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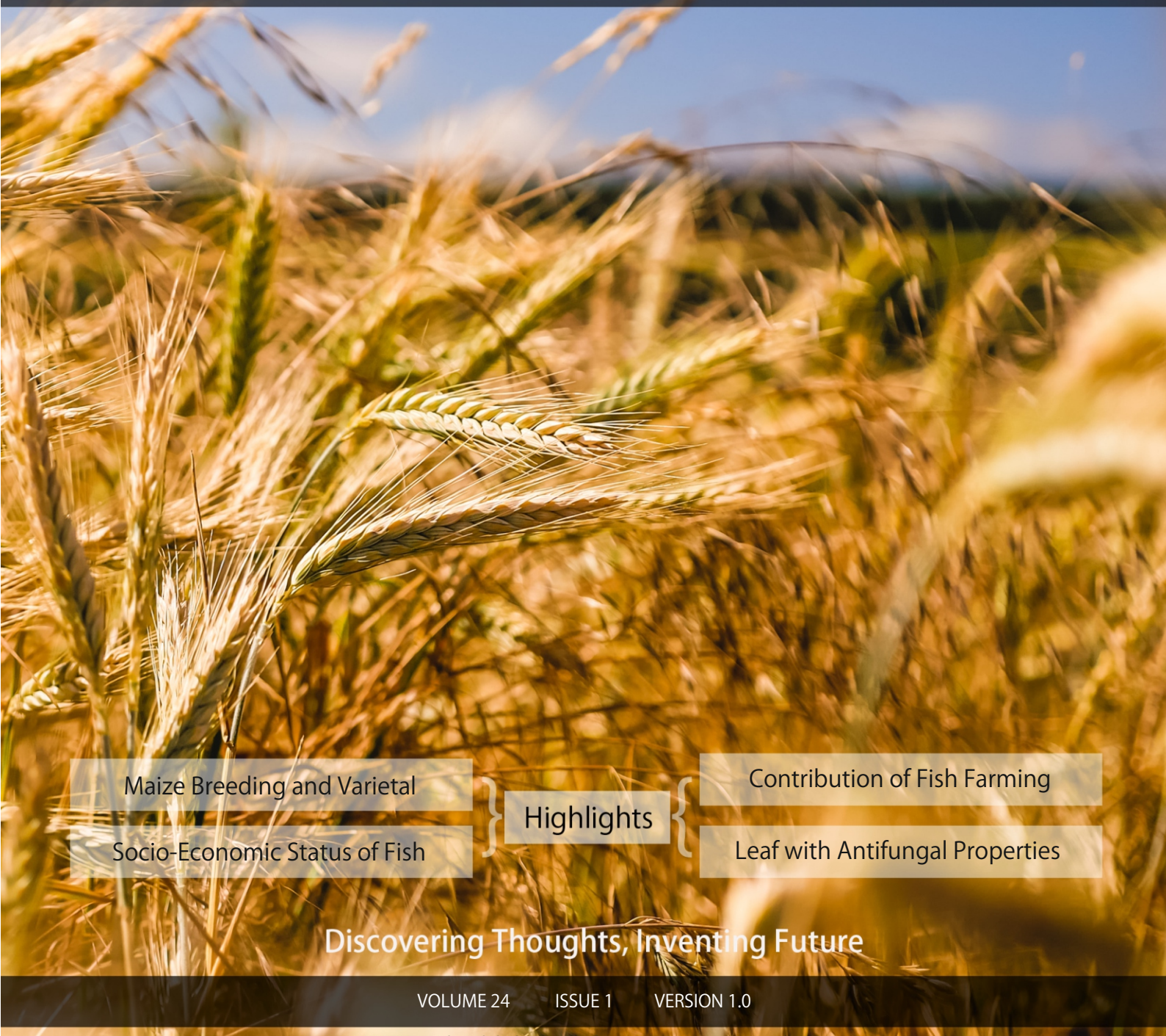

Maize Breeding and Varietal

Socio-Economic Status of Fish

Highlights

Contribution of Fish Farming

Leaf with Antifungal Properties

Discovering Thoughts, Inventing Future

VOLUME 24 ISSUE 1 VERSION 1.0

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The Contribution of Fish Farming to the Socio-Economic Status of Fish Farmers in Ebonyi State, Nigeria

By Igwe, J. A., Olaide, S. Umoh, C. D. & Okeke, PA

Zhejiang Ocean University

Abstract- This study investigated the contribution of fish farming to the socio-economic status of fish farmers in Ebonyi State, Nigeria. Multi-stage sampling techniques was used and 96 farmers were chosen at random. Structured questionnaires were used to collect data, which was then analyzed using descriptive statistics and multiple regression models. The results of socio-economic characteristics revealed that the majority of fish farmers (82.3%) were male, married (62.5%), well-educated, and between the ages of 31 and 40 (43.8%). Benefits derived and constraints faced by farmers had a significant influence on their socio-economic status at $p \leq 0.025$ and $p \leq 0.007$ respectively.

Keywords: benefits-derived, contribution, ebonyi State, fish farming, Nigeria, Socio-economic status.

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The Contribution of Fish Farming to the Socio-Economic Status of Fish Farmers in Ebonyi State, Nigeria

Igwe, J. A. [α], Olaide, S. [σ] Umoh, C. D. [ρ] & Okeke, PA [ω]

Abstract- This study investigated the contribution of fish farming to the socio-economic status of fish farmers in Ebonyi State, Nigeria. Multi-stage sampling techniques was used and 96 farmers were chosen at random. Structured questionnaires were used to collect data, which was then analyzed using descriptive statistics and multiple regression models. The results of socio-economic characteristics revealed that the majority of fish farmers (82.3%) were male, married (62.5%), well-educated, and between the ages of 31 and 40 (43.8%). Benefits derived and constraints faced by farmers had a significant influence on their socio-economic status at $p \leq 0.025$ and $p \leq 0.007$ respectively. The most significant constraints were the high cost of conventional fish feeds, limited access to credit, and the unavailability of fingerlings. The study suggests that farmers be trained in feed formulation, breeding, and other farm management activities to boast production in the study area.

Keywords: benefits-derived, contribution, ebonyi State, fish farming, Nigeria, Socio-economic status.

I. Introduction

Fish is an essential source of animal protein and food security. As an animal protein, it is one of the cheapest, most available and affordable source of quality protein (Omitoyin & Osakuade, 2021). On average, fish and its products account for over 40 percent of total animal protein intake in Nigeria (Egun & Oboh, 2022). It also supplies vitamins, minerals and oils with low level of cholesterol (Odoh *et al.,* 2019). Aside the indispensable role of fish in nutrition and food security, it is a great source of employment and income for farmers' families and different categories of people in its value chain (Subasinghe *et al.,* 2021). Nigerians consume 40% of their animal protein from fish, which is one of the least expensive sources of animal protein (Omitoyin & Osakuade, 2021).

Author α: College of Fishery, Department of Aquaculture Zhejiang Ocean University, Zhoushan 316000, China.
e-mail: jamesigwe94@gmail.com
Author σ: School of Marine Sciences, Ningbo University, Ningbo, 315832, PRC. e-mail: Olaidesaheed65@gmail.com
Author ρ: Institute of Deep-Sea Science and Engineering, University of Chinese Academy of Sciences (UCAS), Sanya, 57200, China.
e-mail: cathyumoh@gmail.com
Author ω: Department of Fisheries and Aquaculture, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.
e-mail: pa.okeke@unizik.edu.ng

In Nigeria, fish farming has a major impact on the prospects for employment. It does not only address the demand for fish consumption but also serves as a source of livelihood for individuals seeking employment opportunities in Nigeria. Studies have highlighted the investment and employment potentials in fish farming, emphasizing its role in creating job opportunities and contributing to economic development in Nigeria (Olabanji & Ali, 2009). It provides a range of professional options, such as jobs in fish farms and hatcheries, aquaculture, and roles like fish hatchery technicians. The industry helps to create jobs for Nigerian workers by offering jobs in sectors including feed production, vegetation management, and equipment manufacturing (Ogunji & Wuertz, 2023). The incorporation of job opportunities and a source of revenue for individuals raises the socio-economic status of farmers and their families in the society (Subasinghe *et al.,* 2021).

Studies on the relationship between fish production and Nigeria's GDP have been carried out; the results highlighted the significance of fish production as a driver of the nation's economic output (Uzonwanne *et al.,* 2023). Fish farming is a major contributor to Nigeria's GDP; in 2020, the sector's share of the country's GDP was 1.09%; in 2021, it was 3.24% in the first quarter (Babangonna, 2021; NBS, 2022).

Fish farming plays a vital role in reducing poverty and contributes significantly to the GDP of Ebonyi State. Economic analysis highlights the positive impacts of fish farming on the local economy which shows a significant reduction of poverty in Ebonyi State (Ozoemena *et al.,* 2022). Additionally, it has been determined that the fisheries sub-sector, which includes fish farming, contributes to the agriculture GDP of Ebonyi State, indicating its significance economically on a regional scale (Ogunji & Wuertz, 2023). It's important to note that fish farming's contribution to Ebonyi State's GDP illustrates its significance for both regional poverty alleviation and economic progress.

The main drawbacks to fish farming enterprise in Nigeria are low productivity, high feed costs, poor infrastructure, bad quality hatchlings, and no access to credit facilities (Akpabio & Inyang, 2007; Ogunremi, *et al.,* 2022; Ogunji & Wuertz, 2023). The limitations in the fish farming industry are also caused by a high mortality rate, a lack of technical skills in fish management and

feeding, a lack of novel technologies adopted, and inadequate extension services (Ogunremi & Olatunji, 2019; Onyeneke, *et al.,* 2020).

It is imperative that these limitations are recognised and addressed if Nigeria's aquaculture sector is to grow sustainably. Hence, the important to emphasise the goals of this research, which include to determine the contribution of fish farming to the socio-economic status of fish farmers in Ebonyi state, ascertain the benefits fish farmers derive from their involvement in fish farming, and identify the respondents' constraints to fish farming.

II. Materials and Method

The study was conducted in Ebonyi State, Nigeria. Ebonyi State is in Eastern part of Nigeria which lies between longitudes 7° 30' and 8° 30'E and latitudes 5 ° 40' and 6 °54'N with a total landmass of 5,935 square kilometers. The State shares a border with Benue State to the North, Enugu State to the west, Imo and Abia States to the south and Cross River State to the east. Ebonyi is primarily an agricultural region. The state produces large quantity of rice, yam, potatoes, maize, beans, vegetables, and cassava. People of the state also engage in production of fish, poultry and livestock such as goat, sheep, cows among others.

Ebonyi has thirteen local government areas as well as local development centres created by the state government. Ebonyi State has a humid tropical climate, with one rainy season and one dry season lasting for 8 and 4 months, respectively. The temperature typically ranges from 20 to 38 degrees Celsius during the dry season and from 16 to 28 degrees Celsius during the rainy season. Harmattan winds are common between December and January. The average annual temperature is 28 degrees Celsius, and the average annual humidity is 50-60%. The region receives an average annual precipitation of 2500mm.

Figure 1: Map of Ebonyi State, Nigeria Population and Sampling Procedure

The population for the study comprised of all fish farmers in Ebonyi State, Nigeria. Multistage sampling technique was used to select the sample for the study. In the first stage, all the 3 senatorial zones (Ebonyi North, Ebonyi Central and Ebonyi South) in the State were selected. In the second stage, random sampling was used to select 2 LGAs each from the senatorial zones, making a total of 6 LGAs from the 13 LGAs in the State. These LGAs include; Afikpo North and Afikpo South, Ebonyi, Ohaukwu, Ikwo and Ezza North. In the third stage, two communities each were randomly selected from the 6 LGAs, giving a total of 12 communities. In the fourth stage, a random sampling was used to select 1 village each from the town communities and finally, 8 fish farmers were also randomly selected to give a total of 96 fish farmers for the study.

a) *Data Collection, Analysis and Measurement of Variables*

Data for the study were obtained through the use a systematic random sampling technique using a well-constructed questionnaire. Descriptive and inferential statistics were used to analyze the data. The independent variables for this study include socio-economic characteristics, enterprise characteristics, fish farmer's involvement in fish farming, benefits of fish farming, constraints to fish farming while the dependent variable is socio-economic status.

Socio-economic characteristics were ascertained by asking the respondents to indicate their age, sex, marital status, level of education attained, household, religion, major occupation and income. Enterprise characteristics of the respondents were elicited by asking them to indicate their source of labour, source of finance, years of farming experience, training on fish farming, types of ponds used, pond stocking capacity, numbers of pond own, fish varieties, method of land acquisition. Fish farmers' involvement in fish farming activities was measured by asking the respondents to indicate their degree of involvement in fish farming activities such as always involved,

occasionally involved and not involved with the assigned numbers of 1, 2, 0 respectively.

The benefits fish farmers derived from fish farming were measured by asking them to indicate the level of benefits from information provided whether it is high, slight and not a benefit with the assigned numbers of 1, 2, 0. With regards to constraints to fish farming, the respondents were asked to indicate their constraints and its degree whether it is major, minor and not a constraint on the basis of information provided. Socio-economic status (dependent variable) was measured by using the scale constructed by Ayeloja *et al.* (2021). This was measured based on the possession of items and quantity for continuous items as a result of fish farmer involvement in fish farming, however, there is an indication of "YES" for possession of items and "NO" for non-possession of items that are categorical among the respondents.

III. Result and Discussion

a) Respondents' Socio-Economic Characteristics

The result of the respondents' socio-economic characteristics presented in table 1 is as follows;

Age is a key factor in productivity and profitability performance of the farmer (Ngeywo *et al.,* 2015). Age distribution of the respondents shows that 43.8% of the respondents were between the ages of 31 and 40 years and 25% of them were between the ages of 41 and 50 years. The implication of this finding believes that most of the respondents (43.8%) were in their economically active age and could make decision and enhance productivity with the hope to become better or venture into fish farming to improve their socio-economic status. This result is consistent with the finding of Adewuyi *et al.* (2010) and Ayeloja *et al.* (2021) from their studies on the analysis of profitability and contribution of fish farming to economic status of fish farmers in Ogun and Oyo states respectively.

Also, the majority of the respondents (82.3%) were male while 17.7% of the respondents were female. This means that males were more involved in fish farming than females which is in agreement with the findings of Ayeloja *et al.* (2021), Adeosun *et al.* (2019) and Adewuyi et al (2010). This could be due to the nature of fish farming which involved regular supervision and monitoring. This was also supported by Olaoye *et al.* (2014); Jambo and Bada, (2021) and Deji and Koledoye (2013) which reported that 80 percent of fish farmers in Ondo State, Nigeria were males.

According Abdulaziz *et al.* (2018), marital responsibility could make farmers make more rational decisions with high accuracy on their own, which could in turn increase their efficiency. Majority (62.5%) of the respondents were married, 24% of them were single, 8.3% are widowed and 5.2% of them divorced. This implies that majority of the respondents were married. On the respondents' religious affiliation, the result also showed that 86.5% of the respondents were Christians, 4.1% of the respondents were Muslims while 9.4 % of them practiced traditional religion. This supports the fact that the Christian religion is a popular religion among the respondents in the study area. This is in line with the finding of Adeosun *et al.* (2019).

Findings also revealed that 52.1% of the respondents had between 4 and 6 persons in their families and 30.2% of them had between 7 and 9 persons in their families. From these findings, it could be deduced that most of the respondents had significant household size which is likely to have influenced fish farming activities. The implication was that there could be more support from spouses and children of the farmers with a view to improving and increasing fish production. This also implied that the fish farmers were responsible and had more roles to play in their families and as such they would be eager to improve their agricultural productivity in order to earn more income. This is in agreement with Olawumi *et al.* (2010) who observed that married household with a reasonable size could provide cheap labor to the family. Also, Nnadi *et al.* (2014) who found that about 35.56% of fish farmers in Delta state have an average household size of greater than six.

In this study, it was also observed that 60.4% of the respondents have tertiary education, 26% of them have secondary education. This implies that most of the respondents attained level of education that qualified them as literate farmers and as such will improve their knowledge and performance in fish farming activities. This finding contradicts the finding of Ayeloja *et al.* (2021).

On the major occupation of the respondents, 41.7% practice fish farming as their main occupation while 19.8% of them are into teaching and civil service respectively. This implies that fish farming in the area is viewed as a profitable venture which makes people to take interest in it despite having other jobs. it is observed that 24% of the farmers earned between 400,000- 500, 000 naira, 23% of the respondents earn 100,000-200,000 while 20.8% earned between 200,000-300,000 naira.

Table 1: Distribution of the Respondents According to Their Socio-Economic Characteristics

Variables	Frequency	Percentage	Mean
Age			
21-30	16	16.7	
31-40	42	43.8	
41-50	24	25	
51-60	9	9.4	
61-70	5	5.2	
Total	**96**	**100**	**31-40**
Sex			
Male	79	82.3	
Female	21	17.7	
Total	**96**	**100**	**Male**
Religion			
Islam	4	4.1	
Christianity	83	86.5	
Traditional	9	9.4	
Total	**96**	**100**	**Christianity**
Marital Status			
Married	60	62.5	
Divorced	5	5.2	
Single	23	24	
Widowed	8	8.3	
Total	**96**	**100**	**Married**
Household Size			
1-3	10	10.4	
4-6	50	52.1	
7-9	29	30.2	
10-11	7	7.3	
Total	**96**	**100**	**4-6**
Level of Education			
No formal education	7	7.3	
Tertiary education	58	60.4	
Primary Edu.	6	6.3	
Secondary Edu.	25	26	
Total	**96**	**100**	**Tertiary education**
Major Occupation			
Teaching	19	19.8	
Trading	18	18.8	
Civil service	19	19.8	
Fish farming	40	41.7	
Total	**96**	**100**	**Fish farming**
Income (N)/Cropping Season			
1,000-100,000	13	13.5	
100,001-200,000	22	23	
200,001-300,000	20	20.8	
300,001-400,000	18	18.7	
400,001-500,000	23	24	
Total	**96**	**100**	**400,001-500,000**

Source: Field survey, 2023

b) Enterprise Characteristics of the Respondents

On the source of labour by the respondents, 44.8% of them used paid labour, 41.7% use family members while 13% of the respondents make use of self labour. This is contradicting to the findings of Onyekuru *et al.* (2019) and Nnadi *et al.* (2014) who observed that farmers depended on their family members for labour in Enugu and Delta states respectively.

Majority (61.5%) of the respondents started the business using personal saving while 5.2% got started with bank loan. This is similar to the finding of Ayeloja *et al.* (2021).On the respondents' years of experience, 43.7% of the respondents had between 1 and 5 years of experience with 56.2% of the respondents having formal

training on fish farming. This implies that majority of those in fish farming have not been in the business for a very long time. Oluwasola and Ige (2015) however, posited that fish farming experience was a significant determinant of net income in catfish production.

On the number of ponds 40.6% of the respondents have 3-4 ponds. On the stocking density, majority (30.2%) of the farmers stock 300-400 fishes. This implied that fish pond production enterprise in the area was mainly of small-scale type, and this supported the findings of Nunoo *et al.* (2012). Majority (49%) of the respondents used both concrete, 32.3% of the respondents used tarpaulin pond, 12.6% of the respondents used earthen pond only as holding/rearing structure. This result contradicts the finding of Ajayi (2013) and Ayeloja *et al.* (2021).

Table 2: Enterprise Characteristics of the Respondents

Variables	Frequency	Percentage	Mean
Source of Labour			
Family members	40	41.7	
Paid labour	43	44.8	
Self labour	13	13.5	
Total	**96**	**100**	**Paid labour**
Source of Finance			
Personal savings	59	61.5	
Family members	25	26	
Friends	2	2.1	
Farmers association	5	5.2	
Micro finance bank	5	5.2	
Total	**96**	**100**	**Personal savings**
Years of Experience			
1-5 years	42	43.7	
6-10 years	33	34.4	
11-15 years	13	13.5	
16-20 years	8	8.3	
Total	**96**	**100**	**1-5 years**
Types of Ponds Used			
Earthen	12	12.5	
Concrete	47	49	
Plastic tank	6	6.3	
Tarpaulin	31	32.3	
Total	**96**	**100**	**Concrete**
Pond stocking density			
200-300	18	18.8	
301-400	14	14.6	
401-500	29	30.2	
501-600	11	11.5	
Above 600	24	25	
Total	**96**	**100**	**401-500**
Number of Pond			
1-2	19	19.8	
3-4	39	40.6	
5-6	38	39.6	
Total	**96**	**100**	**3-4**

Sources: Field survey, 2023

Source and quantity of water available are one of the most important factors to be considered when selecting a site for aquaculture practice. The quantity of water needed for commercial aquaculture varies with the production method employed, type of aquaculture chosen, scale of operation, and species cultured Olaoye *et al.* (2013). Most (58.3%) of the respondents depend directly on either borehole as their major source of water, 28.1 percent depend on deep well as source of water, while 13.5 percent depend on river/stream. In terms of holding/rearing structure, Fish farmers in the study area preferred monoculture to polyculture system (75%). This may be as a result of poor market price for tilapia and also because of the abundance of catfish in the region. Majority of fish farmers adopt monoculture of African Catfish (*Clarias gariepinus*). This might be

because it has been observed that fishes grow better when cultured individually under monoculture system and also help the species to grow to its biggest size. Based on the types of species cultured, majority (86.5%) of the fish farmers in the study area culture mainly *Clarias spp*. under the influence of high market price, greater demand preferences, hardiness of the stock, fast growth, high feed conversion ratio high survival rate under captivity. This may be due to the fact that cat fish appears to be hardy and generally accepted by people. This finding is similar to Ayeloja *et al.* (2021) and Adeosun *et al.* (2019) respectively. On land acquisition 46.9% of the respondents inherited the land, 34.4 percent purchased the land they used for fish farming enterprise.

Majority (68.8%) of the respondents get their fish seed from fish hatcheries while (27.1%) of them source their fish seeds from own farms. This is an indication that they are not well trained to operate a personal fish hatchery, while minority (4.2 %) depend on governments' farms for fish seeds. The fact is that the fingerlings sourced from fish farms are more likely to be healthier and well breed. This finding disagrees with that of Olaoye *et al.* (2013) assessment of farming activities in Oyo state. On source of fish feed, majority (77.1%) depend on commercial feed, 20.7% use locally made fish feeds while a small fraction 2.1% produce their feed.

Based on culturing period (production of table size), (38.5%) of the respondent's culture their fish for four months, 37.5% cultured for six months, 16.7% cultured for three months, while a very low percentage (7.3%) of them cultured their fish for more than six months. Furthermore, majority (55.2%) of the respondent harvest twice a year, while 40.6% and 4.2% do harvest once and thrice respectively. The choice of culture period is usually influenced by factors such as timing towards festive period or due to the lack of feeds as explained by Okoye and Omorinkoba (1994).

Cooperative society is a social participation that helps farmers to pool their resources in order to have access to fisheries inputs and to have insights in their fishing issues. Membership of cooperatives is also a factor that influences the adoption of improved fisheries technologies and poverty alleviation. This shows that majority (54.2%) of the respondents in the study areas were members of cooperative societies while others do not belong to any registered or unregistered society which may be as a result of lack of awareness and interest. Hence, being a member of association /group could create peer pressure for farmers to adopt new technologies. This result is in line with the finding of Olaoye *et al.* (2013).

On the processing of fish, majority (72.9%) of the farmers process their fish supporting the fact that the farmers are well trained and also the believe in the study area that processed fish product cost more than fresh fish hence increasing the income of farmers. Majority (51%) of the farmers use electricity as source of power while 44.8% use generator. Furthermore, on the price/cost of fish in the region majority of the respondent's sale their fish between 1000-1,500/kg while 15.6% sale between 500-800/kg of fish. This might be attributed to the high cost of fish feed, fish seeds and perceived high cost of processed fish in the study area. Majority of the respondents did not receive specialized training on fish farming which can be reflected on their inability to breed/hatch and produce their own feed which have a significant impact on the price of fish in the area.

Table 2: Enterprise Characteristics of the Respondents (contd)

Variables	Frequency	Percentage	Mean
Source of water			
Stream/river	13	13.5	
Well	27	28.1	
Borehole	56	58.3	
Total	**96**	**100**	**Borehole**
Types of culture			
Monoculture	72	75	
Polyculture	17	17.7	
Integrated	7	7.3	
Total	**96**	**100**	**Monoculture**
Fish varieties			
Catfish	83	86.5	
Tilapia	6	6.3	
Common carp	7	7.2	
Total	**96**	**100**	**Catfish**
Method of land acquisition			
Inheritance	45	46.9	
Purchase	33	34.4	

Rent or lease	16	16.6	
Gift	2	2.1	
Total	**96**	**100**	**Inheritance**
Source of fingerlings			
Own farm	26	27.1	
Fish hatchery	66	68.8	
Government hatchery	4	4.2	
Total	**96**	**100**	**Fish hatchery**
Source of fish feed			
Commercial feed	74	77.1	
Local feed	20	20.7	
Own feed	2	2.1	
Total	**96**	**100**	**Commercial feed**
Culture period			
Three months	16	16.7	
Four months	37	38.5	
Six months	36	37.5	
Above 6 months	7	7.3	
Total	**96**	**100**	**Four months**
Harvesting/cropping time (per year)			
Once	4	4.2	
Two times	39	55.2	
Three times	53	40.6	
Total	**96**	**100**	**Three times**
Cooperative society			
Yes	52	54.2	
No	44	45.8	
Total	**96**	**100**	**Yes**
Processing of fish			
Yes	70	72.9	
No	26	27.1	
Total	**96**	**100**	**Yes**
Source of power			
Electricity	49	51	
Generator	43	44.8	
Solar power	4	4.1	
Total	**96**	**100**	**Electricity**
Cost of Fish (Kg)			
N 500-800	15	15.6	
N 800-100	14	14.6	
N 1000-1500	67	69.8	
Total	**96**	**100**	**1000-1500**
Training on fish farming			
Yes	54	43.8	
No	42	56.2	
Total	**96**	**100**	**No**

Source: Field Survey, 2023

c) *Contribution of Fish Farming to the Socio-Economic Status of the Respondents*

The socio-economic status of farmers in this study was measured according to the scale developed by Ovwigho (2000) and adopted by Ayeloja *et al.* (2021). The socio-economic status of the fish farmers was measured in terms of the number of items possessed for continuous items and categorical items by assigning YES and NO to them respectively. The value of 0 and 1 was assigned for possession of items and non-possession of items that are continuous and categorical. The result of the analysis based on the possession and non-possession of items among the respondents in the study area showed that the socio-economic status is high among the respondents with 67.7% and low level of socio-economic status with 32.3% among the respondents with the mean value of 34.17.

Table 3: Contribution of Fish Farming to the Socio Economic Status of the Fish Farmers

	Frequency	Percentage	Mean	Standard deviation	Min	Max
High	65	67.7	34.17	9.46	0.00	42.64
Low	31	32.3				

Source: Field Survey, 2023

d) Fish farmers Involvement in Farming Activities

Table 4 shows the involvement of fish farmers in fish farming activities; majority (70.8%) of the respondents always take part in spawning/breeding of fish while 26% of them are occasionally involved. Majority of the farmers were always involved in the sorting (62.5%), procurement of fish feeds (75%), treatment of water (60.4%), feeding of fish (63.5%) and changing of water. On the other hand, respondents were occasionally involved in harvesting of fish (53.1%), removal of water (58.3%), checking of water temperature (54.2%). This is attributed to the fact that the respondents participated in most of the farming activities and only used paid labour for some of the farm activities. This is in comparison with the finding of Olaoye *et al.* (2021).

Table 4: Fish Farmers' Involvement in Fish Farming Activities

Variable	Never	Occasionally	Always	Mean
Spawning	3 (3.1)	25(26)	68(70.8)	1.229
Sorting	3(3.1)	33(34.4)	60(62.5)	1.31
Procurement of Feed	6(6.3)	18(18.8)	72(75)	1.58
Stocking	-	48(50)	48(50)	1.50
Treatment of water	5(5.2)	33(34.4)	58(60.4)	1.29
Checking of Temperature	9(9.4)	52(54.2)	35(36.5)	1.44
Feeding of fish	2(2.1)	33(34.4)	61(63.5)	1.32
Diseases Control	6(6.3)	52(54.2)	38(39.6)	1.47
Removal of waste matter	-	56(58.3)	40(41.7)	1.58
Harvesting of Fish	-	51(53.1)	45(46.9)	1.53
Changing of Water	-	20(20.8)	76(79.2)	1.20

Source: Field Survey, 2023

e) Benefits Fish Farmers Derived from Fish Farming

Table 5 showed that the majority of the respondents with the mean value of 1.04, 1.11,1.36,1.18,1.39,1.31, 1.11, 1.14 and 1.15, benefitted highly from fish farming in terms of Improve protein in-take, provision of income, knowledge of fish farming, source of employment, increased food security, improvement in materials possession, alternative income source, improvement in social life and improvement in health status while the mean value of 1.17 shows that they slightly used fish farming as a collateral for loan. The observation from this supports the fact that fish farming brings an improvement in the socio-economic status of the respondents in the study area. This finding is in line with Ayeloja *et al.* (2021) and Engle (2008) who reported an improvement in the socio-economic status of farmers in line with the benefits they derive from fish farming.

Table 5: Benefit farmers derived from fish farming

Variables	High	Slight	Not a benefit	Mean
Improve protein in-take	90(93.8)	5(5.2)	1(1.0)	1.04
Provide income	85(88.5)	11(11.5)	-	1.11
Improve Knowledge of fish farming	61(63.5)	35(36.5)	-	1.36
Serves as source of employment	72(75)	21(21.9)	3(3.1)	1.18
Food Security increase	50(52.1)	42(43.8)	4(4.2)	1.39
Use as Collateral for credit	29(30.2)	42(43.8)	25(26)	1.17
Improve materials				

possession	56(58.3)	35(36.5)	5(5.2)	1.31
Improve health status	71(74)	14(14.6)	10(10.4)	1.15
Improves social Life	37(38.5)	36(37.5)	23(24)	1.14
Alternative income source	73(76)	17(17.7)	6(6.3)	1.11

Source: Field Survey, 2023

f) Constraints to Fish Farming

Factors affecting aquaculture production in the region were presented in table 6 in the form of major, minor and not a constraint. Losses at farm also arises from predators such as snakes, monitor lizards, birds and improper harvesting, post-harvest and processing techniques, inefficient marketing due to lack of farmers' investment in marketing activities, which might reduce the revenue generated by farmers along the fish value chain (Agbebi and Fagbenro, 2006).

Nkwocha and Nkwocha (2013) noted that feed type, availability, and high price is a major obstacle to intensive aquaculture profitability in Nigeria. Majority (47.9%) of the respondents perceived that lack of access to credit as a major constraint. Also land acquisition (71.9%), high price of conventional feed (75%) and poor extension services (47.9%) were also a major problem faced by the respondents. In the same vein theft (59.4%), unavailability of fingerlings (52.1%), inadequate water supply (60.4%), disease outbreak (82.3) and mortality of fish (74.0%) were minor problems encountered by farmers. The problems faced by farmers in this study is in accordance with the problems identified by Ajayi (2013), Ume *et al.* (2016) and Ayeloja *et al.* (2021) but disagrees with that of Olaoye *et al.* (2013).

Table 6: Constraints to Fish Farming

Variables	Major	minor	Not a constraint	Mean
Lack of access to credit facility	46(47.9)	35(36.5)	15(15.6)	1.20
Poor extension services	42(47.9)	40(41.7)	10(10.4)	1.32
Theft	16(16.7)	57(59.4)	23(24.0)	1.35
Pollution of water sources	\24(25.0)	57(59.4)	15(15.6)	1.43
Land acquisition	69(71.9)	19(19.8)	8(8.3)	1.11
High price of conventional feed	72(75.0)	20(20.8)	4(4.2)	1.26
Unavailability of fingerlings	35(36.5)	50(52.1)	11(11.5)	1.40
Inadequate water supply	33(34.3)	58(60.4)	5(5.2)	1.55
Disease attack	9(9.4)	79(82.3)	8(8.3)	1.73
Mortality of fish	18(18.8)	71(74.0)	7(7.3)	1.66

g) Result of Correlation Analysis of the Benefits Respondents Derived from Fish Farming and their Socio-Economic Status

The result of the analysis in Table 7 shows that there is a significant relationship between the benefits respondents derived from fish farming and their socio-economic status (r=0.073; p=0.025). It implies that the benefits the respondents gained in ventures into the fish farming business led to an improvement in their socio-economic status. This finding corroborates the finding of Ayeloja *et al.* (2021) who opined that the increase in the socio-economic status of the farmers in Oyo state is as a result of the benefit they gained from fish farming.

Table 7: Result of correlation analysis of the relationship between the benefits respondents derived from fish farming and their socio-economic status

Variables	R-value	p-value	Decision
Benefit derived	0.073	0.025	Significant

Source: Field Survey, 2023

h) Result of Correlation Analysis of the Respondents' Constraints to Fish Farming and their Socio-Economic Status

The result of the analysis in Table 8 shows that there is a significant relationship between the respondents' constraints to fish farming and their socio-economic status (r=0.239; p=0.007). this implies that the constraints to fish farming have a negative effect on the level of socio-economic status of the respondents because these problems affect production and profit making of the farmers. This is similar to the finding of Ume *et al.* (2016) in Anambra state.

Table 8: Result of Correlation Analysis of the Respondents' Constraints to Fish Farming and Their Socio-Economic status

Variables	R-value	p-value	Decision
Benefit derived	0.239	0.007	Significant

Source: Field Survey, 2023

IV. Conclusion and Recommendation

Based on the finding from this study, it can be concluded that fish farming in Ebonyi state is in its developmental stage and is largely on a small scale. The farmers are in their productive age, however, majority of them were male and most of the respondents had 4-6 persons in their family. Farmers attained high level of education giving them edge to understand the strategies involved in the business. The major variety of the fish reared by the farmers was catfish which provides an alternative source of income to them. The contribution of fish farming to the socio-economic status of fish farmers was high, however, the major problem faced by the farmers was lack of access to credit facilities and high price of conventional feeds. There was a significant relationship between the benefit farmers derive from fish farming and socio-economic status.

Based on the findings obtained from this study, we recommend;

- The government should establish fish feed production plant and organize seminar/workshop programme for fish farmers to trained them on the formulation of fish feeds so as to reduce cost of procurement and increase their profit.
- Extension officers should be trained more on the economic dimension of fish farming and not only the technical aspects which will be delivered to fish farmers to enable them understand the economic aspect of their farm thereby leading to efficient use of resources/farm inputs.
- The government should establish hatchery to provide fingerlings to the farmers.
- The government should also make available credit facilities to farmers.

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Normalized Cumulative Ranks for Maize Breeding and Varietal Recommender System

By Santosh Vishwakarma & Shri Niwas Singh

Aquaculture Zhejiang Ocean University

Abstract- Nine varieties of maize (Zea mays L.) namely H4226, RAJAJI, TMMH826, TATA 849, KAVERI 25K-60, RMH 1818, KANAK, BISCO-940 and RASI 4640 were evaluated on thirteen parameters in a randomized block design with three replications. The objectives of the experiment were to select suitable plant types based on considering all the thirteen parameters, suggesting scope for further improvement and recommending suitable maize ideotypes for cultivation by farmers of this region. Normalized cumulative ranks analysis found BISCO-940, KAVERI 25K-60, H4226, TATA 849 and TMMH826 to be top five varieties that could be recommended to farmers for cultivation on the criteria of less number of leaves per plant, small and narrow leaves with high venation, early tasseling and silking, dwarf plant types with lower cob placement, long cobs with less number of bracts for ease of peeling off the cobs and thick cobs with more kernels and kernel rows.

Keywords: composites, hybrid maize, normalized cumulative ranks, synthetics and varietal recommender system.

GJSFR-D Classification: LCC: SB193

Strictly as per the compliance and regulations of:

Normalized Cumulative Ranks for Maize Breeding and Varietal Recommender System

Santosh Vishwakarma [α] & Shri Niwas Singh [σ]

Abstract- Nine varieties of maize (*Zea mays* L.) namely H4226, RAJAJI, TMMH826, TATA 849, KAVERI 25K-60, RMH 1818, KANAK, BISCO-940 and RASI 4640 were evaluated on thirteen parameters in a randomized block design with three replications. The objectives of the experiment were to select suitable plant types based on considering all the thirteen parameters, suggesting scope for further improvement and recommending suitable maize ideotypes for cultivation by farmers of this region. Normalized cumulative ranks analysis found BISCO-940, KAVERI 25K-60, H4226, TATA 849 and TMMH826 to be top five varieties that could be recommended to farmers for cultivation on the criteria of less number of leaves per plant, small and narrow leaves with high venation, early tasseling and silking, dwarf plant types with lower cob placement, long cobs with less number of bracts for ease of peeling off the cobs and thick cobs with more kernels and kernel rows. There is scope for further improvement in the top performer variety BISCO-940 in characters like cob length, & early tasseling and silking. All these three characters could be improved by crossing BISCO-940 with a single variety TMMH826. If this cross proves to be a heterotic combination then a hybrid maize variety could be thought or synthetics and composites could be developed from top five best performers. Thus, normalized cumulative ranks analysis is an excellent versatile tool for plant breeding and varietal recommender system.

Keywords: composites, hybrid maize, normalized cumulative ranks, synthetics and varietal recommender system.

I. Introduction

Maize (*Zea mays* L.) is grown globally in a wide range of environments. However, local field conditions of farmers might suit some specific varieties and farmers might try to look for such suitable varieties based on their criteria of selection. Donald 1968 gave the concept of crop ideotype and since then a lot of crop-ideotypes have been suggested. Here in this experiment, we examine nine maize varieties on thirteen characters *viz.*, leaves/plant, leaf length, leaf width, days to tasseling, days to silking, leaf venation, plant height, cob length, cob placement, number of bracts, number of kernel rows, kernels per row and cob diameter. The idea is to look for maize ideotype with less number of leaves per plant, small and narrow leaves with high venation index, early tasseling and silking, dwarf plant types with lower cob placement, long cobs with less number of bracts for ease of peeling off the bracts from cob and thick cobs with more kernels and kernel rows.

II. Materials and Methods

Nine maize varieties as listed in tables were evaluated on thirteen parameters as mentioned above in the introduction. The data were recorded on five randomly selected plants in each replication. The average values are given in table 1. These values were ranked to make them unitless so that the transformed data become additive. All the ranks of a variety were summed to get cumulative rank (CR) and CR values were divided by minimum value to get normalized cumulative ranks (NCR). These are given in table 2. On sorting table 2 on CR or NCR values in increasing order, we get table 3.

Table 4.1: Average values of three replications

Sort order (rows) VARIETY (down)	Leaves / plant	Leaf length (cm)	Leaf width (cm)	DAYS TO TASSELING	DAYS TO SILKING	LEAF V. INDEX	PLANT HEIGHT	EAR LENGTH	COB PLACEMENT	NO. OF BRACTS	No. of kernel rows	kernels /row	COB DIAMETER
	1	1	1	1	1	0	1	0	1	1	0	0	0
H4226	11	34.46	5.18	48	52	3.09	153.5	37.26	41.23	13	17	33	3.83
RAJAJI	13	47.03	5.8	50	53	2.58	127.1	41.17	53.55	11	14	31	3.85
TMMH826	13	43.09	4.16	47	51	3.6	107	42.64	44.6	12	15	27	3.75
TATA 849	12	34.92	4.66	52	54	2.79	116.4	38.41	44.45	12	15	33	3.84
KAVERI 25K-60	12	28.87	3.77	55	59	4.51	121.7	39.99	44.83	10	15	31	3.77
RMH 1818	11	35.06	5.03	52	55	2.78	108.3	37.91	48.42	10	13	32	4
KANAK	12	34.45	4.4	63	66	3.41	104.6	34.04	41.61	9	14	16	3.77
BISCO-940	12	28.9	3.82	63	66	3.66	94.91	34.03	32.9	11	15	33	3.95
RASI 4640	12	33.46	5.17	61	64	2.32	114.6	35.42	45.8	10	14	33	4.18

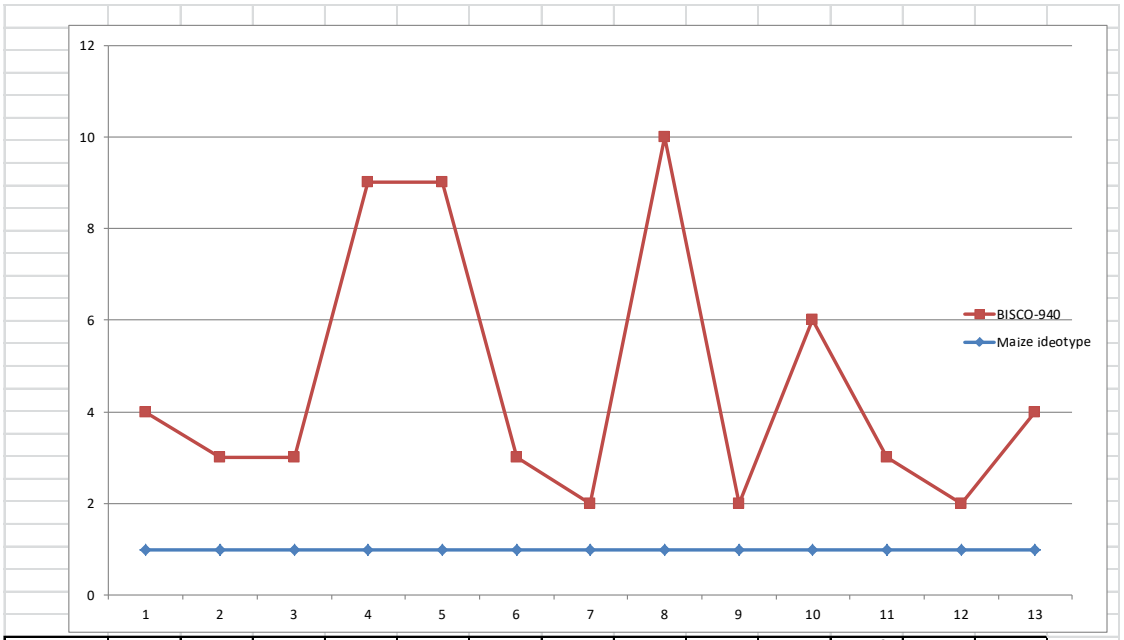
Author α σ: Department of GPB, BRDPG College, Deoria, U.P. 274001, India. e-mail: singhshriniwas769@gmail.com

Sort order (rows) VARIETY (down)	Leaves / plant	Leaf length (cm)	Leaf width (cm)	DAYS TO TASSELING	DAYS TO SILKING	LEAF V. INDEX	PLANT HEIGHT	EAR LENGTH	COB PLACEMENT	NO. OF BRACTS	No. of kernel rows	kernels /row	COB DIAMETER	CR	NCR
	1	1	1	1	1	0	1	0	1	1	0	0	0		
H4226	1	5	8	2	2	5	9	6	2	9	1	1	6	57	1.21
RAJAJI	8	9	9	3	3	8	8	2	9	5	6	6	4	80	1.7
TMMH826	8	8	3	1	1	3	3	1	5	7	2	8	9	59	1.26
TATA 849	3	6	5	4	4	6	6	4	4	7	2	1	5	57	1.21
KAVERI 25K-60	3	1	1	6	6	1	7	3	6	2	2	6	7	51	1.09
RMH 1818	1	7	6	4	5	7	4	5	8	2	9	5	2	65	1.38
KANAK	3	4	4	8	8	4	2	8	3	1	6	9	7	67	1.43
BISCO-940	3	2	2	8	8	2	1	9	1	5	2	1	3	47	1
RASI 4640	3	3	7	7	7	9	5	7	7	2	6	1	1	65	1.38

Table 4.2: Ranks, cumulative ranks and the normalized cumulative ranks

III. Results and Discussion

Table 3 shows the preference order of varieties that should be considered by farmers for selecting suitable maize ideotype for cultivation in their fields in this region. Thus top five varieties namely BISCO-940, KAVERI 25K-60, H4226, TATA 849 and TMMH826 could be recommended for trials. As per table 3, the most suitable variety BISCO-940 could be improved further by paying attention to characters like cob length (ranking 9th) and days to tasseling and days to silking (both ranking 8th) by crossing it with TMMH826 (ranking 1st in all these three characters). The equal values of CR (and hence NCR) of H4226 and TATA 849 indicate that although both these varieties are equally good, yet they may differ in their ranks of various characters like plant height and number of bracts. If, by chance, the cross between BISCO-940 and TMMH826 proves to be heterotic, then a hybrid between these may be thought of and tried. Otherwise synthetic and composite varieties could be tried involving top few varieties. Thus, this analysis opens up a lot of potentials in maize breeding and recommending suitable maize ideotypes. Inbreds could also be analyzed like this to make single cross hybrids or try other potentials. This analysis has been used in many other crops also (Singh 2017, 2018; Singh and Kant 2022, Singh et al. 2018; Singh and Tiwari 2020 and Yadav et al. 2020). The top performer maize variety of this experiment BISCO-940 is also compared graphically as shown in Figure 1 with the maize ideotype being imagined. This graph shows scope for further improvement in most of the characters of the top performer maize variety BISCO-940 except plant height, cob placement and kernel rows. This means that BISCO-940 is at par with maize ideotype in these three characters only. Rest of the characters need maize breeders' attention to improve this variety further.



Characters	Leaves/ plant	Leaf length (cm)	Leaf width (cm)	DAYS TO TASSELING	DAYS TO SILKING	LEAF V. INDEX	PLANT HEIGHT	Cob LENGTH	COB PLACEMENT	NO. OF BRACTS	No. of kernel rows	kernels /row	COB DIAMETER
Maize ideotype	1	1	1	1	1	1	1	1	1	1	1	1	1
BISCO-940	3	2	2	8	8	2	1	9	1	5	2	1	3

Figure 1: BISCO-940 compared graphically with the maize ideotype being imagined here

Sort order (rows) VARIETY (down)	Leaves / plant	Leaf length (cm)	Leaf width (cm)	DAYS TO TASSELING	DAYS TO SILKING	LEAF V. INDEX	PLANT HEIGHT	EAR LENGTH	COB PLACEMENT	NO. OF BRACTS	No. of kernel rows	kernels /row	COB DIAMETER	CR	NCR
	1	1	1	1	1	0	1	0	1	1	0	0	0		
BISCO-940	3	2	2	8	8	2	1	9	1	5	2	1	3	47	1
KAVERI 25K-60	3	1	1	6	6	1	7	3	6	2	2	6	7	51	1.09
H4226	1	5	8	2	2	5	9	6	2	9	1	1	6	57	1.21
TATA 849	3	6	5	4	4	6	6	4	4	7	2	1	5	57	1.21
TMMH826	8	8	3	1	1	3	3	1	5	7	2	8	9	59	1.26
RMH 1818	1	7	6	4	5	7	4	5	8	2	9	5	2	65	1.38
RASI 4640	3	3	7	7	7	9	5	7	7	2	6	1	1	65	1.38
KANAK	3	4	4	8	8	4	2	8	3	1	6	9	7	67	1.43
RAJAJI	8	9	9	3	3	8	8	2	9	5	6	6	4	80	1.7

Table 4.3: Same as table 2 but after sorting on CR or NCR values in increasing order

IV. Summary and Conclusions

On critical examination of tables 1, 2 and 3, it could be safely concluded that top few (say five) varieties namely BISCO-940, KAVERI 25K-60, H4226, TATA 849 and TMMH826 could be recommended to farmer of this region for trials. On the other hand, maize breeders may try hybrid, synthetic and/or composite varieties involving these varieties in various combinations. This analysis could also involve screening inbreds, mutants and all kinds of variants for maize breeding.

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Enhancing Agriculture through AIoT and Data Analytics Middleware

By Hae-Jun Lee

Kangnam University

Abstract- Middleware in Agriculture delves into the data analytics role of systematic Artificial Intelligence of Things (AIoT) in convergence agriculture with smart farming. AIoT devices, remote diagnostic data analytics platforms, data analytics, formal recognition, and vision learning have generated both the amount and nature of work in rural areas. The reason for the developing changes in the global population by age is the bias in the distribution of food resources, as well as changes in climate change and the soil condition of compost. Data scientists are soon attempting to dive convergence Internet of Things (IoT) advances in savvy cultivating to support ranchers in producing better seeds, crop assurance, and manures utilizing AIoT convergence technology [1]. This distinguishes consumer-provider-administrator as a service subscriber role on the platform, which goes for earning the nation's economy and the profitability of ranchers. The central regions where AIoT begins to emerge are agricultural robots, scrutiny, and soil and yield observation. While middleware technology for data analysis is applied, there is a great advantage of analyzing regional observation data at a real-time level.

Keywords: AIoT middleware, data analytics, systematic literature review, AI Technology, agriculture.

GJSFR-D Classification: LCC: S494.5.D3

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Keywords: AIoT middleware, data analytics, systematic literature review, AI Technology, agriculture.

Author: Associate Professor, Ph.D of Computer Engineering, Kangnam University, Republic of Korea. e-mail: haejuna@gmail.com

I. Introduction

Intelligent agriculture has used data analysis and information technology to systematize complex agricultural systems. The field of data analysis has strengthened the agricultural cyclical production process by applying intelligent systems. Data analysis in agriculture could be divided into three production processes and areas: yield, ranger service, livestock (creation and biological welfare), and hydroponic cultivation. AIoT agricultural convergence should be able to reflect crop expansion and real- time changes in farm environments [3]. In detail, precision farming, which employs movement tracking, sensors, and data analysis, optimizes field management, conserves resource information like fertilizer and water, protects soil health, and enhances overall farm efficiency and sustainability. Precision farming, or precision agriculture involves highly controlled, accurate, and optimized agricultural production with AI-aided analysis. It facilitates more efficient resource utilization, better yield, and reduced environmental impact, all at the same time. It pertain to the expected improvement of shrewd PCs, drones, robots, or sensors that might impersonate human exercises to do undertakings for the benefit of individuals and cleverly serve society. Using data processing and learning technology gadgets, application modules hold and analyze these activities history. Brilliant agribusiness, which consolidates AIoT systems and customary horticultural practices, utilizes precision cultivating to screen crop improvement and lift food economies [4].

The approach in which technology has impacted instead, almost every part of our lives isn't remarkable to us. Fans, air conditioners, coolers, plants, entryways, and a lot more can chat with each other and make decisions on actual conditions with practically any human info. In all fields, including brilliant homes, wearables, intelligent urban communities, savvy frameworks such as Universal Middleware, Open Service Gateway initiative (OSGi) and Dynamic Service Platform, connected vehicles, the Modern Internet, store network the executives, medical care, and o forth, AIoT made a critical commitment [5]. IoT is a large group of varied linked devices that use multiple protocols and architectural designs to communicate with one another and carry out predetermined actions on sensor data acquired. Things become more innovate and defensible

judgments are made without human intervention when AIoT are integrated [6].

We examined and could figure out and evaluate the data coming from the many gadgets surrounding us as we join the modern world through the past foot print. When this data is processed, AI is particularly important for IoT devices [7]. Also, We referred to research cases in which blockchain technology is intended to implement the main attributes of blockchain to promote transparency in the agri-food supply chain. They are application cases of precision agriculture, which cross-maps the attributes of agri-food distribution and agri-food origin and sourcing [8].

Agriculture is no longer an exception in this decade of unprecedented technological advancement. Agriculture-related operations were also significantly influenced by AIoT. According to research, deep learning and predictive analysis are proposed, like the R-squared model. Deep learning algorithms in AIoT environments are used to predict the future value of the percentage of GDP produced by agriculture [9]. For further crop creation, it depends on various inward and outside perspectives that are challenging to expect ahead of time, such as each appropriate data analytics knowing weather conditions, manure use, soil quality, bug control, crop wellbeing, weed administration, rise or decrease in temperature, and so on.

Ordinarily utilized techniques miss the mark regarding creating the best results, especially with regards to foreseeing how a yield will act and how much water it will require. Supplement worth will be harmed whenever used in excess, while crop development will be upset whenever utilized in deficient amounts. Water is squandered in irrigational processes by around 60% [10]. Agriculture accounts for around 70% of all water withdrawals globally according to the World Bank, and approximately 60% of that is wasted, largely due to inefficient applications according to the UN's Food and Agriculture Organisation (FAO). For example, problems with home sprinkler systems often go unnoticed. Automated systems usually run every other day, regardless of a rainy forecast. The cumulative effect of inefficient and overzealous watering is taking a toll on our water supply.

In the case of the study for real-time analytics water data, month-wise prediction is performed. The implementations were performed for single and multiple kinds of tree water requirements. After the implementation of the proposed work, the water requirement has been optimized for irrigation, and heavy usage of fresh water and energy waste have also been reduced [11].

AIoT starts with gathering sensor data, analyzing it, and recognizing key components separated by request by the system user that, at last, aid in crop creation[12]. The farming data system considers various factors, including temperature, rainfall figures, weed control, water administration on the board, crop wellbeing checking, and weed control.

Each field, including robotized water system frameworks, agrarian checking models, information examination sought after and supply, crop infection forecast with picture handling, and the exact utilization of pesticides with the sensors, benefited enormously from the AIoT. What's more, the Korean agricultural food market data has sent off various fruitful projects around here, including the Consumer Panel Survey Data (RDA), Outlook and Agricultural Statistics Information System (OASIS), Korea Agro-Fisheries and Food Trade Corporation(KAMIS), and numerous others [13].

The combination of technology and agribusiness has made life simpler for ranchers since they never again need to visit every one of the fields around evening time and remain there until the power or water supply is turned on [14].

Precision farming, smart farming, and digital farming are new ideas in agriculture that are introduced through an increasing number of new approaches, tools, and procedures [15].

The accompanying exercises can be generally dealt with using data information different utilizations of artificial intelligence in farming:

- Checking the entity of soil and yields (screening the harvest's wellbeing). AI might be utilized by organizations to appraise agrarian yields and figure out the most profitable time for gathering by constantly observing harvests and soil wellbeing.
- Finding events of problems (early arrangement of plant sicknesses assists with utilizing the appropriate methodology to battle them) Ranchers will actually want to apply the best sickness-battling procedures with the early arrival of plant diseases.
- A robot activation for cultivating (handling the work difficulties). Reaping assignments might be finished quicker and all the more precisely for representatives by utilizing robots, sensors, machine vision, AI models, and AI frameworks.
- Guesses for Data Information (Empowers right direction with Various dimensions)
- Crop yield anticipating with analytics (foreseeing the best chance to plant). It is possible to gauge the best second to prepare fields and sow seeds utilizing artificial intelligence techniques and devices, bringing about a better return and better value with impeccable timing.
- Strategic spraying (allows for cost savings). The loss of crops in the field caused by the conventional technique of harvesting is decreased with the use of intelligent spraying. Chemical spraying is considered as a crucial technique for managing plant diseases caused by bacteria, fungi, and pest insects.

The number of inhabitants in the globe will rapidly ascend from 7.8 billion in 2020 to around 11 billion before long, as per projections from the Unified Countries. By 2025, there will be 8 billion individuals in the world, and there will be 9.6 billion toward the end of 2050, as per the FAO [16]. To meet the tremendous ascent in population, the world must grow food accordingly. Customary agrarian strategies are lacking to satisfy the rising need for food since ranchers should support yield and give better food to shoppers. AIoT systems and data analysis are essential to meet food demand with limited land, resources, and human resources. By applying AIoT, cloud-based machine learning, satellite images, GPS devices, and advanced analysis technologies, data such as weather, moisture, plant health and soil conditions, and the presence or absence of pests can be collected, and operations based on data analysis can increase yields and reduce costs to improve profitability [17]. Figure 1 shows the practical system architecture Fig1. Agriculture AIoT Advanced Technologies in agricultute.

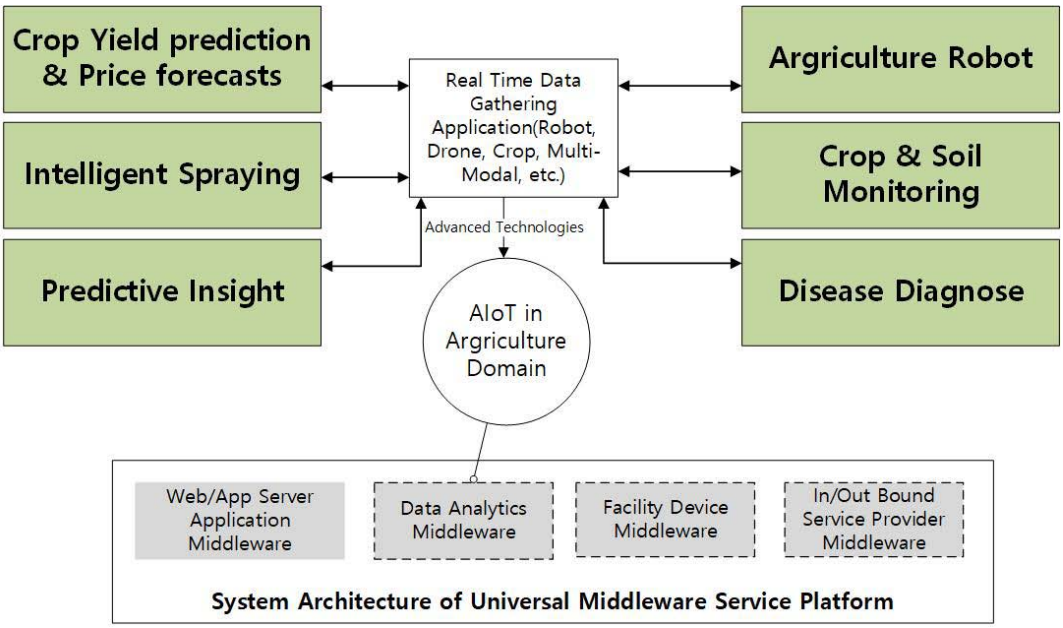

Fig. 1: Agriculture and AIoT Advanced Technologies

A few search queries (Table 1) pertinent to how AIoT are utilized in addressing horticultural troubles were used to separate substance from peer-reviewed scholastic distributions and meetings to secure information zeroing in on the essential parts of this SLR. The data was obtained from the Horticulture Science Data set, Science Direct, and Google Researcher, among different spots.

Table 1: For information recovery during the inquiry recognizable proof, use search strings

Search Terms	About the results
“Data Analysis” AND “Agriculture”	2 700 000
“Agricultural Practices” AND “Artificial Intelligence”	89 900
“Agriculture” AND "Internet of Things”	44 255
“Big data” AND “Agriculture”	22 400
“"Agriculture" AND "Machine learning"	42 22
“Agribusiness AND "Smart sensors”	75 22
“4.0 Agriculture”	4 55
“Shrewd Farming”	47 2
“Precision farming”	75 3

Precision farming is an optimization strategy that incorporates fields and crops specific observation, measurement, and analysis. Robotics, big data, and Advanced analytics are two potential technologies that control precision agriculture. The 4 R's, or proper time, right location, right amount, and right manner, more accurately describe it [18].

"Smart farming": Refers to the method of gathering data from the field and the clever use of that data to carry out the intended operations. It uses data and digital technology and affects all aspects of agricultural operations [19].”

II. Digital Farming in Middleware

Digital farming is a practical idea in light of both brilliant cultivating and accurate data decisions at the right time and in the right way in the field of computed systems using middleware. In the agricultural sector, devices that have been introduced into precision agriculture with information and communication technology can be classified into application services centered on agricultural machinery, robots, and UAVs operating in an interactive environment between wired and wireless sensor networks. Data and services enable farmers to automate a series of previous tasks and enlighten their decision-making. Middleware is a concept that supports open interactions that provide farmers with more options and flexibility between the automation they need and information and communication technology that supports decision-making [20]. For example, middleware could enable a survey on the role of agriculture in the implementation of smart farming components of IoT-based smart farming from the vertical to the horizontal structure of live stock monitoring, Field Monitoring, and green house monitoring. Middleware enables the integration of AIoT devices and supports precision farming practices such as real-time monitoring and decision-making through multiple connectivity options, likes wiring framework service [21]. The strategy gives the information that has been assembled esteem and produces decisions that might be executed for sometime in the future Also, as it offers clients knowledgebase and raw data, it is invaluable for users [22].

Despite the reception of a few contemporary strategies, there are still various issues that should be settled. The objective of the ongoing review piece is to look at a few demonstrated systems utilized in contemporary farming and to represent these procedures actual capacity for what's to come. Figure 2 shows WSN node architecture, including Universal Middleware.

A broad examination is as yet required in creating areas important to observably affect enormous scope ranches in developed nations and on limited scope ranches in emerging nations [23]. Nevertheless the way that the utilization of AIoT and the reception of accuracy in horticulture can extraordinarily work on the general yield and cultivating practices of ranchers.

Focus must be given to how these advances might be made available to non-industrial countries and country locales since the reception of accurate horticulture depends on something other than the utilization of these technologies on business ranches.

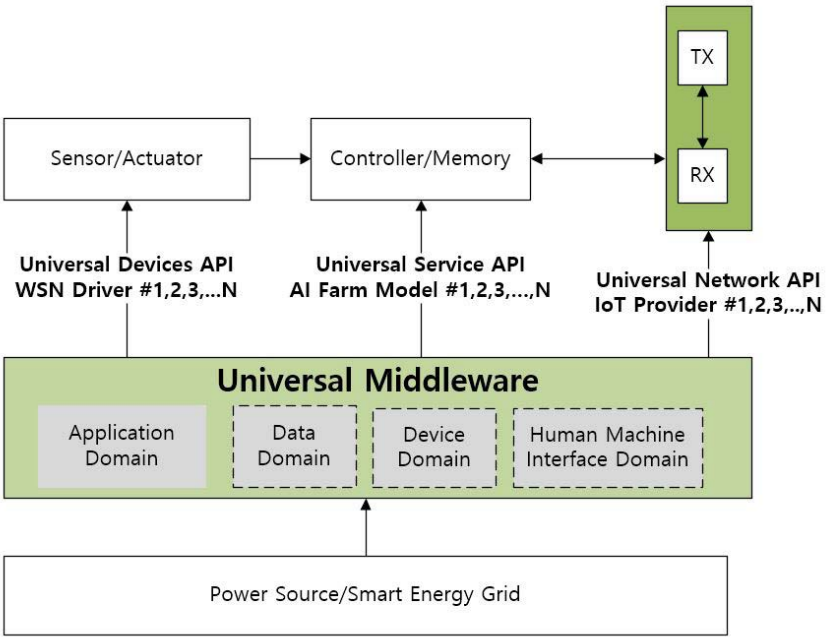

Fig. 2: WSN node architecture including Universal Middleware

It is necessary to develop a network and computer system for rural regions that is more effective and dependable regarding energy supply, network latency, throughput, and performance. Improves access to the advantages of precision agriculture by reducing network delay in locations with lower connections and more significant bandwidth limits [24]. Facilitate the availability of resources for value-added cyclical farming that has the potential to improve production and maybe other aspects of agricultural output.

III. System Methodology using Universal Middleware

Probably one of the most essential aspects of life organized on the space planet is food and agriculture. To address various issues, the convergence of agriculture into the food industry might benefit the public from AI and its IoT subfields, including data analytics, vision learning, and multi-modal handling. Systematic methodologies in Universal Middleware organized methodology level, web access controller, connector, application management, configuration manager, device manager, preferences, light web server, and wire with XML parser. There are applications for agriculture services that are customized in the context of the middleware system. While AI roadmap can be utilized in these cycles during preproduction (crop yield and finding water system spills), creation (sickness location and climate expectation), handling (item assessment), and circulation (stockpiling and customer examination), IoT gear can be utilized to gather valuable data from crude information on ranches in regards to agribusiness and water system [25]. Creators ought to investigate, fathom, and classify the latest examination distributions in their field of revenue prior to doing investigation and reaching resolutions in light of their outcomes. AIoT middleware spans a common agricultural value chain of standards across industries that incorporate multiple applications. IoT applications can use different individual IoT systems depending on the value cycles of crop and livestock production. We present the concept of a universal artificial intelligence (AI) system that operates on an independent AI module interconnected by a comprehensive cloud network [26]. We searched for diary articles, meeting papers, and book sections that examined AIoT applications in agribusiness for the momentum literature study. As the several of interconnected devices continues to grow in IoT systems, various dynamic big data is generated. In one study, intelligent processing and analysis of big data provided a higher level of knowledge base and insight that resulted in better decision-making, prediction, and reliable management of sensors. Using middleware and sensor data analysis within agricultural ecosystems, AI algorithms can explore advanced data-driven case studies while expanding to food, energy, and water integration systems. We explored sustainable works recorded in Yemeserach Mekonnen et al. 2020 J. Electrochem [27].

IV. Following Preparing, Carrying Out, and Reporting Stages

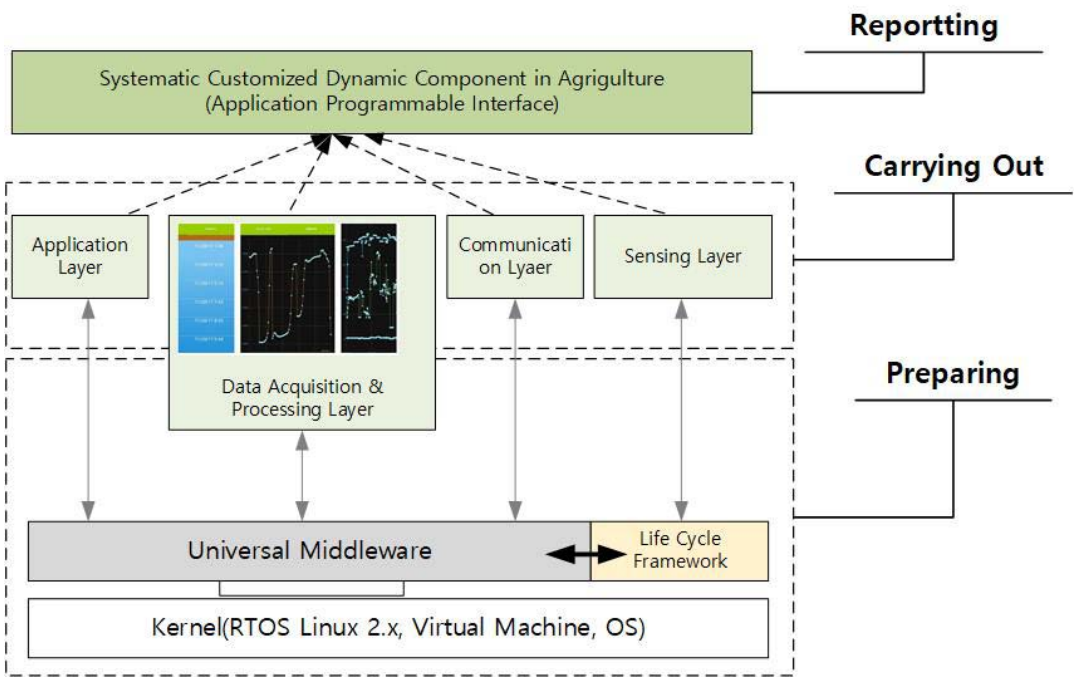

Fig.3: Systematic Methodology in Universal Middleware

Figure 3. Gives the design concept in a natural-time environment of a systematic framework in universal middleware utilized for this work. This methodology can be divided into three areas. First, it is an execution environment in which kernel and universal middleware structures are applied in the form of system porting,

which constitutes system stability. Second, carrying out, which comprises communication, data, and application services, is a modular service managed by the life cycle process. Third, it is a reporting area where users, farmers, or operators can customize data and view information. Data acquisition and processing layers could be easily realized applications of AI and IoT technologies, addressing challenges in data integration or scalability, or enhancing the usability of middleware in diverse agricultural settings.

The justifications for doing a literature review in a particular field are considered account during the planning stage. In this example, various novel applications are introduced, including efficiency, harvest and animal checking, abnormal action recognition, water system spillage location, and observing. The most advantageous AI draws near, including AI, master frameworks, the Internet of Things, and picture/video handling, are likewise investigated notwithstanding these application areas [28].

V. Agricultural Sector

From several angles, intelligent farming technologies impact on the farming industry. The effectiveness of water use, for instance, will benefit from observations and data collection from big farms on humidity, air temperature, soil moisture, and solar intensity. As a result, it will have an impact on agricultural output as a whole. Since the population of the globe is growing every day, it is crucial to employ innovative agricultural practices to boost food output. The ideal method for boosting food output and maximizing profit is, therefore, smart farming. Utilizing IoT platforms and inexpensive sensors, innovative agricultural solutions should be put into practice efficiently while conserving time, money, and resources. The Korean government implemented the policy using the ICT infrastructure to build the supply chain for agri-food. In the United States, the system for smart agricultural technology does not exist. Fundamentally, smart agricultural solutions have been led to high-tech by private-centered competition. Understanding the difference between the two methods can provide a different path than before [29]. The agricultural industry will gain from these implementations in various ways, including enhanced animal farming, remote monitoring of fields, decreased environmental footprints, real-time data collecting, cheaper operating costs, and higher output quality [30].

Brillant farming research and development is encouraged in many nations to increase sustainable food production and improve farmer profitability. One instance of smart farming being used in the agriculture industry was given. They tended to the troubles related to such drives while considering the availability of beneficial examination offices, HR, and ecological contemplations [31].

Figure 4. Illustrates the AI technology of an IoT savvy cultivation framework. Drones, Wi-Fi bots, and IoT sensors (like optical, electrochemical, mechanical soil, area, and airflow sensors) assemble information from the fields and send it to the AI-based brilliant cultivating framework through the cloud. Savvy cultivating frameworks remove data from unstructured information and assist with cultivating the executives and navigation by utilizing various AI, picture handling, PC vision, remote detecting, and master framework techniques. These techniques work on rural and supply organizations' quality, efficiency, and sustainability [32]. Looking at the role of middleware, first, the collected information is processed and sent through the cloud to the service delivery platform on the AI cultivation framework. Next, the service delivery gateway provides functional problems including IoT-based control, energy management, surveillance, remote management, lack of resources, and cost management services. In this case, the service delivery platform integrates various technologies (UPnP, SNMP, AI, photo processing, PC vision, remote detection, unstructured information, etc.) with the application services (HTTP, WAP, Instant Messaging, Web Services) and external systems that use separate security layers (SSL, TLS, WTLS).

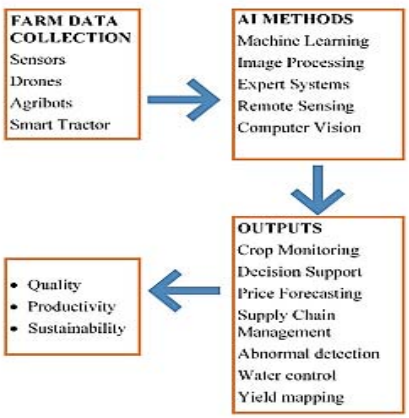

Fig. 4: IoT innovative agricultural system with AI

Proposed an IoT-based data analytics strategy for "digital farming in middleware" to assess agrian output. IoT sensors gather information from farms, assisting farmers in decision-making and crop monitoring. Applications for smart phones and the web are particularly practical in distributing product information and facilitating online shopping. Several AIoT-based agricultural approaches to established farming practices [33]. Their discoveries exhibit that AI-based rural creation and data analytics are more successful and worthwhile, and that ranchers who practice shrewd cultivating have better satisfaction record scores and expectations for everyday comforts than ranchers who utilize traditional farming [34].

VI. Conclusion

Smart farming in Middleware is an idea that incorporates endlessly overseeing ranches using current advances like IoT, robots, and AI to raise the amount and nature of merchandise while diminishing the requirement for human work underway [35]. Middleware develops the required diversity by introducing new technologies due to AIoT while maintaining its advantages while operating a farm. This technical feature is, first, the expansion of the space for connecting the introduced devices. Second, it is communication between all users that appears while integrating vast application services that connect the inside and outside of the farm[36]. Distance using the k-means algorithm with large amounts of data generated during agricultural production. The crop growth curve is simulated and compared with the improved K-means algorithm. The experimental results of the k-means algorithm enable more efficient real-time data communication and information processing functions and play an important role in promoting agricultural informationization and improving levels. When using middleware, it can be used in combination by applying different algorithms depending on the application domain. Considering that populace numbers are rising quickly all over the globe, these benefits will well affect the public economy's profitability and extension. To help ranchers in steppin and utilising AI technology to produce better seeds, crop security, and manures, specialists and researchers are pushing toward utilising recently delivered IoT advances in shrewd cultivating.

The most current uses of AI and IoT with perspective techniques in intelligent farming middleware have also been covered in this study, with an emphasis on the AI techniques or algorithms employed and the accuracy rates attained [37]. Universal Middleware for system methodologies were presented to show the most current AI perceptual design concept and systematic methodology, their related applications, and the accuracy levels achieved. Researchers have seen highly encouraging outcomes when successfully using AI methodologies. This study has offered comprehensive explanations of complex AI applications in smart farming. To sum up, the idea of smart farming and precision agriculture is to improve agricultural civilization, and it seems that the only way agriculture will flourish is if most farmers adopt these technologies into their farming methods [38]. The limitation of this study is that it focused on preparing and carrying out Therefore, in the future, an expanded field case study is needed for personalized verification for each user of Reporting Stages. In particular, private-centered case studies in the United States will be a scientifically important turning point.

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Morphological Characterization of Yam Genotypes from Different Geographic Origins in Angola

By Rosalina Esperança da Silva Carlos, Simone Alves Silva,
Ricardo Franco Cunha Moreira & Sandra Domingos João Afonso

Federal University

Abstract- Yam *(Dioscorea spp.)* is a vegetable of great economic and social importance, cultivated in tropical and subtropical regions. It is a staple food for millions of people, especially in West Africa, valued for its tuberous roots rich in carbohydrates, proteins, vitamins and minerals. In addition to its nutritional value, yam has cultural and medicinal significance, used in ceremonies and therapies. In Angola, climatic and geographic diversity favors the cultivation of different yam genotypes, resulting in a genetic heritage that is crucial for crop resilience and food security. The morphological characterization of genotypes allows the identification of varieties with desirable attributes, such as disease resistance, productivity and nutritional quality, facilitating genetic improvement programs. This study aims to morphologically characterize yam genotypes from different geographic origins in Angola, contributing to the knowledge and conservation of genetic diversity and the development of sustainable agricultural strategies.

Keywords: *dioscorea spp; genetical diversity; descriptor analysis.*

GJSFR-D Classification: *FOR: 0703, 0706*

MORPHOLOGICALCHARACTERIZATIONOFYAMGENOTYPESFROMDIFFERENTGEOGRAPHICORIGINSINANGOLA

Strictly as per the compliance and regulations of:

Morphological Characterization of Yam Genotypes from Different Geographic Origins in Angola

Rosalina Esperança da Silva Carlos [α], Simone Alves Silva [σ], Ricardo Franco Cunha Moreira [ρ] & Sandra Domingos João Afonso [ω]

Abstract- Yam *(Dioscorea spp.)* is a vegetable of great economic and social importance, cultivated in tropical and subtropical regions. It is a staple food for millions of people, especially in West Africa, valued for its tuberous roots rich in carbohydrates, proteins, vitamins and minerals. In addition to its nutritional value, yam has cultural and medicinal significance, used in ceremonies and therapies. In Angola, climatic and geographic diversity favors the cultivation of different yam genotypes, resulting in a genetic heritage that is crucial for crop resilience and food security. The morphological characterization of genotypes allows the identification of varieties with desirable attributes, such as disease resistance, productivity and nutritional quality, facilitating genetic improvement programs. This study aims to morphologically characterize yam genotypes from different geographic origins in Angola, contributing to the knowledge and conservation of genetic diversity and the development of sustainable agricultural strategies. Accessions were collected in the provinces of Cabinda, Cuanza Norte, Cuanza Sul, Malange, Uíge and Huambo, including *Dioscorea esculenta, Dioscorea alata, Dioscorea cayenesis* and *Dioscor eabulbifera*. After collection, the materials were documented with detailed information obtained from interviews with local producers. The accessions were planted at Fazenda Esperança, in the province of Huíla, from August 2022 to October 2023, in a completely randomized experimental design with 15 replications of each species, totaling 60 plants. Management practices included irrigation, staking and manual weeding. The morphological characterization was carried out after six months of planting, evaluating 22 descriptors of the aerial parts of the plants and, after 11 months, the tuber characterization was carried out in the Laboratory of the Institute of Agricultural Research in Huíla. Data analysis revealed significant variability in plant characteristics. All accessions had alternate leaves, with 50% having sagittate leaves, 25% lobed leaves and 25% chordate leaves. The majority of accessions (75%) did not have leaf lobes. Regarding petiole length, 65% had petioles between 5 and 10 cm, predominantly green (65%). The majority of accessions (61.67%) had a distance between the insertion of the petiole on the leaf and the upper end greater than 4 cm. Regarding tubers, 71.67% of accessions had underground tubers, with 31.67% elongated, 43.33% oval and 25% irregular. Statistical analysis showed significant differences between yam species in all morphometric characteristics evaluated, with *Dioscoreabulbifera* standing out with the highest average values for most of these characteristics.

Keywords: dioscorea spp; genetical diversity; descriptor analysis.

I. Introduction

Yam (*Dioscoreaspp*.) is a vegetable of great economic and social importance, widely cultivated in tropical and subtropical regions (Wang *et al*., 2023). It stands out as a staple food for millions of people, especially in West Africa, where species such as *Dioscorea alata* L. and *Dioscorea rotundata* (P.) JM are cultivated for their tuberous roots rich in carbohydrates, proteins, vitamins and minerals (Cazé Filho, 2002; Karkute*et al*., 2017; In addition to its nutritional value, yam has cultural and medicinal significance, being used in various ceremonies and for therapeutic purposes (Padhan; Panda, 2020; Sousa; Raizada, 2020).

In Angola, with its varied climatic and geographical conditions, it offers a favorable environment for the cultivation of different yam genotypes (Kumar *et al*., 2014). The genetic diversity found in the country's yam plantations is the result of traditional agricultural practices, which involve the selection and propagation of local varieties adapted to the specific conditions of each region (Danquah *et al*., 2022). This genetic heritage is fundamental to the resilience of crops and the country's food security.

The morphological characterization of yam genotypes allows the identification of varieties with desirable attributes, such as disease resistance, productivity and nutritional quality, in addition to facilitating genetic improvement programs (Agre et al., 2019; Syombua *et al* ., 2021; Norman *et al. al*., 2022).

To fully exploit the agricultural and economic potential of yam in Angola, it is crucial to obtain a detailed understanding of the morphological characteristics of the different genotypes present in the country. In this sense, this study aims to morphologically characterize yam genotypes from different geographic origins in Angola, aiming to contribute to the knowledge and conservation of the crop's genetic diversity, as well

Author α: PhD in Agricultural Sciences at the Federal University of Recôncavo da Bahia. Institution: Federal University of Recôncavo da Bahia (UFRB). e-mails: rosalina.carlos258@gmail.com and vitorialina77@gmail.com

Author σ: PhD in Plant Genetic Improvement from the Federal University of Pelotas. Institution: Federal University of Recôncavo da Bahia (UFRB). e-mail: sas@ufrb.edu.br

Author ρ: PhD in Genetics and Plant Breeding from Universidade Estadual Paulista/Jaboticabal. Institution: Federal University of Recôncavo da Bahia (UFRB). e-mail: ricardofcm@ufrb.edu.br

Author ω: PhD in Agricultural Sciences from the Federal University of Recôncavo da Bahia. Institution: Instituto Superior Politécnico do Cuanza Sul (ISPCS). e-mail: sandra.afonso3@gmail.com

as to the development of sustainable and efficient agricultural strategies.

II. Material and Methods

*a) Obtaining and Processing Plant Mat*erial

The accessions were collected from expeditions in the provinces of Cabinda, Cuanza Norte, Cuanza Sul, Malange, Uíge and Huambo, belonging to the country of Angola (Figure 1). Of these, we obtained two accessions *Dioscorea esculenta* (L.) B., five from *Dioscorea alata* L., six from *Dioscorea cayenesis* L. and two from *Dioscorea bulbifera* L., as shown in Table 1.

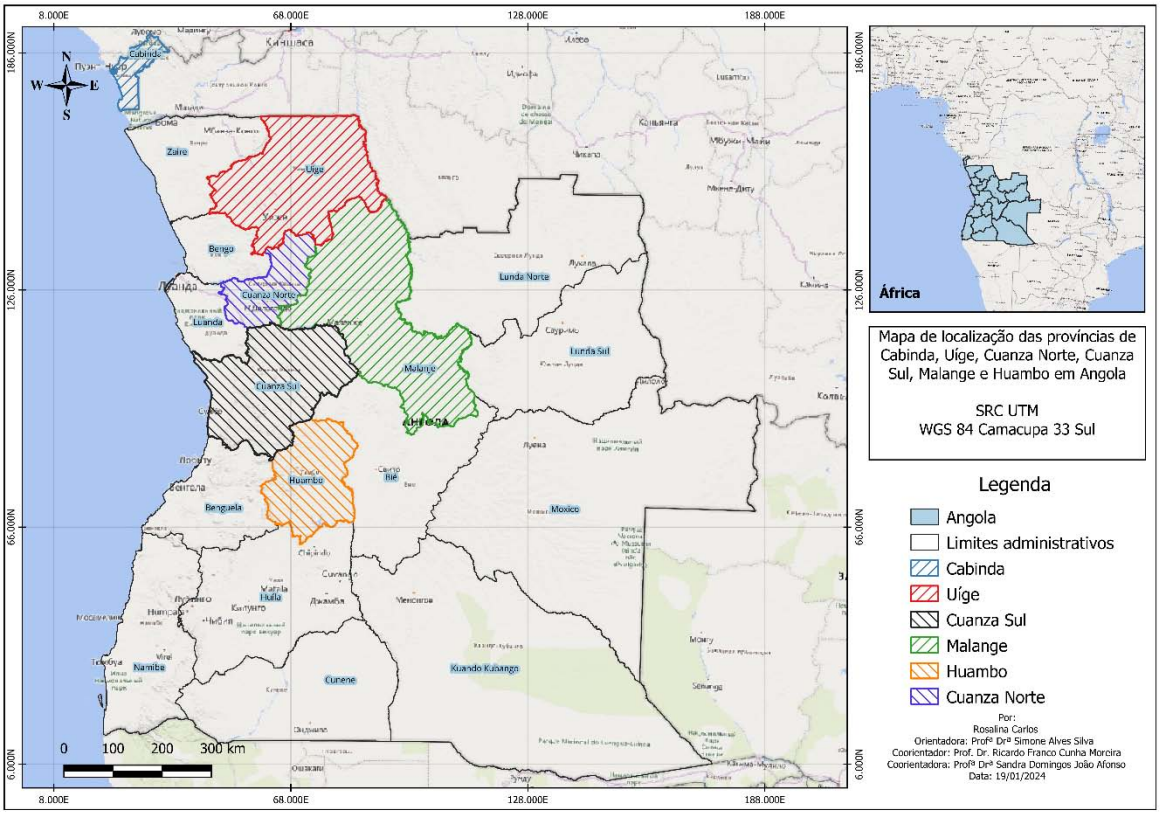

Figure 1: Location of yam (*Dioscorea spp.*) collection points in six provinces of Angola

Source: CARLOS (2024)

Table 1: Geographic location of the yam accessions *Dioscorea spp.* in different provinces of Angola

Identification	Access	Common name	Geographic coordinates	Province
1	*Dioscoreaesculenta*	Assipi	12°46'48"S, 15°45'00"E and 1,700m	Huambo
two	*Dioscoreaesculenta*	Assipi	11°12'36"S, 13°50'24"E and 0 to 10m	Cuanza Sul
3	*Dioscorea alata*	Purple Mbanza	07°36'36"S, 15°03'00"E and 850m	Uíge
4	*Dioscorea alata*	N'guenge	09°18'00"S, 14°54'36"E and 1,180m	Cuanza Norte
5	*Dioscorea alata*	N'guenge	09°32'24"S, 16°20'24"E and 1,180m	Malange
6	*Dioscorea alata*	Mbambi	05°32'60"S, 12°11'60"E and 20m	Cabinda
7	*Dioscorea alata*	Yam	11°12'36"S, 13°50'24"E and 0 to 10m	Cuanza Sul
8	*Dioscorea cayenesis*	Yam	12°46'48"S, 15°45'00"E and 1,700m	Huambo
9	*Dioscorea cayenesis*	Yam potato	07°36'36"S, 15°03'00"E and 850m	Uíge
10	*Dioscorea cayenesis*	Mbambi	05°32'60"S, 12°11'60"E and 20m	Cabinda
11	*Dioscorea cayenesis*	Ngame	09°18'00"S, 14°54'36"E and 1,050m	North Cuanza
12	*Dioscorea cayenesis*	Yam	11°12'36"S, 13°50'24"E and 0 to 10m	Cuanza Sul
13	*Dioscorea cayenesis*	N'guenge	09°32'24"S, 16°20'24"E and 1,180m	Malange
14	*Dioscorea bulbifera*	Heart Potato	09°18'00"S, 14°54'36"E and 1,050m	Cuanza Norte
15	*Dioscorea bulbifera*	Heart Potato	07°36'36" S, 15°03'00" E and 850 m	Uíge

After collection, the materials were identified and documented with detailed information about each accession, which was obtained through interviews with local producers, covering aspects such as local nomenclature, management methods and use of varieties.

b) Area and Experimental Design

After obtaining access provided by rural producers, this material was taken to Fazenda Esperança, located in the city of Huíla (14°91'75"S, 13°49'25"E and 1,805m altitude), to be deployed in the field during the period from August 2022 to October 2023 . The region is characterized by having a humid to dry subtropical climate, with an average annual temperature varying between 20°C and 22°C. Precipitation is relatively uniform throughout the year, with a more intense rainy season from October to April, while the months of May to September tend to be drier.

The experimental design adopted was completely randomized, containing 15 replications of each species obtained, totaling a collection of 60 plants. Each genotype was arranged in plots consisting of three lines of 5 plants, totaling 15 plants per plot. Plants were spaced 1.0 to 1.2 meters between rows and 0.8 to 1.0 meters between plants within each row. During growth, management practices such as irrigation, staking and manual weeding were implemented. These practices ensured adequate plant development and minimized competition for resources.

c) Morphological Characterization

After six months of planting, the characterization of the aerial part (leaves and stems) was carried out, using descriptors selected according to the key proposed by IPGRI/IITA (1997) for species of *Dioscorea*. 22 descriptors were evaluated, of which 15 were qualitative and 7 quantitative (Table 2). The characterization of the aerial part was conducted with the aid of a ruler and analog universal caliper. The plants evaluated were those selected for tuber multiplication.

Table 2: Descriptors used for the morpho-agronomic characterization of yam accessions (*Dioscoreaspp.*) in Angola

Identification	Descriptor	Classes (codes)
	Stalk	
1	Color	1. Green; 2. Green with purple bands; 3. Green with brown bands; 4. Purple
two	Wings	1. Gift; 2. Absent.
	Wing color	1. green; 2. Purple
3	Thorns	1. Gift
4		2. Absent
5	Growth direction	1. Schedule; 2. Counterclockwise.
	Presence of glasses	1. Gift; 2. Absent.
6	Diameter (15 cm from the base of the plant)	1. < 0.4 cm; 2. 0.4 - 0.6 cm; 3. >0.6cm
7	Stem shape	1. Polygonal; 2. Round
	Sheets	
8	Position	1. Alternate; 2. Opposite
9	Form	1. Cordata; 2. Sagitada
10	Petiole length	1. <5cm; 2. 5 - 10 cm; 3. >10 cm.
11	Petiole color	1. Green; 2. Green with brown; 3. Purple
12	Distance from the insertion of the petiole on the leaf to the upper end of the leaf (adult leaves)	1. <2cm; 2. 2 - 4 cm; 3. >4cm
13	Distance from the insertion of the petiole on the leaf to the lower end of the leaf (adult leaves)	1. <10cm; 2. 10 - 15 cm; 3. >15cm
14	Leaf width at largest portion (adult leaves)	1. <10 cm, 2. 10 - 15 cm; 3. >15cm
	Tubers	
15	Underground	1. Gift; 2. Absent
16	Presence of aerial tubers	1. Gift; 2. Absent
17		1 one; 2. Some; 3. Many
	Number of tubers	1. One; 2. Some; 3. Many
18	Form	1. Elongated; 2. Irregular; 3. Oval
19	Length	1. <20cm; 2. 20 - 40 cm; 3. >40cm
20	Width (major axis)	1. <7cm; 2. 7 - 12 cm; 3. >12cm
21	Shell color	1. Brown; 2. Yellow
22	Pulp color	1. White; 2. Yellow; 3. Purple; 4. Purple with white

Source: Adapted IPGRI/IITA (1997)

At 11 months since implantation, the tubercles were characterized. The physical analyzes were carried out in the Laboratory of the Agricultural Research Institute (IIA) of Huíla. The tubers were subjected to a visual inspection and evaluated for health, physical integrity, size and shape. They were then washed in

running water. Subsequently, they were weighed on a semi-analytical scale, peeled and sliced mechanically.

The measurements taken included the weight of the tuber with the skin (kg) and the weight of the tuber without the shell (g), which were obtained using a digital scale. In addition, the tuber length (cm), longitudinal and transverse diameter (cm), and longitudinal and transverse thickness (cm) were recorded. These measurements were carried out with the aid of a ruler and digital caliper. Subsequently, the tubers were cut in half and evaluated for longitudinal and transverse thickness. The weight of the tuber without the shell was measured again for recording.

d) Statistical Analysis

For the set of data obtained through the descriptors, the percentage frequencies of each class and the entropy level of the descriptors were calculated using Renyi's entropy coefficient (Renyi, 1961). The physical characterization of the tubers was submitted to analysis of variance (ANOVA), using the F test, and the means were compared using the Tukey test ($p<0.05$). Data analysis was performed using the R program (R Core Team, 2024).

III. Results and Discussion

Analysis of morphological data from yam accessions in several provinces of Angola revealed significant variability in the characteristics of the plants studied (Table 3). Among the 60 accessions analyzed, all had alternate leaves, suggesting a peculiar adaptation of these plants to the Angolan environment. The presence of alternate leaves in yam plants may be a reflection of their chromosomal evolution and genetic basis, as discussed by Bredeson *et al.* (2022). This characteristic may be related to agronomically important traits, as mentioned by Maroya *et al*. (2022), which address the transformation of yam seed systems in West Africa, highlighting the importance of producing high-quality seed tubers.

Table 3: Absolute, percentage and relative frequencies and entropy level for the evaluated descriptors of the *Dioscoreaspp yam accessions*. In different provinces of Angola

Descriptors	Classes	Frequency Absolute	Frequency Percentage (%)	Frequency Relative	Level of Entropy(H')
Sheet position	Alternate	60	100	1	0
	Opposite	-	-	-	
Leaf shapes	Cropped	15	25	0.25	1.5
	Sagittadic	30	50	0.5	
	lobada	15	25	0.25	
Number of leaf lobes	Absence	45	75	0.75	0.81
	One	15	25	0.25	
	Three	-	-	-	
Petiole length	< 5cm	13	21.67	0.22	1.27
	5 - 10 cm	39	65	0.65	
	> 10 cm	8	13.33	0.13	
Petiole color	Green	39	65	0.65	1.24
	Green with brown	6	10	0.1	
	Purple	15	25	0.25	
Distance from the insertion of the petiole on the leaf to the upper end	< 2cm	5	8.33	0.08	1.25
	2 - 4 cm	18	30	0.3	
	> 4 cm	37	61.67	0.62	
Distance from the insertion of the petiole on the leaf to the lower end	10 cm	26	43.33	0.43	1.53
	10 - 15 cm	21	53	0.35	
	> 15 cm	13	21.67	0.22	
Sheet width	< 10 cm	31	51.67	0.52	1
	10 - 15 cm	29	48.33	0.48	
	> 15cm	-	-	-	
Width between lobes	> 6 cm	45	75	0.75	0.81
	6 - 10 cm	15	25	0.25	
	> 10 cm	-	-	-	
Stem color	Green	45	75	0.75	0.81
	Green with Purple strip	-	-	-	
	Green with Brown band	15	25	0.25	
	Purple	-	-	-	

Presence of thorn	Gift	15	25	0.25	0.81
	Absence	45	75	0.75	
Presence of wings	Gift	30	50	0.5	1
	Absence	30	50	0.5	
Wing color	Green	30	50	0.5	1
	Purple	30	50	0.5	
Presence of aculei	Gift	15	25	0.25	0.81
	Absence	45	75	0.75	
Growth direction	Time	15	25	0.25	0.81
	Counter-clockwise	45	75	0.75	
Stem diameter	< 0.4 cm	60	100	1	0
	0.4 - 0.6 cm	-	-	-	
	> 0.6 cm	-	-	-	
Stem shape	Polygonal	-	-	-	0
	Round	60	100	1	
Underground tubers	Gift	43	71.67	0.72	0.86
	Absent	17	28.33	0.28	
Number of tubers	One	6	10	0.1	1.13
	Some	43	71.67	0.72	
	Many	11	18.33	0.18	
Tuber shape	Elongated	19	31.67	0.32	1.55
	Oval	26	43.33	0.43	
	Irregular	15	25	0.25	
Tuber length	< 20 cm	46	76.67	0.77	0.78
	20 - 40 cm	14	23.33	0.23	
	> 40 cm	-	-	-	
Tuber width	< 7 cm	28	46.67	0.47	1.43
	7 - 12 cm	24	40	0.4	
	> 40cm	8	13.33	0.13	
Shell color	Brown	45	75	0.75	0.81
	Yellow	-	-	-	
	Purple	15	25	0.25	
Tuber color	White	46	76.67	0.77	0.78
	Yellow	14	23.33	0.23	
	Purple	-	-	-	
	Purple with white	-	-	-	
	White with purple	-	-	-	

Regarding the shapes of the leaves, 50% of the accessions had sagitate leaves, 25% had lobed leaves, and another 25% had cut leaves. The sagittal shape of the leaves plays a crucial role in the efficiency of light capture and water drainage. This format is advantageous in environments with high humidity, such as some areas of Angola, where better drainage can minimize the proliferation of pathogens (Norman; Tongoona; Shanahan, 2011). According to Ferriol *et al.* (2023), the presence of sagittate leaves can be seen as an adaptive strategy to maximize sunlight capture, reflecting an evolutionary response to local environmental conditions.

In addition to the shape of the leaves, it was observed that the majority of accessions (75%) did not have lobes, while 25% exhibited one lobe. The absence of lobes may be related to greater efficiency in regulating water loss through transpiration and optimization of light capture, as indicated by Brodribb *et al*. (2007). Unlobed leaves can facilitate a smaller exposed surface area, reducing evapotranspiration and potentially improving water retention in environments where water availability is a critical constraint.

In terms of petiole length, 65% of accessions had petioles between 5 and 10 cm in size, suggesting a possible morphological adaptation to optimize the capture of environmental resources. The predominant color of the petioles was green (65%), which suggests an efficient photosynthetic capacity. The green color of the petioles indicates a high density of chlorophyll, which contributes to the efficiency of photosynthesis, especially under variable light conditions (Riekötte *et al*., 2022). This adaptation is essential to ensure that the plant can maximize light absorption and, consequently, energy production in different lighting scenarios.

Analysis of the distance between the insertion of the petiole on the leaf and the upper end revealed that 61.67% of the accessions had a distance greater than 4 cm. This characteristic may indicate a strategy to maximize exposure to sunlight, allowing the leaves to be

arranged to avoid mutual shading and ensuring better light capture (Onwueme; Johnston, 2000). This arrangement can also influence photosynthesis efficiency and biomass production, reflecting an adaptive response to different light conditions.

Regarding the width of the leaves, 51.67% of the accessions had leaves with a width of less than 10 cm, while 75% showed a width between lobes greater than 6 cm. Variation in leaf width and distance between lobes can directly affect hydraulic conductivity and maximum leaf photosynthesis rate, as discussed by Tsukaya (2006). These morphological differences can influence the adaptation of plants to different environments and their ability to compete for resources.

For stem color, 75% of accessions had green stems, while 25% displayed stems with a brown band. The green color of the stem is associated with the presence of chlorophyll, which may contribute to supplementary photosynthesis, while stems with brown bands may indicate greater lignification or the presence of defense compounds (Aremu*et al.,* 2019). These characteristics may reflect adaptations to environmental pressures, such as the need for defense against herbivores or the optimization of photosynthetic efficiency.

The morphological diversity observed in yam plants, particularly in leaf shapes, petioles and stem colors, indicates the plants' varied strategies for optimizing light capture and resource utilization, highlighting the importance of genetic and morphological diversity in increasing adaptability of plants to specific environments. Studies in Tanzania and Uganda have characterized yam genotypes based on leaf characteristics, flowering characteristics, and tuber shapes, revealing substantial phenotypic variability within the species (Massawe; Temu, 2022; Ferriol, 2023).

The presence of thorns was observed in 25% of the accessions, possibly as an adaptation for defense against herbivores. Spines are defense mechanisms that make it difficult for herbivores to access tubers, reducing predation and helping the plant survive in environments where herbivore pressure is high (Nilsen; Orcutt, 1996). Such adaptation may be essential for the preservation of energy reserves in tubers, ensuring the availability of resources for growth and reproduction in adverse conditions.

The growth direction was predominantly counterclockwise (75%), and all stems had a round shape. The counterclockwise growth direction observed in 75% of accessions may have implications for the architecture of the root and tuber system. This orientation may be related to internal growth mechanisms that favor a more efficient distribution of tubers in the soil, optimizing the absorption of nutrients and water (Khan; Gement; Villordon, 2016). Such a growth pattern can also minimize competition between roots and tubers, allowing for better development and more efficient use of available resources.

In relation to underground tubers, 71.67 % of the accessions had tubers, with the majority having one or a few tubers, and only 18.33% having many tubers. Tubercle shapes varied, with 31.67 % elongated, 43.33% oval and 25% irregular. Variability in tuber shapes has a significant impact on storage capacity and resource use efficiency. Elongated tubers, which correspond to 31.67% of accessions, offer a greater contact surface with the soil, which can facilitate nutrient absorption. Oval and irregular tubers can adapt better to different types of soil and environmental conditions, promoting a more uniform distribution of nutrients and better adaptation to variations in the environment (Epping; Laibach, 2020). This morphological diversity may reflect adaptive strategies to optimize resource use efficiency and maximize survival in different ecological conditions.

The majority of tubers were less than 20 cm long (76.67%) and less than 7 cm wide (46.67%), which may indicate an adaptive strategy to maximize biomass production and agricultural yield. Smaller tubers tend to be more efficient in terms of growth, allowing for greater planting density and better use of available space and resources (Squire, 2004). They can also facilitate harvesting and reduce processing costs, making production more efficient and economically viable.

As for the color of the shell, 75% were brown and 25% purple. These characteristics may reflect adaptations to different environmental conditions and abiotic stresses. Tubers with brown skin, observed in 75% of accessions, are generally more resistant to physical damage and pathogen attacks due to the presence of phenolic compounds that act as natural barriers (Lattanzio *et al*., 2006). Tubers with purple skin, which represent 25% of accessions, contain anthocyanins, which protect against oxidative stress and UV radiation, contributing to the durability and resistance of plants in adverse environments.

The color of the tuber was predominantly white (76.67%), followed by yellow (23.33%). The color of the tuber pulp has direct implications for the nutritional value and acceptability of the final product. White pulps, predominant in 76.67 % of accessions, are typically rich in starch and provide an effective source of energy (Ukwuru; Egbonu, 2013). The yellow pulp, present in 23.33 % of accessions, may indicate the presence of carotenoids, which are important for human health as precursors of vitamin A. The color of the pulp also influences consumer preference, affecting demand and value market for tubers.

Entropy was used to measure the variability of each descriptor, where higher values indicate greater diversity and lower values indicate homogeneity (Jost, 2006). All accessions had alternate leaves, stems with a diameter of less than 0.4 cm, and round stems. This

homogeneity may be the result of natural or artificial selection that favored specific characteristics, adapted to the local environment or prevalent agricultural practices (Muraleedharan; Rajan, 2024). The complete absence of variability may, in some cases, indicate successful adaptation to stable environmental conditions, but it may also limit the ability of plants to respond to environmental changes or new biotic challenges (Vishnu; Rajan; Jaishanker, 2023).

In contrast, some descriptors exhibit high entropy, such as leaf shapes (H' =1.5) and growth direction (H′=1.55). The shapes of the leaves show an almost uniform distribution between cut (25%), sagitate (50%) and lobed (25%), while the direction of growth presents a balanced distribution between clockwise and counterclockwise growth. High entropy for these descriptors indicates high genetic variability, suggesting the presence of multiple growth forms and strategies within the population. This may be beneficial for adaptation to different environmental conditions and selection pressures. It would be useful to review articles that discuss the importance of genetic variability in adapting plants to variable environments and how this can influence survival and productivity.

Descriptors with moderate entropy, such as the number of leaf lobes (H′=0.81) and the presence of spines (H'=0.81), indicate that, although there is a predominant characteristic, there is a notable presence of variability. Most accessions do not have lobes (75%), but 25% have a lobe. Similarly, the predominance of accessions without thorns (75%) is accompanied by 25% of accessions with thorns. The moderate entropy suggests that these characteristics are important for adaptation and may vary according to different selective pressures. Furthermore, studies on yam genotypes in Tanzania revealed high morphological variabilities among 74 genotypes, with characteristics such as thorns at the base of the stem contributing to the observed variabilities (Massawe; Temur, 2022). This variability in morphological characteristics is crucial for understanding the genetic diversity and possible adaptations of yam species, highlighting the importance of these characteristics in breeding programs and yam selection processes (IAdejumobi *et al.,* 2023).

It is relevant to investigate how the presence or absence of certain morphological traits, such as lobes and spines, can affect the plant's interaction with its environment and its pathogens (Pérez-Harguindeguy *et al*., 2016).

Descriptors such as petiole length (H′=1.27), petiole color (H′=1.24) and wing color (H′=1.24) show a relatively balanced distribution between classes, indicating a significant phenotypic diversity that can be associated with genetic variations or environmental influences. Most petioles measure between 5-10 cm, with lower frequencies for other classes. The color of the petiole is predominantly green, but there are significant presences of purple and green petioles with brown. The color of the wings has a balanced distribution between green and purple. The balanced distribution of these descriptors suggests that multiple variables can influence the phenotypic expression of these traits, and it is important to understand how these variations can impact plant functionality and efficiency, allowing populations to persist and adapt to changing conditions (Lasky *et al.,* 2023).

Finally, descriptors with low entropy, such as stem color (H'=0.81) and the presence of spikes (H′=0.81), indicate a clear predominance of certain characteristics, but with a slight presence of variability. Most stems are green, with a smaller presence of green stems with a brown band, and most accessions do not have needles. Low entropy suggests a clear predominance of certain characteristics, possibly indicating selection for more favorable characteristics (Vishnu; Rajan; Jaishanker, 2023).

analysis of the data in Table 4 reveals notable differences between yam species in relation to all morphometric characteristics evaluated. The extremely low p-values indicate a high statistical significance in these differences, highlighting the importance of these variables in differentiating between species.

Table 4: p value, coefficient of variation (CV) and means for tuber and pulp weights (g), tuber length (cm), longitudinal and transverse diameters (mm) and transverse and longitudinal thicknesses (cm) of the accesses from yam *Dioscoreaspp*. In different provinces of Angola

Variables	*p*- value	CV (%)	Average General	*Dioscorea the can*	*Dioscorea Cayenesis*	*Dioscorea bulbifera*	*Dioscorea esculent*
Tuber weight	2.00×10^{-16}	39.47	337.43	413.13b	143.87c	705.73a	87.00c
Pulp weight	1.84×10^{-14}	54.3	259.17	269.53b	122.20c	588.53a	56.40c
Length	2.00×10^{-16}	23.76	15.44	19.63b	8.66c	27.87a	5.59c
Longitudinal diameter	2.00×10^{-16}	18.89	51.05	48.92b	33.38c	78.47a	43.43b
Transverse diameter	6.75×10^{-6}	17.65	60.89	62.95ab	60.40b	71.40a	48.81c
Transverse thickness	2.00×10^{-16}	14.98	5.13	5.41b	4.10c	7.11a	3.90c
Longitudinal thickness	2.00×10^{-16}	12.77	5.52	4.95b	5.10b	7.89a	4.14c

**Averages followed by equal letters indicate that there is no significant difference between species, using the Tukey test at 5% probability*

The weight of the tuber (PT) and pulp (PP) showed considerable variation between species (Figure 2A and 2B respectively). Dioscorea *bulbifera* (DB) stood out significantly with substantially higher averages for both characteristics: 337.43 g for tuber weight and 259.17 g for pulp weight, compared to the other species. These high values suggest a superior energy storage capacity, which can be attributed to an efficiency in the accumulation of reserves. The coefficients of variation (CV) indicate significant morphological diversity for these characteristics. In contrast, *Dioscorea esculenta* (DE) showed the lowest mean values for tuber and pulp weight, reflecting a different adaptive strategy, possibly favoring smaller and lighter tubers, as evidenced in the lower mean tuber weight values.

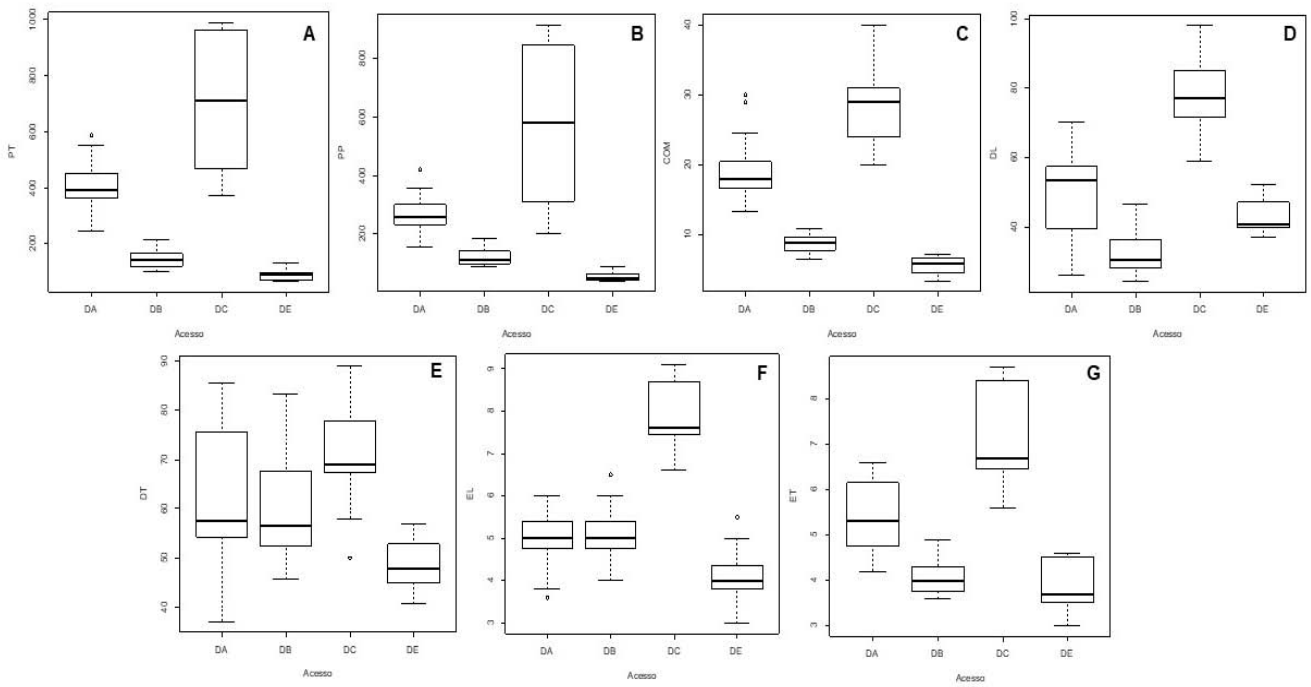

Figure 2: Averages for tuber (PT) and pulp (PP) weights, tuber length (COM), longitudinal (DL) and transverse (DT) diameters and transverse (ET) and longitudinal (EL) thicknesses for *Dioscorea*accessions *alata* (DA), *Dioscoreacayenesis* (DC), *Dioscoreabulbifera* (DB) and *Dioscoreaesculenta* (DE) in different provinces of Angola

Some *Dioscorea bulbifera genotypes* exhibited notably larger aerial tuber weights and diameters, which contributed to an increase in overall tuber production per plant. Genetic variability and heritability analyzes revealed significant differences between plant accessions in terms of yield and yield-related traits, with the potential for larger and heavier tubers in certain accessions. These findings suggest that the species has significantly larger and heavier tubers, highlighting the variability in tuber characteristics (Lu *et al.* , 2024).

Furthermore, it was observed that *Dioscorea bulbifera* had significantly larger and heavier tubers, results similar to those found in Angola. The efficiency in accumulating energy reserves in this species may be an advantageous adaptive characteristic for biomass production in agricultural contexts (Rayamajhi *et al.,* 2020).

For tuber length (COM) and longitudinal diameter (DL), *Dioscorea bulbifera* (DB) also presented the highest average values: 27.87 cm for length and 78.47 mm for longitudinal diameter. *Dioscorea alata* (DA) and *Dioscorea cayenensis* (DC) showed intermediate values, while *Dioscorea esculenta (*DE) showed the lowest values, with an average of 5.59 cm for tuber length and 43.43 mm for longitudinal diameter (Figure 2C and 2D). The transverse diameter (DT) follows a similar pattern, with *Dioscorea bulbifera* (DB) again exhibiting the highest average values (71.40 mm), standing out for its ability to grow in volume (Figure 2E).

Regarding longitudinal (EL) and transverse (ET) thicknesses, *Dioscorea cayenensis* (DC) and *Dioscorea alata* (DA) present higher values for transverse thickness, while *Dioscorea bulbifera* (DB) has the highest longitudinal thickness. *Dioscorea esculenta* (DE) exhibited the lowest thicknesses for both parameters, reinforcing the trend towards smaller and more compact tubercles (Figure 2F and 2G).

The work by Silva, Araújoe Pires (2020) also reinforces these conclusions, highlighting that *Dioscorea bulbifera* showed high efficiency in storing carbohydrates, which is beneficial in agricultural systems that prioritize biomass production. The study suggests that the ecological adaptability of this species may explain its ability to produce larger and heavier

tubers. In contrast, *Dioscorea esculenta* tends to produce smaller tubercles, possibly due to an ecological adaptation to less fertile soils and more challenging environmental conditions.

The differences observed in morphometric and morphological characteristics between yam species indicate significant genetic diversity within the genus *Dioscorea* in Angola. *Dioscorea bulbifera* (DB) stands out for its larger and heavier tubercles, which suggests an efficient adaptation to store large amounts of energy reserves. This characteristic is especially valuable in agricultural contexts where biomass production is a priority. This capability can be beneficial for uses where tuber volume and weight are critical to yield.

On the other hand, species such as *Dioscorea esculenta* (DE), with smaller and lighter tubercles, may be adapted to specific environmental conditions or agricultural systems that favor smaller tubercles. These characteristics may reflect adaptations to different ecological niches or cultivation strategies, where smaller tubers may be advantageous.

Furthermore, Chen *et al. (2022) discuss how genetic diversity among Dioscorea* species can influence these morphological and adaptive variations. The study revealed that variations in longitudinal and transverse diameters, as well as transverse and longitudinal thicknesses, can influence not only crop yield, but also resistance to pests and diseases, storage capacity and nutritional quality. Therefore, when selecting yam varieties for cultivation, it is crucial to consider both morphometric characteristics and environmental requirements and cultivation preferences, to maximize the yield and efficiency of agricultural production.

IV. Conclusion

There is significant morphological and morphometric variability among yam accessions in the provinces of Angola. Dioscorea *bulbifera* stood out for the greater weight and dimensions of its tubes, indicating a greater nutrient storage capacity and structural robustness, in contrast to *Dioscore aesculenta* and *Dioscorea cayenesis*, which presented smaller measurements.

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Research on the Power Consumed by Drives of Machines for Working with Greenhouse Soil

By P.I. Pavlov & A.O. Vezirov

Saratov State University

Abstract- The quality of soil preparation for greenhouses is a key factor influencing crop yields in organic farming. Several machines perform various operations for working with greenhouse soil: a soil removal machine, a loader-mixer for soil components, and a machine for laying soil components. Theoretical research has established that the greatest influence on the power of the component laying machine comes from: the speed of the conveyor chain, the angular velocity of the dosing drum, the number of conveyor scrapers, and the number of drum slats. For the power of the soil removal machine, the influencing factors are: the size of the cut soil layer, the speed of the machine itself, and the angle of the bucket surface.

Keywords: power, regression equation, graphical dependency, combined layer, machine for removing and loading greenhouse soil.

GJSFR-D Classification: LCC: S631.5

Strictly as per the compliance and regulations of:

Research on the Power Consumed by Drives of Machines for Working with Greenhouse Soil

P.I. Pavlov [α] & A.O. Vezirov [σ]

Abstract- The quality of soil preparation for greenhouses is a key factor influencing crop yields in organic farming. Several machines perform various operations for working with greenhouse soil: a soil removal machine, a loader-mixer for soil components, and a machine for laying soil components. Theoretical research has established that the greatest influence on the power of the component laying machine comes from: the speed of the conveyor chain, the angular velocity of the dosing drum, the number of conveyor scrapers, and the number of drum slats. For the power of the soil removal machine, the influencing factors are: the size of the cut soil layer, the speed of the machine itself, and the angle of the bucket surface. Experimental research confirmed the results of theoretical studies and established the parameter values of the combined layer that minimize power consumption: conveyor chain speed 0.33-0.37 m/s, number of conveyor scrapers 7-8, angular velocity 6.0-6.5 rad/s, and the number of dosing drum slats 6. For the soil removal machine, these parameters are: bucket angle 25-27 degrees, forward speed 0.2-0.25 m/s, and the size of the cut soil layer 0.18 m. The presented results confirm the effectiveness of the machinery complex for greenhouse soil preparation.

Keywords: power, regression equation, graphical dependency, combined layer, machine for removing and loading greenhouse soil.

I. Introduction

The preparation and use of greenhouse soil is one of the most energy- and labor-intensive operations in growing plants in protected soil. The quality of the prepared soil directly affects the yield of the crops grown, and consequently, the cost of the final product. Previously, a technological scheme for the preparation, use, and removal of greenhouse soil was proposed [1,2]. This technology is based on the use of a comprehensive set of machines for working with greenhouse soil: a combined layer, a loader-mixer, and a soil removal machine [3-5].

One of the key indicators of the efficiency of these machines is the power required to drive their working elements or to move the machine while performing technological operations. The power value is influenced by both structural factors–related to the design and geometric parameters of the working elements and operational factors–related to their movement parameters.

The aim of this study is to determine the specific structural and operational parameters that have the greatest impact on the power of the considered machines; to establish the nature of this dependency; and to justify the parameter values at which the power value is minimized.

The research conducted jointly with Ph.D. in Technical Sciences Mukhin D.V. and Ph.D. in Technical Sciences Levchenko A.V. allowed us to establish analytical and experimental dependencies of power on structural and operational parameters for each machine [6-7].

The main working elements of the combined layer are the chain conveyor and the dosing drums. Therefore, the total drive power of the machine P_y (W) will be equal to the sum of the power consumed by the drive (power on the shaft) of the chain conveyor $P_{тр}$ (W) and each of the two dosing drums $P_б$ (W):

$$P_y = P_{тр} + P_{б1} + P_{б2}. \quad (1)$$

By previously finding expressions for determining each term and performing the corresponding mathematical operations, equation (1) will take the form:

$$P_y = \left\{\left(K_{сд} l_{ск} b_{ск} \tau_{сд} + g\rho_{кт} l_{ск} b_{ск} h_к f_{вн} + g\rho_{кт} l_{ск} b_{ск} h_{кп} f_н + m_{ск}\frac{v_c}{t}\right)\frac{l_{тр}}{l_{ск}} + \sigma_к b_{ск} h_{ок}\right\} v_c + 0{,}5 z_{n1} D_{н1} \omega_{б1} \left(m_1 \frac{\omega_{б1} R_{б1}}{t} + f_{вн1} m_{кб1} g - m_1 g \cos\beta\right) + 0{,}5 z_{n2} D_{н2} \omega_{б2} \left(m_2 \frac{\omega_б R_б}{t} + f_{вн2} m_{кб2} g - m_2 g \cos\beta\right), \quad (2)$$

Where, $K_{сд}$ – coefficient of increase in the shear area, accounting for the deviation of the actual shear surface shape from the theoretical for the chain conveyor; $b_{ск}$ – width of the conveyor scraper, m; $h_{ск}$ – height of the conveyor scraper, m; $\rho_{кт}$ – density of the component transported by the conveyor, kg/m³; v_c – conveyor chain (scraper) speed, m/s; $\rho_к$ – average density of the component in the dosing drum hopper, kg/m³; α_n – central angle between the drum slats, degrees; $D_в$– diameter of the dosing drums along the generating line of the cylinder, m; $D_н$ – diameter of the dosing drums along the outer edges of the longitudinal slats, m; $\omega_б$ - angular speed of the dosing drum, rad/s; $\alpha_п$ – angle between the blades, degrees; B_n – width of the longitudinal slat of the drum, m; z_n – number of

Author α σ: Saratov State University of genetics, biotechnology and engineering named after N.I. Vavilov, Saratov, Russia.
e-mail: vezirov2008@mail.ru

longitudinal slats on the drum; $n_к$ – rotational speed of the dosing drum, s^{-1}; $\tau_{сд}$ – ultimate shear stress of the material component in the chain conveyor, Pa; $h_{кп}$ – total height of the component layer in the front hopper, m; $f_н$ – coefficient of friction of the component on the surface of the front hopper deck; $f_{вн}$– coefficient of internal friction of the component in the first hopper; $h_к$ – height of the component layer in the front hopper, m; $\sigma_к$ - crushing stress of the component, Pa; $h_{ок}$ – height of the separated component layer before the damper in the first hopper, m; $m_{ск}$ – mass of the separated component by the chain conveyor scraper, kg; m– mass of the separated component by the dosing drum slat, kg; $m_{кб}$– mass of the main component in the middle and rear hoppers, kg [8]. The index «1» refers to the first dosing drum, the index «2» to the second.

The power of the soil removal machine $P_{уд}$ (W) is the sum of the following terms: the power consumed for horizontal soil movement P_{ox} (W), the power required to lift the soil along the surface of the bucket (vertically) to the unloading conveyor P_{ox} (W), and the power necessary for moving the machine and driving the unloading conveyor P_0 (W):

$$P_{уд} = P_0 + P_{ox} + P_{oy}. \quad (3)$$

Substituting the previously found expressions for determining each term into equation (3), we get:

$$P_{уд} = P_0 + v \cdot \left\{\tau_р \cdot B \cdot \delta + 2 \cdot \sigma_д \cdot b \cdot h + \frac{\rho\left(B \cdot h \cdot v^2 + b_k \cdot h_k \cdot v \cdot t \cdot g \cdot f_к\right)}{cos\gamma} + 2 \cdot \tau_о \cdot l_{бпо} \cdot s + \frac{2 \cdot \rho \cdot b \cdot h_0 \cdot v_0 \cdot g \cdot f_о \cdot cos\theta}{cos\gamma}\right\} + v \cdot sin\gamma \cdot \left(\rho \cdot B \cdot h \cdot v \cdot t \cdot g + \frac{\rho\left(B \cdot h \cdot v^2 + b_k \cdot h_k \cdot v \cdot t \cdot g \cdot f_к\right)}{sin\gamma} + \frac{2 \cdot \rho \cdot b \cdot h_0 \cdot v_0 \cdot g \cdot f_о \cdot \sin\theta}{sin\gamma}\right), \quad (4)$$

Where, P_0 – is the power required to move the machine itself during operation, in watts; $\tau_р$ – is the soil cutting stress, in N/m; B– is the bucket width (cutting edge width), in meters; δ – is the thickness of the cutting edge of the blade, in meters; $\sigma_к$ – is the soil rupture stress, in N/m^2; b – is the width of the soil layer, in meters; h– is the height of the soil layer, in meters; ρ – is the density of the removed soil, in kg/m^3; v – is the translational working speed of the machine, in m/s; $b_к$ – is the width of the lateral surface of the blade, in meters; $f_к$ – is the coefficient of friction of the soil on the bucket surface; τ_0 – is the shear stress of the soil on the blade, in N/m^2; s – is the height of the soil layer on the blade, in meters; h_0 – is the height of the soil layer on the blade, in meters; v_0 – is the speed of the soil movement on the blade, in m/s; f_0 – is the coefficient of friction of the soil on the blade surface; γ – is the angle of inclination of the bucket surface, in degrees; θ – is the average angle of the blade surface, in degrees [9].

Analysis of equations (2) and (4) shows that significant factors influencing the total power of the drive system of the combined layer include parameters such as chain speed, number of chain conveyor scrapers, angular speed of the drums, and the number of slats installed on them. The power required for the movement of the soil removal machine is influenced by the height of the removed soil layer, translational speed of the machine, and the angle of inclination of the bucket surface. These parameters can be identified as key factors affecting power optimization during the experimental phase of research.

II. Research Methodology

For the experiment, two prototypes were fabricated: a combined layer (with a scraper conveyor length of 2.5 meters) and a soil removal machine. The research was conducted in the production conditions of a greenhouse complex. The methodology involved a series of two-factor experiments for each machine. Structural parameters (such as the number of scrapers and slats) were adjusted by installing the required quantity on the working elements, while the chain conveyor speed and drum rotational frequency were regulated by changing the sprockets on the drive shafts. The data were processed using regression analysis methods with the «Statistica» software package. Regression equations and corresponding three-dimensional graphical dependencies were derived. The adequacy of the regression equations in describing the experimental data was assessed using the Fisher's criterion.

III. Results and Discussions

Experimental research enabled the construction of a graphical dependency and determination of the influence of angular speed and the number of slats on the power of the drive system of the combined layer (Figure 1).

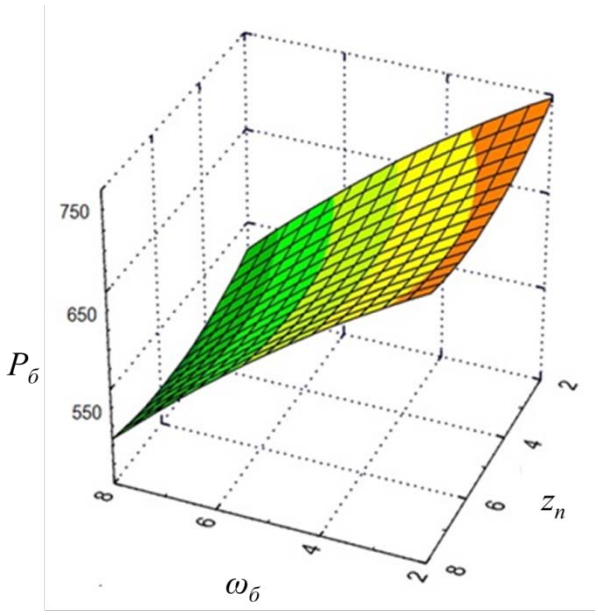

Figure 1: Dependence of the Power on the Drive Shaft of the Dosing Drum of the Combined Layer $P_б$ (W) on the Angular Speed $\omega_б$ (rad/s) and the Number of Slats z_n(pcs)

With increasing angular speed, the power on the drive shaft increases across the entire investigated range. Minimum power corresponds to high angular speeds. At low angular speeds, the power increases due to material buildup in the drum from the hopper. As angular speed increases, the mass of incoming material decreases, torque decreases, and required power drops.

The influence of the number of slats on power is less significant: maximum power is observed at z_n =2, then it slightly decreases and stabilizes around z_n =6-8. This is because the number of slats has little impact on the mass of material fed from the hopper, and the filling of the space between the slats remains relatively constant, resulting in almost unchanged power.

The analysis of experimental data allowed for the construction of a graphical dependency describing the power dependence on the drive of the scraper conveyor, based on the chain's translational speed and the number of scrapers (Figure 2).

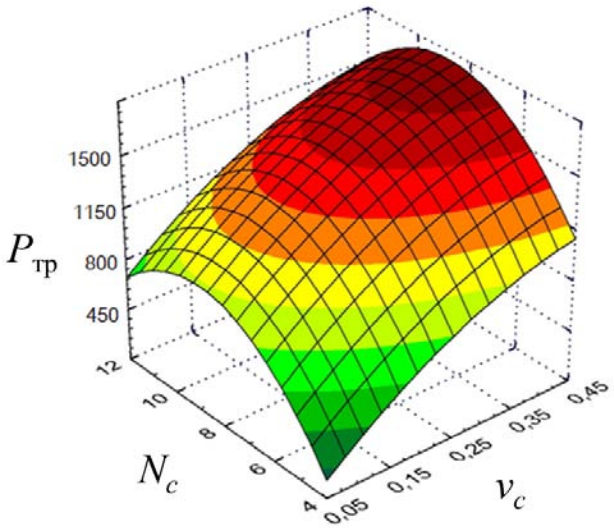

Figure 2: Dependency of the Power Consumed by the Scraper Conveyor Drive of the Combined Layer $P_{тр}$ (W) on the Chain Speed v_c (m/s) and the Number of Scrapers N_c (pcs)

The obtained dependencies show that the change in power due to these parameters is similar to the change in torque but with greater intensity. As the chain speedv_c with scrapers increases, the required power increases across the entire investigated range. For instance, with N_c =4, increasing v_c from 0.1 to 0.3 m/s leads to a rise in power from 1347 to 2975 W.

However, when $v_c > 0.35$ m/s, the rate of power increase slows down.

The influence of the number of scrapers on power follows a quadratic pattern: as the number of scrapers N_c increases, power initially increases, reaches a maximum around $N_c = 6$, and then decreases. Increasing N_c from 4 to 6 at a chain speed $v_c = 0.21$ m/s results in an increase in power from 1927 to 3532 W. This dependency is explained by changes in torque. With increased chain speed, the mass of moved components increases. However, at high speeds, components may not fully fill the space between the scrapers, leading to a reduced rate of power increase. Increasing N_c from 2 to 8 also increases the mass of moved components, requiring additional power. If $N_c > 8$, the useful volume of the space between scrapers decreases, reducing the mass of components and consequently the required power.

The processing of experimental data has revealed the influence of the soil layer height and translational speed on the power expended for the movement of the soil removing machine. The obtained values form the basis of regression equation (5).

$$P = 6443{,}37 - 479{,}61 \cdot v - 84{,}651 \cdot h + 17413{,}2 \cdot v^2 + 162{,}321 \cdot v \cdot h + 0{,}377 \cdot h^2 \quad (5)$$

The analysis of the dependency (Figure 3) shows that the power expended for the machine movement increases with the speed. The change in power occurs linearly, with the growth intensity increasing as the height of the removed layer increases. For instance, at $h = 60$ mm, increasing the speed from 0.11 to 0.17 m/s results in a power increase from 4045 to 4792 W, which is an 18% rise.

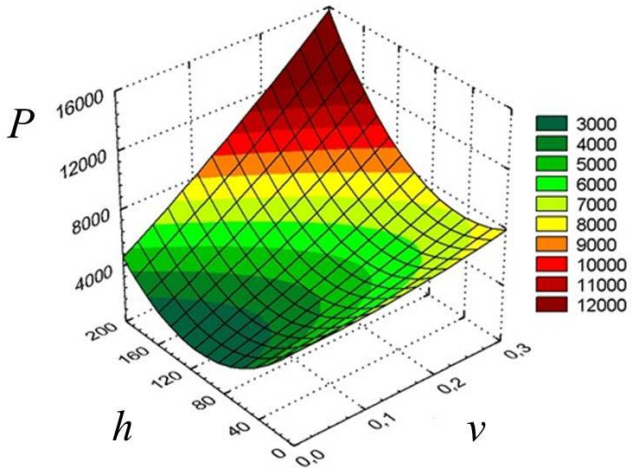

Figure 3: Dependency of Power Expended for the Movement of the Soil Removing Machine P (W) on the Machine's Speed v (m/s) and layer height h (mm)

At $h = 100$ mm, increasing the speed within the same range results in an increase in power from 3980 to 4925 watts, or 23.5%. Similar behavior is observed at other values of the investigated parameters. Increasing both speed and layer height leads to an increase in the mass requiring movement, thereby increasing the required power. However, the influence of layer height on power is not linear: at low heights, the layer has almost no effect on power, but when $h > 80-100$mm, power begins to significantly increase. Regression analysis and its graphical representation show that there is no optimum – power increases with parameter increases.

Additionally, the influence of the slope angle of the dumping surface and the machine's speed on the power expended for moving the soil removing machine was determined, and regression equation (6) was developed:

$$P = 5740{,}316 + 18869{,}3 \cdot \upsilon - 291{,}654 \cdot \gamma - 13732{,}64 \cdot \upsilon^2 + 85{,}833 \cdot \upsilon \cdot \gamma + 5{,}438 \cdot \gamma^2 \quad (6)$$

The power expended for moving the machine increases almost directly proportional across the entire range with increasing speed (Figure 4). This is due to the increase in the separated and moved mass of soil with increasing speed. At $\gamma = 20$ degrees, increasing the speed from 0.11 to 0.17 m/s results in a power increase from 4189 to 4950 watts. At $\gamma = 30$ degrees, increasing the speed leads to a power increase from 4160 to 5010 watts, or by 20%.

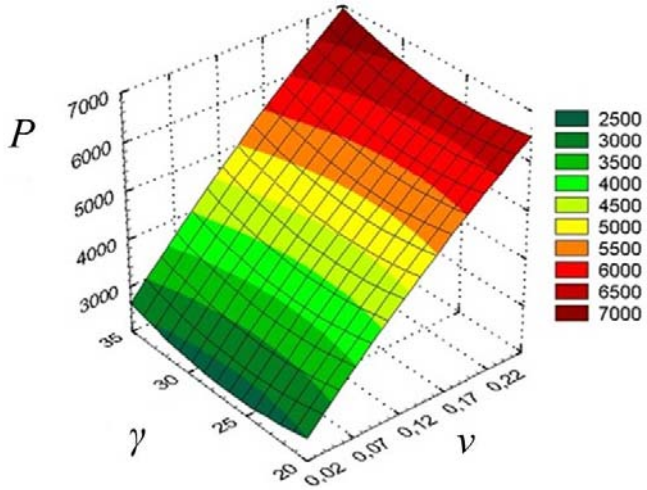

Figure 4: Dependence of power expended for the movement of the soil removing machine *P* (W) on the machine's movement speed *v* (m/s) and the inclination angle of the surface of the ejector γ (degrees)

The influence of the surface slope angle is expressed in a more nonlinear manner. Power increases at smaller or larger slope angles. This change in power is explained by variations in traction force due to the slope angle. For $\gamma <$ 25 degrees, the length of the working surface of the ejector increases, elongating the soil path and increasing resistance forces to the machine's movement. For $\gamma >$ 27 degrees, the interaction between the ejector and the soil changes: soil accumulates in front of the ejector, creating additional resistance. Increasing the slope angle from 30 to 35 degrees at v = 0.17 m/s leads to an increase in power from 5007 to 5549 W. The lowest power is achieved at γ = 25-27 degrees; deviation from these values increases power due to changes in traction force and interaction between the ejector and the soil.

IV. Conclusions

The analysis of experimental results allowed us to establish optimal values for the operational parameters of the machines, where the power consumption for driving their mechanisms reaches its minimum.

For the combined paver, these parameters are: chain conveyor speed v_u = 0.33-0.37 m/s and number of scrapers N_c = 7-8; angular velocity of dosing drums ω = 6.0-6.5 rad/s and number of blades z_n = 6.

For the soil remover machine, the optimal parameters are: bucket tilt angle γ = 25-27 degrees, translational speed v = 0.2-0.25 m/s, and depth of removed soil layer h = 0.18 m.

Thus, through the conducted experimental studies, we identified the influence of design and operational parameters on the power consumption of machines involved in the greenhouse soil preparation process. Furthermore, we determined rational values for these parameters that exert the greatest influence on the power required to drive the mechanisms of these machines.

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Innovative and Affordable Feed Solutions for Enhancing Cattle Finishing in Tanzania

By Zabron Nziku, Valentino Urassa, Jonas Kizima, Hamis Lugundi, Walter Mangesho, Salum Kafuku, Angela Majoya, Hossiana Mgonja, Zeno Massawe, Barick Masakia, Samuel Munguru, Said Mbelwa, Rose Loina, Ayoub Kambadu, Angelo Mwilwa & Lovince Asimwe

Abstract- In Tanzania, livestock significantly contributes to the national economy, with the beef sub-sector accounting for 2.2% of the GDP. However, unfinished cattle at slaughterhouses result in suboptimal beef quality. Proper finishing is crucial because it adds value to the quality of beef meat. Apart from genetics, applying the right feed technology and feeding strategies on beef cattle before slaughter can increase output by 70% and perhaps coequal with health. The current study developed two feed diet formulas using local feed materials given the high quality and affordable cost for the Zebu cattle finishing business.

Keywords: *cattle, finishing, fattening, feed formula, diet.*

GJSFR-D Classification: *LCC: SF94.5*

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Innovative and Affordable Feed Solutions for Enhancing Cattle Finishing in Tanzania

Zabron Nziku [α], Valentino Urassa [σ], Jonas Kizima [ρ], Hamis Lugundi [ω], Walter Mangesho [¥], Salum Kafuku [§], Angela Majoya [χ], Hossiana Mgonja [ν], Zeno Massawe [Θ], Barick Masakia [ζ], Samuel Munguru [£], Said Mbelwa [€], Rose Loina [₣], Ayoub Kambadu [₴], Angelo Mwilwa [₲] & Lovince Asimwe [₳]

Abstract- In Tanzania, livestock significantly contributes to the national economy, with the beef sub-sector accounting for 2.2% of the GDP. However, unfinished cattle at slaughterhouses result in suboptimal beef quality. Proper finishing is crucial because it adds value to the quality of beef meat. Apart from genetics, applying the right feed technology and feeding strategies on beef cattle before slaughter can increase output by 70% and perhaps coequal with health. The current study developed two feed diet formulas using local feed materials given the high quality and affordable cost for the Zebu cattle finishing business. The study involved 60 Tanzanian Short Horn Zebu (SHZ) cattle, divided into three age categories and randomly assigned to three treatments. Two diet formulas using local feed materials were developed and tested over an 11-week period. Also, the experiment has Phase I trial and Phase II for validation. The diet comprised Maize meal, Cassava root meal, and Rice Polish as energy sources while Leucaena Leaf meal, Soya bean meal, and Sunflower seed cake were protein sources in both diet formulas with varying energy amounts. The mineral mixture (Josera for beef) and Molasses powder were included. Quality evaluation of the feed resources and formulated diets was conducted, and the least cost feeds analysis with Win Feed 2.8 a computer software program was used toquantify feed quality and quantity required to meet the requirements of Zebu cattle for finishing and their cost implications. Cattle's initialweight data was registered followed by weekly weights captured by a digital weighbridge scale. The general linear model procedure using SAS software was used to obtain the means. Results revealed that both tested feed rations performed well, with slightly significant differences between the two formulas on weight gain per day, conforming in phases I & II. The average DMI (dry matter intake) was 4.67kg and 7.3kg, for control and formulated diets, respectively. The composition of the formulated diets bywin Feed 2.8 programs was19.01 protein, and 12MEMJ/kg. The average cost per kg of the diets was TSHs 498. Results indicated significant improvements in weight gain for cattle fed the formulated diets compared to the control group, with daily live weight gains of 0.86kg and 0.25kg, respectively. In conclusion, the formula prototype is worthwhile and can be applied for commercial purposes in finishing the SHZ cattle genotype in Tanzania. However, more research on seasonal variation and further research for other cattle breeds/strains is recommended.

Keywords: cattle, finishing, fattening, feed formula, diet.

Author α σ ρ ω ¥ § χ ν Θ ζ £ € ₣ ₴: Tanzania Livestock Research Institute (TALIRI), Eastern Zone, Box 5016, Tanga, Tanzania.
e-mail: czabronn@gmail.com
Author ₲ ₳: Ministry of Livestock and Fisheries (MLF), Box 2870, Dodoma, Tanzania.

I. Introduction

In Tanzania, livestock plays an important role in building a national economy as considered the first and second livelihood drivers. Tanzania has approximately 33.9 million cattle, predominantly indigenous breeds, making it the second-largest cattle population in Africa after Ethiopia (MLF, 2023).". The beef sub-sector contributes about 2.2% to the GDP compared to other livestock species and products (Ministry of Livestock and Fisheries (MLF), 2023). Several initiatives and platforms for the improved beef industry in the country are evident this include; the presence of 50-improved abattoirs, 532-markets (506-primary, 14 second aries, and 12-borders), 15 national ranches, and 5 livestock multiplications units of which some have been newly constructed between 2015-2021 (MLF, 2023).

Despite the initiatives, less effort has been made to improve the quality of beef meat. Today most cattle are brought at slaughterhouses without a special diet. Proper feeding cattle before slaughters crucial because it adds value to the quality of beef meat and as are sult more income for improved livelihood and a sustainable market. To achieve that appropriate knowledge, technology, and capacity building on cattle feeds for beef cattle finishing are key. Apart from genetics, the application of the right feed technology and feeding strategies can increase its output by 70% and perhaps be coequal with health. Several studies recommended the importance of cattle finishing practice (FAO, 2022, Muzzo and Provenza, 2018 Asimwe, 2016). The application of cattle finishing technique is not new in Tanzania, however; the questions lie in what quality of feeds is used as supplements and its associated costs per unit kilogram.

To answer that, the current project was dedicated to developing Innovative and Affordable Feed Solutions for Enhanced beef quality in the market, employment, and livelihood and hence increased contributions to the national economy on a sustainable basis.

a) General Objective

Develop and enhance the availability of quality and cost-effective beef cattle feeds for increased beef meat quality in Tanzania.

b) Specific Objectives

- DevelopedInnovative and Affordable Feed Solutionsby considering locally available feed resourcesfor cattle finishing in Tanga region
- Enhanced participation of stakeholders by genderin developing Innovative and Affordable Feed Solutionsfor cattle finishingin Tanga region

II. Materials and Methods

a) Study Location and Stakeholders

This research work was conducted on-stations at TALIRI Tanga. TALIRI Tanga was chosen because of the available resources and infrastructures necessary for the experiment which included animal scientists, a feed mixing machine, and an experimental building for individual feed cattle testing. The majority (90%) of stakeholders involved in the study were from the Tanga region.

b) Experimental Design

Infrastructures, feed materials, and beef animals necessary for developing the innovative and affordable feed solutions and testing experiments were locally outsourced from within the Tanga region. A total of 60 beef cattle were involved in the feeding experiment. 40 indigenous cattle (Tanzanian Short-horned Zebu-TSHZ) and 20 crossbred cattle (mainly Boran and Holsten Friesian) were used in the first experiment. The Complete Randomized Block Design (CRBD) in a 3 x 2 x 3 x 2 factorial arrangement was used given every experimental unit to have the same probability of receiving any treatment. Four factors were considered: dietary treatment, Sex, Age, and Row pen with three levels (D_1, D_2, and D_3), two levels (male and female), three levels of age categories (<3, 3-4, >4 years) and two levels of pen (Row1 and Row2), respectively. The experimental animals were randomly assigned to individual pens with specific treatment as per protocol for 11 weeks.

Phase II for validation considered the same feed formulas and feeding protocols as in Phase I. However, based on the recommendations of phase I, in phase II only Diet 1 and TSHZ cattle were considered. At all stages of the experiment, the private sector on feed manufacturing and gender engagement were considered and given priority.

c) Dietary Treatments

The four dietary treatments were D_1 (contained maize meal, Leucaena, cassava leaves, and sunflower seed cakes' meal) D_2 (contained processed cassava roots as an energy source mixed with *leucaena,* cassava leaf, and sunflower seed cakes' meals), and D_3 (Control-Hay). The diet composition and balancing as per animal requirements were done by using *Win Feed* a computer software.

d) Animal Management

i. *Housing*

An experiment was done in an open side and roofed house made of poles with two rows (30x2) of individual pens and a concrete floor facing North-South set in an are a where Mosoon wind is common. In addition, good ventilation, shading, drainage, hygiene, and water were prerequisites maintained.

ii. *Feeding*

Beef cattle assigned to diet$_1$ (D_1) and diet2(D_2) were supplied with basal diet in ad-lib and supplemented with 2kg of formulated diet every morning. The group assigned to the control diet (D_3)(hay and corn silage) was not supplemented with concentrate in the formulated diets. The mixed grass hay with corn silage and ad-lib water was the main basal diet and was given across all animals under the experiment.

e) Health Management

Two weeks before the experiment all health aspects such as deworming individual identification, and animal acclimatization processes were conducted. Acclimatization was necessary because animals were purchased from local markets by different pastoralists with different environments and management before being brought to TALIRI with new environments and feed types.

f) Data Collection

Data collection covered a period of 11 weeks and only 8 weeks (Week 3 to Week 10 of the experiment) of its data were considered in the current analysis report. Because in the first two and last weeks of the experiment, Walter became a major challenge.

Data collected included the quantity and quality of feed materials and formulated diets, the initiallive weight of cattle for the experiment, and subsequent weekly live weight data measured using a digital weighbridge scale. Apart from live weight gain information, the health and eating habits of individual animals were monitored. Optimal feed required for maintenance and live weight gain of Zebu cattle given the cost for producing one kg of potential formula for cattle finishing diet by a Win Feed a computer software. The general linear model procedure using SAS software was used to obtain the means.

III. Results and Discussion

a) Stakeholder Participation by Gender

The smallholders included smallholder farmers (agro-pastoralists), private sectors mainly animal feed processors, beef business people, researchers, and policymakers who participated in the current study as part of awareness creation and capacity building. They were engaged during project inception, research works

and data collection, training on the project outcome, selection and purchase of cattle for the experiment, and mobilization and processing of local feed resources (cassava, leucaena, maize, hay, and silage). Overall women constituted 50.41% of the participants who participated in different project activities (Table 1).The feed resource mobilization and processing activity engaged more women than men by 86%, since equal opportunity was provided to men and women, the observed results possibly because the feed materials (Leucaena and cassava leaves) were easily accessible and light to carry. Also, suggests that the engagement opportunities are beneficial and gender-sensitive (Obosha, 2021). On the other hand, training fetched the least women participation, which can be explained by the time limit for women to travel for the meeting as they were occupied with various home activities. Participated stakeholders benefited abundantly both economically and socially (Peña and Valls, 2023).

Table 1: Stakeholders by gender engagement during the development of innovative and affordable feed solutions for cattle finishing in Tanga region

Activity description	Men	Female	%Female
Project Inception meeting	5	7	58
Research and data collection	10	5	33
Purchase of beef animals from markets	5	2	29
Hay and Silage preparation for finishing cattle	30	34	53
Labor contract	1	2	67
Mobilization and processing of local feed resources	10	60	86
Training workshop, project outcome	60	13	17
Total	121	123	50.41

b) Feed Ingredients, Chemical Composition of Feeds, and Cost of Formulated Diet Used

The analysis of feed ingredients, chemical composition, and diet costs used in developing feed solutions are presented in Table 2. Eight feed ingredients were locally sourced for diet formulation based on percentages. Also, the composition was measured in particular energy in MJ/kg DM and the cost was per kilogram.

i. *Feed Ingredients*

Nine (9) feed ingredients were used to formulate two diets for the cattle finishing feed solution experiment (Table 2). Besides the basal diet, corn, rice polish, and cassava roots were the main energy sources, while leucaena leaf, sunflower seed cake, and soya beans for protein. These feed ingredients are all sourced locally and seem available in the Tang a Region abundantly.

ii. *Chemical Composition*

Both diets (one and two) were of high quality in terms of crude protein (CP%, DM) of 16.2% and 14.60; and metabolizable energy (ME)of 11.16 and 10.36 MJ/kg DM (Table 2). The results are of high quality compared to values reported in the work by Gebremariam and Belay, 2021 and Mrema et al. (2022) reported CP% DM of 2.76 to 10.9, and 6.08 to 11.60 MJ/kg DM from local feed materials in Tanzania, respectively. The current analysis results suggest that feed materials obtained from the Tanga region are of high-quality potential for formulating cattle finishing diets.

c) Costs Per Kilogram of Formulated Diets for Cattle Finishing

The cost analysis associated results associated with producing one Kilogram of the formulated feed diet is presented in Table 2. Without adding a profit margin, Diet One cost was about TSHs 498 and TSHs—490 for Diet two per kilogram, respectively. The reported costs were considered cheap for Tanga region, such that the average price of one Kilogram for concentrates with a similar ingredient composition was about TSHs 500 to 1000 (Mlote et al., 2012) as a field survey in 2011/2022. Equally, the requirement of finishing cattle and feeding at optimal was considered as per recommendation in the nutritional requirement for beef cattle (NRC, 1996).At this point, these obtained results on diet quality and cost evaluation given the locally sourced feed materials were considered a feasible feed solution for cattle finishing in Tang a region. Therefore, given a room to select quality high-quality ingredients

Table 2: Feed ingredients, chemical composition, and cost of formulated diets used

Feed Ingredients	Diet 1 %	Diet 2 %	Control%
Hay & silage (Basal diet)	45	56.6	100
Maize meal	11.92	9.6	0
Rice polish	6.92	2.62	0
Cassava root meal	1.92	4.62	0
Leucaena leaf meal	18	4.62	0
Sunflower seed cake	1.9	12.66	0
Soya bean meal	6.44	8.24	0
Minerals Conc	2.9	0.94	0
Chemical composition			
ME (MJ/kg DM)	11.16	10.36	6.95
CP	16.20	14.60	4.90
Ca	1.66	0.5	0.37
P	1.24	0.72	0.19
Cost per kilogram			
Price/kg (TSH)	498.69	495.76	225.22

d) Effects of Diets on Performance of Finishing Cattle

Table 3 shows Phase I results tested at P≥ 0.5; whereby age category, sex, and penning were not significant. Crosses responded better significantly to the diets than the TSHZ cattle for weekly and total weight gain, respectively. The mean comparison on diets 1 & 2 was all significant to diet control with diet 1ranking first for both weekly and total weight gain, respectively.

The higher gain from crossbred cattle could be a result of better adaptation to the finishing experiment as reported by (Bertipaglia et al., 2010), genetic characteristics and environment (Sakowsk et al.2022),and diet quality and dry matter intake per body weight (DMI/BWT)(Marshall et al 2009)compared to TSHZ that are originally raised and adopted in free grazing. However, Diet 1 seemed to perform better for TSHZ than Diet 2, which can be explained by the possible differences in diet energy density (Bertipagli a *et al.,* 2010).

Table 3: Effects of diet, genotype, Age, sex, and pen on weight gain of finishing cattle

Factors	Parameters		
Dietary	Weekly gain	Total gainP≥ 0.5	
D1	8.04[a]	88.50[a]	***
D2	7.58[a]	83.41[a]	***
D3	3.87[b]	42.58b***	
Genotype			
Crossbred	6.82[a]	75.00[a]	
TSHZ	6.23[b]	68.60[b]	
Age category			
<3 years	6.61[a]	72.20[a]	
3 - 4 years	6.53[a]	71.82[a]	
> 4 years	6.29[a]	69.16[a]	
Sex			
Female	6.52[a]	71.67[a]	
Male	6.43[a]	70.69[a]	
Row pen			
1	6.50[a]	71.52[a]	
2	6.44[a]	70.80[a]	

Key: D = Diet, the similar superscript in the column means no significant difference

Table 4 shows the interaction effects of genotype and diet. TSHZ responded better to Diet 1and crossbred for Diet 2. Suggesting that diets1 and 2 its economically efficient and are genotype dependent (Mollel *et al.,* 2014;Neto et al.2023)un improved cattlege no type attained higher gain per small amount of feeds

due to lower Feed Conversion Ratio (FCR) and a short period in weight change.

Table 4: Interaction effects of genotype and dieton finishing cattle weight gain

Parameters	TSHZ			Crossbred		
	Diet1	Diet2	Control	Diet1	Diet2	Control
Weekly gain (Kg/week)	7.82	7.23	3.84	8.22	8.72	3.92
Total gain (Kg/11 weeks)	86.00	76.54	42.20	90.44	96.00	43.14

e) Validation

Table 5 shows the Phase II results that were inconsistent with Phase I and performed significantly better than the control. The recorded average daily live weight gain of 0.62kg/dayin 11 weeks for the best-ranked formulated diet against 0.02/kg/day for the control is significant studies reported by Kimirei et al., 2022 and Asimwe et al., 2015 for TSHZ supports the current findings.

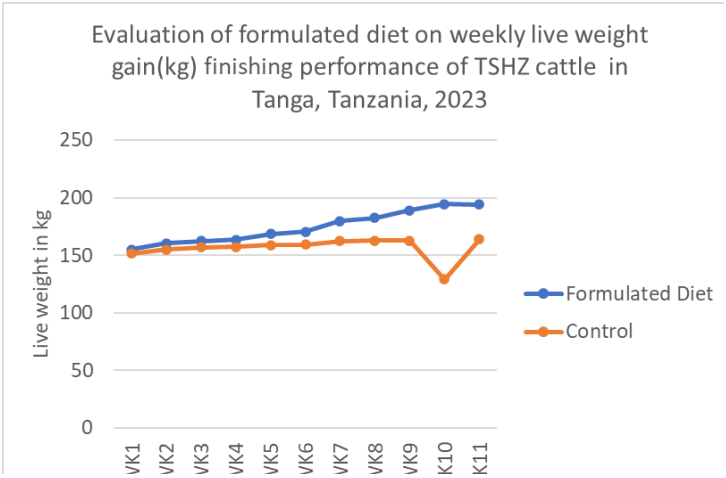

Figure 1: Evaluation of formulated diet on weekly live weight gain (kg) finishing performance of TSHZ cattle in Tanga, Tanzania

IV. Conclusion

This study demonstrated that developing local feed formulas for cattle finishing can significantly enhance the quality of beef, leading to increased profitability for producers and contributing to the national economy, job creation, and the potential for commercial application. The locally developed feed formula prototype by TALIRI not only reduces costs but also creates job opportunities for youth, the private sector, and scientists in Tanzania. Engagement of the private sector, coupled with research expertise, was crucial in the successful development and potential commercialization of the feed formula. Further research should focus on developing feed formulas for other livestock species such as chickens, fish, and dairy cattle. This expansion is essential for diversifying and strengthening the livestock industry in Tanzania.

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Impact of Farm Mechanization on the Psychological Health of the Farmers: A holistic Study in West Bengal, India

By Anannya Chakraborty & Jesmin Abedin

Seacom Skills University

Abstract- *Context:* The present study is based on the impact of farm mechanization on psychological health of the farmers. The physical drudgeries of the farmers caused by daily farm works leave a long term impact on their mental wellbeing. The farm mechanization not only helps in reducing the physical strain, but also it creates a significant impact on the farmers' psychological state.

Objectives: To find out the factors which are improved by the mechanization of farming and how those are impacting the psychological health of the farmers.

Methods: The study has been conducted in the Raipur Gram Panchayet and village, Sriniketan block, Birbhum district of West Bengal. Total 150 farm families were selected for the study with a class interval of 3(2.75 to be precise).

Keywords: *farm mechanization, psychological health, communication, wellbeing.*

GJSFR-D Classification: *LCC S494.5.M42*

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Impact of Farm Mechanization on the Psychological Health of the Farmers: A Holistic Study in West Bengal, India

Anannya Chakraborty [α] & Jesmin Abedin [σ]

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Results and Discussion: It was found in the study that, improved and mechanized way of farming has a significant impact on the psychological health and wellbeing of the farmers.

Significance: The policy makers, extension functionaries and other state holders can get useful references from the study and the study can further be replicated in locales with similar kinds of socio-economic and techno-managerial situations.

Keywords: farm mechanization, psychological health, communication, wellbeing.

I. Introduction

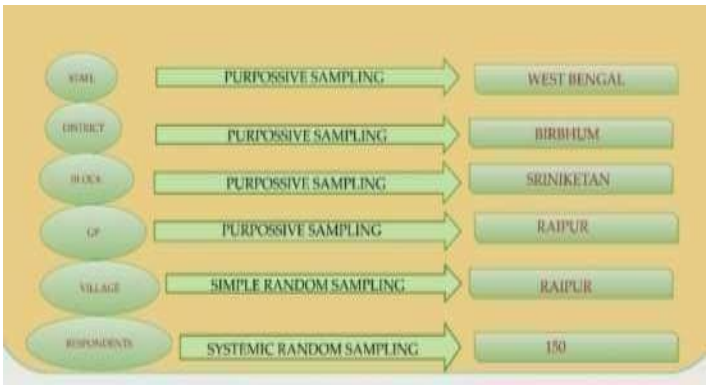
The modernization of agriculture is driven by various factors, including population growth, urbanization, changing dietary patterns, globalization, climate change, and advancements in science and technology. It aims to address the challenges of feeding a growing population sustainably, enhancing food security, reducing poverty, promoting rural development, and mitigating environmental degradation. While agricultural modernization offers opportunities for increasing productivity, profitability, and competitiveness, it also poses challenges related to access to technology, knowledge, resources, and environmental sustainability. Therefore, achieving sustainable 15 agricultural modernization requires a balanced approach that considers social, economic, environmental, and ethical dimensions to ensure inclusive and equitable development while safeguarding natural resources and ecosystem integrity. The modernization of agriculture represents a transformative process aimed at enhancing productivity, efficiency, and sustainability in the agricultural sector. In response to changing socio-economic, environmental, and technological dynamics, countries worldwide are embracing modern agricultural practices and technologies to meet the growing demand for food, ensure food security, and promote rural development. Before the emergence of the modern agricultural tools and techniques, the farmers were suffering so much from the drudgeries of agricultural works. These suffering of theirs were include not only physical, but also psychological stress. Bentley et al. (2019) found in their study that the psycho-social risks, such as high demands, role conflict, lack of managerial or co-worker support, stress, bullying and discrimination in the work environment, are detrimental to both health and well-being of older workers and can also increase the probability of early retirement. This is one of the reasons why many of the farmers don't want to be in agriculture and their mass shifting towards the urban and semi urban areas.

In this paper we will discuss how the farm mechanization has impacted on psychological health of the farmers positively and has reduced their occupational stress to a significant extent.

II. Methodology

This study was conducted in Raipur Gram Panchayet and village, Sriniketan block, Birbhum district of West Bengal. Total 150 farm families were selected for the study with a class interval of 3 (2.75 to be precise). The sampling method used for the study is as follows-

Author α: Assistant Professor, Department of Agricultural Extension, School of Agriculture, Seacom Skills University, West Bengal, India.
Author σ: Pass out student, Department of Agricultural Extension, School of Agriculture, Seacom Skills University, West Bengal, India.
e-mail: chakraborty.ext@gmail.com



Pilot Study: A pilot study, pilot project, pilot test, or pilot experiment is a small-scale preliminary study conducted to evaluate feasibility, duration, cost, adverse events, and improve upon the study design prior to performance of a full-scale research project. We have done a pilot study with 10% samples of the total respondents to see whether the questionnaires are applicable and capable for extracting the required information from the tribal women of the area under study.

a) Methods of Data Collection

Preparation of Interview Schedule: On the basis of the findings of pilot study interview schedule was prepared with the help of review literature and by the assistance of chairman of Advisory Committee. The schedule consists of Agro-economic, Socio- personal and Techno managerial.

Pre Testing of Interview Schedule: Main objective of this performance is to detect the discrepancies that have emerged and to eliminate them after necessary modification in the schedule. The individuals who responded in pretesting have been excluded in the final sample for the study.

Techniques of Field Data Collection: The respondents were personally interviewed during summer vacation. Local language (Bengali) was used to retrieve the information from the respondent. The entries were done by the student investigator himself at the time of interview.

b) Statistical Tools

The statistical tools used for the study are coefficient of correlation and step down regression.

Coefficient of correlation: The correlation coefficient is a statistical measure of the strength of the relationship between the relative movements of two variables. The values range between -1 and +1. If the calculated number greater than +1 or less than - 1 means that there was an error in the correlation measurement. A correlation of -1 shows a perfect negative correlation, while a correlation of 1.0 shows a perfect positive correlation. A correlation of 0 shows no linear relationship between the movements of the two variables.

Correlation Coefficient Equation:

Where,

rxy – The correlation coefficient of the linear relationship between the variables x and y

xi – The values of the x-variable in a sample $\bar{x}$ – the mean of the values of the x-variable yi– the values of the y-variable in a sample $\bar{y}$ – the mean of the values of the y-variable

Stepwise Multiple Regressions: Regression analysis is a widely used statistical approach that seeks to identify relationships between variables. The idea is to pool relevant data to make better informed decisions and is a common practice in the world of investing. Stepwise regression is the step-by-step iterative construction of a regression model that involves automatic selection of independent variables. The availability of statistical software packages makes stepwise regression possible, even in models with hundreds of variables.

III. Results

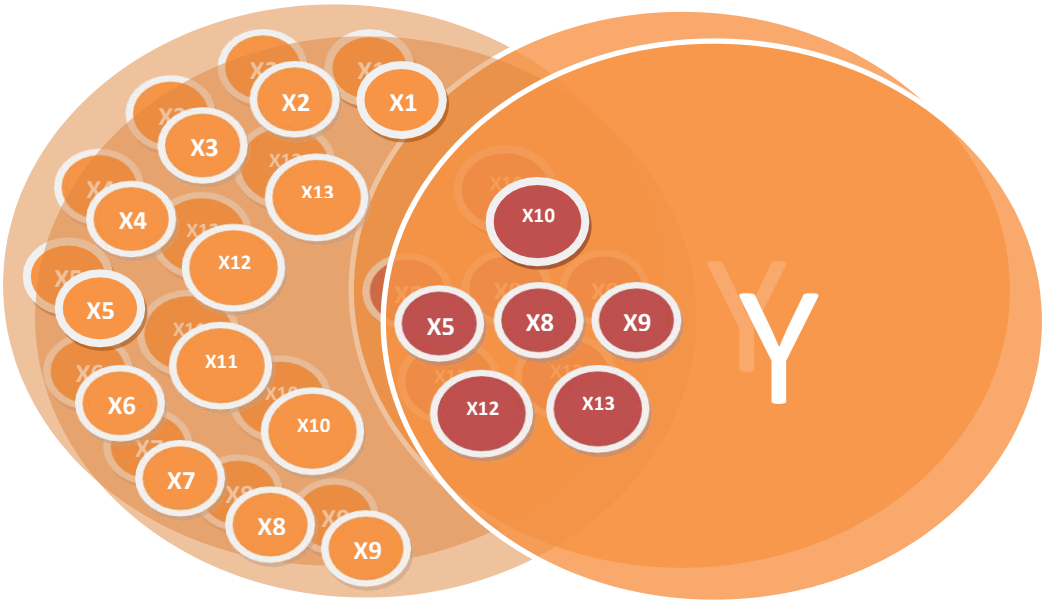
The correlation of coefficient between dependent variable Improvement ofPsychological health (Y) and the 13 independent variables (X1……X13)

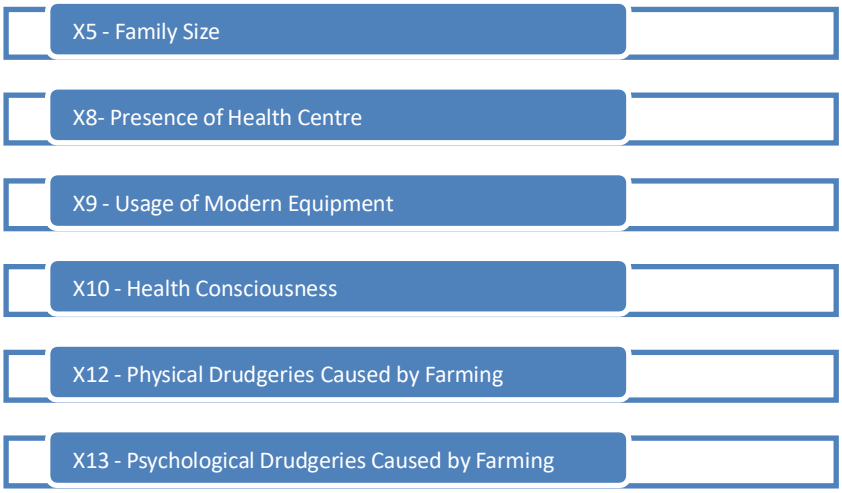
Sl No.	Variables	Correlation Coefficient	Remark
1	Age (X1)	0.0328	
2	Educational Qualification (X2)	-0.02186	
3	Total Monthly Income (X3)	-0.0228	
4	Monthly Expenditure on Health Issues (X4)	-0.02225	
5	Family Size (X5)	-0.153005	*
6	Cultivated Crops (X6)	-0.04155	
7	Available Land (X7)	-0.00495	
8	Presence of Health Centre (X8)	0.090	*
9	Usage of Modern Equipment(X9)	0.0615	*
10	Health Consciousness (X10)	0.092047	*
11	Relation with Relatives and Neighbors (X11)	-0.018	
12	Physical Drudgeries Caused byFarming (X12)	0.1749	*
13	Psychological Drudgeries Caused by Farming (X13)	0.1416	*

This is clearly visible Family Size (X5), Presence of Health Centre (X8), Usage of Modern Equipment (X9), Health Consciousness (X10), Physical Drudgeries Caused byFarming (X12) and Psychological Drudgeries Caused by Farming (X13) have significant correlation with the dependent variable Improvement of Psychological health (Y3).

Family size is a two way serrated saw. In the one hand it would give the strength to walk in the farming field but on the other hand it would surely give more burden to feed empty stomach. If the survival expenditure of the family is more than there would be a very small amount of resource left to be spend on the mental health issues presence of health center and health consciousness would create a significant positive impact on the mental health status of the respondents. Usage of the modern equipment will lessen the physical and psychological drudgery of the respondents, which would be very helpful to improve their mental health.

The Model of the correlation of coefficient between dependent variable Improvement of Psychological health (Y) and the 13 independent variables (X1……X13)





Step down regression of 13 independent variables vs dependentvariables Improvement of Psychological health (Y)

Name of the Variables	B	Beta	t
Age (X1)	0.017	0.064	0.455
Educational Qualification(X2)	0.335	0.504	3.222
Total Monthly Income (X3)	-0.001	-0.482	-1.208
Monthly Expenditure on Health Issues (X4)	-0.144	-0.062	-0.167
Family Size (X5)	-0.233	-0.220	-1.056
Cultivated Crops (X6)	0.002	0.383	1.109
Available Land (X7)	0.749	0.330	1.751
Presence of Health Centre(X8)	0.016	0.006	0.020
Usage of Modern Equipment (X9)	1.016	0.349	2.355
Health Consciousness (X10)	0.200	0.306	0.773
Relation with Relatives andNeighbors (X11)	0.062	0.208	0.930
Physical Drudgeries Causedby Farming (X12)	0.540	0.178	0.781
Psychological DrudgeriesCaused by Farming (X13)	0.125	0.179	0.546

$R^2 = 0.5878$

The result depicted in the above table revealed that step down regression analysis between exogenous variable Improvement of Psychological Health (Y) Vs 13 Causalvariables.

It has been found that the R^2 value is 0.5878. It is to infer that 58.78% of variance in the consequent variable have been explain by the combination of these 13 causal variables.

Step down regression 9th step for Improvement of Psychological health (Y)

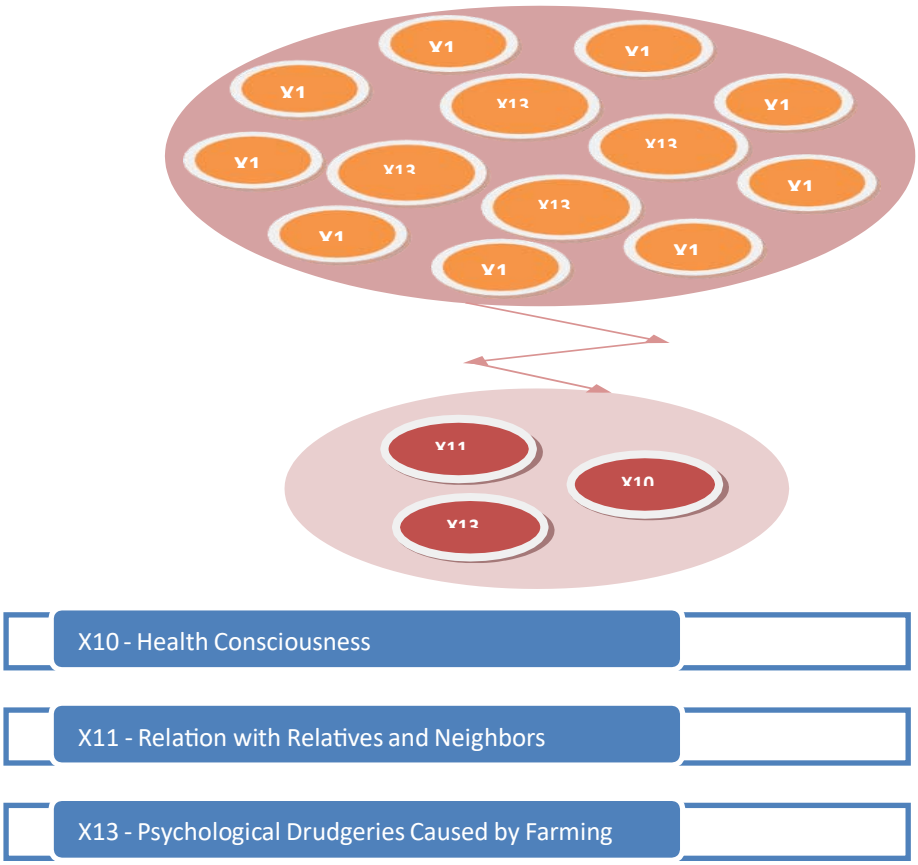
Name of the Variables	B	Beta	t
Health Consciousness (X10)	0.306	0.460	3.783
Relation with Relatives andNeighbors (X11)	0.599	0.264	2.047
Psychological DrudgeriesCaused by Farming (X13)	0.890	0.306	2.344

R^2=0.8138

The above table presents the stepwise regression and it has been depicted that 3 casual variable), Health Consciousness (X10), Relation with Relatives and Neighbors (X11), Psychological Drudgeries Caused by Farming (X13) has been retained in the last step. The R^2 value being 0.8138 shows that 81.38% of variance in the consequent variableshas been explained by the combination of only these 3 casual variables.

Health consciousness is a key factor to detect mental health. Communication can improve the mental health status of an individual. If people are more health conscious more communicative and less stressed then it would surely improve their psychologicalhealth.

Step down regression of 13 independent variables vs dependentvariables Improvement of Psychological health (Y)



IV. Discussion

In case of Exogenous Improvement of Psychological health (Y3) after doing research study we can easily say that the coefficient of correlation is visible Family Size (X5), Presence of Health Centre (X8), Usage of Modern Equipment (X9), Health Consciousness (X10), Physical Drudgeries Caused by Farming (X12) and Psychological Drudgeries Caused by Farming (X13) have significant correlation. And in case of step down regression the result revealed that the analysis between mentioned exogenous variable vs 13 causal variables. it has been found that the R^2 value being 0.5878 shows that 58.78% of variance in the consequent variable have been explain by the combination of these 13 casual variable. And in the 9th step or final of step down regression it has been depicted that 3 casual variables has been retained in the last step. The R^2 value being 0.8138 shows that 81.38% of variance in the consequent variables has been Health Consciousness (X10),

Relation with Relatives and Neighbours (X11)and Psychological Drudgeries Caused by Farming (X13) explained by the combination of only these 3 casual variables.

The recommendation which we can give to the policy makers:-

- The women should be encourage to have more localized and cosmopolite information to change their present scenario. The government's schemes and programmes which are beneficiary and useful for purchasing latest agricultural equipment should be known by the tribal women. For this a proper bridge should be made in between the government agencies and the tribal women. Opinion leaders who can get the firsthand information from the government agencies and to communicate these information to the other stake holder, should be identified and trained properly.
- As we have found that, this particular village is quite remote and backward. It is very much late to adopt new technology or implements. So, the main problem we can say there is a communication gap, if a contact person or opinion leaders would be there it will be easy for them to adopt things easily and if the contact person is women it will be more comfortable for them to communicate.

V. Conclusion

Saju et. al. (2023) has found in their study that the quantifiable variables associated with farmers's well being are attachment family, friends and peer groups, belongingness and other social engagements. In this study also we have found out that farm mechanization effectively increases the health consciousness of the farmers and establishes better communication and relationship with relatives and neigh bors. It was also evident from the study that mechanized way of farming significantly reduces not only the physical but also the psychological drudgeries of the farmers. The number of the members of the family is negatively significant with the psychological health of the farmer. It indicates that lesser the family size better would be the psychological health of the members. Henceforth, we can conclude from the study that, usage of modern equipment in the farming is pretty much helpful in maintaining a good psychological health of the farmers and their subsequent mental, physical and social well being.

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Declaration of competing interest: The authors have no conflicts of interest.

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Authors Contribution: Both the first and second authors have contributed in problem identification, ideation, data collection and formulation of conclusion.

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Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

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