of Islam *et al.* [16] who reported that the OC content of soils slightly decreased due to application of inorganic fertilizers while the results tended to increase in soils treated with organic fertilizer. Similarly, [17] reported that application of organic manure increased the OC content of the soil whereas a decreasing trend was detected with the application of chemical fertilizers. The soil OC recorded in the various plots (0.35%-0.78%) was, however, below the 2% critical level suggested by [18] below which soil structural stability will not be guaranteed.

Soil OC is beneficial for long-term sustainability of the agro-ecosystem. It is reported that soil OC affects the soil physical, chemical and biological behaviour [19] and plays

a significant role in maintaining soil quality andagricultural production [20]. It is also reported that SOC promotes aggregation, improve soil physical properties, and increase productivity and activity of soil organisms [21].

Soil pH

pH value was significantly (P<0.05) higher in the Control compared to the fertility treated soils. The pH values of treated soils were from 5.1 – 6.1 indicating acidic nature, and with the DNP treated soil having the lowest value. A report by [22] showed that the soil pH decreased by the application of organic fertilizer. This is in agreement with the findings of Janzen [23] that application of nitrogen fertilizer significantly depressed soil pH. The findings of this result is also in agreement with the report of Ge *at al.* [24] that long-term fertilization can decrease soil pH due to the continuous excessive application of N fertilizers. Likewise, [25] opined that addition of inorganic fertilizers increases soil acidity.

Bulk density

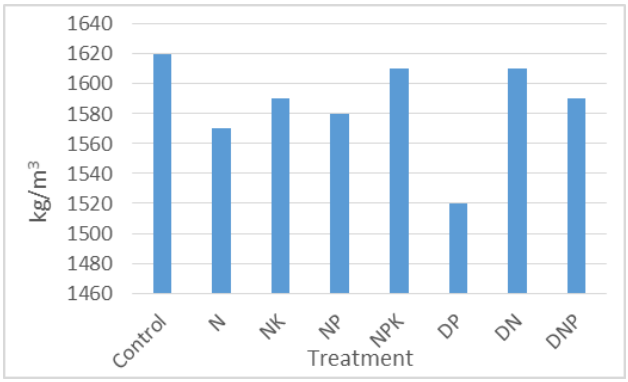

Fig. 1. Variation in bulk density for various soil treatments

Figure 1 showed that highest bulk density was highest in the Control, while the plots under fertility treatments showed slightly lower bulk densities. Among the fertility plots, highest bulk density was recorded in the NPK and DN plots respectively, while the lowest occurred in the N plot. Amoah*et al.* [7] reported that bulk densities of soils treated with cow dung and those with inorganic (NPK) fertilizer combined with cow dung were less than Control (with no fertilizer application). Reduction in bulk density of soil due to application of cattle manure in a long-term integrated nutrient management was also reported by [26]. Similarly, [27] reported decrease in bulk density of soils treated with inorganic fertilizer and those with inorganic fertilizer and farm yard manure as against Control with no fertilizer application under long-term fertility management. The authors however reported no significant difference in the bulk densities of the soils treated with inorganic fertilizer and those in combination with farm yard manure. According to Amoah*et al.* (2012), the decrease in bulk density could be attributed to manure effect, which improves the soil by reducing its density. The decrease in bulk density could also be the result of greater organic matter content of the soil and better aggregation [28].

Soil consistency

Table 4 shows the result of soil consistency with fertility treatment. Analysis of the soils showed that the Control was highly plastic, and the application of fertility treatment has reduced the plasticity. Thus, there was decrease in plasticity index of the soils under the various fertility treatments to medium plastic from highly plastic of the Control, with the exception of the plot under N treatment. Soils containing N and P are observed to have relatively lower plastic limits, while dung (D) appeared to be an improver of the plastic limit (i.e. increases plastic limit). The plasticity index is the difference between the plastic limit and the liquid limit and it indicates the range of moisture content over which soil have various shear strength values in increasing order from plastic limit, being highest at the plastic limit. Soils with low plastic limits had lower clay content, while soils with higher limits had higher clay contents. According to Ezeokonkwo [30], plastic soil become less plastic by the introduction of NPK fertilizer. The author reported that the plastic quality of the soil decreases as the percentage of fertilizer increases. The reason for was the bounding of fertilizer elements by the soil particles, a situation that could cause the soil containing NPK fertilizer to crumble easily. The findings of this study is also in agreement with the report of Paul and Abraham [31] that addition of fertilizer to soils affects the Atterberg's limits properties of the soil by reducing the liquid limit and the plastic limit of soils.

Table 4. Effect of fertility treatment on soil consistency

Plot no.	Soil treatment	Plastic limit %	Liquid limit %	Plasticity index %	Degree of plasticity*
1	Control	9.64	28.80	20.77	High plastic
2	N	9.23	30.00	20.27	High plastic
3	NK	7.15	23.00	15.85	Medium plastic

4	NP	6.35	24.00	17.05	High plastic
5	NPK	7.64	23.00	15.36	Medium plastic
6	DP	10.43	24.00	13.57	Medium plastic
7	DN	8.48	22.60	14.12	Medium plastic
8	DNP	6.42	22.00	16.58	Medium plastic

*Burmister [29]

V. CONCLUSION

Results of this study showed that properties of ferruginous soils are influenced by fertility treatment under long-term continuous cultivation. Inorganic fertilizer, when singly applied, or in combination with dung, affects the soil particle size, resulting in reduction of sand component and increase in silt. Clay component of the soils was not affected. Soil OC and pH were significantly ($P<0.05$) lower in the fertility plots compared to the Control. Long-term fertility treatment also resulted in lower soil bulk density and plasticity from high to medium plasticity. Bulk density was highest (1620 kg/m3) in the Control, while the plot under DP showed the least value of 1520 kg/m^3. Measures to enhance the soil OC are thus recommended as that will not only enhance the soil aggregate stability, but reduce the risk of soil erosion.

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Nagging Food Insecurity Amidst Numerous Public Agricultural Policies, Strategies, Programmes and Projects in Nigeria: Identifying and Fixing the Key Issues

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Abstract**—** *Despite numerous public agricultural policies, strategies, programmes and projects aimed at boosting agricultural production for the attainment of food security in the past consecutive five decades in Nigeria, seven out of ten Nigerians are food insecure. The study identified the key issues that need to be fixed, using theoretical and documentary methods and survey research designs. Four hundred (400) academics/practitioners in food policies/production/security were purposively selected based on online visibility. They were reached for information, using Google Questionnaire. Data were analysed using frequency tables and factor analysis. Finding sidentified six (6) key issues that needed to be fixed, namely predominance of smallholder subsistence farming, use of rudimentary tools, unimproved varieties of seeds and other inputs, traditional storage and preservation practices, deficit of marketing infrastructure, and dependence on rain-fed agriculture. Fixing themcan address the four dimensions of food security. The key issues were related more to science technology and innovation (STI) than to other selected development sub-sectors. They were attributable to poor STI adoption and can be fixed by STI adoption. Therefore, STI adoption for agricultural production was recommended for the attainment of food security in Nigeria.*

Keywords**— Agricultural production, Science technology and innovation adoption,Food security policy, Pillars of food security, Dimensions of food security.**

I. INTRODUCTION

Hungry people–persons with a sense of inner emptiness – are bereft of a sense of discernment of right and wrong. They settle for anything that can minister to their empty stomachs, even if it offends someone. What is bitter tastes good to them. Food is a foremost basic need of people and food security is a *sine qua non* for meaningful development, which is about improving the welfare of people. The welfare of people begins with food, but does not end with it. People may do without clothing or shelter for as long as necessary, but not food, the absence of which destabilizes them mentally, such that they cannot engage in any meaningful activity to help selves, other people or the society. Faced with an abject lack of food, clothing and shelter, the destitute scavenge for food from waste dumps, ignoring the other two basic needs of people, while going naked or ragged and making habitat of anything at all(Schuldt, 2019).

Therefore, it is a front-burner development concern that more than one billion people are hungry mostly in sub-Saharan Africa (SSA) and Latin America and the Caribbean (LAC), while 2 billion eat too much wrong food (Kaur, 2019). This unacceptable situation informs the SDG 2 which aims to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" by 2030 in all the countries of the world (http://sustainabledevelopment.un.org/focussdgs.html).The first United Nations Millennium Development Goal (MDG 1) had aimed to "eradicate extreme poverty and hunger" between 2000 and 2015 in all the countries of the world. Poverty is connected to food. Indeed, the thresholds for determining that someone is poor were originally calculated as the budget necessary to buy a certain number of calories, plus some other indispensable purchases, such as housing. A poor person is essentially someone without enough to eat (Banerjee and Duflo, 2011).At the end of the

target year, 2015, the G8 countries might have hit the MDGs, but Nigeria certainly did not, with hunger rising and poverty deepeningto the point that Nigeria became the poverty capital of the world by 2019(http://sustainabledevelopment.un.org/focussdgs.html).It is being hoped that SDG 2will not fare the way of MDG 1 in Nigeria.

In the past five decades (1970-2019), Nigeria has had a plethora ofpublic agricultural policies, strategies, programmes and projects for boosting agricultural production for the attainment of food security and agricultural sustainability. It is curious that, in spite of the numerous public initiatives and interventions, seven out of ten Nigerians are food insecure (Okojie, 2019). There must be some issues which need to be identified and fixed. What are the key issues behind the failure of public agricultural policies, strategies, programmes and projects for food security in Nigeria? What is the extent fixing them can address the four dimensions of food security? To which development sub-sectors are the key issues related? How can the key issues be fixed? These are the objects ofthe study, the findings of which would help teaseout workable recommendations for way-forward.

1.1 Review of relevant literature

The concepts of food security policy, science technology and innovation (STI) and its adoption are reviewed. A brief profile of food security in Nigeria is examined. Public policies, strategies, programmes and projects for boosting agricultural production for the attainment of food security in Nigeria, as well as factors affecting food security and their effects on development in Nigeria are reviewed.

1.1.1Food security policy

Food security policy includes decision-making around production and processing techniques, marketing, availability, utilization and consumption of food in the interest of meeting or furthering social objectives. It is designed to influence the operation of the food and agricultural system for the community (local, national, regional or global) and for commitment to nurturing the development of a food secure nation in which all citizens are hunger-free, healthy and benefit from the food systems that impact their lives. It affirms the nation's commitment to supporting sustainable food systems that provide people with high quality food, employment, and that also contribute to the long-term well-being of the environment(FAO, 2009).

It addresses current access to quality food in the nation, hunger and malnutrition, impacts/effects of an inadequatediet, citizen education,economic injustice in the foodsystem, urban agriculture, the role of schools and other publicinstitutions, and emergency response. The document is organized by a statement of the issues, followed by actions needed to address those issues (FAO, 2009).

1.1.2Science technology and innovation (STI) and its adoption

According to National Academies of Sciences, Engineering, and Medicine (NASEM, 2017), STI refers to science technology and innovation. Other nuances and their acronyms are S&T (science and technology), R&D (research and development), STIP (science, technology, innovation and partnership), and R&P (research and partnership).

Scientific research produces discoveries to improve lives and societies; technological breakthroughs revolutionize commerce and knowledge-sharing; and innovation inspires people to seek new solutions to persistent problems. The use of technology in industrial development and the resulting gaps in productivity explains the differentials in development status of countries. Countries with high levels of investment in physical capital instead of in technology run the risk of facing diminishing returns and slow growth. Ultimately, weak productivity growth in developing countries exacerbates poverty, energy deficiency and environmental debt, to name but a few significant implications. Conversely, investment in technology guarantees continuous productivity growth and potential for inclusive and sustainable industrial development. It is therefore important to focus on the factors that are involved in increased technical efficiency (more output per input or more resource productivity) and technological change, both of which are components of productivity growth. A significant reason behind developing countries' weak productivity is the low rate of innovation. A coordinated national system of innovation (NSI) is needful to promote investment in innovation, decreases the constraints on the creation of new knowledge and technology, and boosts the rates of adoption and adaptation of existing technologies. STI policies help raise productivity, improve firm competitiveness, support faster growth and create jobs (NASEM, 2017).

According to Eneh (2010), STI adoption refers to the stage in which STI is selected for use by an individual or an organization. Related terms are technology diffusion and technology integration. The former refers to the stage in which the technology spreads to general use and application, while the latter connotes a sense of acceptance, and perhaps transparency, within the user environment. Typically, adoption of a new technology signals a confidence in its potential to alleviate a particular problem or to make a job easier or more efficient; rarely has bringing about new social and functional conditions been a consideration.

1.1.3A brief profile of food security in Nigeria

Before attainment of political independence in 1960, Nigeria was self-sufficient in food production and exported not only food but also raw materials to England. The establishment of the Department of Botanical Research in 1893; the acquisition of over 10 sq. km. of land at Moor Plantation in Ibadan for cotton production in 1905; the establishment of the Department of Agriculture in the North in 1912 and the establishment of Central Department of Agriculture after the Amalgamation of 1914 put Nigeria on a steady path to agricultural development.In the early 1960s, Nigeria was one of the world's most promising agricultural producers. Regionally focused policies based on the economic principle of commodity comparative advantage ensured that the agricultural sector served as the nation's main source of food and livelihoods (Ibirogba, 2018).

The immediate post-independence years were the golden era of agriculture in the country. Service accounted for 32%, manufacturing 11% and agriculture over 30% of the country's gross domestic products (GDP). The productiveness of Nigerian soil, enhanced by conducive climate and weather, supported the production of avariety of foods and cash crops. Until early 1970s, Nigeria was leading in the production of cash crops, such as cocoa, cotton, groundnuts, palm oil/kernel, rubber, etc., which were mostly exported to Britain, United States of America (USA), Canada and Germany. Till the early 1980s, animal husbandry, fishing and poultry contributed more than 2% to the country's GDP. A 1987 report of the United Nations Food and Agriculture Organization(UN FAO)submits that there were 12.2 million cattle, 13.2 million sheep, 26 million goats, 1.3 million pigs, 700,000 donkeys, 250,000 horses, and 18,000 camels in Nigeria around this period. Most of these livestocks were owned by rural dwellers (Odumade, 2017).

Nigeria soon turned to petroleum as the mainstay of the nation's economy, neglected agricultural sector and rapidly grew into a major food importer. The oil-economy quickly polarized the nation's population into a small fraction of high-income group that benefit from the oil wealth and a major fraction of low-income group suffering food insecurity because it cannot afford imported foods. Nigeria became shackled in food insecurity (Matemilola and Elegbede, 2017).

Engagement of a sizable ratio of the population in subsistence agriculture and high regulation of the economy of 1960-1986 became the responses, which could only ensure supply, but not affordability and accessibility, of food (Adebayo, 2010). Food supplies improved considerably in the subsequent deregulated economy that followed the adoption of the Structural Adjustment Programme (SAP) in 1986. But, food accessibility, utilization and security status worsened. Between 1980 and 1990, per capita agricultural production even declined or stagnated (Dauda, 2006).

Currently, Nigeria's estimated 200 million population grows at an annual rate of 2.6. Yet, staple food crops are under-produced. Maize, vegetables and cassava crops yields are constant in the past 10 years in Nigeria because there is no right hybrid seeds and seedlings for cultivation; those available are adulterated. Crops yields are 1.2mt/ha maize and 2mt/ha cassava, as against 3mt/ha and 6mt/ha respectively by peers in other African countries. Nigerian farmers record the least yield/ha in Africa. Tomato yield is 7mt/ha in Nigeria, 20mt/ha in Kenya, 8mt/ha in Ghana and 76mt/ha in South Africa. Maize yield is 1.6mt/ha in Nigeria, 2mt/ha in Kenya and Ghana, and 6mt/ha in South Africa. Potato yield is 3.7mt/ha in Nigeria, 15.5mt/ha in Kenya, and 38.8mt/ha in South Africa. Rice paddy yield is 2mt/ha in Nigeria, 3mt/ha in Kenya, Ghana and South Africa. Nigeria has the lowest yield/ha globally. Crops yield gaps are high in Nigeria. Average rice yields in Nigeria are between 1 and 2.5 tons/ha against potential yields of 5–6 tons/ha. Maize yields in Nigeria are less than 2 tons/ha on average compared to greater than 9 tons per hectare attained in the USA. Half of fruits and vegetables get lost to post-harvest rot because of inadequate storage facilities and huge road deficits. Nigeria is the poverty capital of the world with 91.8 million Nigerians living in extreme poverty. Rural communities account for 52.8% of poverty in Nigeria. This low productivity results in extensive and persistent food insufficiency/insecurity and poverty. Up to 70% of Nigerians are food insecure (Okojie, 2019).

1.1.4Public policies, strategies, programmes and projects for boosting agricultural production for the attainment of food security and agricultural sustainability in Nigeria

A societyevolves three basic ways to provide food as an existential imperative: (i) policy to rely on its resources (e.g. primitive societies), (ii) food imports to supplement local production (e.g. modern economies), and (iii) involving the control of the resources of others to ensure regular supply of its needs (e.g. imperialists). The Vision 2010 recognized that Nigeria is well endowed with natural resources and sought to improve the enabling environment to enhance the exploitation of these resources to make NigeriaAfrica's leading economy and an industrial nation (Njoku, 2000).

Nigeria has had a plethora of policies, strategies, programmes and projects for boosting agricultural production for the attainment of food security and agricultural sustainability (Okuneye, 2002).Nigeria's

agriculture policies, which are geared towards ensuring food security and improved nutrition among citizens, particularly children, include (1) Agriculture Promotion Policy (2016-2020) driven by engagement of market place participants, farmers, states, investors, financial institutions and communities, and (2) National Plan of Action on Food and Nutrition in Nigeria (Abu, 2012).

Pre-independence government policies, strategies, programmes andprojects focussed on agricultural commodities (especially export crops) which generated extractable surpluses in agriculture. Regional governments created development corporations for agricultural interventions. Corporations in the East and West regions established oil palm, cocoa and rubber plantations. The North region provided extension services to transform smallholder production activities. Allocations to agriculture in 1951-1959 period averaged 7.5%, 8.3% and 13.6% of total government expenditure in the West, East and North respectively. The marketing boards extracted surpluses from agriculture for the development of other sectors, since agriculture was the goose that laid the golden egg and provided the engine of growth for the rest of the economy.In 1960-1966 period, agricultural development was a responsibility of the region, except agricultural research located in the Federal Ministry of Economic Development. Food production surpassed population growth. Output of export crops grew by 4-6%. Government agricultural allocation averaged 7% in 1962-1968 period. Oil revenue grew upto the early 1970s, and allocation to agriculture dropped to 2.2% in 1966-1975 period. To spend the oil money, a floodgate of imports were maintained up to 1980s,when depressed domestic prices accelerated the decline of local food production and contributed to the economic crisis that erupted in the early 1980s. The neglect of the agricultural sector notwithstanding, certain agricultural programmes were initiated. The National Accelerated Food Production Project (NAFPP) was established in four states in 1973 and extended to all states in 1977. Three Agricultural Development Projects (ADPs) were established in 1975 in Funtua, Gausau and Gombe, and were increased to 13 in 1979 (Njoku, 2000).

Ten (10) federal universities/colleges of agriculture (https://www.federal-universities-and-colleges-of-agriculture), 16 national agricultural research institutions (https://agriculturenigeria.com/research) and 12 river basin development authorities (RBDAs) were established in the 1970s to accelerate agricultural development, power generation, navigation, rural development, among others (Ogundele, 2019; Akindele and Adebo, 2004; http://lawnigeria.com/LawsoftheFederation/RIVER-BASINS-DEVELOPMENT-AUTHORITIES-ACT.html; https://en.wikipedia.org/wiki/River_Basin_Authorities_in_Nigeria).

From 1978, fall in oil prices continued into the 1980s, leading to a drastic fall in government revenue. Government made some investments in development of extension services, distribution of improved inputs (notably fertilizer) and development of marketing facilities. Several parastatals were created for large-scale farming activities, including the National Livestock Production Company, the National Grains Production Company and the National Root Crops Production Company. The Federal Ministry of Agriculture was created in 1975, besides the Federal Ministry of Natural Resources created in 1964. Operation Feed the Nation (OFN) started in 1976, while the State Marketing Boards were replaced with National Commodity Board in 1977. Nonetheless, agriculture received 1% allocation of the federal expenditure during 1975-1979 period. In 1979-1983 period, the Economic Stabilisation Act (ESA) of 1982 was established to restrict food importation and exportation. The Green Revolution Programme (GRP) came to expand the production of grains. Allocation to agriculture rose to 13% of federal government expenditure. In 1983-1999 period, commodity boards were abrogated, public companies were deprived of agricultural production, the Directorate of Food, Roads and Rural Infrastructure (DFRRI) was established to foster rural and agricultural development, ADP received improved budget, and building of a fertilizer and Savana Sugar projects took place. The National Agricultural Land Development Authority (NALDA) came on board in 1990 to make land available to people who wanted to go into farming. The National Agricultural Research Project (NARP) was also established. The Nigeria Export Import Bank (NEXIM) was established in 1990 to provide fund to indigenous exporters. Also lending their support were international financiers, including the World Bank, UNDP, FAO, UNIDO and others (Njoku, 2000).

In spite of these public agricultural policies, strategies, programmes and projects aimed at boosting agricultural production for the attainment of food security in the past consecutive five decades, seven out of ten Nigerians are food insecure (Okojie, 2019). This is intriguing and contrary to the expectations that putting sufficient public agricultural policies, strategies, programmes and projects on ground would boost agricultural production and result in food security in Nigeria. Therefore,it has become necessary to identify the key issues that need to be fixed.

1.1.5 Factors affecting food security and their effects on developmentin Nigeria

Ogundele(2019), Okojie (2019), Odumade (2017), Matemilola and Elegbede (2017) and Njoku (2000) submit

that the factors affecting food security are climate, predominance of smallholder subsistence farming, technology, use of rudimentary tools, loss of farmlands, unimproved varieties of seeds and other inputs, pests and diseases, traditional storage and preservation practices, water stress (irrigation), deficit of marketing infrastructure, dependence on rain-fed agriculture, and poverty. These and other factors lead to famine (undernourishment, malnutrition, wasting and stunting), soil erosion, deforestation (overgrazing, over-cultivation), rising prices, debt, and social unrest.But, boosting agricultural production for the attainment of food security ensures a well-fed and healthy population, availability of raw materials for local use and export, growth of foreign reserves through export of raw materials, ease of financing (from rich foreign reserves) food import to supplement local production, transfer of productive resources (investable surpluses of capital and labour) to other sectors of the economy for economic development of the country, value addition through effective value chain management, revenue improvement through payment of taxation, diversification that averts the vagaries of price fluctuation of the nation's monolithic oil economy, and provision of remunerative employment. Unfortunately, numerous and varied public agricultural policies, strategies, programmes and projects to boost agricultural production for the attainment of food security since 1970 have not yielded the desired food security status.

II. METHODS

A combination of theoretical and documentary research methods and a survey research design was adopted. Four hundred (400) academics/practitioners in food policy/production/security were purposively selected based on their online visibility, qualifications, experiences and outputs, as most competent to address the research questions. Inclusion criteria were having a minimum of ten (10) cognate research highly rated publications in food security policy and agricultural production, and being among the first 400 persons to indicate availability for the study. Exclusion criterion was inability to make it to the list of the first 400 persons selected based on the inclusion criteria.

Information was elicited in three separate questionnaires. The first questionnaire, which served for preliminary survey, contained an open-ended question on the issues that needed to be fixed to reverse the failure trend ofthe numerous public agricultural policies, strategies, programmes and projects and bring about the much needed food security. The suggested items formed a long list of twenty-eight (28)random answers arranged vertically in descending order of frequency.The list was subjected to factor analysis to pick the key issues, which happened to be six (6) (Table 1).

Table 1: Factor scores for the key issues

S/N	Item	Factor scores		
		1	2	3
1	Predominance of smallholder subsistence farming	0.51	0.52	0.62
2	Use of rudimentary tools	0.41	0.43	0.52
3	Unimproved varieties of seeds and other inputs	0.61	0.63	0.73
4	Traditional storage and preservation practices	0.67	0.68	0.89
5	Deficit of marketing infrastructure	0.56	0.67	0.79
6	Dependence on rain-fed agriculture	0.44	0.70	0.89

Source: SPSS

The second questionnaire, whichwas sent again to respondents, contained questions on the extent the key issues were real, fixing the key issues could address the four dimensions of food security, and the key issues were related to selected development sub-sectors (politico-economic, socio-religio-cultural and STI). Analysis showed that the key issues were more related to STI than the other two sub-sectors. Based on this finding, the third questionnaire was sent to the respondents to interrogate the extent to which the key issues were attributable to poor STI adoption and to which STI adoption could fix them.

The answer options for the questions in the second and third questionnaires were arranged on a scale of "great extent" (scale 4), "good extent" (scale 3), "average extent" (scale 2) and "low extent" (scale 1). The data were arranged in a frequency table and subjected to factor analysis, to obtain the factor scores/weights. Factor weight was obtained as the quotient of the frequency score and 400.

III. RESULTS

Twenty-eight (28) factors suggested by respondents for the failure of government efforts geared towards food security were predominance of smallholder subsistence farming, use of rudimentary tools, unimproved varieties of seeds and other inputs, traditional storage and preservation practices, deficit of marketing infrastructure, dependence on rain-fed agriculture, weak institutions, insecurity, leadership ineptitude, poor administration of justice, inadequate infrastructure, unsupportive macro-economic environment, poor basic health, poor basic education, business-unfriendly environment, policy summersault, abandonment of projects, poor release of project funds, lack of patriotism, corruption, poverty, greed, crime, nepotism, tribalism, mediocrity, cronyism, and sycophancy. The first 6 (Table 1) automatically appeared on the factor analysis table as having factor scores above the universal minimum benchmark of 0.4, thereby proving that the factors were significant and were the key issues. The other 22 factors were, therefore, considered insignificant.

Table 2 shows the factor scores for the extent fixing the key issues could address the four dimensions of food security. All the factor scores were above the universal minimum benchmark score of 0.40, showing that each of the key issues could address each of the four dimensions of food security.

Table 2: Factor scores for the extent fixing the key issues can address the four dimensions of food security

S/N	Item	Factor scores (Availability of sufficient amount of food through the provision of machines and technology for mechanized food production to keep per capita food production high at all times)			Factor scores (Stability of food supply by provision of chemicals and techniques to preserve/store produced food and to supplement available food through imports if necessary)			Factor scores (Accessibility to the available food through production of food that is affordable to all income levels at all times, culturally appropriate, and from sources that are environmentally sound and just, as well as address infrastructure deficits, such as feeder roads, for effective distribution and marketing of food)			Factor scores (Utilization of food with adequate nutrition through provision of scientific means of procurement, ingestion and digestion, education and health)		
		1	2	3	1	2	3	1	2	3	1	2	3
1	Predominance of smallholder subsistence farming	0.53	0.62	0.51	0.53	0.62	0.51	0.53	0.62	0.51	0.53	0.62	0.51
2	Use of rudimentary tools	0.41	0.43	0.52	0.41	0.43	0.52	0.41	0.43	0.52	0.41	0.43	0.52
3	Unimproved varieties of seeds and other inputs	0.61	0.51	0.73	0.61	0.51	0.73	0.61	0.51	0.73	0.61	0.51	0.73
4	Traditional storage and preservation practices	0.89	0.67	0.74	0.89	0.67	0.74	0.89	0.67	0.74	0.89	0.67	0.74
5	Deficit of marketing	0.79	0.51	0.63	0.79	0.51	0.63	0.79	0.51	0.63	0.79	0.51	0.63

	infrastructure												
6	Dependence on rain-fed agriculture	0.44	0.70	0.89	0.44	0.70	0.89	0.44	0.70	0.89	0.44	0.70	0.89

Source: SPSS

Table 3 shows the frequency scores for relatedness of the key issues to selected development sub-sectors (politico-economic, socio-religio-cultural and STI). STI had the highest frequency scores for each of the key issues, showing they all belonged to STI development sub-sector more than the other two sub-sectors. Table 3 also shows the factor weights for the relatedness of the key issues to selected development sub-sectors. STI had the highest factor weight for each of the key issues, showing they were related to STI development sub-sector more than the other two sub-sectors.

Table 3: Frequency scores for relatedness of key issues to selected development sub-sectors

S/N	Item	Frequency scores			Factor weights		
		Politico-economic	Socio-religio-cultural	STI	Politico-economic	Socio-religio-cultural	STI
1	Predominance of smallholder subsistence farming	117	103	180	0.2925	0.2575	0.45
2	Use of rudimentary tools	121	101	178	0.3025	0.2525	0.445
3	Unimproved varieties of seeds and other inputs	132	107	161	0.330	0.2675	0.4025
4	Traditional storage and preservation practices	128	111	161	0.320	0.2775	0.4025
5	Deficit of marketing infrastructure	146	102	152	0.365	0.255	0.38
6	Dependence on rain-fed agriculture	140	108	152	0.350	0.270	0.38

*Source:*Field work 2019

Table 4 shows the factor scores for the extent the key issues were attributable to poor STI adoption. The factor scores were all above the universal minimum benchmark score of 0.4, showing that all the key issues were attributable to poor STI adoption.

Table 4: Factor scores for the extent the key issues are attributable to poor STI adoption

S/N	Item	Factor scores		
		1	2	3
1	Predominance of smallholder subsistence farming	0.48	0.54	0.59
2	Use of rudimentary tools	0.50	0.73	0.75
3	Unimproved varieties of seeds and other inputs	0.51	0.47	0.73
4	Traditional storage and preservation practices	0.43	0.61	0.71
5	Deficit of marketing infrastructure	0.49	0.62	0.64
6	Dependence on rain-fed agriculture	0.56	0.58	0.83

Source: SPSS

Table 5 shows the factor scores for the extent STI adoption could solve the problems associated with the key issues. The factor scores for STI adoption were all above the universal minimum benchmark score of 0.4, showing that STI adoption could solve the problems associated with each key issue.

Table 5: Factor scores for the extent STI adoption could fix the key issues

S/N	Item	Factor scores		
		1	2	3
1	Predominance of smallholder subsistence farming	0.43	0.57	0.52
2	Use of rudimentary tools	0.82	0.79	0.67
3	Unimproved varieties of seeds and other inputs	0.57	0.42	0.77
4	Traditional storage and preservation practices	0.49	0.64	0.73

5	Deficit of marketing infrastructure	0.44	0.67	0.69
6	Dependence on rain-fed agriculture	0.45	0.78	0.59

Source: SPSS

IV. DISCUSSION/ CONCLUSION

4.1 Discussion

Since the key issues were determined by statistical factorization of the suggestions from top expert theoreticians and practitioners in food policy and production, they were regarded as most credible, and are briefly discussed below.

4.1Predominance of smallholder subsistence farming

Njoku (2000) submits that farms below 10 ha still account for over 95% of agricultural production in Nigeria. This is predicated on land fragmentation which still holds sway, especially in South-east Nigeria, where customary inheritance laws operate. Labour-intensive smallholder subsistence farming promotes extensification to use more farmers, more land and other resources to produce less food with attendant costs to the environment. On the other hand, mechanized farming promotes intensification to use less number of farmers and resources to produce more food.

Seventy-five (75%) of the world's poorest people derive their livelihood from farming small plots of land about the size of a football field. Agricultural mechanization will help the small farmers in developing countries to increase production and sell more crops to combat global hunger and poverty (Drake, 2013). Aditya (2020) submits that mechanization of agriculture and farming process applies machines to work on land for agricultural production. Mobile mechanization attempts to replace animal power with machine power, while stationary mechanization aims at reducing the drudgery of certain operations which have to be performed either by human labour or by a combined effort of human beings and animals. Thus, mechanization may be partial (only a part of the farm work is done by machine) or complete (animal or human labour is completely dispensed with by power-supplying machines).According to Ndubuisi (2019), benefits of agricultural mechanization include reduction of manual labour drudgery, food sufficiency, foreign exchange generation through exportation of excess produce, employment generation through improved youth participation in agricultural activities, longer shelf-life of produce through improved preservation and packaging, among others.Emami, Almassi, Bakhoda and Kalantari (2018) submit that agricultural mechanization is the key to food security in developing countries.

STI and its adoption supply the machinery for mechanized farming to produce more food with less inputs, but are hampered by land fragmentation which promotes smallholder subsistence farming characterized by a vicious cycle of low productivity, low income and low investment or poverty. This poverty or lack of investible fund ensures that technologies are not adopted. Smallholder subsistence farming needs to be jettisoned for STI-driven mechanized farming (Emami*et al*, 2018).

4.2 Use of rudimentary tools

Even in the era of 4th Industrial Revolution, most Nigerian farmers still use traditional hand-tools (hoe, cutlass, pick-axe, shovel, etc.) for agricultural practice. Ogundele (2019) asserts that adoption of STI replaces rudimentary tools with machines to enable mass-production of food for teeming population. Use of machines produces food that is affordable to people of all socio-economic statuses. Eighty years ago, 25% of disposable income was spent on food. Today, it hovers around 10% in Canada and the U.S. – the lowest in the world. Therefore, mechanized agriculture, which relies heavily on machines (STI adoption), is the way to go.

4.3 Use of unimproved varieties of seeds and other inputs

So far, crop yields are marginal, compared to the potentials, because the improved varieties of seeds and other inputs are not used. For example, maize yields in Nigeria are less than 2 tons/ha on average, compared to greater than 9 tons/ha in the USA that drive agricultural production with STI adoption. Okojie (2019) opines that Nigeria needs to adopt STI techniques to provide improved varieties of seeds and other inputs to ensure bumper harvest corresponding to the potentials of rich agricultural environment. Such STI techniques are tissue culture, use of genetically modified organisms (GMOs) to produce genetically modified foods (GMFs), among others.

4.4 Traditional storage and preservation practices

Absence of storage and preservation facilities predispose half of fruits and vegetables to loss to post-harvest rot and pest attack, in addition to field losses (Eneh, 2011). According to Odumade (2017), STI supplies appropriate chemicals for pests control measures and preservation of agricultural yields, and needs to be adopted to solve Nigeria's issues of agricultural field and post-harvest losses.

4.5 Deficit of marketing infrastructure

Marketing infrastructure, such as network of feeder roads and railways, are not only deficit but the available ones are often in appalling conditions of rapid decay amidst deficient maintenance culture. Electricity power supply is irregular and in very short supply duration, where

available, because of inadequate power generation and poor distribution. Other comatose infrastructures abound. These facilities are products of STI and can be remedied by STI adoption. Therefore, STI adoption will take care of the daunting challenges to Nigeria's agricultural production. This is in line with the report of Matemilola and Elegbede (2017).

4.6 Dependence on rain-fed agriculture

Dependence on rain-fed agriculture is still the vogue in Nigeria and other African countries. Sachs (2008) submits that irrigation problem in Africa can be solved by rainwater harvesting and micro-irrigation driven by STI for dry season crop production.

4.7 Implications of findings for development

Since fixing the key issues could address the four dimensions of food security, all the six key issues are related more to STI than to the other development sub-sectors, all the key issues are attributable to poor STI adoption, and STI adoption can fix the key issues, it can be asserted that STI and its adoption are pivotal to Nigeria's quest for food security. This finding is externally validated by the report of Senor and Singer (2009) on Israel's experience which shows that agriculture ought to be 95% STI and 5% physical labour. Relying on the universities and R&D institutions to generate and transfer knowledge that increases productivity and yield, Israel has used STI to conquer their many natural disadvantages to emerge as a leading food net exporter. NASEM (2017) reports that the U.S.A. employs STI to respond to challenges and USAID focuses on STI to improve development outcomes.

Adoption of STI will address the four dimensions of food security in Nigeria by ensuring (1) availability of sufficient amount of food through the provision of machines and technology for mechanized food production to keep per capita food production high at all times; (2) stability of food supply by provision of chemicals and techniques to preserve/store produced food and to supplement available food through imports if necessary; (3) accessibility to the available food through production of food that is affordable to all income levels at all times, culturally appropriate, and from sources that are environmentally sound and just, as well as address infrastructure deficits, such as feeder roads, for effective distribution and marketing of food; and (4) utilization of food with adequate nutrition through provision of scientific means of procurement, ingestion and digestion, education and health.

Adopting STI to functionalize public policies, strategies, programmes and projects for boosting agricultural production for the attainment of food security will enhance good feeding and health for the population, supply of raw materials for local use and export, growth of foreign reserves through export of raw materials, ease of financing (from rich foreign reserves) food import to supplement local production, transfer of productive resources (investable surpluses of capital and labour) to other sectors of the economy for economic development of the country, value addition through effective value chain management, revenue improvement through payment of taxation, diversification that averts the vagaries of price fluctuation of the nation's monolithic oil economy, and provision of remunerative employments.

4.2 Conclusion

Six key issues behind the failure to achieve food security in Nigeria have been established as predominance of smallholder subsistence farming, use of rudimentary tools, unimproved varieties of seeds and other inputs, traditional storage and preservation practices, deficit of marketing infrastructure, and dependence on rain-fed agriculture. They were found to be related more to STI development sub-sector than to other selected sub-sectors. Each of them was attributable to poor STI adoption and can be fixed by STI adoption. Fixing them was able to address the four dimensions of food security. Thus, poor STI adoption begets the key issues which can be fixed by STI adoption for agricultural production for food security.

Evolving STI trend for mechanized agricultural production, storage system and preservation, transport and marketing of agricultural products is imperative for addressing the nagging food insecurity in Nigeria. STI-driven agricultural production will turn Nigeria from food insecure to a food secure nation. Therefore, STI adoption is recommended for Nigeria's march to food security.

CONFLICT OF INTEREST

There is no conflict of interest.

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Effect of Physico-chemical properties of water on population of Macrozoobenthos of Kunghada Bandh Lake, Dist.- Gadchiroli, Maharashtra (India)

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Abstract— *Correlation study of physicochemical properties with biota of any fresh water body depicts the status of any ecosystem. Correlation of physicochemical parameters with benthic organisms especially macrozoobenthos of Kunghada Bandh Lake was organized to know the status of this fresh water ecosystem. This type of study is very useful to calculate the quality of water and restoration of such type of fragile ecosystem time to time. Samples were collected from five different sampling stations for two years i.e. from February 2012 to January 2013 and February 2013 to January 2014. Macrozoobenthos were collected from all five stations by using 'Ekman's dredge' and 'Van-Vin grab'. Annelids observed more in monsoon and winter than summer. Total 09 species of arthropods were recorded. Minimum average of Arthropods was recorded in summer and maximum average of Arthropods in monsoon. The same trend was followed by molluscan species. The increased concentrations of most of the chemical parameters in summer affects on the population of most of the faunal component in decreased manner.*

Keywords— ***Physico-chemical, Population, Macrozoobenthos, Kunghada bandh.***

I. INTRODUCTION

The study of hydrobiology means relation between water and living thing i.e. micro and macro organisms present in aquatic ecosystems (Chatwal G.R.,1996). Kunghada Bandh Lake (latitude 20.22˚N and longitude 80.01˚E.) is constructed by British Government in 1890 present in Chamorshi Tahsil of Gadchiroli district which is easternmost part of Maharashtra state of India. Lake having area near about 5.95 sq. km. occupying water capacity 3.017 cubic density while the useful water storage is about 2.844 cubic density. It is the huge lake and having water spread area about 34.70 hectare. Perimeter of the lake is 1372 meter having main canal of 8.96 kilometer in length. This study is organised for the determination of correlation and effect of physicochemical parameters on population of benthic organisms especially macrozoobenthos of the lake. This type of study is always useful to maintain fair quality of water and restoration of such type of fragile ecosystem time to time.

The physico-chemical and biological factors affect the quality of water according to their characteristics and nature.

Benthic organisms or zoobenthos is the group of community of an organisms which live on, in or near the shore of water body, this zone is also known as profundal zone or benthic or bottom zone. Zoobenthos generally cannot survive in the upper parts of the water column due to the pressure difference between the lower and upper parts of the water column. The food chains of most of the benthic organisms are comprises dead and decaying matter and most of them are detrivores in nature. The main food sources of these organisms are planktons, algae and other organic runoff that comes from catchment area of lake. Various physic-chemical and biological factors play an

important role in the presence or absence of benthic organisms in any aquatic ecosystem. For this correlation study; macrobenthos having size more than 1 milimeter or 1,000 micrometer (µm) were taken in to consideration.

Fig.1:Satellite image of 'Kunghada Bandh' (Curtsy: Google map)

II. MATERIAL AND METHODS

The water samples and macrozoobenthos were collected from five different stations covering East, West, North, South and Centre part of lake. The water samples collected in a plastic can from each station and immediately analysed in the laboratory. Some parameters were analysed on the spot such as temperature, pH, dissolved oxygen, etc. by using titrometric mobile test water kit and digital devices. The macrozoobenthos were collected from all five stations in white enamel tray by using 'Ekman's dredge' and 'Van-Vin grab'.

The samples were collected every month during morning period two years i.e. February 2012 to January 2014 and categorized them according different species. During the investigation various parameters like physical, chemical and biological were taken into consideration for correlation study.

The analyses of all collected samples were determined by as per available and prescribed standard methods(AWWA , APHA ,2005, Santhanam *et.al.*, 1989, Trivedi R.K. and Goel P.K., 1984,Welch P.S.,1952). The collected macrozoobenthos were segregated and identified according to different phylum up to species level with the help of various standard keys (Needham J.G.,1962 and Tonapi G.T., 1980). The densities of macrozoobenthos were calculated by using the following formula.

$$\mathrm{N/M^2} = \frac{n \text{ X } 10^4}{A}$$

Where,

N= Total No. of organisms (actual count of particular species in its residing habitat)

n = No. of organisms per sample (actual count of particular species per dredge)

A= Area of the sampler (6" X 6" X 6").

III. RESULT AND DISCUSSION

1. Physico- chemical parameters:

Most of the physico-chemical factors affect the quality of water which results in fluctuation in frequency of benthic organisms (BIS.,2012).

The minimum average of temperature (22.38, ±0.92) was recorded in winter and maximum average of temperature (25.98,±1.56) in summer as compared to the annual average of temperature (24.73,±2.03). Temperature mostly increases during summer and declines during winter because of atmospheric temperature are highest in summer and winter has lowest (Dubey M.A. *et.al.*, 2013, Rajanna A.H. and Belagalli S.L., 2011),). During the study, temperature recorded lowers in winter and more in summer.

pH is the most important factor in water both for flora and fauna. The acceptable limit of pH in drinking

water should be in the range of 6.5 to 8.5 (BIS, 2012). The minimum average pH (7.67, ±0.17) was recorded in monsoon while maximum average pH (8.11,±0.11) in summer as compared to the annual average of pH (7.94,±0.65). It occurs might be due to the when photosynthesis uses up dissolved CO_2, which acts like carbonic acid. Carbon dioxide removal, in effect reduces the pH of water.

Total solids (mg/lit.) are equal to the suspended solids plus total dissolved solids. Minimum average of total solids (78.25, ±4.49) was recorded in winter and maximum average of total solids (102.25,±6.27) in summer as compared to the annual average of total solids (93.42,±12.92). Total dissolved solids (mg/lit) comprise inorganic salts and some small amounts organic matter which are dissolved in water. The acceptable limit of Total dissolve solids in drinking water should not be more than 500 mg/l (BIS, 2012).The minimum average of total dissolved solids (60.88, ±4.88) was recorded in winter and maximum average of total dissolved solids (81.5,±5.18) in summer while average of total dissolved solids is 74.21,±11.21. Total dissolved solids mostly increase during summer due to increases in sedimentation and decrease in quantity of water which results in decrease in depth of water also. Suspended solids used as an indicator to check water quality. The minimum average of suspended solids (17.37, ±1.56) was recorded in winter and maximum average of suspended solids (20.75,±1.44) in summer (Wilson, P.C., 2010)

Turbidity (NTU) in water is caused by suspended matter, such as silt, clay, finely divided organic and organic matter, soluble coloured organic compounds, microscopic organisms, and planktons (AWWA-APHA., 2005). The acceptable limit of Turbidity in drinking water should not be more than 1 NTU (BIS, 2012). The minimum average of turbidity (6.3, ±0.25) was recorded in winter and maximum average of turbidity (7.32,±0.22) in monsoon as compared to the annual average of turbidity (6.78,±0.49) (Wilson, P.C., 2010).

Electrical conductivity (µmhos) is the measure of a material's ability to conduct or accommodate of an electric current or an electric charge. Minimum average of electrical conductivity (95.0, ± 5.43) was recorded in winter and maximum average of electrical conductivity (114.37, ± 9.81) and annual average of electrical conductivity is (107.46,±11.29). Conductivity mostly increases during summer because of surface evaporation of water which results in rising of concentration of salts while decline in conductivity during in winter is due to the sedimentation and utilization of minerals by growing phytoplankton and macrophytes (Puri, P.J *et.al.*2010).

A high level of hardness is not health concern but still up to 80 mg/lit is standard limit for drinkable water ((AWWA-APHA., 2005). Both calcium and magnesium are very useful for plants and animals. The acceptable maximum limit of total hardness in drinking water should be 200 mg/l (BIS, 2012). Minimum average of total hardness (63.16, ±2.96) was recorded in winter and maximum average of total hardness (86.95,±3.57) in summer as compared to the annual average of total hardness (76.02,±10.91). It might be due to high temperature in summer which results in the breakdown of rocks, less amount of water and domestic uses specially detergents (Sukund , B.N. and Patil, H.S., 2004)). Calcium is very important for the formation of bones in vertebrates and shell in molluscans. A low level of calcium in water reduces the number of fauna. Minimum calcium hardness (31.32, ±0.99) was recorded in winter and maximum calcium hardness (41.72, ±5.53) in summer and annual average of calcium hardness is (37.08,±5.69). Calcium hardness was mostly decline during winter and increases in summer in lake water (Karim L.R. *et.al.*, 2012 and Kumar B.M. *et.al.*, 2004). Magnesium is very important for plants to form chlorophyll; less amount of magnesium reduces the population of phytoplankton and aquatic plants. The minimum average of magnesium hardness (31.35, ±2.17) was recorded in winter and maximum average of magnesium hardness (45.22,±5.23) in summer as compared to the annual average of magnesium hardness (38.78,±7.29). The magnesium hardness recorded less in winter because most of the magnesium is utilized by large vegetation (Shinde, S.K. *et.al.*, 2010).

Calcium plays an important role in the maintenance of structural and functional integrity of cell membranes in ion retention and absorption of both flora and fauna (Wetzel, R.G., 1975). The acceptable limit of Ca^{++} in drinking water should not be more than 75 mg/l (BIS, 2012). Minimum average of Ca^{++} (12.72, ±0.48) was recorded in winter and maximum average of Ca^{++} (16.69,±2.21) in summer as compared to the annual average of Ca^{++} (14.90,±2.22). Magnesium is very important for plants to form chlorophyll; less amount of magnesium reduces the number of phytoplankton and plants. It also acts as micronutrient in enzymatic transformation, especially in algae, bacteria and fungi. Minimum average of Mg^{++} (7.52, ±0.52) was recorded in winter and maximum average of Mg^{++}(10.85,±1.26) in summer as compared to the annual average of Mg^{++}(9.31,±1.75). It might be due to the degradation of plants, more leaching of rocks in summer and most of the magnesium is utilized by large vegetation in monsoon and winter (Pawar S. and Sonawane S., 2011).

Table1: Average monthly values of physico-chemical parameters during two years (Feb. 2012 to Jan. 2014)

S.N.	Parameters	Unit	Summer				Monsoon				Winter			
			FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
01	Water Temperature	^{0}C	24	25.2	26.5	28.2	27.1	26.1	25.5	24.6	23.85	22.5	21.5	21.7
02	Ph	.....	8.0	8.0	8.25	8.2	7.9	7.75	7.45	7.6	7.95	8.3	7.9	7.95
03	Total Solids	mg/lit	97	96.5	103.5	112	116	98	93.5	91.5	83	82	76	72
04	TDS	mg/lit	76	78	82.5	89.5	94	79	74	74	66	65.5	56	56
05	Suspended Solids	mg/lit	21	18.5	21	22.5	22	19	19.5	17.5	17	16.5	20	16
06	Turbidity	NTU	6.45	6.6	6.7	7.15	7.2	7.65	7.4	7.05	6.7	6.3	6.15	6.05
07	Elect. Cond.	µmhos	102	110.5	116	129	120.5	113.5	110.5	107.5	103	96	88	93
08	Total Hardness	mg/lit	81.85	85.65	88.95	91.35	86.5	81.4	76	67.95	63.9	60.6	60.45	67.7
09	Ca - Hardness	mg/lit	38.55	44.35	34.75	49.25	38	41.2	40.4	33.15	32.5	31.9	29.85	31.05
10	Mg - Hardness	mg/lit	43.3	41.3	54.2	42.1	48.5	40.2	35.6	34.8	31.4	28.7	30.6	34.7
11	Calcium–(Ca^{++})	mg/lit	15.42	17.74	13.9	19.7	15.2	16.48	16.16	13.26	13	12.76	11.94	13.2
12	Magnesium–(Mg^{++})	mg/lit	10.39	9.91	13.01	10.1	11.64	9.65	8.54	8.35	7.54	6.89	7.34	8.33
13	Dissolved Oxygen	mg/lit	5.7	5.8	5.8	5.55	6.0	6.3	6.55	6.8	6.4	6.55	5.95	5.85
14	Free CO_2	mg/lit	5.8	5.9	6.2	6.6	6.05	5.6	5.5	5.2	5.3	5.2	4.75	4.9
15	Alkalinity	mg/lit	68.1	72.35	74.25	75.95	76.3	71.6	68.35	64.65	58.95	58.65	57.25	59.4
16	Acidity	mg/lit	5.65	5.3	5.0	4.7	4.5	4.25	4.3	4.05	3.8	3.6	3.4	4.0
17	Phosphate	mg/lit	0.68	0.79	0.92	1.09	1.92	1.41	1.13	0.09	0.07	0.12	0.085	0.17
18	Nitrate	mg/lit	0.21	0.285	0.39	0.56	0.68	0.98	0.98	1.11	1.04	0.64	0.22	0.25
19	Sulphate	mg/lit	18.75	20.1	21.75	22.4	22.8	23.1	20.85	19.4	17.8	17.15	16.65	17.35
20	Chloride	mg/lit	4.7	4.5	4.6	5.3	5.9	6.7	6.8	6.9	7.1	6.35	6.0	6.25

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Table 2: Average annual and seasonal values of physico-chemical parameters during two years (Feb. 2012 to Jan. 2014)

S.N.	Parameters	Unit	Annual				Summer	Summer	Monsoon	Monsoon	Winter	Winter
			Min	Max	Avg.	SD	Avg.	SD	Avg.	SD	Avg.	SD
1	Water Temperature	^{0}C	21.5	28.2	24.72	2.02	25.97	1.55	25.82	0.90	22.38	0.92
2	pH	.....	7.45	8.3	7.93	0.24	8.11	0.11	7.67	0.16	8.02	0.16
3	Total Solids	mg/lit	72	116	93.41	12.92	102.25	6.26	99.75	9.67	78.25	4.49
4	TDS	mg/lit	56	94	74.20	11.33	81.5	5.18	80.25	8.19	60.87	4.87
5	Suspended Solids	mg/lit	16	22.5	19.20	2.07	20.75	1.43	19.5	1.62	17.37	1.55
6	Turbidity	NTU	6.05	7.65	6.78	0.48	6.72	0.26	7.32	0.22	6.3	0.24
7	Elect. Cond.	µmhos	88	129	107.45	11.29	114.37	9.80	113	4.82	95	5.43
8	Total Hardness	mg/lit	60.45	91.35	76.02	10.91	86.95	3.57	77.96	6.87	63.16	2.96
9	Ca - Hardness	mg/lit	29.85	49.25	37.07	5.69	41.72	5.52	38.18	3.13	31.32	0.99
10	Mg - Hardness	mg/lit	28.7	54.2	38.78	7.28	45.22	5.23	39.77	5.44	31.35	2.16
11	Calcium–(Ca^{++})	mg/lit	11.94	19.7	14.89	2.21	16.69	2.21	15.27	1.25	12.72	0.47
12	Magnesium–(Mg^{++})	mg/lit	6.89	13.01	9.30	1.74	10.85	1.25	9.54	1.30	7.52	0.52
13	Dissolved Oxygen	mg/lit	5.55	6.8	6.10	0.38	5.71	0.10	6.41	0.29	6.18	0.29
14	Free CO_2	mg/lit	4.75	6.6	5.58	0.52	6.12	0.31	5.58	0.30	5.03	0.22
15	Alkalinity	mg/lit	57.25	76.3	67.15	6.85	72.66	2.92	70.22	4.28	58.56	0.80
16	Acidity	mg/lit	3.4	5.65	4.37	0.65	5.16	0.35	4.27	0.16	3.7	0.22
17	Phosphate	mg/lit	0.07	1.92	0.70	0.58	0.87	0.15	1.13	0.66	0.11	0.03
18	Nitrate	mg/lit	0.21	1.11	0.61	0.33	0.36	0.13	0.94	0.15	0.53	0.33
19	Sulphate	mg/lit	16.65	23.1	19.84	2.23	20.75	1.42	21.53	1.50	17.23	0.41
20	Chloride	mg/lit	4.5	7.1	5.92	0.89	4.77	0.31	6.57	0.39	6.42	0.41

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Dissolved oxygen is fluctuates seasonally. Most of the aquatic animals and plants are very sensitive to the dissolved oxygen. Temperature, light, turbidity also fluctuate the concentration of dissolved oxygen. If it is decline then survival rate of animals and plants also decline. Benthic organisms are adapted to the low concentration of water due to which they can survive in concentration of dissolved oxygen. More oxygen concentration in water indicates the good quality of water (Welch, P.S., 1952). The minimum average of dissolved oxygen (5.71, ±0.1) was recorded in summer and maximum average of dissolved oxygen (6.41,±0.29) in monsoon as compared to the annual average of dissolved oxygen (5.47,±0.48). Low temperature in monsoon and winter than summer, leads to presence of high dissolved oxygen (Prasad B. N. and Manjula S., 1980,Zutshi D.P. and Vass K.K., 1978). Like dissolved oxygen, carbon dioxide is also play an important role in respiration and photosynthesis process. Generally more dissolved free carbon dioxide occurs in water body with large vegetation and dead and debris material. It is indirectly proportional to the dissolved oxygen as if there is high dissolved oxygen then there is low free carbon dioxide and vice versa. The minimum average of free carbon dioxide (5.04, ±0.22) was recorded in winter and maximum average of free carbon dioxide(6.12,±0.31) in summer as compared to the annual average of free carbon dioxide(5.58,±0.52) (Kaushik S. and Saksena D.N., 1991).

Alkalinity of surface water is mainly a function of carbonate, bicarbonate and hydroxide content and it is taken as an indication of the concentration of these constituents. The acceptable limit of Total Alkalinity in drinking water should not be more than 200 mg/l (BIS, 2012). Minimum alkalinity (58.56, ±0.80) and maximum alkalinity (72.66,±2.92) respectively noted in winter and summer as compared to the annual average of alkalinity (67.15,±6.86).

Strong mineral acids, weak acids such as carbonic and acetic and hydrolyzing salts such as aluminium sulphates or iron may contribute to the measured acidity. Acids also contribute to corrosiveness and influences chemical speciation, biological processes, and chemical rates. It also reflects change in the quality of the source of water (AWWA-APHA., 2005). The low acidity (3.7, ±0.22) was recorded in winter and maximum acidity (5.16,±0.35) in summer. The acidity was mostly decline in winter and increase in summer as photosynthesis uses up dissolved carbon dioxide.

Phosphorous is very essential nutrient as all living organisms require phosphate to make DNA and ATP. Animals easily meet their phosphate needs by eating other living things. Plants absorb phosphate from ground and rocks. The minimum average of phosphate (0.11, ±0.04) was recorded in winter and maximum average of phosphate (1.14,±0.69) in monsoon as compared to the annual average of phosphate (0.71,±0.59). Phosphate mostly increases during monsoon due to increase in algal bloom and surface run-off while decreases in summer due to decrease in algal bloom and less vegetation in water (Welch, P.S., 1952).

Nitrate is an important source of nitrogen for plant and animal life. Animal matter, human and animal waste, household septic systems and fertilizers are the common sources of nitrogen. Excess nitrogen in drinking water has been found to cause methenoglobinemia or Blue Baby Syndrome (Fewtrell, L. 2004). The minimum average of nitrate (0.36, ±0.13) was recorded in summer and maximum average of nitrate (0.94,±0.16) in monsoon as compared to the annual average of nitrate (0.61,±0.33). Nitrate mostly increases during monsoon due to increase in vegetation and surface run-off which include fertilizers while decreases in summer due to decrease in vegetation and surface run-off in water (Chatwal G.R.,1996, Das A.K.,1989 and Pande P.C. *et.al.*, 1969).

Sulphates occur naturally in numerous minerals, including Epsomite ($MgSO_4.7H_2O$), Gypsum ($CaSO_4.2H_2O$), Barite ($BaSO_4$). The reversible inter conversion of Sulphate and Sulphide in the natural environment is known as the 'sulphur cycle'. The EPA secondary Drinking Water Regulations recommend a maximum concentration of 250 mg/l. Minimum average of sulphate (17.24, ±0.41) and maximum average of sulphate (21.54,±1.51) in monsoon observed in lake water as compared to the annual average of sulphate (19.84,±2.23). Sulphate mostly increases during monsoon due to surface run-off which include fertilizers while decreases in summer due to decrease in surface run-off in water (Kaur H.*et.al*, 1996).

Chloride concentrations vary considerably according to the mineral content of the earth in any given area. Chlorides are dissolved from rock and soils The minimum average of chloride (4.77, ±0.31) maximum average of chloride (6.57,±0.4) in Summer and monsoon respectively as compared to the annual average of chloride (5.92,±0.9). Chloride mostly increases during monsoon due to surface runoff (AWWA-APHA., 2005).

2. Macrozoobenthos:

Benthic organisms play a very important role in the ecosystems. Depending upon the size they are mainly categorized into three types- Macrozoobenthos, Meiozoobenthos and Microzoobenthos (Mare M.F., 1942). The influence of benthic organisms varies according to the quality and quantity of water body

Table 3: Total number of macrozoobenthos (N/M²) observed during two year (Feb. 2012 to Jan. 2014)

Class, Order & Family	SUMMER (N/M²)				MONSOON (N/M²)				WINTER (N/M²)			
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
C- Oligochaeta	377.78	311.11	155.56	44.44	111.11	266.67	244.44	377.78	355.56	400.00	311.11	244.44
F- Tubificidae	222.22	155.56	88.89	0.00	44.44	155.56	133.33	200.00	177.78	222.22	177.78	133.33
F- Lumbricidae	155.56	155.56	66.67	44.44	66.67	111.11	111.11	177.78	177.78	177.78	133.33	111.11
C- Hirudinea	88.89	66.67	22.22	0.00	22.22	66.67	111.11	133.33	88.89	133.33	88.89	111.11
C- Arachnida	88.89	66.67	22.22	0.00	44.44	88.89	111.11	111.11	133.33	155.56	111.11	111.11
C- Crustacea	44.44	22.22	0.00	0.00	44.44	88.89	111.11	66.67	88.89	44.44	66.67	44.44
C- Insecta	444.44	266.67	177.78	22.22	244.44	333.33	711.11	666.67	533.33	555.56	400.00	511.11
O- Odonata	155.56	88.89	22.22	0.00	111.11	133.33	222.22	244.44	200.00	222.22	133.33	155.56
O- Diptera	177.78	44.44	88.89	0.00	66.67	200.00	288.89	266.67	288.89	288.89	244.44	244.44
F- Culicidae	66.67	22.22	44.44	0.00	22.22	44.44	111.11	88.89	111.11	111.11	88.89	44.44
F- Culicidae	44.44	0.00	0.00	0.00	44.44	88.89	66.67	111.11	88.89	44.44	66.67	88.89
F- Tabanidae	66.67	22.22	44.44	0.00	0.00	66.67	111.11	66.67	88.89	133.33	88.89	111.11
O- Hemiptera	111.11	133.33	66.67	22.22	66.67	155.56	200.00	155.56	44.44	44.44	22.22	111.11
F- Nepidae	66.67	66.67	44.44	0.00	44.44	88.89	111.11	66.67	44.44	0.00	22.22	66.67
F - Nepidae	44.44	66.67	22.22	22.22	22.22	66.67	88.89	88.89	0.00	44.44	0.00	44.44
C-Gastropoda	488.89	288.89	155.56	44.44	133.33	355.56	444.44	533.33	577.78	466.67	488.89	444.44
F-Viviparidae	200.00	133.33	66.67	44.44	0.00	111.11	155.56	177.78	155.56	111.11	133.33	155.56
F-Thiaridae	88.89	44.44	0.00	0.00	44.44	88.89	88.89	133.33	111.11	88.89	133.33	88.89
F-Lymnaeidae	111.11	66.67	44.44	0.00	44.44	66.67	111.11	88.89	133.33	88.89	88.89	111.11
F-Pachilidae	88.89	44.44	44.44	0.00	44.44	88.89	88.89	133.33	177.78	177.78	133.33	88.89
C-Bivalvia	200.00	133.33	66.67	0.00	200.00	266.67	311.11	377.78	311.11	377.78	288.89	266.67
F-Unionidae	66.67	44.44	22.22	0.00	44.44	88.89	88.89	133.33	88.89	133.33	88.89	88.89
F-Unionidae	88.89	44.44	44.44	0.00	88.89	88.89	88.89	133.33	155.56	111.11	111.11	88.89
F- Unionidae	44.44	44.44	0.00	0.00	66.67	88.89	133.33	111.11	66.67	133.33	88.89	88.89
Total Number of species(N/M²)=	**1733.33**	**1155.56**	**622.22**	**111.11**	**800.00**	**1622.22**	**2044.44**	**2266.67**	**2088.89**	**2133.33**	**1755.56**	**1733.33**

Table 4: Statistical analysis of Macrozoobenthos (N/M²) observed during two years (Feb. 2012 to Jan. 2014)

Class, Order & Family	Genus & Species	A-Avg.	S-Avg.	M-Avg.	W-Avg.	A.SD	S-SD	M-SD	W-SD	A-Total	S-Total	M-Total	W-Total
C-Oligochaeta	⟶	266.67	222.22	250.00	327.78	108.49	130.53	94.77	57.47	3200.00	888.89	1000.00	1311.11
F-Tubificidae	*Limnodrillushoffemeistry*	142.59	116.67	133.33	177.78	65.71	82.21	56.66	31.43	1711.11	466.67	533.33	711.11
F-Lumbricidae	*Lumbricus variegatus*	124.07	105.56	116.67	150.00	44.87	50.61	39.67	28.87	1488.89	422.22	466.67	600.00
C-Hirudinea	*Hirudinaria granulosa*	**77.78**	**44.44**	**83.33**	**105.56**	**42.07**	**35.14**	**42.67**	**18.43**	**933.33**	**177.78**	**333.33**	**422.22**
C-Arachnida	*Hydracarina*sp.	**87.04**	**44.44**	**88.89**	**127.78**	**43.94**	**35.14**	**27.22**	**18.43**	**1044.44**	**177.78**	**355.56**	**511.11**
C-Crustacea	*Gelasimus*sp.	**51.85**	**16.67**	**77.78**	**61.11**	**33.13**	**18.43**	**24.85**	**18.43**	**622.22**	**66.67**	**311.11**	**244.44**
C-Insecta	.⟶	**405.56**	**227.78**	**488.89**	**500.00**	**196.29**	**152.65**	**203.06**	**59.84**	**4866.67**	**911.11**	**1955.56**	**2000.00**
O-Odonata	Dragonfly nymph & Damselfly nymph	**140.74**	**66.67**	**177.78**	**177.78**	**73.89**	**60.86**	**56.66**	**35.14**	**1688.89**	**266.67**	**711.11**	**711.11**
O-Diptera	.	**183.33**	**77.78**	**205.56**	**266.67**	**101.48**	**65.73**	**86.60**	**22.22**	**2200.00**	**311.11**	**822.22**	**1066.67**
F-Culicidae	*Culex* larvae	62.96	33.33	66.67	88.89	37.22	24.85	35.14	27.22	755.56	133.33	266.67	355.56
F-Culicidae	*Anopheles* larvae	53.70	11.11	77.78	72.22	36.80	19.25	24.85	18.43	644.44	44.44	311.11	288.89
F-Tabanidae	*Tabanus*sp.	66.67	33.33	61.11	105.56	41.57	24.85	39.67	18.43	800.00	133.33	244.44	422.22
O-Hemiptera	.	**94.44**	**83.33**	**144.44**	**55.56**	**56.02**	**42.67**	**48.43**	**33.33**	**1133.33**	**333.33**	**577.78**	**222.22**
F-Nepidae	*Nepa*sp.	51.85	44.44	77.78	33.33	31.86	27.22	24.85	24.85	622.22	177.78	311.11	133.33
F-Nepidae	*Ranatraelongata*	42.59	38.89	66.67	22.22	29.34	18.43	27.22	22.22	511.11	155.56	266.67	88.89
C-Gastropoda	.⟶	**368.52**	**244.44**	**366.67**	**494.44**	**166.66**	**165.55**	**148.66**	**50.61**	**4422.22**	**977.78**	**1466.67**	**1977.78**
F-Viviparidae	*Vivipara bengalensis*	120.37	111.11	111.11	138.89	55.52	60.86	68.49	18.43	1444.44	444.44	444.44	555.56
F-Thiaridae	*Melanoidesstriatella*	75.93	33.33	88.89	105.56	42.99	36.85	31.43	18.43	911.11	133.33	355.56	422.22
F-Lymnaeidae	*Lymnealutiola*	79.63	55.56	77.78	105.56	35.67	40.06	24.85	18.43	955.56	222.22	311.11	422.22
F-Pachilidae	*Fanusater*	92.59	44.44	88.89	144.44	52.77	31.43	31.43	36.85	1111.11	177.78	355.56	577.78
C-Bivalvia	.⟶	**233.33**	**100.00**	**288.89**	**311.11**	**113.13**	**74.54**	**64.79**	**41.57**	**2800.00**	**400.00**	**1155.56**	**1244.44**
F-Unionidae	*Lamellidensmarginalis*	74.07	33.33	88.89	100.00	38.84	24.85	31.43	19.25	888.89	133.33	355.56	400.00
F-Unionidae	*Lamellidenscorreanus*	87.04	44.44	100.00	116.67	40.02	31.43	19.25	24.22	1044.44	177.78	400.00	466.67
F-Unionidae	*Parreysiacorrugata*	72.22	22.22	100.00	94.44	42.67	22.22	24.85	24.22	866.67	88.89	400.00	377.78

Avg = Annual Average, S. Avg = Summer Average, M. Avg = Mansoon Average, W. Avg = Winter Average, SD= Standard Deviation

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Other than food for different pray, different types of benthic organisms have different role in ecosystems like bio indicators of water. During qualitative analysis 19 species of macrozoobenthos from Phylum-Annelida, Arthropoda and Mollusca were noted during the collection from all sites of Kunghada Bandh.

After quantitative analysis, minimum average of total macrozoobenthos (905.56N/M^2) was recorded in summer and maximum average of total macrozoobenthos (1927.18N/M^2) in winter as compared to the annual average of total macrozoobenthos (1505.56N/M^2). Seasonal fluctuation of macrozoobenthos was observed due to quantity of water and depth of water in lake (Dutta S.P. *et.al.*,2000, Rosenberg D.M. andResh W.H., 1992).

During the study period three species of annelids were found i.e. *Limnodrillus hoffemeisteri*, *Lumbricus variegatus* and *Hirudinaria granulose.* Minimum annelids (266.67 N/M^2) were recorded in summer while maximum (433.33 N/M^2) in winter as compared to the annual average of Annelids (344.44 N/M^2) which covering 29.91 % out of the total number of macrozoobenthos (Chapman P.M. *et.al.*, 1982 and Glowacka I., *et.al.*, 1976).Oligochaeta mostly prefer organically rich environment and remain dominated in severally polluted conditions. Oligochaeta are adapted to every kind of water and are found in vegetation, algal bloom, in floating rotting material and bottom mud. During investigation, annelids observed more in monsoon and winter than summer (Wetzel, R.G., 1975).

Arthropods are the largest phylum with a great diversity. Total 9 species of arthropods were observed from lake i.e. *Hydracarina* sp., *Gelasimus* sp, *Dragonfly* sp, *Damselfly* sp, *Culex* sp, *Anopheles* sp, *Tabanus* sp., *Nepa cinerea* and *Ranatra elongata*. During the study minimum population (288.89 N/M^2) of arthropods were recorded in summer while maximum (694.44 N/M^2) in monsoon season. Arthropods were covering 37.07 % out of the total macrozoobenthos population. The seasonal fluctuation in arthropod population was observed due to quantity of water and depth of water. The aquatic insects are known to have strong relationship with water fluctuations (Ebert T.A. and Balko., 1987). As hardness, carbonates and bicarbonates increase in water the stages of developmental stages to observed minimum (Fraser F.C.,1934 and Lonkar S.S. *et.al.*, 2014). Dipterans noted more when dissolved oxygen increases with decreasing temperature. Such type of favourable conditions affects on population of dipterans (Kodarkar M.S., 1995 and Mathew P.M., 1978).Hemiptera are mainly found at the S_3 and S_4 sites of lake as these sites were received maximum runoff contains organic substances (Kaushik S. and Saksena D.N., 1991).

Phylum Mollusca is the second largest phylum with great diversities and species richness, basically gastropoda and bivalvia are the only two classes represented the molluscan in fresh water bodies (Shanmugam A. and Vairamani S., 2005). In all 7 species (4 gastropodes and 3 bivalves) were recorded from this fresh water aquatic ecosystem i.e. *Vivipara bengalensis*, *Melania striatella*, *Fanus ater*, *Lymnea luteola*, *Parreysia corrugata*, *Lamellidens marginalis*, and *Lamellidens correanuI.* Minimum population of Molluscan (344.44N/M^2) was recorded in summer and maximum (805.56N/M^2) in monsoon as compared to the annual average of Molluscan (601.85N/M^2) covering 40.02 % out of the total population of macrozoobenthos of lake. As the pH of lake water not acidic the population of mollusca is in fair quantity (Apte D., 1988). With the increased volume of water the population shows more during rainy season (Bath K.S. *et.al*, 1999 and Tijare R.V., 2012).

IV. CONCLUSION

Various physic-chemical parameters play an important role in water quality as well as diversity and richness of organisms. Mostly temperature is a very important factor. Others factors like pH, Dissolved oxygen, free CO2, Suspended solids, etc. also affect the frequency of macrozoobenthos. It was mostly observed macrozoobenthos found very less in summer season than monsoon and winter season. Phylum Arthropoda were dominated among the all group which is followed by mollusca and then annelids.

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The Nutrient Content of *Paspalum atratum* Grass Associated with *Macroptilium lathyroides* Legume Inoculated with Rhizobium through the Application of Molybdenum and Phosphorus Fertilizers

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Abstract— *The experiment aimed to increase the nutrient content of Paspalum atratum grass associated with Macroptilium lathyroides legume inoculated with Rhizobium through the application of molybdenum (Mo) and phosphorus (P) fertilizer. The experiment used randomized block design (RBD) with factorial pattern. The first factor was Rhizobium inoculation consisted of Mo and P fertilizers without Rhizobium inoculation (R_0) and with Rhizobium inoculation (R_1). The second factor was planting pattern: grass monoculture (A_1), legume monoculture (A_2), one row of grass between one row of legumes (A_3), and one row of grass between two rows of legumes (A_4). There were eight treatments and each combination was repeated three times so that there were 24 experimental plots. The results showed that application of R_1 increased the nutrient content of forage. A_3 and A_4 treatments were increased the nutrient content of forage compared with A_1 dan A_2. The conclusion of the research that the association of Paspalum atratum grass and Macroptilium lathyroides legume inoculated with Rhizhobium and fertilized with Mo and P was able to increase nutrient content.*

Keywords— ***grass-legume association, molybdenum, nutrient content, phosphorus, Rhizobium***

I. INTRODUCTION

The availability of forage is still hampered due to the limited land for forage planting and the low of quantity and quality of forage. Efforts to improve the quality and quantity of forage feed can be carried out with various efforts, both extensively and intensively.

The association between grasses and suitable legumes will be able to meet the nitrogen deficiency in the grass so that can complement each other. Generally, grasses contain lower protein content than legumes. Legumes have the ability to fix nitrogen in the air due to the presence of nodules on the legume roots, then nitrogen will be returned to the soil and can be used by grass as a nutrient. Reksohadiprojo (1994) stated that mixed planting of grass and legumes is better than grass monoculture, besides protein, legumes also contain higher levels of phosphorus and calcium. Accordingto Suarna et al. (2014) grass that is planted with legumes or the association of grass with legumes will provide good interactions with the physical, chemical and biological environment between the two plant species.

The availability of sufficient nutrients in the soil is important for growth and puductivity of plant. Several nutrients play an important role in the symbiotic process of *Rhizobium* such as molydenum (Mo) as part of the nitrogenase enzyme and every nitrogen-fixing bacteria requires Mo during the fixation process. *Rhizobium spp.* is a type of microorganism that lives in symbiosis with

leguminous plants and functions to fix nitrogen biologically. Biological nitrogen fixation is a major source of nitronen (N) input in agricultural soils and rhizobia chemically converts nitrogen from the air to make it available to plants. The N fixation process is influenced by many factors including phosphorus (P) (Badar et al., 2015). Without proper P fertilization, rhizobia activity and nitrogen fixation are suppressed because P promotes early root formation, lateral root formation, and strong roots. It is very important for nodule formation and for binding to atmospheric nitrogen (Rahman et al., 2008). Togay et al. (2008) found that the application of phosphorus and molybdenum caused an increase in all characters of the lentil legume (*Lens culinaris* Medic.). Soils that have low phosphorus content and very alkaline, fertilization with phosphorus 60 kg/ha and molybdenum 6 g/kg seeds resulted the highest in plant height, number of branches, pods, seeds, number of nodules, root and shoot dry weight and protein.

The research is about the use of Mo and P fertilizers in the association of *Paspalum atratum* with *Macroptilium lathyroides* inoculanted with *Rhizobium* to increase forage productivity through the contribution of legumes.

II. MATERIAL AND METHODS

The study used fertilizer dose of 1.0 kg Mo ha^{-1} and 20 kg P ha^{-1}, and *Rhizobium* inoculation. The experiment used randomized block design (RBD) with factorial pattern. The first factor was *Rhizobium* inoculation consisted of Mo and P fertilizers without *Rhizobium* inoculation (R_0) and with *Rhizobium* inoculation (R_1). The second factor was planting pattern: grass monoculture (A_1), legume monoculture (A_2), one row of grass between one row of legumes (A_3), and one row of grass between two rows of legumes (A_4). There were eight treatments and each combination was repeated three times so that there were 24 experimental plots. There were 8 treatment units were: R_0A_1, R_0A_2, R_0A_3, R_0A_4, R_1A_1, R_1A_2, R_1A_3, and R_1A_4. Each treatment unit consisted of three replications, so there were 24 plots or experimental units

The variables observed were dry matter, ash, organic matter, crude protein, crude fiber, crude fat, total digestible nutrient, nitrogen free extract, and gross energy content. Analysis of dry matter, ash, organic matter, crude protein, crude fiber, total digestible nutrients, nitrogen free extracts, and gross energy content using the method of Association of Official Analytical Chemists (1990).

The materials used in the study were poles of *Paspalum atratum* grass, seeds of legume *Macroptilium lathyroides*, triple super phosphate (TSP) fertilizer, ammonium molybdate fertilizer, and *Rhizobium* inoculants.

The data obtained were analyzed by means of variance and if the treatment showed a significant difference ($P<0.05$), and was continued with Duncan's multiple-distance test (Steel and Torrie, 1991).

III. RESULTS AND DISCUSSIONS

The combination of treatment with Mo and P fertilizers with *Rhizobium* (R1) and without *Rhizobium* (R0) inoculation had no significant effect ($P>0.05$) on the content of dry matter, ash, organic matter, crude protein, crude fiber, total digestible nutrients, and the gross energy of *Paspalum atratum* grass and *Macroptilium lathyroides* legume and their associations (Table 1). Leguminous plants have the ability to bind N_2 in the air when in symbiosis with *Rhizobium* bacteria. The role of Mo and P combined with *Rhizobium* in the nitrogen fixation process has not been optimal so that the nutrients needed by plants cannot be produced optimally so that there is no difference between the nutrient content of forages in treatment R0 and R1. Susilawati et al. (2014) found that giving molybdenum had no significant effect on forage yields and the content of crude fiber components of *Panicum maximum* grass forage.

The content of nitrogen free extract (NFE) in treatment R_0 was significantly higher ($P<0.05$) compared to R_1 (Table 1). This is because the crude protein content in treatment R_0 which tends to be lower causes the NFE levels to increase and even shows a significant difference with the treatment R_1. NFE is a digestible carbohydrate. In accordance with Koten (2018) that the decreasing nitrogen content in plant tissue, it will further increase NFE levels of plant.

The dry matter content in treatments A_1 and A_3 was significantly ($P<0.05$) higher compared to treatments A_2 and A_4 (Table 1). The high dry matter content in treatments A_1 and A_3 indicated a lower water content, whereas the water content in treatments A_2 and A_4 was higher. There was an interaction between *Rhizobium* inoculants and planting patterns, indicating that the two treatments influenced each other.

Table 1. The Nutrient Content of Paspalum atratum Grass Associated with Macroptilium lathyroides Legume Inoculated with Rhizobium through the Application of Molybdenum and Phosphorus Fertilizer

Variables	*Rhizobium*[1)] Inoculation	Planting Pattern[2)]				Average
		A_1	A_2	A_3	A_4	
		……. % …….				
Dry matter	R_0	20,12 a A	17,32 b A	20,55 a A	18,11 b A	19,02 A
	R_1	19,54 a A	18,74 a A	18,12 ab B	16,75 b A	18,28 A
	Average	19,83 a	18,03 b	19,33 a	17,43 b	
Ash	R_0	12,70	8,61	10,01	10,27	10,40 A
	R_1	12,95	8,51	10,61	10,88	10,74 A
	Average	12,82 a	8,56 c	10,31 bc	10,58 b	
Organic matter	R_0	87,30	91,39	89,99	89,73	89,61 A
	R_1	87,05	91,49	89,39	89,12	89,26 A
	Average	87,18 c	91,44 a	89,69 b	89,42 bc	
Crude protein	R_0	7,73	22,79	15,81	18,67	16,25 A
	R_1	8,67	22,52	16,54	18,40	16,53 A
	Average	8,20 d	22,65 a	16,18 c	18,53 b	23,14 A
Crude fiber	R_0	27,28	20,38	23,31	21,59	24,72 A
	R_1	26,91	22,39	24,08	25,47	
	Average	27,10 a	21,39 b	23,70 b	23,52 b	
Ether extract	R_0	14,07	15,74	15,50	16,02	15,33 A
	R_1	14,73	17,61	16,18	17,96	16,62 A
	Average	14,40 a	16,68 a	15,84 a	16,99 a	
Total digestible nutrient (TDN)	R_0	32,53	49,59	42,88	47,27	43,07 A
	R_1	34,09	47,26	41,93	40,87	41,04 A
	Average	33,31 b	48,42 a	42,40 a	44,07 a	
Nitrogen free extract (NFE)	R_0	28,58	20,40	23,42	21,58	23,49 A
	R_1	26,52	16,78	21,79	15,53	20,16 B
	Average	27,55 a	18,59 c	22,61 b	18,56 c	
		……. kkal g^{-1} …….				
Gross energy	R_0	3,51	3,97	3,37	4,00	3,71 A
	R_1	2,97	4,01	3,61	3,81	3,60 A
	Average	3,24 b	3,99 a	3,49 b	3,90 a	

Noted:

1) R_0 = combination of Mo and P fertilizers without Rhizobium innoculation, R_1 = combination of Mo and P fertilizers with Rhizobium innoculation
2) A_1 = grass monoculture, A_2 = legume monoculture, A_3 = one row of grass between one row of legumes, A_4 = .one row of grass between two rows of legumes
3) The average value of the treatment followed by the same lowercase letter in one row and the same capital letter in one coloumn was not significantly different (P>0.05)

The highest ash content in treatment A_1 and significantly different ($P<0.05$) was higher than treatment A_2, A_3 and A_4, while the lowest ash content was in treatment A_2 (Table 1). There is a tendency that the presence of grass in the association pattern results in higher ash content and can be seen from the cropping pattern in the A_3 and A_4 treatments. The ash content indicates the mineral content of the plant. On the other hand, the organic matter content of the A_2 treatment showed the highest and the lowest values in the A_1 treatment. Organic matter consists of protein, ether extract, and carbohydrates.

Crude protein content between all treatments showed significant differences ($P<0.05$) and the highest was in treatment A_2 which was legume monoculture while the lowest was in treatment A_1 (grass monoculture) (Table 1). The association of grasses and legumes in the A_4 treatment showed a higher value than the A_3 treatment. This shows that as a source of protein, legumes contain higher protein than grass. The increaseing population of legumes in pattern planting with association between grass and legume, the crude protein content in treatment A_4 is higher than A_3. Skerman et al. (1988) stated that *Macroptilium lathyroides* has high nutritional value with crude protein content between 7.6 - 19.2%. The N content varies from 1% (after losing most of the leaves) to 4% in the vegetative period with digestibility between 40 - 70%.

Ether extract content in treatments A_1, A_2, A_3, and A_4 showed no significant difference ($P>0.05$) (Table 1). Ether extract content is influenced by plant age and plant growth phase. The experiment used *Paspalum atratum* and *Macroptilium lathyroides* with almost the same age and growth phase so that it had no effect on ether extract content. Farda et al. (2020) stated that fats contained in plants usually forming in unsaturated fats both linoleic acid and linolenic acid.

Crude fiber content in treatments A_2, A_3, and A_4 showed no significant difference ($P>0.05$) and the three treatments showed significant differences ($P<0.05$) with treatment A1 (Table 1). Crude fiber content was closely related to the age of cutting and all treatments, both grass and legumes were cut at the same age. The lower crude fiber content in treatments A_2, A_3, and A_4 was influenced by the presence of legumes in these treatments because legumes are forages with high protein content and lower fiber content than grass. Crude fiber content is affected by the age of the plant and also the part of the plant.

The content of total digestible nutrients (TDN) in treatments A_2, A_3, and A_4 showed no significant difference ($P>0.05$) and the three treatments showed significant differences ($P<0.05$) with treatment A_1 (Table 1). TDN content is closely related to crude fiber content because crude fiber is classified as a food substance that is difficult to digest so that the low crude fiber content in treatments A_2, A_3, and A_4 causes the TDN content was increased while decreased in teratment A_1.

The content of the nitrogen-free extract (NFE) in treatment A_1 was the highest and significantly different from treatments A_2, A_3, and A_4 and between treatments A_2 and A_4 was not significantly different ($P>0.05$) (Table 1). NFE is an digestible carbohydrate because it does not contain cell walls or crude fiber. NFE is related to the content of water, ash, crude protein, crude fiber, crude fat and crude fiber. The value of NFE will be higher if the content of water, ash, crude protein, crude fiber, and crude fat is lower, vice versa. The highest gross energy content was in treatment A_2 and not significantly different with treatment A_4 and the two treatments were significantly different ($P<0.05$) higher than treatments A_1 and A_3. This is because grass as source of energy while legumes as source of protein.

IV. CONCLUSION

The application of Mo and P fertilizers to the association of *Paspalum atratum* grass and *Macroptilium lathyroides* legume inoculated with *Rhizhobium* could increase the nutrient content of forage.

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Investigation of Inhibitory Potential of Monkey Cola (*Cola Milleni*) against some Microorganisms

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Abstract— *Microorganisms are used in processing bulky, perishable and inedible raw materials into safe, shelf- stable and palatable foods. The microbial activity of aqueous and ethanol extracts of pods and seeds of Monkey cola was evaluated for potential antimicrobial activity against important bacterial and fungal strains common to plants and animals. The antibacterial and antifungal activities of extracts from the seeds and pods of Monkey cola were tested against five bacterial strains — Escherichia coli, Erwinia carotovora, Xanthomonasaxonopodis, Staphylococcus aureus, and Pseudomonas solanicearium, and four fungal strain; Colletotrichum gloesporioides, Phytophthora megacarrier, Colletotrichum acutatum and. Fusurium oxysporium using standard methods. The zone of inhibition of the extracts were compared with standards of amoxicillin ciprofloxacin, for antibacterial and kocide for antifungal activity. The results showed remarkable inhibition (13-33mm) of the bacterial growth against the tested organisms. The antifungal activity of seed ethanoic extract result showed maximum mycelial growth of 100 percent against tested fungal organisms. Hence, the plant is recommended as bioactive natural product that may serve as leads in the development of new pharmaceuticals products against microorganisms in both plants and animals.*

Keywords— ***Monkey cola, microorganisms, inhibition zone, antibacterial activity, antifungal activity.***

I. INTRODUCTION

Microorganisms constitute the largest group of living things or organisms on earth and with only a small portion of microbial species been identified. It is also called microbes and may be unicellular or multicellular, based on the number of cells. Microorganisms are one of the most diverse organisms and they include bacteria, fungi, archaea, protozoa, algae, and viruses.

Microorganisms are ubiquitous in the environment, where they have a variety of essential functions. Some microorganisms are Pathogenic; cause infections or intoxications, Saprophytic; play a role in biodegradation and cause food spoilage and Cultured; like probiotic bacteria that are essential in food processing (FAO 2009). Bacteria are the most important microorganisms to the food processor to produce several compounds (enzymes, flavors, fragrances etc.) either specifically for application as food additives or in situ as a part of food fermentation processes (Longo and Sanromán, 2006). Most are harmless, many are highly beneficial, some indicate the probable presence of filth, disease organisms, spoilage and a few cause diseases. There are thousands of species of bacteria, but all are single-celled and fall into three basic shapes: spherical, straight rods, and spiral rods with high rate of production. Microorganisms determine the characteristics of the fermented food, e.g., acidity, flavour and texture, as well as health benefits that go beyond simple nutrition (Vogel *et al*., 2011). Lipases of different microbial origin have been used for refining rice flavour, modifying soybean milk and for improving the aroma and accelerating the fermentation of apple wine (Hasan *et al*., 2006; Treichel *et al*., 2010; Sangeetha *et al*., 2011).

Africa is endowed with humongous biodiversity resources (Kuete, 2013) and it has an estimation of about 45,000 species of plant out of which 2,000 species or more are used for medicinal purpose (Muanya, 2015). Africa is located

within the tropical and subtropical climate and plants in this region accumulate important secondary metabolites as a natural means of sustenance in their hostile environment (Bourgaud*et al.*, 2001; Vardhini and Anjum, 2015). Based on her tropical conditions, Africa has a strong ultraviolet ray of the tropical sunlight and numerous pathogenic microbes, including several species of bacteria, fungi, and viruses, suggesting that African plants could accumulate chemo preventive substances more than plants from the northern hemisphere (Mahomoodally, 2013).

Monkey cola with botanical name *Cola millenii* is known as "atewo-edun" (Yoruba) or "achiokokoro" (Igbo) and belongs to the family Sterculiaceae (Ratsch, 2005). The tree grows up to about 15meters or more in height with a low crown of arching branches. Monkey cola leaves are reported to be used in the treatment of ring worm, scabies, gonorrhea, dysentery and ophthalmic conditions (Odugbemi, 2006). The fruit is bright red in a stellate clustern covered with a felted fibrous coal and has an edible kernel/seed (Orisakeye and Ojo, 2013). The wood is white and very resilient which is used in Nigeria and Liberia for rat traps and bows. The phytochemical, proximate, mineral element compositions and antioxidant effects of leaves have been reported (Adeniyi *et al.*, 2004; Ibironke and Olusola 2013; Orisakeye and Ojo, 2013).

Communicable diseases are the most important global problem (Nair *et al*., 2017), it's the major source of death (Vu *et al.*, 2015), and cause the death of almost 50,000 people's deaths per day (Namita and Mukesh, 2012) which mainly occur due to food poisoning. The World Health Organization (WHO) reported that about 80 percent of the world's population depend on traditional medicine for their primary healthcare needs (Nair *et al.*, ,2005). The rural dwellers which had above 60 percent of the World population are still forced to practice traditional medicines for their common day ailments, most of these people form the poorest link in the trade of medicinal plants, due to poverty, ignorance and unavailability of modern health facilities. It was reported by Monier and Abd, (2016) that 25 percent of the medical drugs used in developed countries are based on plants and their derivatives.

In appraising new antimicrobials or antibiotics, evaluation of biological activity is essential for the assessment of susceptibility of pathogens to the antimicrobial agent. Antimicrobial sensitivity or susceptibility testing is used in pathology to determine the resistance of certain microbial strains to different antimicrobials and in pharmacology research it is used to determine the efficacy of new antimicrobials from biological extracts against different microorganisms (Das *et al.*, 2010). Microbial growth or its inhibition can be measured in a number of ways, such as viable counts, direct microscopic counts, turbidity measurement, bioluminescence and fluorimetry (Grare *et al.*, 2008). The current exploratory study was designed to evaluate the microbial and antifungal property of medicinal plant Monkey cola on disease causing pathogens common to both plant and animal.

II. MATERIAL AND METHODS

2.1 Collection, extraction and formulation of plant materials:

Fresh matured disease free of Monkey cola fruits were collected during the early raining season (April, 2019) from a village called Imafon in Akure Ondo state, Nigeria. It lies between longitude 5°06‟E to 5°38‟E and between latitude 7°07‟N to 7°37‟N in the Southwestern Nigeria. The collected fruits were washed thoroughly several times with running tap water, rinsed with sterile distilled water. The fruits were identified and authenticated by a botanist. The fruits were separated into seeds, seeds coats and pods (Figure 1).

Fig.1; Seed (A), seed coats (B) and pods (C) of Monkey cola

The fine powdered samples were divided into two, extracted in aqueous and ethanol at room temperature with continuous stirring on an electric shaker. They were filtered through double layers of muslin cloth, centrifuged at 9000 rpm for 10 min and the solvents were removed in vacuum using rotary evaporator at 40°C. The dried extracts of the plant

materials were then stored in air-tight jars at 4°C for microbial analysis. The formulation of the extracts was made by dissolving the ethanoic and aqueous extract of each fruit materials in distilled water to a final concentration of 100 mg/ml, to obtain Monkey cola seed aqueous extract (A), Monkey cola seed ethanol extract (B), Monkey cola pods aqueous extract (C), and Monkey cola pods ethanol extract (D).

2.2 Studied Microorganisms

The clinical isolates strains were used in this study. Five bacterial strains, namely: *Escherichia coli, (E. coli,* (AA), *Erwinia carotovora, (E. carotovora* (AB*), Xanthomonasa xonopodis, (X. axonopodis* (AC*)), Staphylococcus aureus, (S. aureus* (AD*)) and Pseudomonas solanicearium, (P. solanicearium* (AE*)) were used as test organisms. Four fungi strains, namely: Colletotrichum gloesporioides, (C. gloesporioides* (BA*)), Phytophthora megacarrier, (P. megacarrier* (BB*)), Colletotrich umacutatum, (C. acutatum (*BC*)) and Fusurium oxysporium, (F. oxysporium* (BD*)).* These microorganisms were selected based on their potential to cause food poisoning as well as infections in both plants and animals.

2.3 Evaluation of Antibacterial assay of the samples

The bacterial isolates used for this assay were obtained from Crop, Soil and Pest Management Department of Federal University of Technology, Akure, They Organisms (AA, AB, AC, AD, and AE were cultured aerobically at 37°C for 24hrs on peptone water and antibacterial test was carried out in the Mueller Hinton Agar plates using Agar well diffusion method (Aibinu *et al*., 2007). Pure isolates of each peptone cultured bacterium were seeded on nutrient agar plates for about 30mins. Sterile cork borer of 10mm diameter was used to make wells on the solidified Agar into which 0.5ml of extract of the samples were aseptically introduced. The plates were incubated at 37°C for 24hrs. Antibacterial activity was determined by measurement of Inhibition Zone diameter around the wells using digital Vernier caliper to the nearest millimeter (mm). Results were quoted as radii (mm) of the zone of inhibition around the well (subtracting the radii/diameter of the cork borer). Control plates were also set up using standard antibiotics Amoxicilin Clavulanic acid at 0.1g/ml (w/v). The tests were performed in triplicate for each bacterial strain evaluated and the final results were expressed as arithmetic mean.

2.4 Evaluation of Antifungal assay of the samples

The selected fungi of choice used for this experiment are; *Colletotrichum gloesporioides* (BA*), Phytophthora megacarrier* (BB*), Colletotrichum acutatum* (BC)and *Fusurium oxysporium* (BD*).*

The Antifungal evaluation was performed using poisoined food techniques of Mohana and Raveesha (2007). 5ml of each reconstituted sample were aseptically mixed with 20ml of sterile molten potato Dextrose agar (PDA) that have been cooled to 45°C before been poured and allowed to solidify at ambient temperature. The 48hrs old cultured of each fungus were inoculated at the center of the PDA plate with the aid of 4mm cork borer and sterile inoculating needle. Kocide, a standard antifungal agent was used as a positive control at 100mg/ml. A negative control plates (NTR) without any treatment were also set up. All the plates were incubated at 27°C for 72hrs. Mycelial growth were measured with the aid of digital Vernier caliper to the nearest millimeter (mm). Mycelial growth inhibition was calculated in percentage using the formula (1) by Vinesh and Devendra, (2013).

$$Mycelin\ growth\ inhibition = \frac{NTR-TR}{NTR} * 100 \quad (1)$$

Where NTR- Average diameter of mycelial growth (fungal colony) in control

TR- average diameter of mycelial growth (fungal colony) in treatment

The tests were performed in triplicate for each fungal strain evaluated and the final results were expressed as arithmetic mean.

2.5 Statistical Analysis

All statistical analyses were performed using Minitab Statistical Software, version 18 (Minitab Inc., USA). Data were expressed as standard error of mean ± (SEM). Statistical analysis was performed by one-way analyses of variance (ANOVA) test and the means were separated using Tukey test at significant level value of $p<0.05$.

III. RESULTS AND DISCUSSION

Antimicrobial Activities of Crude Monkey Cola Extract of Pods and Seeds

The microbial study in the research is antibacterial and antifungal activities of selected bacteria and fungus strains that cause food poisoning as well as infections in both plants and animals.

3.1 Antibacterial activities of crude Monkey cola extract of pods and seeds.

The present study investigated the in vitro antibacterial activity of two different solvents (aqueous (AQ) and ethanoic (ET)) of pods and seeds of Monkey cola extracts against the five bacterial strains represent as AA-AE**.** The results of antibacterial activities revealed that (AQ) and (ET) extracts of Monkey cola showed significantly higher inhibitory activity (between 20-33mm) against (AA) and

(AD). All extracts of Monkey cola showed inhibiting activity (between 13-25mm) against (AB) and (20-32mm) against (AE) (Table1). The present investigation has shown that the (AQ) and (ET) extracts of Monkey cola have active phytochemical, which can inhibit the growth of the studied pathogenic bacteria. All crude plant extracts of Monkey cola showed antibacterial activities against both Gram positive and Gram-negative bacteria strains tested. The potency of the extracts was assessed quantitatively by determining inhibition zones as given in Table 1 for all the extracts. The average inhibition of the pods (AQ) extract was highest against the growth of AA (33.00 ± 1.00) and the lowest against AB (21.33 ± 0.58) while pods (ET) extract were highest for AD (33.00 ± 1.00) and lowest for AE (24.67 ± 1.53). The average inhibition of the seeds (AQ) extract was highest against the growth of AA (25.00 ± 0.00) and the lowest against AB (13.33 ± 0.58) while seeds (ET) extract was highest for AA (32.67 ± 1.53) and lowest for AB (13.00 ± 0.58). The pods (AQ) had the highest inhibition zone while seeds (ET) had the lowest value.

It was found that ethanoic and aqueous extracts of Monkey cola from pods showed significantly higher zone of inhibition (21-33mm) against all the strains of bacteria studied and comparable higher than the standard antibiotic amoxicillin clavulanic acid of inhibition zone (18-20mm) as shown in Table 1. The result shows that both extracts from the pods performed extremely higher than the synthetic antibiotics for all the studied bacteria strains. In the study some bacterial shown a stronger effect than aqueous extract which could be explained by the differences in the compounds between these two extracts.

Table 1. Inhibition effect of Antibacterial assay (diameter Zones of inhibition) of the pods and seed extracts of Monkey cola.

	Inhibition zones in mm				
Treatments	**Gram Positive Bacteria**		**Gram Negative Bacteria**		
	(AB)	(AA)	(AC)	(AD)	(AE)
Pods (AQ)	21.33 ± 0.58^{B}	33.00 ± 1.00^{A}	24.00 ± 2.00^{A}	22.00 ± 1.00^{BC}	32.00 ± 1.00^{A}
Pods (ET)	25.00 ± 0.00^{A}	25.33 ± 2.52^{B}	24.00 ± 2.00^{A}	33.00 ± 1.00^{A}	24.67 ± 1.53^{B}
Seeds (AQ)	13.33 ± 0.58^{D}	25.00 ± 0.00^{B}	15.00 ± 1.00^{B}	24.00 ± 1.00^{B}	23.00 ± 1.00^{BC}
Seeds (ET)	13.00 ± 0.58^{D}	32.67 ± 1.53^{A}	14.00 ± 2.00^{B}	22.67 ± 2.00^{BC}	20.00 ± 2.00^{C}
Control	20.00 ± 0.00^{C}	20.00 ± 0.00^{C}	18.00 ± 0.00^{B}	20.00 ± 0.00^{C}	20.00 ± 0.00^{C}

All values represent a mean of three replicate tests and the standard error of the mean (SEM) has been calculated. The mean score in a column with different superscript letters are significantly different at $p<0.05$.

The result of antibacterial showed that all the extracts of (AQ) and (ET) of Monkey cola with inhibition zones against AA (23-33mm), AD (22-33mm) and AE (21-32mm) inhibit better than synthetic antibiotics of inhibition zone (20mm) for these three strains of bacteria. It was found that ethanoic solvent extracts showed significantly higher zone of inhibition of (25-33mm) against AA which is lower than the ethanoic extract of Marigold (48mm) and higher than Tamarid ethanoic extract of 15mm against AA as reported by Alcasid *et al*., (2016). The extracts of aqueous and ethanoic solvents of Monkey cola showed a higher zone of inhibition of 25-30mm and lower than extracts of chloroform, butanol, ethyl acetate and n-hexane extract of Medicago falcate of inhibition zone of 17-19mm as reported by Javid *et al*., (2015).

3.2 Antifungal activities of crude Monkey cola extract of pods and seeds

The Aqueous (AQ) and ethanoic (ET) extracts of Monkey cola for both seeds and pods were evaluated for antifungal activity against Four fungi strains labelled; BA, BB, BC and BD. All crude plant extracts of Monkey cola showed antifungal activities against fungal strains tested as tabulated in Table 2. The results revealed that aqueous and ethanoic extract of Monkey cola showed significantly at $p<0.05$ higher inhibitory activity (3.69-100) against BA and (2.14-100) against BB. All extracts of Monkey cola showed activity (39.92-100) against BC and (0.100) against BD (Table2). The present investigation has shown that the aqueous and ethanolic extract of Monkey cola have active phytochemical, which can inhibit the growth of the studied pathogenic fungi. All crude plant extracts of Monkey cola showed antifungal activities except seed aqueous extract against BD. Plate 3 showed the picture of the fungal strain and the extracts.

Table 2. Inhibition effect of Antifungal assay (percentage Zones of inhibition) of the pods and seed extracts of Monkey cola.

	Inhibition Zones in percentage			
Treatments	**BA**	**BB**	**BC**	**BD**
Pods (AQ)	83.03 ± 0.08^{B}	83.53 ± 0.15^{B}	39.00 ± 0.42^{D}	73.05 ± 0.06^{C}
Pods (ET)	42.65 ± 0.05^{C}	43.49 ± 0.04^{C}	39.92 ± 0.48^{D}	42.70 ± 0.01^{D}
Seeds (AQ)	3.69 ± 0.04^{D}	2.14 ± 0.04^{D}	42.40 ± 0.02^{C}	0.00 ± 0.00^{E}
Seeds (ET)	100.00 ± 0.0^{A}	100.00 ± 0.00^{A}	100.00 ± 0.00^{A}	100.00 ± 0.00^{A}
Control	100.00 ± 0.00^{A}	100.00 ± 0.00^{C}	60.57 ± 0.04^{B}	89.90 ± 0.10^{B}

Mean score in a column with different superscript letters are significantly different at $p<0.05$ with SEM-standard error of mean

The evaluation of antifungal rates of two different solvents (aqueous and ethanoic) of pods and seeds of Monkey cola extracts were studied. The potency of the extracts was assessed quantitatively by determining % mycelia al growth inhibition (Table 2). The average inhibition of the monkey cola seeds ethanoic extract was highest against the growth of all the fungus studied (100 %) and it showed a higher value than standard antifungal (Kocide) with 60.57 % and 89.90 % against BC and BD respectively. The ethanoic extracts of the seeds of Monkey cola showed prominent antifungal activity treatment of pathogenic diseases associated with the infection of these four pathogens. and could inhibit all the pathogens of the studied fungus. The average inhibition of the aqueous extract of pods against BA, (83.03 %), BB (83.53 %), BC (39 %) and BD (73.05) inhibit with higher value than pods ethanoic extracts of (42.65 %), (43.49 %), (39.92 %) and (42.70 %) for BA, BB, BC and BD respectively. The lowest was recorded against BD (0.00 ± 0.00) with seeds aqueous extract while 3.69 ± 1.00 %), 2.14 % and 42.40 % were recorded by BA, (83.03 %), BB (83.53 %), and BC respectively.

IV. CONCLUSION

The study had clearly revealed the antibacterial and antifungal potential of Monkey cola pods and seeds against common bacterial and fungal. The ethanoic and aqueous extracts of the parts of Monkey cola showed prominent antibacterial and antifungal activity treatment of pathogenic diseases associated with the infection of these studied strains pathogen both in plants and animals. The Monkey cola plant extracts which is eco-friendly control measure can be used as source of antibacterial, antifungal and in preventing food borne disease or as preservative in pre- and post-harvesting processing of food and bio-materials. The synthetic fungicides and antibiotic can pose harmful effects to environment and living organisms including humans and also increase the cost of production.

The other parts of the plants should be evaluated for antimicrobial properties. Also, other solvents could be used to extract the Monkey cola and minimum inhibitory concentrations to evaluate the potency of the extract.

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Introduction of Feed Technology in Support Development of Beef Cattle

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Abstract**—** *The problem of beef cattle breeding developed by rural communities was done traditionally. Farmers use land under coconut for raising beef cattle, but feed consumed was low quality grass. This condition has an impact on low productivity of beef cattle so that selling price was also low. This research was conducted with the aim of analyzing potential for forage development in Bolaang Mongondow Regency. The research method used was a survey, with determination of location is by purposive sampling, which was village that has most cattle population. Data collected were primary and secondary. Respondents were determined by purposive sampling, namely 30 farmers who use land under a coconut tree. Data were analyzed descriptively and using IDD analysis. PMSL Value 21396.39, KPPTR(SL) 12043.76, PMKK Value 107557.8, KPPTR (KK) 87438.8. The carrying capacity index value of 1.40 shows that based on potential of existing land, real population can still be increased up to 1.40 times. In conclusion, development of land under a coconut can be done through introduction of forage. Suggestion, forage is developed by considering its quality.*

Keywords**— forage, beef cattle, coconut land, introduction.**

I. INTRODUCTION

The agricultural sector is a sector that contributes significantly to the development of the local, regional and national economy. The paradigm of future agricultural development is sustainable agricultural development, industrial culture, global competitiveness, and has an ecosystem approach. The ecosystem in question is an ecological system formed by an inseparable reciprocal relationship between living things and their environment. An order of unity as a whole and as a whole between all elements of the environment that influence each other is also included in the ecosystem.

Bolaang Mongondow Regency develops the agricultural sector which includes food crops, plantations, livestock, fisheries and horticulture sub-sectors. The development of food crops is related to rice, corn and soybeans. The development of the three food crops is the realization of a government program whose goal is to be self-sufficient. But soybeans were less successful in this area so that there was very little interest from farmers in this area to develop it. Program to increase production, productivity and quality of food crops to achieve sustainable self-sufficiency in rice and maize. Land support and the availability of feed are urgently needed to encourage farmers to develop beef cattle farming businesses (Rusdiana and Talib, 2019).

The Bolaang Mongondow Regency Government continues to encourage an increase in the population of beef cattle so that this commodity becomes a priority in the development of the livestock sector. The problem is that beef cattle farming is developed traditionally. Whereas beef cattle farming has many roles and functions and is very meaningful for smallholder farmers' businesses in rural areas (Sodiq et al. 2017). Farmers use agricultural land, both dry land for food crops and land under coconut trees to graze beef cattle. Beef cattle in this case consume field grass that grows wild on these lands. On the other hand, some farmers develop beef cattle in cages but the feed given is rice straw or corn straw which is of low quality. This condition shows that the productivity of beef cattle is lower than the same cattle in other areas in North Sulawesi. The low productivity of cattle causes the selling price is also low.

Based on the thoughts and problems above, a study was carried out on the need for the introduction of feed technology as a staple food for beef cattle. This research was conducted with the aim of knowing the potential for forage development for beef cattle in Bolaang Mongondow Regency.

II. RESEARCH METHODS

The research method used was a survey method, through direct interviews with farmers using a list of questions. The data collected were primary and secondary data. Primary data obtained from interviews and direct observation of farmers. The research location was determined by purposive sampling, namely by considering the village that had the largest cattle population. Respondents were determined by purposive sampling, namely 30 farmers who used land under coconut trees. Analysis of the data used was descriptive analysis and carrying capacity index.

III. RESULTS AND DISCUSSION

The cattle business in the study area was developed traditionally with a total ownership of about 2-6 heads (according to the results of the study). This amount is categorized as a household scale and was developed to cultivate agricultural land and was used to transport agricultural products. In fact, beef cattle business in rural areas is expected to support the national demand for beef. This is a great opportunity for farmers to develop beef cattle (Steflyando et al. 2014). The slow increase in cattle productivity was caused by various obstacles (Elly et al. 2018a, Elly et al. 2018b, Elly et al. 2019a, Elly et al. 2019b). One of the obstacles faced by cattle farmers in the research location was the problem of feed. Factors that become obstacles in developing beef cattle include land as an ecological basis for raising beef cattle that has not been optimized (Sodiq et al. 2018).

The feed needed by beef cattle does not only play a role in meeting basic life needs but also for increasing production and quality of meat. Feed in this case should receive attention from both farmers and the government. Feed must be available continuously to cover the needs of cattle. However, the available feed must have quality to meet the nutritional needs of beef cattle. The provision of quality feed must also be followed at an affordable price. The cost of feed for beef cattle is the biggest cost (Rusdiana and Praharani, 2018). The increase in body weight of cattles is influenced by feed factors (Nur et al. 2018).

The results showed that the research location had the potential for development under coconut trees for forage development. The carrying capacity of land in Bolaang Mongondow Regency was seen from the potential for effective livestock development and carrying capacity index. The potential for effective livestock development was analyzed using the maximum potential based on land resources (PMSL), the capacity to increase the cattle population based on land resources (KPPTR (SL), the maximum potential based on the head of the farming family (PMKK) and the capacity to increase the cattle population based on the head of the family (KPPTR (KK), and land carrying capacity index (IDD).The conditions of maximum potential and IDD analysis are stated in Table 1.

The data in Table 1 shows that the maximum potential value in cattle units in Bolaang Mongondow based on land resources (PMSL) according to the results of the analysis was 21,396.39. This value indicates that based on land resources in the research area it can still accommodate a population of beef cattle of 21,396.39 AU.

Table 1. Maximum Potential Condi-tions and IDD Analysis in Bolaang Mongondow Regency

No	Coefficient/Variable	Value
1.	PMSL	21.396,39
2.	KPPTR(SL)	12.043,76
3.	PMKK	107.557,80
4.	KPPTR(KK)	87.438,80
5.	IDD	1,40

Descriptions :

PMSL =Maximum potential in cattle unit (AU) based on land resources

KPPTR(SL)= Capacity to increase cattle population (AU) based on land resources

PMKK = Maximum potential (AU) based on farmer's family head

KPPTR(KK)= Capacity to increase cattle population (AU) by Head of Family

IDD = Carrying Capacity Index

Furthermore, the value of the capacity for increasing the population of cattle based on land resources (KPPTR(SL) according to the results of the analysis was 12,043.76 (Table 1). This value indicates that to meet the maximum potential of land resources, the population of cattle in the study area can still be increased to as much as 12,043.76 AU.

The maximum potential value based on the head of the farmer's family (PMKK) according to the results of the analysis was 107,557.80 (Table 1). These results indicate

that based on the availability of labor, with each having 3 AU, the cattle population can be increased to 107,557.80 AU. The value of the capacity for increasing the population of cattle based on the head of the family (KPPTR (KK) according to the analysis was 87,438.80 (Table 1). This value indicates that the increase in the number of farmers as the head of the family, the population of beef cattle can be increased by 87,438.80 AU.

The carrying capacity index value in Table 1 was 1.40 which indicates that based on the existing land potential, the real population can still be increased up to 1.40 times. Based on this value, it shows that the cattle population in the study area can still be increased. The Carrying Capacity Index according to the results of research that has been carried out by several researchers was to show the status of the land in the provision of feed (Anggraini and Putra. 2017).

Based on the potential of the land above, it is necessary to introduce quality forage technology such as dwarf grass. Forage was all feed sources of crude fiber derived from plants, especially green plant parts (Salendu and Elly, 2012).

The introduction of technology is an innovation for the progress of the beef cattle business depending on the characteristics of the cattle farmers. The characteristics of farmers based on various studies not only affect the success of their businesses but also affect technology adoption (Mauludin, 2012) and (Suteky et al. 2017). Characteristics of farmers that affect the introduction of feed technology include age and education level. The age of respondents ranged from 32 to 66 years, with the highest distribution being respondents ranging from 32 to 64 years (86.67 percent). Farmers who were over 65 years old were only around 13.13 percent. The age of the respondents was categorized as productive age. This condition shows that farmers had physical ability in managing beef cattle business. Age can also had an impact on farmers in making decisions to apply the introduced technology. Behavior in making decisions, and being able to work optimally and productively was influenced by the age of the farmer (Tarmizi et al. 2018).

Education is also one of the factors that influence farmers in applying the introduced technology. The level of education of respondents according to the results of the study was mostly categorized as low. The largest distribution of education was elementary school graduates (53.33 percent) followed by those who did not graduate from elementary school and junior high school graduates (each 16.67 percent). The remaining 13.33 percent finished high school. This condition has an impact on the slowness of farmers in accepting or adopting technology. The level of education affects the adoption of innovation and technology by farmers in raising livestock (Mulyawati et al. 2016). The indication is that this situation will affect the way of thinking, learning ability, and intellectual level of farmers. The role of extension workers in this case is very important. The government needs to intervene and assist farmers in introducing feed technology.

IV. CONCLUSIONS AND SUGGESTIONS

Based on the results of the study, it can be concluded that the development of land under coconut trees can be done through the introduction of forage. Suggestions, forage that can be developed should be quality forage.

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Integrated of Organic Manures and Inorganic Fertilizers was Effecive for Yield, Component Yield and Quality of Landrace Rice on An Giang, Vietnam

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Abstract— *The present study aimed to determine the effect of different organic and inorganic source of fertilizers on growth and performance of rice. The experiment was conducted at two locations: Tinh Bien and Tri Ton AnGiang province with two varieties of landrace rice with AG3 and AG4. Each experiment has seven treatment. Treatments included a combination of organic and inorganic nutrients at sevenrates (F1:80-40-40+ organic manures 10 t ha-1;F2:60-40-40+ organic manures 10 t ha-1;F3: 40+40+40+ organic manures 10 t ha-1;F4: 20-40-40+ organic manures 10 t ha-1. F5:only organic manures 12 t ha-1; F6: control no dose of NPK;F7: farmers used: 120-40-60+ organic manures 12 t ha-1). The experiment is arranged on the farmer's field, a split-plot in a randomized complete block design with three replications. Treatments produced significant results for plant height. Panicle length and grain yield but thousands grains weight was not significant. Result showed that application of half of recommended 60-40-40 + organic manures 10 t ha-1 produced significantly higher value for grain yield and good for quality lance rice.*

Keywords— ***landrace rice, nutrition N. P. K. productivity, factors that constitute productivity.***

I. INTRODUCTION

The use of nitrogen fertilizer (N) contributes to the productivity of major food crops and has contributed to the rapid growth of the world's population (Tilman et al., 2011). The use of nitrogen fertilizer is expected to increase to produce enough food to feed the world's population.Which is expected to be 9.3 billion people by 2050 (Ladha et al., 2005). However, increasing the N rate does not appear to be effective in increasing productivity, as N efficiency decreases at high nitrogen levels (Tilman et al., 2011). Conventional agriculture indicates the direction of increasing maximum productivity by using high-dose chemical fertilizers that continuously lead to environmental degradation. It shows that reducing soil fertility leads to lower organic matter content and effective use of nutrients. Farmers feel the most impact among others is that the plant does not respond to fertilizer despite increased dosages; and the increase in plant productivity cannot be compared to the addition of fertilizer (Padmini 2009);(Padminiet al.,2013). Depending on chemical fertilizers as a source of nutrition, besides it tends to reduce soil yields causing a decrease in yield. It also reduces the quality of rice.For example the structure of rice becomes hard due to its high amylose content and low amylopectine (Jian et al., 2004).Some traditional Sabah local varieties have the potential to be grown as they can contribute to higher rice yields and their accommodation rates can be minimized by the adoption of NPK. The SerendahMerah (V3) variety received with F1 has no significant difference between the NPK fertilizer applied. So it can be recommended for farmers, the amount of fertilizer used in F1 treatment (60:30:30 kg ha-1) is the least.So it offers an economic advantage because low fertilizer costs are needed to achieve higher yields and better grain quality. (Mohdet al.,2018). A field experiment was conducted for the effect of different sources of

nutrients on NPK uptake by rice at various growth periods. The NPK uptake by rice at various growth periods was significantly increased with the application of 100% NPK in combination with FYM @ 10t ha-1. However, it was on par with that of green manuring together with 100% NPK during both the years of the study (Mohanaet al.,2017). Most of the landrace rice land in An Giang belongs to the group of poor sandy soils and uneven distribution of rainfall during the year.In addition to the use of low-yield genotypes (Ishag. 1980). The objective of this study is to improve the yield of landrace rice varieties and find a relationship between the dosages of N. P. K and integrated application of organic manures and inorganic fertilizers was effective for enhancing growth, yield, and the yield components of landrace rice.

II. MATERIALS AND METHODS

2.1. Two varieties of landrace AG3 and AG4.

2.2. Experimental experiments were conducted in Tri Ton and Thanh Bien AnGiang provinces, with sandy soil structures. Experimental soils have been cultivating seasonal rice for ten years and in recent years have been managed in the conservation system for the seasonal rice region. Prior to the experiment the soil layer was collected in each area in layers 0 to 30 cm deep to make up the composite sample. which was used to analyze chemical indicators according to the method of (Raijet al.,2001) and particle size according to (Camargo et al.,2009) - Experimental layout: The experiment is arranged on the farmer's field A split-plot in a randomized complete block design (02 varieties, 7 experiments,3 repetitions, at 02 locations, the area of each laboratory is 25 m2).

Experimental layout method

No	Treament : (F)= (N-P-K)
1	F1 = 80-40-40 + organic manures10 t ha-1
2	F2= 60-40-40 + organic manures10 t ha-1
3	F3= 40-40-40 +organic manures10 t ha-1
4	F4= 20-40-40 +organic manures10 t ha-1
5	F5= only organic manures10 t ha-1
6	F6= 0-0-0+ 0
7	F7= farmers (120-40-60 + organic manures12 t ha-1)

About fertilization: only use innocuous fertilizers to assess the effect of nutrients on rice crops.experiments do not use compost and other fertilizers. Single forms of in innocuous stools are used as follows: urea (46% N).phosphatesupe (16% P2O5. 20% CaO) and potassium chloride (60% K2O).

Agro-morphology Analysis

AG 3 and AG4 traditional varieties were planted in the field at Tri Ton and Tinh Bien .During the wet season from 2020. Seeds were sown in the raised seedbeds.and 30-day old seedlings were transplanted at one seedling per hill. Hills were established at distances of 20 x 20cm. The standard cultural management practices for rice were followed (Bui. 1986).

Quality traits

A total of AG 3 and AG 4 varieties were evaluated (Table 1) and the following quantitative traits were considered: Panicle length (cm): length of panicle at maturity measured from the base of the plant to the tip of the panicle (taken from 10 random selected primary panicles per accession per replication). Panicles per plant (number): the total number of panicles per plant (from 10 random selected primary panicles per accession per replication). 1000-grain weight (g): weight of 1000 welldeveloped grains at 14% moisture content (from 5 random selected primary panicles per accession per replication). Filled grains (number): obtained from counts of total number of filled grains per panicle (from 5 random selected primary panicles per accession per replication). Unfilled grains (number): obtained from counts of total number of unfilled grains per panicle (from 5 random selected primary panicles per accession per replication). Yield obtained from the harvested plants in each replication. Harvested grains were threshed, cleaned, drie, and weighed for each accession per replication. Moisture content per plot was determined immediately after weighing using a moisture meter. Yield = weight of harvested grain (g)/number of hills harvested x number of possible hills x MF (of the harvested grain).

Cooking and eating properties

Milled grains underwent assessment of physical traits (grain dimensions. proportion of head rice in milled rice, and chalkiness) and then a test portion of each sample was ground into fine flour (100-mesh) using aUdy Cyclone Sample Mill (model 3010–30. Fort Collins. CO). Reverse osmosis (RO) water and reagent-grade chemicals were used for the chemical analyses.

+ **Amylose content**: The AAC of isolated rice starch was analysed by using the iodine reagent method [AACC International.1999]. Briefly,exactly 25mg rice flour was gelatinized overnight in 2ml of 1.0N NaOH in a water bath set at 50°C. The solution was boiled in the water bath for 10 min and then cooled to room temperature. The cooled solution was extracted three times with 5ml of butanl:petroleum ether (1:3) to remove the lipid.After which 1.5ml of 0.4N KI was added to the solution and mixed. The AC was determined in duplicating

with an ART-3 Automatic Titrator, according to the manufacturer's instruction (Hirama Laboratories. Japan) in which 1.57mM KIO_3 was titrated at a speed of 2.5µl per s to the starch solution. The titration terminal was automatically detected with a sensitivity setting of 3, and the used volume of KIO_3 was transformed into amylose content. Standard amylose solutions were prepared as checks by dissolving pure amylose and amylopectin in distilled water (Tan YF et al., 1999).

+Gelatinisation temperature

GT was determined using the alkali digestion test [Little RR et al 1958]. A duplicate set of six whole-milled kernels without cracks was selected and placed in a plastic box (5×5×2.5cm). 10mL of 1.7% (0.3035M) KOH solution was added. The samples were arranged to provide enough space between kernels to allow for spreading. The boxes were covered and incubated for 23h in a 30°C oven. The starchy endosperm was rated visually based on a seven-point numerical spreading scale as a standard evaluation system for rice [IRRI .2013]. According to the ASV score. GT of rice grains can be classified into four groups: high (1–2), high-intermediate (3), intermediate (4–5), and low (6–7) [IRRI.2013].

+Gel consistency

Gel consistency was determined as previously described [IRRI.2013]. Rice flour (100mg) was mixed with ethyl alcohol (0.2mL) containing 0.025% thymol blue and 0.2M potassium hydroxide (2mL) and heated in a boiling water bath for 8 minutes. After heating, the sample tubes were allowed to cool in an ice-water bath and immediately laid horizontally on the table. Gel consistency was measured by the length of the cold rice paste in the culture tube held horizontally for one hour, Hard, medium,and soft gel standards such KhaoDawmali 105 are respectively included in every set.

Milling recovery

Brown rice samples of 100 g from each treatment plot were milled in a McGill-type miller no. 2 with the 685 g added weight on the pressure cover for 30 sec, followed by 30 sec without the added weight. Total milled rice weight was determined. Head rice yield was determined by sizing milled rice with a Satake testing rice grader TRG 05A using a 4.75-mm mesh indentation, weighing the brokens and whole grain fractions. Total and head milled rice yields were calculated as percent of rough rice. Head rice yield in kg/ha was calculated from rough rice yields determined at harvest of each experiment from a 5-m 2 area within each plot.

Data Analysis

Analysis of variance.

The agro-morphological data collected were initially analyzed through analysis of variance to verify genetic variation in the traits measured. The few traits with insignificant genetic variation, based on the F-test, were not considered for further analyses.

III. RESULT AND DISCUSSION

3.1. *Experimental soil properties*:The production of landrace rice grains is extremely important thanks to the structure of the soil. The soil must have a bright, light texture with good drainage system and moderately low amount of organic matter. The results of land analysis at Tri Ton and Tinh Bien locations showed that the maximum humidity reserves fluctuated from 40.8% to 41.0% for TinhBien and Tri Ton in order. Organic C content is not high (0.92% and 0.86%). This suggests that organic matter is not so high suitable for growing landrace rice because the soil is often porous, allowing root remove and lodging. Bright soil color reduces the color of the shell.Ensures the attractiveness of rice grains and catches the eye with the market. The soil drains well,providing air inside the soil for the root system to grow. The percentage of lightning particles is very low (1.2-2.02%) (Table 1). Mild - neutral soil (pHKCl 6.01-6.25). Landrace rice grows best in slightly soil with 6.0 to 6.5.

Table 1: Some properties of the tested soil (0–30 cm depth) before sowing

Property	**Value assessment**	
	site I: Tri Ton	**Site 2 : Tinh Bien**
Component distribution (%)		
Sand	66,4	65,78
Silt	32,5	31,20
Clay	3,1	2,02

Property	**Value assessment**	
	site I: Tri Ton	**Site 2 : Tinh Bien**
Soil texture	Sandy loam	Sandy loam
Saturation percent (S,P%)	41,0	40,8
pH (soil)	6,09	6,35
E,C (dS m^{-1}, at 25 °C)	0,42	0,55
Soil physical and chemical analysis		
Total N (%)	0,089	0,093
Available N (ppm)	28,0	47,0
P (ppm)	7,40	11,20
K (ppm)	137,6	148,5
Exchangeable cation (meq/L)		
Ca^{++}	0,90	0,98
Mg^{++}	0,38	0,29
Na^{+}	0,08	0,19
K^{+}	0,25	0,39
Organic carbon (ml/lit) -C (%)	0,92	0,86

3.2. Effects of fertilizers on plant height, filling and unfilling of landrace rice.

3.2.1. Analysis of the impact of fertilizers on the componts of yield composition of rice plants This analysis is based on factors: productivity and productivity composition in two different locations.

a) *Experiments at Tri Ton*: Treatments produced significantly different effect on all measured parameters: plant height. Filled/ panicle and unfilling % at 5% level of significance. The average plant height of the AG3 is 128.5cm in the F6 non-fertilization test. The tallest height in the F7 treatment(134.6 cm). N fertilizer changes have a change in the height of the landrace rice on AG 3 which is statistically significant on the treatments. The average height of AG4 when not fertilized is 127.5 cm in the F6 and the tallest is also in the full fertilization test (F7) according to farmers (138.3 cm). For the number of filling / panicle recorded the fertilization change experiments are statistically significant on the treatments.

b) *The experiment at TinhBien* similar to the experiment in Tri Ton.Most of the treatment are statistically significant for plant height, filling and unfilling %. For plant height of AG3 is 130.2 cm in the non-fertilization treatment F6. The tallest in the F2 (134.2 cm). The ratio of filling / panicle is highest in the F2,then the F1 and F3 treatments. The rate of % unfillingthe highest fertilizer levels F5. F 6 is 22.1% and 28.6% respectively. For the AG4 the lowest height in the F6 test and the tallest in the F2 test is 126.1cm,136.6cm respectively in order. (Table 2). The highest recorded filled / panicle of F2 to F1. The lowest percentage of filling/ panicle is F6, then F5. (Table 2)

Table 2. Effects of fertilizer on the development of landrace rice

Factors (F)	AG 3			AG4		
	Plant height (cm)	Filled grains / panicle (number)	% unfilling	Plant hight (cm)	Filled grains / panicle (number)	% unfilling
Site 1: Tri Tôn						
F1= 80-40-40+organic manures10 t ha-1	132.7	112.5	15.2	138.2	108.3b	20.1
F2= 60-40-40 + organic manures10 t ha-1	134.8	100.4	13.7	136.6	109.2a	15.6
F3= 40-40-40 +organic manures10 t ha-1	132.1	108.3	18.2	133.6	99.4c	12.8
F4= 20-40-40 +organic manures10 t ha-1	131.5	98.4	16.7	132.5	89.6d	22.4
F5= only organic manures10 t ha-1	130.8	92.6	20.4	131.3	78.6e	20.1
F6= 0-0-0+ 0	128.5	61.5	25.7	127.5	63.7f	25.4
F7= Famers (120-40-60 + organic manures r 12 t ha-1	134.6	117.1	19.5	138.3	108.5b	16.5
Site 2: Tinh Bien						
F1= 80-40-40+ organic manures 10 t ha-1	132.5c	118.9b	12.2f	135.7b	112.3b	14.5d
F2= 60-40-40 + organic manures 10 t ha-1	134.2a	119.6a	12.6f	134.6c	113.2a	12.9e
F3= 40-40-40 +organic manures 10 t ha-1	133.5b	118.3b	17.6e	133.6d	109.6c	14.8d
F4= 20-40-40 +organic manures 10 t ha-1	131.7d	99.4e	18.5d	133.6d	89.5e	12.6e
F5= only organic manures 10 t ha-1	131.2d	98.5f	22.1b	132.3e	79.5f	21.6b
F6= 0-0-0+ 0	130.2e	71.5g	28.6a	126.1f	68.1g	32.6a
F7= Famers (120-40-60 + organic manures 12 t ha-1	132.7c	115.4d	19.1c	137.9a	100.2d	18.9c

3.2.2. Effects of fertilizers on yield for landrace rice.

a) *Experiments at Tri Ton*: Treatments produced significantly different effect on all measured parameters: panicle length and grain yield, thousand grains weight at 5% level of significance. The panicle lengthof AG3 fluctuates from 27.8-26.6cm. In the thousand grains weightthere is no significance for the all treatments except not fertilization (F6) for lower weight in AG 3. For AG 4. The treatments for thousand grains weight are highest in F1. F2 and F7 (30.5grams). The lowest thousand grains weightare also in F6 (28.6grams). In terms of recorded productivity like AG 3 for the highest productivity in the F2 test. This is recorded on AG 4 (F2) for a yield of 4.6 tons / h.a).fertilizers application (60 -40-40 kg/ha+ organic manures 10 t ha-1) increased grain yield both AG 4 and AG 3 at Tri Ton.

b) *Experiments at TinhBien:* Treatments produced significantly different effect on all measured parameters: panicle length and grain yield. Thousand

grains weight at 5% level of significance.Yield recorded the same AG 3 yield higher than AG 4. However,1000-grain weight is higher than AG 3. On the yield of the treatments are statistically significant. The most productive test on the F2 test (table 3). On the treatment of only organic fertilizer, the yieldis achieved 3.5ton/ha for AG 3 and 3.8ton/ha for AG 4. The results showed that among the various nutrient combinations. Combine application of inorganic fertilizer F2 and F1 the yield the same with the result of Kumari*et al*. (2018). Positive effect of straw incorporation was also found by Kumari*et al*., (2018) in rice-wheat cropping system. Zhao *et al.*,(2019) compared straw removal with straw incorporation in rice-wheat cropping system and found that increase in wheat yield was significant and rice was not significant. Zhao *et al.*,(2019) found the positive influence of straw incorporation on soil aggregation and enzyme activities. Mahapatra (1991) found that one third of the inorganic N can be substituted by applying rice or wheat straw at the time of planting to give similar rice yields. Similar results were also reported by Salahin*et al.* (2017).

Table 3. Effects of fertilizers on yield and yield components in landrace rice

Factors (F)	AG3			AG4		
	panicle length (cm)	1000-grain weight (g)	yield(ton/ha)	panicle length (cm)	1000-grain weight (g)	yield(ton/ha)
Site1: TriTon						
F1= 80-40-40+ organic manures 10 t ha-1	27.8a	28.7a	4.2a	29.2a	30.5a	4.5a
F2= 60-40-40 + organic manures 10 t ha-1	27.7a	28.6a	4.3a	28.2b	30.5a	4.6a
F3= 40-40-40 +organic manures 10 t ha-1	27.6a	28.4a	4.2a	28.5b	29.9b	4.3a
F4= 20-40-40 +organic manures 10 t ha-1	27.7a	28.8a	3.6a	28.6b	29.9b	3.2a
F5= only organic manures 10 t ha-1	27.6a	28.6a	3.5b	28.6b	29.3b	2.9b
F6= 0-0-0+ 0	26.6b	27.4b	2.9c	27.6c	28.6b	2.5b
F7= Famers (120-40-60 + organic manures r 12 t ha-1	27.7a	28.7a	4.2a	28.5b	30.5a	4.2a
Site 2: Tinh Bien						
F1= 80-40-40+ organic manures 10 t ha-1	27.6b	28.4a	4.6b	28.7a	30.5a	4.5a
F2= 60-40-40 + organic manures 10 t ha-1	28.6a	28.6a	4.8a	28.9a	30.1a	4.5a
F3= 40-40-40 +organic manures 10 t ha-1	28.7a	28.7a	4.2d	28.3a	30.2a	4.3b
F4= 20-40-40 +organic manures 10 t ha-1	28.4a	28.7a	4.3c	27.8b	30.4a	4.2c
F5= only organic manures 10 t ha-1	27.7b	27.8b	3.5e	28.4a	29.6b	3.8d
F6= 0-0-0+ 0	26.4c	27.4b	2.8f	28.9a	28.7c	3e
F7= Famers (120-40-60 + organic manures 12 t ha-1	28.4a	28.5a	4.6b	28.6a	30.7a	4.3b

3.2.3. The effected of fertilizers on rice qualities(Cooking and eating properties) of landrace rice

a) *Experiments at Tri Ton*:Analyzing the amylose content of AG 3 varieties recorded fluctuations in fertilizer levels that have changed statistically. Amylose levels

increased slightly when nitrogenlevels were increased. In the full fertilizer treatment (F1) the average amylose (%) content is calculated for AG3 (18.6). Similar to the experimental fertilization of F7 (amylose content is 18.6%). Other tests showed that lower amylose levels ranged from 17.2% to 17.7%. For AG4 varieties in the high amylose test is the F7 (fertilizer according to farmers). Thus, the amylose content has changed due to changes in the amount of fertilizer. Next Gel consistency (GC) also recorded fluctuations on both two varieties. In particular, in gelatinisation temperature (GT)there is no change in the tests for both varieties (table 4).This is also noted on the AG 4. The GT popularity alone has not changed al of treatments.

b) *Experiments in TinhBien*: The amylose content recorded on the tests shows statistical significance on the tests the lower the fertilizer level, the lower the amylose content. The fluctuation in amylose levels is not high in F1 until F6 tests except in F7. For both AG 3 and AG4 varieties. Gel consistencyis the same for amylose content that are not statistically significant on AG 4. However.there is little change amylose at on AG3 at F7 treatment (Famers (120-40-60 + organic manures 12 t ha-1).

Table 4. Effected of fertilizers on cooking and eating propertiesof landrace rice

Factors (F)	AG3			AG4		
	Amylose content (%)	Gel consistency l(mm)	Gelatinisation temperature	Amylose content (%)	Gel consistency l(mm)	Gelatinisation temperature
Site1: TriTon						
F1= 80-40-40+ organic manures 10 t ha-1	18.6a	87.5a	5	18.3a	85.5c	5
F2= 60-40-40 + organic manures 10 t ha-1	17.8b	87.9a	5	17.5b	86.7b	5
F3= 40-40-40 +organic manures 10 t ha-1	17.7b	87.7a	5	17.2b	86.4b	5
F4= 20-40-40 +organic manures 10 t ha-1	17.6b	85.6c	5	16.6c	87.5a	5
F5= only organic manures 10 t ha-1	17.2b	86.7b	5	16.5c	87.2a	5
F6= 0-0-0+ 0	17.4b	86.7b	5	16.2c	86.2b	5
F7= Famers (120-40-60 + organic manures r 12 t ha-1	18.9a	83.2c	5	18.5a	85.6c	5
Site 2: Tinh Bien						
F1= 80-40-40+ organic manures 10 t ha-1	17.9b	86.7b	5	16.8b	88.5a	5
F2= 60-40-40 + organic manures 10 t ha-1	17.2b	87.6a	5	16.2b	88.2a	5
F3= 40-40-40 +organic manures 10 t ha-1	17.3b	87.2a	5	16.3b	88.7a	5
F4= 20-40-40 +organic manures 10 t ha-1	17.8b	86.6b	5	16.7b	88.6a	5
F5= only organic manures 10 t ha-1	17.6b	87.6a	5	16.8b	88.1a	5

F6= 0-0-0+ 0	17.2b	86.5b	5	16.5b	88.4a	5
F7= Famers (120-40-60 + organic manures 12 t ha-1	18.1a	86.4b	5	17.2a	86.5b	5

3.2.4. The effected of fertilizers on the milledqualities of landrace rice

a) *Experiment at Tri Ton*: Analyzing the rate of milling on rice varieties with different levels of fertilizer recorded in terms of the ratio of head rice, brown rice and the ratio of white rice both varieties AG3 and AG 4 on two points of statistical significance. Analysis of brown rice ratios showed that the F2 treatment gave a high percentage of head rice on both varieties of 55.4% on varieties (AG3) and 52.4% on (AG4). The treatment had the lowest percentage of head rice in the F7 (46.7%). The same of AG 4 (48.7%). AG 3 had much higher head rice at treatment F2 (60-40-40 + organic manures 10 t ha-1). (Table 5)

b) *The experiment at TinhBien* is similar to the one at Tri Ton. The milling ratios of AG3 and AG 4 are statistically significant in the treatments. It is worth noting that the proportion of head rice recorded as AG3 shows higher head rice of AG 4. Treatment F2(60-40-40 + organic manures 10 t ha-1) give hight head rice at AG 3 and AG 4.

Table 5. Effect of fertilizers on milled rice content for landrace rice

Factors (F)	AG3			AG4		
	Brown rice (%)	White rice (%)	Head rice (%)	Brown rice (%)	White rice (%)	Head rice (%)
Site1: TriTon						
F1= 80-40-40+ organic manures 10 t ha-1	80.5d	73.4d	48.8d	82.4a	76.8a	51.2b
F2= 60-40-40 + organic manures 10 t ha-1	81.6c	76.4a	55.4a	80.6c	75.6b	52.5a
F3= 40-40-40 +organic manures 10 t ha-1	81.5c	72.5e	54.b	81.6b	71.4e	50.4c
F4= 20-40-40 +organic manures 10 t ha-1	84.2a	74.6c	53.5c	82.7a	72.5d	50.6c
F5= only organic manures 10 t ha-1	82.1b	72.5e	53.3c	81.6b	75.6b	50.3c
F6= 0-0-0+ 0	81.5c	73.4d	53.2c	80.3c	74.6c	50.5c
F7= Famers (120-40-60 + organic manures r 12 t ha-1	80.5d	75.2b	46.7e	81.2b	74.5c	48.7e
Site 2: Tinh Bien						
F1= 80-40-40+ organic manures 10 t ha-1	80.7b	74.2c	52.3c	82.4a	74.5c	52.7b
F2= 60-40-40 + organic manures 10 t ha-1	81.6a	76.8a	55.6a	81.6b	76.2a	53.2a
F3= 40-40-40 +organic manures 10 t ha-1	78.9c	76.5a	54.6b	82.4a	74.5c	50.4d
F4= 20-40-40 +organic	80.5b	74.5c	54.3b	80.6c	74.5c	51.4c

manures 10 t ha-1						
F5= only organic manures 10 t ha-1	81.5a	74.5c	55.2a	80.4c	75.1b	51.2c
F6= 0-0-0+ 0	80.6b	74.7c	54.7b	80.7c	76.4a	51.7c
F7= Famers (120-40-60 + organic manures r 12 t ha-1	80.4b	75.4b	48.6d	80.9c	75.1b	49.8e

3.3. Discussion

The nitrogen -deficient tree will be elongated in both at Tri Ton and Tinh Bien experiments for both AG3 and AG4 varieties in the treatment F 6. In two sites, the AG4 variety had a higher plant height, compared to the AG3 variety. This is in the same with Dobermann and Fairhust's (2000) comments.The application of nitrogen fertilizer can increase the height of the plant, the number of panicles.According to (Spargo et al.,2013). "the desired pH range of 6.0 to 7.0 of most crops but acidity reduces the availability of nitrogen.Phosphorus and potassium. P deficiency of this nutrient can lead to a decline in plant growth; weak root system, and seed quality, low yield. Phosphorus plays an important role in the development of roots,promoting early flowering and ripening and resistance to disease and drought. In table 2 with treatment 5 and 6 lack of phosphorus the plant height is the same with other treatment but the yield is very low table 3. Phosphorus deficiency can delay the maturation of rice crops and increase sensitivity to rice disease (Fageria et al., 2003). Potassium-deficient plants cannot use nitrogen and water more efficiently and are more susceptible to disease." Low to moderate soils require fairly reasonable management (Belachew and Abera. 2010). Furthermore.The proper application of potassium is closely related to the dependence of cell walls, bundles and growth intensity of the trunk, which enhances resistance to the tree against reclining beans (Kong et al., 2014).Rice plants that are deficient in potassium will often have high cases when the disease enters which can lead to the incidence of the disease. Therefore, this study was conducted to assess the effect of different levels of NPK fertilizer on the growth and productivity of landacerice varieties. Soil organic matter is the local biodegradation that affects soil structure and porosity.The rate of penetration of water, humidity, the diversity and biological activity of soil organisms and the availability of nutrients (Bot and Benitez 2005). Soil structure affects soil fertility and how air and water move through the soil (Macie. 2013).The results revealed no interaction effects of NPK fertilizers and rice varieties on the physiological characteristics, lodging incidence characteristics and yield component. There were significant different observed on the plant height, panicle number, percentage of filled grains and 1,000 grains weight of different rice varieties. Different levels of NPK exerted significant effect on yield and component yield such as 1,000 grains weight and grain yield. This can happen because compost has high nutrients. The tallest plant height is affected by a combination of compost and a fertilizer recommendation N. P. K but does not differ significantly when compared to other experiments except by combining compost and fertilizer n. P. K. at 80 N consciousness (F1). The increase in the height of landrace rice may be related to the full availability of water in the test area during the test period. However,Tri Ton and TinhBien are mainly based on heavenly water, so the disruption of water sources affects the development of rice crops. In this experiment. AG 3 and AG 4 had a slight increase in amylose levels in the F7 test.Which was consistent with previous reports (El-Kadyet al.,1999) reporting that the application of nitrogen fertilizer slightly increased amylose content.

Fertilization depending on the rice variety with the level of 120 N / ha significantly increased the proportion of whole rice decreased in the F7. The yield is also reduced due to the landrace and the leaves are more likely to fall when applying high nitrogen fertilizer. These productivity trends also to explain that limping alone cannot serve to reach the maximum potential of acidic soils.Thus suggesting that depleted soils N and K.Which clearly affect crop performance as were observed when these modifications (fertilizer P) were applied in combination with manure (Farag and Zahran. 2014). Organic sources along with chemical fertilizers have improved the productivity and quality of landraceon the F1 test also recorded in Table 4 . Therefore, it can be inferted that potassium manurealong with K released from straw, increases the availability of this nutrient in complexes and in soil solutions, allowing for better absorption of nutrients as evidenced by the nutritional status of the crop.In many physiological and metabolic processes,including photosynthesis, osmosis, nutrient transport, carbohydrate transport and storage, nitrogen absorption and protein and starch synthesis (Hawkesford et

al.. 2012; Raza et al.. 2014).Given the importance of nitrogen fertilization for the yield in grains from rice crops, it is necessary to know the best dose for each variety as well as its effect on productivity components and other agrocological parameters such as cycle yield, plant height and yield composition of the plant. Increasing the rate of nitrogen fertilizer can increase productivity but reduce particle quality on the F7 test. On the other hand, there are many factors that play a huge role in the quality of rice. The quality of cooked rice and its taste, which is important to consumers.The most important factor that can affect the quality of cooked rice is the amylose (AC) content, which is part of the starch. Other factors such as gel consistency (GC) and gelatinization temperature (GT). In general, the AC in rice grains will determine the softness and hardness of the grain after the cooking process. GC is the mucus ratio during cooking. In fact. GT is the water temperature of starch particles at an irreversible expansion (Zamani and Alizade. 2007). Dong et al. (2007) showed that nitrogen intake had a profound effect on the quality of cooking and the nutritious value of rice, with an increase in GC but a decrease in AC. Young Lee (2006) in this study concluded that there was a negative correlation between the amount of nitrogen and amylase in rice on Table 4 and the rate of milling quality also decreased table 5. Dong et al. (2007) showed that nitrogen intake had a profound effect on the quality of cooking and the nutritious value of rice, with an increase in GC but a decrease in AC. Young Lee (2006) in this study concluded that there was a negative correlation between nitrogen and amylase levels in grains.

IV. CONCLUSION

Integrated application of organic manures and inorganic fertilizers was effective for enhancing growth,yield, and the yield components of landrace rice. The increase in the rate and dosage of N. P and K from the F1 treatment has significantly increased plant height.Panicles per plant (number. 1000-grain weight (g). Filled grains / panicle). The interaction between genotypes and fertilization of nitrogen, phosphate and potassium had a significant effect on all agricultural and crop yield indicators at both test sites. The genotype of the AG3 gives the value of the above indicators higher than that of the AG4 in both locations. The increase/decrease in fertilizer intake has had a significant and statistically significant effect ($p \leq 0.05$) on the yield and quality oflandrace rice grains in both all treatments the exception of 1000-grain weight. AG 3 and AG 4 received with F2 had significantdifferent between NPK fertilizer applied.Therefore it can be recommended to farmers. Theamount of fertilizer used in treatment F2 (60:40:40 kg ha-1+ organic manures 10 t ha-1) is the least.Thus, it gives aneconomical advantage as low fertilizer cost is required to achieve higher yield and better grainquality.

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