IJOEAR

International Journal of Environmental & Agriculture Research

www.ijoear.com

ISSN
2454-1850

Volume-8, Issue-2, February 2022

Preface

We would like to present, with great pleasure, the inaugural volume-8, Issue-2, February 2022, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas.

Environmental Research:

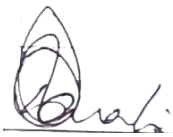
Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

Mukesh Arora
(Managing Editor)



Dr. Bhagawan Bharali
(Chief Editor)

Fields of Interests

Agricultural Sciences	
Soil Science	Plant Science
Animal Science	Agricultural Economics
Agricultural Chemistry	Basic biology concepts
Sustainable Natural Resource Utilisation	Management of the Environment
Agricultural Management Practices	Agricultural Technology
Natural Resources	Basic Horticulture
Food System	Irrigation and water management
Crop Production	
Cereals or Basic Grains: Oats, Wheat, Barley, Rye, Triticale, Corn, Sorghum, Millet, Quinoa and Amaranth	Oilseeds: Canola, Rapeseed, Flax, Sunflowers, Corn and Hempseed
Pulse Crops: Peas (all types), field beans, faba beans, lentils, soybeans, peanuts and chickpeas.	Hay and Silage (Forage crop) Production
Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
Tree Nut crops: Hazlenuts. walnuts, almonds, cashews, pecans	Berry crops: strawberries, blueberries, raspberries
Sugar crops: sugarcane. sugar beets, sorghum	Potatoes varieties and production.
Livestock Production	
Animal husbandry	Ranch
Camel	Yak
Pigs	Sheep
Goats	Poultry
Bees	Dogs
Exotic species	Chicken Growth
Aquaculture	
Fish farm	Shrimp farm
Freshwater prawn farm	Integrated Multi-Trophic Aquaculture
Milk Production (Dairy)	
Dairy goat	Dairy cow
Dairy Sheep	Water Buffalo
Moose milk	Dairy product
Forest Products and Forest management	
Forestry/Silviculture	Agroforestry
Silvopasture	Christmas tree cultivation
Maple syrup	Forestry Growth
Mechanical	
General Farm Machinery	Tillage equipment
Harvesting equipment	Processing equipment
Hay & Silage/Forage equipment	Milking equipment
Hand tools & activities	Stock handling & control equipment
Agricultural buildings	Storage

Agricultural Input Products	
Crop Protection Chemicals	Feed supplements
Chemical based (inorganic) fertilizers	Organic fertilizers
Environmental Science	
Environmental science and regulation	Ecotoxicology
Environmental health issues	Atmosphere and climate
Terrestric ecosystems	Aquatic ecosystems
Energy and environment	Marine research
Biodiversity	Pharmaceuticals in the environment
Genetically modified organisms	Biotechnology
Risk assessment	Environment society
Theoretical production ecology	horticulture
Breeding	plant fertilization

Board Members

Dr. Goswami Tridib Kumar

Presently working as a Professor in IIT Kharagpur from year 2007, He Received PhD degree from IIT Kharagpur in the year of 1987.

Prof. Khalil Cherifi

Professor in Department of Biology at Faculty of Sciences, Agadir, Morocco.

Dr. Josiah Chidiebere Okonkwo

PhD Animal Science/ Biotech (DELSU), PGD Biotechnology (Hebrew University of Jerusalem Senior Lecturer, Department of Animal Science and Technology, Faculty of Agriculture, Nau, AWKA.

Prof. Özhan ŞİMŞEK

Agriculture Faculty, Department of Horticulture, Çukurova University, Adana, 01330 Turkey.

Dr. Anka Ozana Čavlović

Working as Professor in the department of Faculty of Forestry, University of Zagreb, Svetošimunska 25, Zagreb.

Dr. Rakesh Singh

Professor in Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Also Vice President of Indian Society of Agricultural Economics, Mumbai.

Dr. Sunil Wimalawansa

MD, PhD, MBA, DSc, is a former university professor, Professor of Medicine, Chief of Endocrinology, Metabolism & Nutrition, expert in endocrinology; osteoporosis and metabolic bone disease, vitamin D, and nutrition.

Dr. Ajeet singh Nain

Working as Professor in GBPUA&T, Pantnagar-263145, US Nagar, UK, India.

Dr. Salvinder Singh

Presently working as Associate Professor in the Department of Agricultural Biotechnology in Assam Agricultural University, Jorhat, Assam.

Dr. Salvinder received MacKnight Foundation Fellowship for pre-doc training at WSU, USA – January 2000- March 2002 and DBT overseas Associateship for Post-Doc at WSU, USA – April, 2012 to October, 2012.

Dr. V K Joshi

Professor V.K.Joshi is M.Sc., Ph.D. (Microbiology) from Punjab Agricultural University, Ludhiana and Guru Nanak Dev University, Amritsar, respectively with more than 35 years experience in Fruit Fermentation Technology, Indigenous fermented foods, patulin ,biocolour ,Quality Control and Waste Utilization. Presently, heading the dept. of Food Science and Technology in University of Horticulture and Forestry, Nauni-Solan (HP), India.

Dr. Mahendra Singh Pal

Presently working as Professor in the dept. of Agronomy in G. B. Pant University o Agriculture & Technology, Pantnagar-263145 (Uttarakhand).

Dr. Sanjoy Kumar Bordolui

M.Sc. (Ag.), PhD, FSTA, FSIESRP, Assistant Professor, Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. W.B., India. He received CWSS Young Scientist Award-2016, conferred by Crop and Weed Science Society, received Best Young Faculty Award 2019 conferred by Novel Research Academy, received Innovative Research & Dedicated Teaching Professional Award 2020 conferred by Society of Innovative Educationalist & Scientific Research Professional, Chennai.

DR. Owais Yousuf

Presently working as Assistant professor in the Department of Bioengineering, Integral University-Lucknow, Uttar Pradesh, India.

Dr. Vijay A. Patil

Working as Assistant Research Scientist in Main Rice Research Centre, Navsari Agricultural University, Navsari. Gujarat- 396 450 (India).

Prof. Salil Kumar Tewari

Presently working as Professor in College of Agriculture and Joint Director, Agroforestry Research Centre (AFRC) / Program Coordinator in G.B. Pant University of Agric. & Tech., Pantnagar - 263 145, Uttarakhand (INDIA).

Dr. S. K. Jain

Presently working as Officer Incharge of All India Coordinated Sorghum Improvement Project, S. D. Agricultural University, Deesa, Gujarat.

Dr. Deshmukh Amol Jagannath

Presently working as Assistant Professor in Dept. of Plant Pathology, College of Agriculture polytechnic, NAU, Waghai.

Mr. Anil Kumar

Working as Junior Research Officer/Asstt. Prof. in the dept. of Food Science & Technology in Agriculture & Technology, Pantnagar.

Mr. Jiban Shrestha

Scientist (Plant Breeding & Genetics)

Presently working as Scientist (Plant Breeding and Genetics) at National Maize Research Programme (NMRP), Rampur, Chitwan under Nepal Agricultural Research Council (NARC), Singhdarbar Plaza, Kathmandu, Nepal.

Mr. Aklilu Bajigo Madalcho

Working at Jigjiga University, Ethiopia, as lecturer and researcher at the College of Dry land Agriculture, department of Natural Resources Management.

Mr. Isaac Newton ATIVOR

MPhil. in Entomology, from University of Ghana.

He has extensive knowledge in tree fruit orchard pest management to evaluate insecticides and other control strategies such as use of pheromone traps and biological control to manage insect pests of horticultural crops. He has

knowledge in agronomy, plant pathology and other areas in Agriculture which I can use to support any research from production to marketing.

Mr. Bimal Bahadur Kunwar

He received his Master Degree in Botany from Central Department of Botany, T.U., Kirtipur, Nepal. Currently working as consultant to prepare CCA-DRR Plan for Hariyo Ban Program/CARE in Nepal/GONESA.

Table of Contents

Volume-8, Issue-2, February 2022

Analyzing the contribution of Rwinkwavu marshland irrigation scheme on community livelihood improvement in Kayonza District, Eastern Rwanda

Alphonse Nkurunziza[1*], Christophe Mupenzi[2], Prosper Manikuze[3]

Department of Environmental studies, University of Lay Adventists of Kigali (UNILAK), Kigali-Rwanda
*Corresponding Author

Received:- 02 February 2022/ Revised:- 10 February 2022/ Accepted:- 16 February 2022/ Published: 28-02-2022

Abstract— *Smallholder farmers across the world and particularly in developing countries have been facing a problem of food insecurity and slow rate of livelihoods improvement because of climate-induced droughts and lack of effective use of modern agricultural techniques. Rainfall patterns have become more unpredictable and inconsistent with the traditional farming seasons and practices. Faced with such challenges, together with the rising population growth and its pressure on natural resources as well as strategies to eradicate hunger, many governments adopted irrigation systems and wetlands development for agriculture to improve food security and welfare of farmers and community in general. This study aims to analyse whether and the extent to which the development of Rwinkwavu marshland and introduction of irrigation system for rice growing in the area have been impacting on the community's livelihoods improvement since the development of the marshland in 2014. Among the methodological approaches and tools used, a comprehensive desk review to explore available related research works in order to trace the gaps, field visit for researcher's own observation and collection of information on site and available data in different institutions, exploration of satellite imagery of the study area and combination of primary and secondary data to allow the comparison of land use and cover changes before and after the marshland development, questionnaire and focused group discussions were used to collect the farmers and community's view on the role of marsland transformation in livelihoods improvement. In addition, GIS was used to analyse and process spatial data of the land use/cover change of the area while collected data on community's view were processed in Microsoft Excel and analyzed using SPSS. The findings indicate that the Rwinkwavu marshland reclamation and transformation to modern rice growing area has highly and positively contributed to community livelihoods improvement. It was recommended further researches in other reclaimed areas countrywide in order to allow decision makers to have enough data that help to compare the efforts and investments made in the sector with the impacts on population. Further researches to compare and balance the benefits from transformation made with the benefits from on natural ecosystem services as well as the impacts on natural habitat are also recommended.*

Keywords— Agriculture, Community livelihoods, Irrigation system, Marshland development, Kayonza District.

I. INTRODUCTION

Global food security is a worldwide concern and the challenge is how to feed a growing population which currently is estimated at 7 billion and projected to reach 9.2 billion particularly with the projection from 5.8 billion in 2015 to 7.9 billion in less developed regions by the year 2050 [12]. In Sub-Saharan Africa (SSA), where most economies are largely agrarian-based, the demand for arable farmlands continues to be a thorny issue for many countries. The scarce arable land faces competition, soils are becoming exhausted and water becoming increasingly scarce, competition for fertile farming lands and limited access to any available farmland for many areas of SSA has led to people invading wetlands and other marginal areas for agricultural and other transforming activities. In this fight for survival, they often engage in unsustainable use of these natural resources, causing degradation and other adverse effects[1].

Due to increasing population growth, poverty reduction, and development efforts, wetlands are increasingly being utilized and transformed for more value addition in different parts of the world. Wetland development projects significantly impact on their ecological productivity and economic output and more often than not generate conflicts concerning control of the

resources between different users for instance pastoralists and farmers or small-scale farmers and large-scale capitalist farmers [6].

Wetlands provide valuable ecosystem services to society. Despite this, in many parts of the world, wetlands have been degraded or lost, and demand for development, particularly from agriculture is putting pressure on many of those that remain [3]. Achieving environmental sustainability and at same time satisfying the need for increased food production, enhanced economic growth and poverty reduction, is an issue of growing importance the world over [8].Rwinkwavu marshland, the main focus of this study, is a place where most of the above conditions prevail though at a local scale. The area is experiencing population growth, poverty, ecological stress and limited productive resource base. The main natural resource available, the wetland, is increasingly becoming scarce as competition for control and access to, and its utilization increases amongst multiple and contested uses by various stakeholders within the local community [12]; [10]. The latest incidence is the entry of big-scale investment in agricultural activities, following the construction of a dam upstream and development of irrigation system to enable rice growing in the area since the year 2014 [2].

It has also been argued that most studies conducted on Rwandan wetlands have laid much emphasis on natural sciences largely on nutrient dynamics, water quality, aquatic ecology and fisheries, hydrology and catchment's modelling and vegetation dynamics with very little to do with human welfare and utilization impacts. On the same note these studies have not explored much into details of livelihood improvement for the local communities with respect to wetland utilization, conservation and management [10]; [4]. The assessment of the impact of these activities on the livelihoods of the local community is a case at hand.

II. MATERIALS AND METHODS

2.1 Description of the Study Area

Rwinkwavu Marshland is located in the Eastern Province, Kayonza District, stretching across three sectors namely Mwiri, Gahini and Rwinkwavu as indicated on Figure 1. It is located at agro-climatic zone of eastern savanna that was characterized, before the development of irrigation scheme, by rolling grassland with scattered trees and shrubs, short period of rain and long dry seasons and often large herds of grazing animals on the savanna that thrive on the presence of grass and trees [5]. Though, the climate of Rwanda is generally characterized by alternation of two wet seasons (SOND and MAM) and two dry seasons (JF and JJO), the area is characterized by low precipitation and the historical background indicate that it has been invaded by severe droughts [7]. The region has no river except small tributaries that feed wetlands and lakes which indicate that water is not abundant in the area.

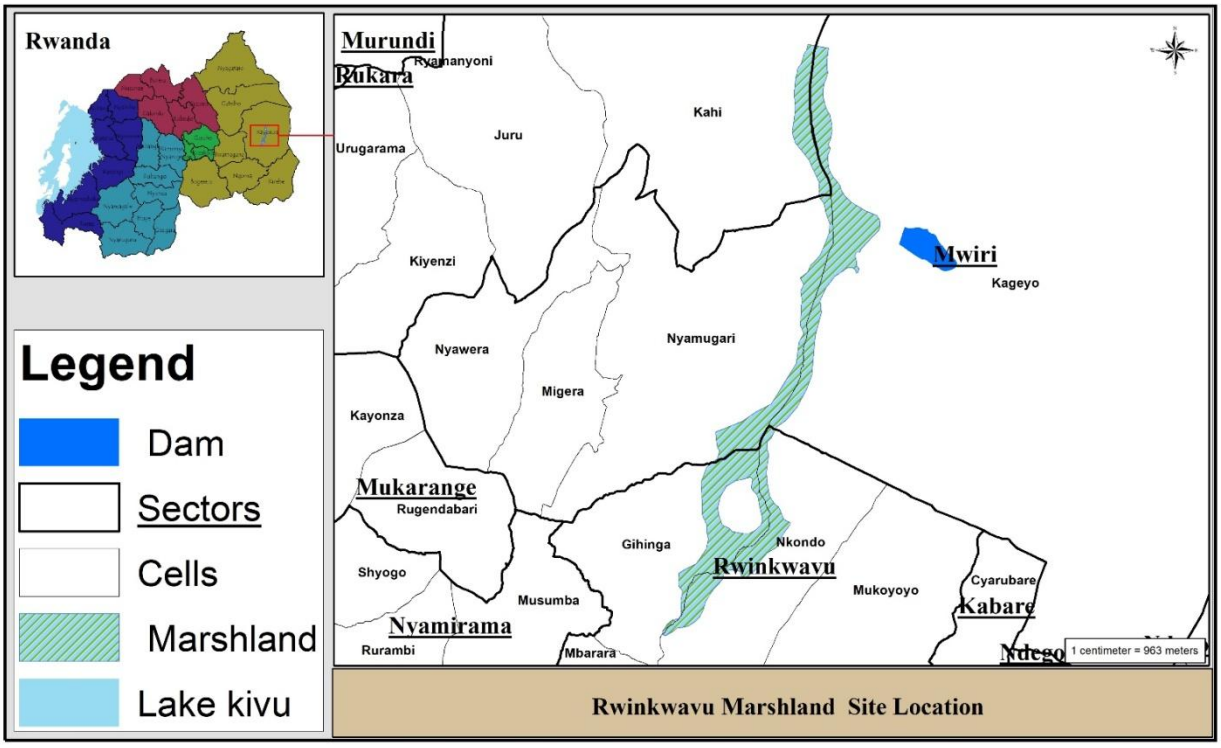


FIGURE 1: Map of the study area indicating the location of Rwinkwavu marshland

In Rwinkwavu marshland, the construction of the dam & irrigation infrastructures was implemented to enhance irrigated rice production in Rwinkwavu marshland of Kayonza District. Irrigation development works were executed in two phases: phase one of Rwinkwavu upper marshland have been executed during the period from 2013 to 2015, phase two of Rwinkwavu lower marshland have been executed in 2017-2018. The total area of the marshland covered by irrigation scheme is 1,600 ha and consequently the project beneficiaries practicing irrigated rice farming in the scheme are made up of 4468 beneficiaries, 2771 males and 1697 females) distributed in the three sectors. Among the key activities and infrastructures put in place by Rwinkwavu marshland development with irrigation system to allow water channeling in the marshland, include the construction of Rwinkwavu water reservoir located at 10km long upstream of 6.3 million m^3 of storage capacity and a maximum height of 9,50m of the embankment, and Kageyo dam of 5 million m3 located on right side in middle of the marshland, main irrigation canals of 56.9 km length with 7 main water intakes, 38.5 km length of main drainage canal and access roads along and inside the marshland of 31km length (MINAGRI, 2011).

2.2 Data Collection

For the purpose of this study, the researcher collected two categories of data: primary data consisting of spatial data collected on field in the study area, researcher's observations, information from focused group discussions as well as the questionnaire distributed to selected key informants by a calculated sample of 98 individuals representing the study population while secondary data were the available shapefiles from the mapping conducted during the development of Rwinkwavu irrigation scheme and satellites images. Both qualitative and quantitative data were collected through household surveys, focused group discussions, key informant interviews and community workshops to gather the views about the utilization of the scheme and the impact on community's livelihoods.

2.3 Data Analysis

Geographical Information System Tools was used to convert Spatial data collected on field into shapefiles as well as to digitize the satellite images of the study area retrieved for different periods on Google Earth in order to convert them into shapefiles that allowed to produce maps indicating the status of Rwinkwavu irrigation scheme before and after the development of Rwinkwavu irrigation scheme leading to detection of changes occurred in the area.

Data collected using questionnaire on the community livelihoods before and after the existence of the irrigation scheme were organized, processed using Microsoft Excel and statistically quantified in order to determine the changes in livelihoods of farmers practicing agriculture in the irrigation scheme. To this end, SPSS version 16 has been used. About Hypotheses testing, given the two hypotheses set as Ho: Situation is the same in the 2 distributions and H1: Situation is significantly different in 2 distributions, p-value and level of significance were determined from SPSS and helped to know which of the two hypothesis is to be accepted and come up with the decision making as per Table 1. Because the research questionnaire data consist of one sample and two variables, Paired sample t-test was used. This consists of a statistical technique that is used to compare two population means in the case of two samples that are correlated. Paired sample t-test is used in 'before-after' studies, or when the samples are the matched pairs. The output informations from this analysis helped the researcher to know whether the development of Rwinkwavu irrigation scheme has contributed to the improvement of livelihoods.

TABLE 1
HYPOTHESIS TESTING APPROACH FOR DECISION MAKING

p-value and significance level	Decision	Conclusion
When p-value is greater than alpha	fail to reject Ho	Situation is the same in the two distributions
When p-value is less than alpha	reject Ho	Situation is significantly different in the two distributions

III. RESULTS AND DISCUSSION

3.1 Land use/cover changes of Rwinkwavu marshland following the development of irrigation system

The information gathered from key informants of the current research as well as spatial data either collected in agriculture sector related institutions or collected on field indicated a total change in the land cover and use of the study area as indicated by Figure 4.1. Before the reclamation of the marshland by development of irrigation scheme in 2014 to 2015, the marsh was really a poorly managed natural resource with 31% of its portion used by local resident for grazing their pasture while the other part was used for multi-varied crop agriculture for only family subsistence.

Due to poorly managed agricultural practices in the marshland, the initially grown crops as indicated on the map, the harvest used to be highly threatened by climate related extreme events. Contrally, after the irrigation system was developed in the marshland, water to support good growth conditions of crops was ensured permanently, rice growing was adopted as a single crop in the reclaimed area, introduction of technology oriented agriculture and related training to farmers as well as market oriented agriculture among other have been the new chapter of land exploitation in the study area.

The physical features characterizing the study area before the marshland reclamation as per satellite image of 2011 on Figure 3 are mainly the shrubs and other natural plantations as well as some crops grown by local residents in the area. The information received on field and from different existing archive documents indicated that due to the fact that the marsh was not managed in terms of infrastructures and boundaries, it was likely to be threatened by floods during heavy rainy seasons and severe droughts during wet seasons all of which used to affect negatively traditional agro-farmers who relied on the marshland.

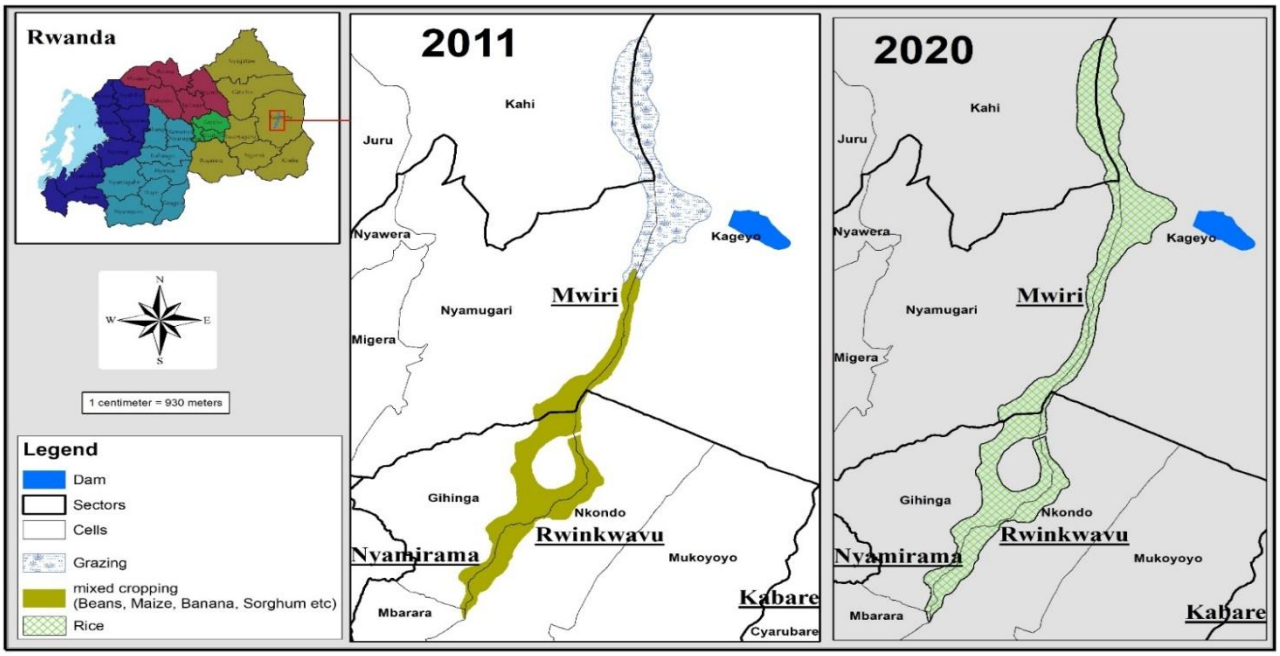


FIGURE 2: Map Comparing Land cover/use of Rwinkwavu marshland in 2011 and in 2020.

FIGURE 3: The upper part of Rwinkwavu marshland in 2011 compared to 2020 retrived from Google Earth

3.2 The impact of Rwinkwavu irrigation scheme to community livelihood improvement

The population size was 4468 rice farmers; the sample size was 98. After collection of data, participation rate was 100%. After editing, coding and entering data into SPSS version 22, the researcher generated tables to analyze and tabulation was made in order to present results of this research in a form that is reader friendly in terms of understanding.

3.2.1 Hypothesis testing based on Comparison of socio-economic situations of community before and after Rwinkwavu marshland reclamation.

The table below is an output of SPSS analysis by performing t test to test for the set hypotheses

TABLE 2
PAIRED SAMPLE T TEST OF HYPOTHESES

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Ensuring food security for family before irrigation scheme - Ensuring food security for family after irrigation scheme	-1.38776	.48974	.04947	-1.48594	-1.28957	-28.052	97	.000
Pair 2	Ability to pay efficiently clothes to the whole family before irrigation scheme - Ability to pay efficiently clothes to the whole family after irrigation scheme	-1.36735	.48456	.04895	-1.46450	-1.27020	-27.935	97	.000
Pair 3	Paying health insurance before irrigation scheme - Paying health insurance after irrigation scheme	-2.94898	.86600	.08748	-3.12260	-2.77536	-33.711	97	.000
Pair 4	Paying school fees of children before irrigation scheme - Paying school fees of children after irrigation scheme	-2.04082	.94070	.09502	-2.22941	-1.85222	-21.477	97	.000
Pair 5	Expanding my cropland and/or buying fertilizers before irrigation scheme - Expanding my cropland and/or buying fertilizers after irrigation scheme	-2.52041	.73540	.07429	-2.66785	-2.37297	-33.928	97	.000
Pair 6	Ability to construct/rehabilitate my residential house before irrigation scheme - Ability to construct/rehabilitate my residential house after irrigation scheme	-2.45918	.57738	.05832	-2.57494	-2.34343	-42.164	97	.000
Pair 7	Regular employment before irrigation scheme - Regular employment after irrigation scheme	-3.32653	.90560	.09148	-3.50809	-3.14497	-36.364	97	.000
Pair 8	Buying household assets before irrigation scheme - Buying household assets after irrigation scheme	-1.92857	.81544	.08237	-2.09206	-1.76509	-23.413	97	.000
Pair 9	Transport means before irrigation scheme - Transport means after irrigation scheme	-2.84694	.56262	.05683	-2.95974	-2.73414	-50.093	97	.000
Pair 10	Access to bank credits before irrigation scheme - Access to bank credits after irrigation scheme	-2.87755	.82818	.08366	-3.04359	-2.71151	-34.396	97	.000
Pair 11	Expanding to other business (Transport, shop, services, etc) before irrigation scheme - Expanding to other business (Transport, shop, services, etc) after irrigation scheme	-3.58163	.73110	.07385	-3.72821	-3.43506	-48.497	97	.000
Pair 12	Monthly income (in Frw) before irrigation scheme - Monthly income (in Frw) after irrigation scheme	-1.41837	.57299	.05788	-1.53324	-1.30349	-24.505	97	.000

Ho: situation after irrigation scheme development is the same as situation before.

Ha: situation after irrigation scheme development is significantly different from the situation before.

Student t-value from table ($t_{0.025}$; $_{97}$) is 1.985. All calculated values in the table above are between -21.477 and -50.093. They are out of the range -1.985 and +1.985. This means that we reject null hypothesis. Then, we conclude that situation after irrigation scheme is significantly different from the situation before. (Decision and conclusion may be done according to p-value of 0.000. It is less than alpha (0.05) which leads to the rejection of null hypothesis.) This improvement of socio-economic situation is obviously due the irrigation development works which allowed the effective and efficient exploitation of the marshland as well as the enhanced crop production.

This finding is in concordance with finding of Nabahungu (2011) in "Contribution of wetland agriculture to farmers' livelihood in Rwanda" where he says: "The rice in Cyabayaga was the largest contributor to household income providing on average $ 1045 per household per season."

3.2.2 Correlation analysis between Impacts of wetland reclamation and livelihood improvement

Based on the content of the questionnaire for the comparison of the livelihood of community without marshland reclamation and what became the changes in livelihood following the marshland reclamation, the following correlation analysis was generated.

TABLE 3
PAIRED SAMPLES CORRELATIONS ANALYSIS

		N	Pearson Correlation	Sig.
Pair 1	Ensuring food security for family before irrigation scheme & Ensuring food security for family after irrigation scheme	98	.845	.000
Pair 2	Ability to pay efficiently clothes to the whole family before irrigation scheme & Ability to pay efficiently clothes to the whole family after irrigation scheme	98	.777	.000
Pair 3	Paying health insurance before irrigation scheme & Paying health insurance after irrigation scheme	98	.	.
Pair 4	Paying school fees of children before irrigation scheme & Paying school fees of children after irrigation scheme	98	.436	.000
Pair 5	Expanding my cropland and/or buying fertilizers before irrigation scheme & Expanding my cropland and/or buying fertilizers after irrigation scheme	98	.494	.000
Pair 6	Ability to construct/rehabilitate my residential house before irrigation scheme & Ability to construct/rehabilitate my residential house after irrigation scheme	98	.786	.000
Pair 7	Regular employment before irrigation scheme & Regular employment after irrigation scheme	98	.506	.000
Pair 8	Buying household assets before irrigation scheme & Buying household assets after irrigation scheme	98	.604	.000
Pair 9	Transport means before irrigation scheme & Transport means after irrigation scheme	98	.880	.000
Pair 10	Access to bank credits before irrigation scheme & Access to bank credits after irrigation scheme	98	.832	.000
Pair 11	Expanding to other business (Transport, shop, services, etc) before irrigation scheme & Expanding to other business (Transport, shop, services, etc) after irrigation scheme	98	.573	.000
Pair 12	Monthly income (in Frw) before irrigation scheme & Monthly income (in Frw) after irrigation scheme	98	.950	.000

Based on the results indicated in Table 3, we say that the reclamation of Rwinkwavu marshland and development of irrigation system that improved agricultural practices is positively correlated with situation after which indicate the improvement of community's livelihood if we look at the Pearson correlation values that are between 0,777 and 0,95 on the major factors indicating improvement of livelihood. In fact, when the Pearson correlation is statistically significant (p-value less than alpha) that is to say that the situation before was described by lowest categories of Likert scale (impossible, very low level, low level, moderate) while the situation after is described by highest categories of Likert scale (high level, very high level). This is an indicator of a very good improvement. Therefore, Rwinkwavu marshland has significantly contributed to community livelihoods improvement.

3.2.3 The extent Contribution of Rwinkwavu marshland rice irrigation scheme

TABLE 4
COMMUNITY'S PERCEPTION ON THE SIGNIFICANCE CONTRIBUTION TO LIVELIHOODS

	Moderate significance	High significance	Very high significance
To beneficiaries' improvement of social relations	6.1%	28.6%	65.3%
To beneficiaries' general livelihood improvement	11.2%	74.5%	14.3%

The contribution of Rwinkwavu marshland rice irrigation scheme on community livelihood improvement is qualified to be at a high level and is due to the good production of rice after irrigation practice as indicated by figure the respondents 'views in Table 4 where the researcher during the field trips in the study area has realised a very high production as well as a good organization of production market without forgetting a well-managed rice production value chain in place. According to the information collected from field, the enhancement of social relations is due to a number of factors such as collective rice harvesting system, farmers working in cooperatives, grouping farmers in zones and forming micro socio-economic solidarity funds (ibimina) among others which all gather farmers together in their daily activities related to the rice production in the marshland compared to the activities before marshland reclamation which were undertaken on individual scale.

IV. CONCLUSION

In conclusion, the present study has revealed that Rwinkwavu marshland has completely changed in terms of land use and cover as a result of its reclamation and development of irrigation scheme that allowed the shift from traditional practices like multivariate crops cultivation, grazing and exploitation for usual natural ecosystem services to strategic management of the marshland and technology based practices for rice growing. The positive impacts from the marshland's reclamation are not only proven by the high production found on stores of farmer's cooperatives during and after the harvest period, but also by the improvement of the socio-economic status of the community as indicated by the statistical analysis performed during this study which indicate a high positive correlation between the shift to modern agriculture in the marshland with the improvement of the livelihoods. However, this study covered only one marshland among many that have undergone reclamation, and this called for further researches in other areas in order to gather sufficient data that can allow to compare the benefits from reclamation such natural resources with the naturally offered ecosystem services.

ACKNOWLEDGEMENTS

The authors would like to express their thanks to all the institutions and a respondent who sacrifices their time to provide information and data as well as whomever else provided inputs that contributed to the successful completion of this study.

REFERENCES

[1] Adams, M. (1995). Wetland and floodplain development in dry land Africa In: Binns and Tonny (Eds) People and Environment. Sussex, UK.: John Wiley & sons, Ltd.

[2] GoR. (2018). Strategic Plan for the Transformation of Agriculture in Rwanda-Phase IV. Kigali, Rwanda: Government of Rwanda-Ministry of Agriculture.

[3] IWMI. (2006). Working wetlands: a new approach to balancing agricultural development with environmental protection. Water policy briefing issue 21. Colombo, Sri Lanka.: International Water Management Institute.

[4] Kalunde, K. (2008). Irrigation based Livelihood, challenges and opportunities. A gendered technography of irrigation development intervention in the Lower Moshi irrigation scheme in Tanzania. A Ph.D Thesis. Wageningem: University of Wageningem, Netherlands. ISBN: 978-90.

[5] Kayonza District. (2019). Environmental and social management plan (ESMP) for construction of 100 classrooms and 140 latrines under quality basic education for human capital development (QBE-HCD) project in Kayonza District. Final Report. The District of Kayonza, Eastern Province, Rwanda.

[6] Kinaro, O.Z,. (2008). Wetland Conversion to large-scale agricultural production; implications on the livelihoods of rural communities, Yala Swamp, Lake Victoria basin, Kenya. Final Master Thesis, Department of water resources and environment, University of Linköpi. Linköping, Sweden: University of Linköping.

[7] MINAGRI . (2011). Technical and feasibility study for the construction of Rwinkwavu irrigation scheme in Kayonza District; Final Report. CIMA International. Kigali: Ministry of agriculture and animal resources, Rwanda.

[8] Nabahungu, N. (2011). Contribution of wetland agriculture to farmers' livelihood in Rwanda; Case of smallholder farmers living in the vicinity of the Cyabayaga and Rugeramigozi wetlands. Journal of Ecological Economics; Volume 71, 15 November 2011, Pages 4-12.

[9] Nabahungu,N.L. (2012). Problems and opportunities of wetland management in Rwanda. A Ph.D Thesis. Wageningen : Wageningen University; Netherlands. ISBN 978-90-8585-924-6.

[10] Ong'ang'a, O. (2005). Lake Victoria and its Environs: Resources, Opportunities and challenges, 2nd edition. Osienala Kisumu, Kenya 1-118.

[11] Rutagengwa,A. 2016. (n.d.). Analysis of Change of the Marshland Value in Rwanda: Case Study of Muvumba irrigation scheme, Nyagatare District. Master's Thesis; . Kigali: College of Science and Technology, University of Rwanda.

[12] Thenya, T. (2006). Analysis of macrophyte biomass productivity, utilization and impacts on various eco-types of Yala swamp, Lake Victoria basin, Kenya. Ecology and development series No. 48, 2006.

[13] United Nations (UN). (2017). World population prospects: The 2006 Revision. Department of Economic and Social Affairs, New York: United Nations.

Worm Collection and Characterization of Vermicompost produced using different worm species and waste feeds materials at Sinana on – Station of Bale highland southeastern Ethiopia

Mulugeta Eshetu[1*], Daniel Abegeja[2], Tilahun Chibsa[3], Negash Bedaso[4]

[1,2]Oromia Agricultural Research Institute, Sinana Agricultural Research Center, Soil Fertility Improvement and soil and Water Conservation Team, P. O. Box 208, Bale-Robe, Ethiopia.
[3]Oromia Agricultural Research Institute, Natural Resource Directorate, Addis Ababa, Ethiopia
[4]Oromia Agricultural Research Institute, Asela Agricultural Mechanization Research Center
*Corresponding Author

Received:- 2 February 2022/ Revised:- 07 February 2022/ Accepted:- 13 February 2022/ Published: 28-02-2022

Abstract— *Soil fertility decline and high prices of inorganic fertilizers are among the major bottlenecks for sustainable crop production and agricultural productivity particularly for small holder farmers. Considering these issues this study was conducted at Sinana Agricultural Research Centre, on - station to evaluate worm collected from different sites and characterizations of vermicompost nutrient content made from different feed sources. Trials house or vermiculture was constructed on 15 m x 13 m land size having six worm bins in the house in which single worm bin 9 m^2 area. Inside worm bin were covered using plastic geo-membranes to make safe for earthworms while on the top and partially, the body of house coverd by corrugated iron sheet in order protect from rain, flying predators and mesh wire for aeration purpose was used. The earthworm collection conducted contains two parts. The first part was locally collected from Sinana and Dinsho Districts from moist cool, around dead leaves (straw), moist bark dead trees leaves and farm yard manure stored for a long period of time at home garden. The second part was the red worm (Eisenia fetida) taken from Ambo Agricultural Research Center. Crop residue of field pea, faba bean, wheat and barley after chopped both using grinding machine and manually mixed with farm yard manure were used both for vermicompost and conventional compost. The major chemical properties such as pH, EC, OC, TN, available P, CEC, exchangeable bases (Ca, Mg, K and Na) and micronutrients (Fe, Mn, Cu and Zn) were conducted using standard laboratory procedures. Results for nutrient content characterizations indicated that 6.93 to7.83; 0.003 to 0.007 ds/m ; 12.97 to 28.82%; 1.42 to 4.68%; 6.16 to 9.76%; 25.31 to 89.89 mg/kg and 33.23 to 65.43 $cmol_+/kg$ for pH; Ec; OC; TN; C:N; Av.P and CEC; respectively were obtained. Both exchangeable bases and micronutrients also follows similar trend for major essential plant nutrients in which relatively highest value obtained from vermicompost made using Eisenia Fetida while the lowest values obtained from conventional compost. It can be concluded that high vermicompost quality in terms of nutrient containing such as nitrogen, phosphorus, potassium, exchangeable bases and micro nutrients was produced from the mixture of field pea, faba bean, wheat and barley straw or residue using red earthworms (Eisenia foetida) than locally collected worm species and conventional compost. It should be recommended that multiplication, demonstration of Vermiculture and vermicompost produced using Eisenia fetid and integrated use with inorganic fertilizer is need in Sinana and similar agro - ecology.*

Keywords— Eisenia Fetida, Vermicompost, Conventional compost, Nutrient quality.

I. INTRODUCTION

In different parts of the world currently agriculture parcties characterized by excessive inputs of chemical fertilizers, pesticides, and herbicides, while the insufficient application of organic fertilizers (Gill and Garg, 2014). These excess uses of chemical fertilizers and pesticides have resulted in numerous negative effects on the environment, including water,

degradation of soil quality and losses of agricultural biodiversity. Vermicomposting is an eco biotechnological process that transforms energy rich and complex organic substances into stabilized humus like product vermicompost having an environmentally sound and economically viable technology particularly for the farming community (ThiruneelaKandan and Subbulakshmi, 2015). Vermicompost one of the enriched with critical nutrients such as Nitrogen, phosphorus, and potassium as well as high concentrations of highly decomposed organic matter that serve as resource for improving soil fertility and crop productivity.

Vermicompost has many advantages over traditional compost in terms of its physical structure, nutritional content and biochemical value due to the higher mineralization and humification rate through the vermicompost process (Lim *et al*., 2014). Earthworms play important roles in soil formation and fertility, functioning as an element of a food web and also responsible for altering dynamics of the ecosystem through the maintenance and modification. The study of earthworms was started by Charles Darwin who made the first report on the role of earthworms in the breakdown of organic matter in the ecosystem (Lowe *et al*., 2014). Preparations of vermicompost technology utilizing earthworms, most frequently from the genus *Eisenia fetida* is plays an essential role in decomposing of **organic matter** and agro-wastes which supports as improving soil fertility, efficient natural recycling and enhanced plants' growth particularly economically, affordable for small holder farmers (Tajbakhsh *et al*.,2011; Bhat *et al*.,2017 and Kovacik *et al*.,2018).

The earthworms have different effects on the decomposition of **organic matter**, surface area and its quality. The mature and quality of vermicompost is important to predict its potential impact on soil fertility which depends on knowledge of the microbial structure and functions. Vermicompost is one excellent product technology used as plant growth hormones, higher level of enzymes, greater microbial population and tend to hold more nutrients over a longer period without adversely impacting the environment (Mustafa *et al.,* 2019 and Moustafa *et al*., 2020).

In different areas of the world commonly traditional management practice of post harvest residues rather than incorporation into the soil or uses as sources organic inputs subjected to elimination by open air burning leads to release of green house gases (ThiruneelaKandan and Subbulakshmi, 2015). According to Sartaj *et al* (2016) mixing cow dung crop residues helping to improve their acceptability by *Eisenia fetida* and improved **physicochemical** characteristics of produced vermicompost. In this study in addition to worm collection and evaluate the adaptability determining vermicompost quality produced from mixed farmyard manure with crop residues such as wheat, barley, faba bean and field pea straw or residue curtail role.

The decomposition rate of vermicompost decomposition rate than conventional compost due to transformation of organic materials takes place through earthworm gut where the end materials contain high microbial activities, rich in nutrient contents, plant growth regulator (Fabio, 2012) In Bale Zone particularly on the highland crop residues such as wheat, barley, faba bean, field pea are the major easily accessible residues mostly the farmers were burn on the field. However, soil fertility declines as results of nutrient leaching, loss through soil erosion, due to limited inputs of both organic and inorganic fertilizer sources major problems for sustainable crop productions and agricultural productivity.

Therefore, mixed use of these locally available resources with farm yard manure have curtail role to improve crop productions and agricultural productivity in sustainable ways. Among this vermicompost is environmentally sound full and economically, affordable particularly for small holder farmers. Based on this, the study was initiated with the specific objectives to collect the earthworm from different agro ecology; to evaluate the adaptation of earthworm collected from different agro ecology and to characterize the nutrient contents vermicompost produced by earthworms using different mixed feed sources.

II. MATERIAL AND METHODS

The study was conducted in Sinana District which is one of the Bale highlands Oromia Regional State, Southeastern Ethiopia. This District is bordered by Goro District in the east, Dinsho District in west, Agarfa and Gassera in the north and northeast and Goba District. Sinana Agricultural Research Center is located about 493 km from the capital city of Addis Ababa. Geographically, Sinana Agricultural Research Center is located at 7^{o} $4^{'}$ $10^{"}$ to 7^{o} 9' 10" N and 40^{o} $12^{'}$ $40^{"}$ to 40^{o} 16' 40" E (Figure 1).

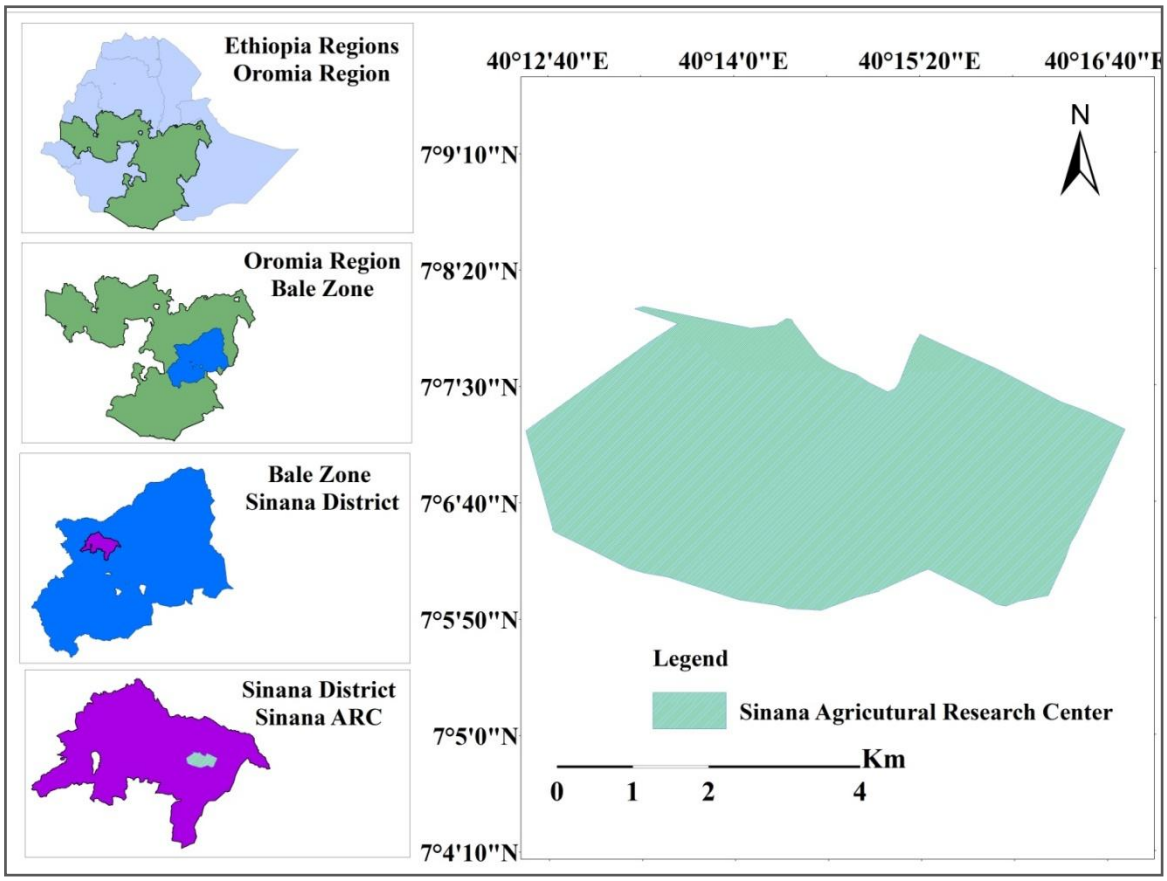


FIGURE 1: Map of the study site

2.1 Worm Shade construction and Establishment of Vermiculture

Trials house or vermiculture was constructed on 15 m x 13 m land size. In the house three worm worm bin in two replications were constructed from concrete cement in rectangle form at 60 cm depth having area 3 m x 3 m (9 $m^{2)}$ for each worm bin. Window or hole was developed at common sides for each box to make suitable horizontal vermicompost harvest method (figure 2). Inside worm bin were covered using plastic geo-membranes to make safe for earthworms. Partially, the house was covered by Corrugated iron sheet in order to protect rain, flying predators those attack worms and mesh wire was used for aeration purpose (figure 2).

Figure 2. Trail house for vermicompost and Vermiculture establishment at Sinana on- Stations

2.2 Feeds or substrates preparations and Earthworm Collection

The major locally easy available crop residues wheat, barley, faba bean and field pea straw or residue and farmyard manure were used in mixed ratio as a feed sources for vermicompost produced. The substrates or crop residue were chopped using grinding machine and manually then finally mixed with decomposed farmyard manure in a ration of 2 (field pea):2 (faba bean):1 (wheat straw):1 (barley straw) and 2 (farm yard manure) in a total of 8 kg mixed for each worms and one control (without worm or conventional compost)were used. Using water cane water was added to maintain optimum moisture for worms as it needed and facilitated decompositions as suitable for worms. Feed sources and water were measured and uniformly added to worm bin box (5 kg) for each was used. The vermicompost produced was started by uniformly released 50 worms independently according to their collections into the feed sources (Table 1) while the conventional compost contains only the mixtures of all feeds sources without any worms and the other managements were uniform for all.

The earthworm collection conducted contains two parts, one was the locally collected from Sinana and Dinsho Districts. After field survey on the availability and identification suitable area for earthworm the local worm collection were done from moist cool, around dead leaves (straw), moist bark dead trees leaves and farm yard manure stored for a long period of time at home garden. The second part was the red worm (*Eisenia fetida*) taken from Ambo Agricultural Research Center. After 40th day the numbers of earthworms were taken data obtained indicated a significant variation among worm types collected (Table 1).

TABLE 1
TREATMENTS, FEED COMBINATION AND DATA COLLECTED ON EARTH WORM ADAPTATION

No. Bin	Worm Types	IW	WPB	AWL (cm)	FPS	FBS	FYM	WS	BS	TFPB
					Kg					
1	*Eisenia fetida*	50	616.00	3.00	2.00	2.00	2.00	1.00	1.00	8
2	*Eisenia fetida*	50	740.00	3.00	2.00	2.00	2.00	1.00	1.00	8
3	Dinsho Worm	50	269.00	2.30	2.00	2.00	2.00	1.00	1.00	8
4	Dinsho Worm	50	186.00	2.40	2.00	2.00	2.00	1.00	1.00	8
5	Sinana Worm	50	25.00	2.00	2.00	2.00	2.00	1.00	1.00	8
6	Sinana Worm	50	71.00	2.30	2.00	2.00	2.00	1.00	1.00	8

Where: IW = initial worm; WPB = worm per bin; AWL= Average Worm Length; FBS = field pea straw; FBS = Faba bean straw; FYM = Farm Yard Manure; WS=Wheat Straw; BS = barely straw; TFPB = total feeds per bin

2.3 Vermicompost Harvesting and Laboratory Analysis

At the end of experiment, a total number of parent earthworms and newly hatched earthworms were recorded. The Vermicompost in the containers were then harvested and sieved (2mm) to remove earthworms and un decomposed materials. The harvested homogeneous vermin-compost was then stored separately and finally the vermin- compost quality was analyses at Sinana agricultural research center soil laboratory and at Haramaya university soil chemistry laboratory.

The pH and EC of both vermicompost and conventional compost was measured in the supernatant suspension of a 1:2.5 soil to water ratio using a pH meter and electrical conductivity; respectively (Rhoades, 1982). Walkley and Black (1934) used for the determination of organic carbon. Total nitrogen was determined using the Kjeldahl method as described by Bremner and Mulvaney (1982). Available P was determined following the Olsen method (Olsen, 1954) using ascorbic acid as reducing agent.

Total exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) were conducted for Ca^{2+} and Mg^{2+} were determined by atomic absorption spectrometry (*AAS*) while K^{+} and Na^{+} were determined by flame photometer (Okalebo *et al.,* 2002*).* Cation exchange capacity (CEC) was determined using (Chapman, 1965). Percent base saturation (PBS) was calculated as follows;

$$PBS\ (\%) = \left\{\frac{Ca^{+2} + Mg^{+2} + K^{+} + Na^{+}}{CEC} \times 100\right\}$$

The available micronutrients (Fe, Mn, Cu and Zn) were extracted by diethylenetriaminepenta acetic acid (DTPA). Finally, their contents were quantified using AAS at their wave lengths as described by (Lindsay and Norvell, 1978).

III. RESULT AND DISCUSSION

3.1 Selected chemical properties of Vermicompost and conventional compost

3.1.1 The pH and Electrical Conductivity

As the laboratory analysis result revealed that the highest (7.83) and the lowest (6.93) pH value was recorded for vermicompost and conventional compost; respectively (Table 2). According to Santamaria *et al* (2001), the pH values of all type of vermicompost are found in suitable range for survival of earthworms since pH value greater than 8.5 is harmful to microorganism. This finding agreement with finding of Jouquet *et al* (2013) who stated that the values of pH was ranged from 6.8-8.41 for vermicompost. Additionally, Derib *et al* (2017) reported that, the pH of vermicompost suitable as compared to conventional compost. Electrical conductivity (Ec) values were not significant variation in which totally it ranges from 0.003 to 0.007 ds/m (Table 2). According to Santamaria *et al* (2001), EC values of both conventional and vermicompost were free from salinity. The current values of EC obtained both from vermicompost and conventional compost made from mixed materials are suitable for earthworm feeds sources, survival for earthworms and applicable for crop production. Similarly, Tadele *et al* (2020) also obtained suitable range of vermicompost EC values for both earthworm and crop production.

3.1.2 Organic carbon and total nitrogen

The mean value organic carbon varied from 12.97 to 28.82% in which the highest mean value were obtained vermicompost prepared from *Eisenia Fetida* while the lowest from conventional Compost (Table 2). Different authors Eyasu *et al* (2015); Hiranmai *et al* (2016) and Derib *et al* (2017) also found the higher percentage of organic carbon for vermicompost prepared using *Eisenia Fetida* as compared to conventional compost. The values of total nitrogen in this study ranged from 1.42 to 4.68% in which the highest mean value were obtained vermicompost prepared from *Eisenia Fetida* while the lowest from conventional Compost (Table 2). This might be due to the high nitrification rate in which ammonium ions are converted into nitrates in case of vermicompost produced using *Eisenia Fetida*. This result line with the finding of Ibrahim *et al* (2013) and Tadele *et al.*, (2020) who stated that Total nitrogen content in vermicompost can range quite widely from 0.1% to 4% or more and 3.04 to 4.26%; respectively.

3.2 Carbon to Nitrogen Ratio and Available Phosphors

3.2.1 Carbon to Nitrogen Ratio (C: N)

The calculated carbon to nitrogen ratio (C: N) varied from 6.16 to 9.76% **(**Table 2). As the result indicates that the lowest (6.16%) was registered under vermicompost prepared using *Eisenia Fetida* whiles the highest (9.76) from worm collected from (Table 2). The C: N ratio values for worm collected from locally and that of conventional compost almost no significant variation in which all values greater than C:N ratio of vermicompost prepared using *Eisenia Fetida.* This result confirmed with different authors Kalantari *et al* (2009); Hiranmai *et al* (2016) and Derib *et al* (2017) who stated that vermicompost had lowest C: N ratio as compared to conventional compost.

3.2.2 Available Phosphorus

The laboratory analyzed for available phosphorus (Av. P) shows that highest (89.89 mg/kg) while the lowest value of (25.31 mg/kg) values was recorded under vermicompost prepared using *Eisenia Fetida* and conventional compost; respectively (Table 2). This might be due to hormone releases of *Eisenia Fetida that* improve decomposition rate and full decomposition materials used that increased the content of phosphorus in the vermicompost. Similar, Zarei *et al* (2011) and Jayanta *et al* (2015) reported the highest available phosphorus contents in vermicompost. The results of current study revealed that a significant variation among locally collected worms, conventional compost and vermicompost prepared using *Eisenia Fetida.*

Muzafer and Pinky (2017) also reported available phosphorus content in vermicompost which depend on the types of earthworm's and feed materials used.

TABLE 2
NUTRIENT CONTENTS OF VERMICOMPOST AND CONVENTIONAL COMPOST FOR SELECTED CHEMICAL PARAMETERS AT SINANA

Treatments	PH-H2O	EC (ds/m)	OC	TN	C:N	Ava. P (mg/Kg)
			%			
Sinana Worms	7.3	0.005	18.83	1.93	9.76	43.29
Eisenia Fetida	7.83	0.007	28.82	4.68	6.16	89.89
Dinsho Worms	7.35	0.005	20.19	2.14	9.43	56.27
Conventional Compost	6.93	0.003	12.97	1.42	9.13	25.31

3.3 Cation exchangeable capacity and Exchangeable bases

3.3.1 Cation exchangeable capacity

Cation exchangeable capacity (CEC) values of vermicompost prepared using different earthworm species and that of conventional compost using different mixed feed sources were varied from 33.23 to 65.43 $cmol_+$/kg (Table 3). As the results revealed that the highest (65.43 $cmol_+$/kg) and the lowest (33.23 $cmol_+$/kg) were obtained from vermicompost prepared using *Eisenia Fetida and* conventional compost*;* respectively. This might be due to vermicompost made using *Eisenia Fetida* high nutrient rich particularly due to high organic carbon content, better mineralization and full decompositions of substrates. This result was garment with the finding of Tadele *et al.* (2020) who reported that CEC in vermicompost ranges from 57- 68.70 mg/kg for vermicompost made from different substrates.

3.3.2 Exchangeable bases (Ca, Mg, K and Na)

The analyzed result showed that the values for exchangeable bases (Ca, Mg, K and Na) were varied from 22 to 34.77 $cmol_+$/kg, 0.31 to 1.40 $cmol_+$/kg, 0.99 to 2.25 $cmol_+$/kg and 0.35 to 0.55 $cmol_+$/kg for Ca, Mg, K and Na; respectively (Table 3). In all exchangeable bases (Ca, Mg, K and Na) values the highest were obtained from vermicompost made using *Eisenia Fetida* while the lowest was obtained from conventional compost. In general, the vermicompost obtained using *Eisenia Fetida* using mixed farm yard manure and other straw were rich in exchangeable cations than conventional compost. The result agreement with the findings of Amir and Fouzia (2011) reported that the exchangeable bases (Ca, Ma and K) were significantly increased in vermicompost as compared to pit compost. The calculated percent base saturations (PBS) valued was varied from 59.16 to 71.17 % in which the highest value was obtained from conventional compost while the lowest was from vermicompost made using Eisenia Fetida (*red worms*). The lowest PBS for vermicompost made using *Eisenia Fetida* might be due to the highest CEC contents as compared to vermicompost made using local earthworm and conventional compost.

TABLE 3
CATION EXCHANGEABLE CAPACITY AND EXCHANGEABLE BASES STATUS OF VERMICOMPOST AND CONVERSIONAL COMPOST AT SINANA

Treatments	CEC	Exchangeable base				PBS
		Ca	Mg	K	Na	
	$cmol_+$/kg					%
Sinana Worms	46.67	28.29	0.68	1.99	0.42	67.80
Eisenia Fetida	65.43	34.77	1.40	2.25	0.55	59.16
Dinsho Worms	45.44	29.71	0.73	1.23	0.42	70.62
Conventional Compost	33.23	22.00	0.31	0.99	0.35	71.17

IV. MICRO NUTRIENTS CONTENTS

The analyzed result for Micro nutrients contents ranges 0.80 to 0.71, 1.20 to 1.48, 1.40 to 1.89, and 0.04 to 3.18 for Fe, Mn, Cu and Zn; respectively (Table 4). The highest Zn values was obtained from vermicompost made using *Eisenia Fetida.* Similarly, Rajiv *et al* (2010) found the highest Zn contents in vermicompost. As the results revealed that vermicompost have better micro nutrients contents than conventional compost for the study conducted using different worms and different mixed feed sources.

TABLE 4
AVAILABLE MICRO NUTRIENTS STATUS OF VERMICOMPOST AND CONVERSIONAL COMPOST AT SINANA

Treatments	Micro nutrients			
	Fe	Mn	Cu	Zn
	mg/kg			
Sinana Worms	0.72	1.48	1.65	2.25
Eisenia Fetida	0.72	1.48	1.89	3.18
Dinsho Worms	0.80	1.16	1.64	0.08
Conventional Compost	0.71	1.20	1.40	0.04

V. SUMMARY AND CONCLUSION

The quantity and characteristics of most chemical properties such CEC, NT, Av. P, K, Zn and the like depends on the types of earth warms spices (locally collected or the world wide adapted *Eisenia fetid)* and types of compost (vermicompost or conventional compost). High vermicompost quality in terms of nutrient containing such as nitrogen, phosphorus, potassium, exchangeable bases and micro nutrients was produced from the mixture of field pea, faba bean, wheat and barley straw or residue using red earthworms (Eisenia foetida) than locally collected worm species and conventional compost. It should be recommended further multiplication of *Eisenia fetid* and demonstration of Vermiculture in Sinana and similar agro - ecology. Farther study should be recommended on vermicompost equivalence with inorganic fertilizers to use this technology in integrated ways for crop productions.

ACKNOWLEDGEMENTS

The author likes to acknowledge Oromia Agricultural Research Institute for financial support, Sinana Agricultural Research Center for logistic supports. Also the author likes to express heartfelt and deep gratitude to Sinana Agricultural Research Center, Soil fertility Improvement and problematic Soil Management Research Team staff members for their active participation in conducting this research works. Thanks to Ambo Agricultural Research Center for their cooperation in providing red earth worms (*Eisenia fetida)* to conduct vermicompost experiments.

REFERENCES

[1] Amir Khan and Fouzia Ishaq. 2011. Chemical nutrient analysis of different composts (*Vermicompost*and*Pitcompost*) and their effect on the growth of a vegetative crop *Pisumsativum. Asian Journal of Plant Science and Research,* 1 (1): 116-130.

[2] Bhat, S., J. Singh and A. Vig, 2017. Instrumental characterization of organic wastes for evaluation of vermicompost maturity. J. Anal. Sci. Technol.,8, 1.

[3] Derib Kifle, Gemechu Shumi and Abera Degefa. 2017. Characterization of Vermicompost for Major Plant Nutrient Contents and Manuring Value. *Journal of Science and Sustainable Development,* 5 (2), 97-108.

[4] Eyasu Mekonnen and Anteneh Argaw, 2015. Bioconversion of Wastes (Khat Leaf Leftovers and *Eucalyptus* Twigs) into Vermicompost and Assessing Its Impact on Potato Yield. *Journal of Agronomy,* 14 (1): 37-42.

[5] Fabio Aprile. 2012. Evaluation of Cation Exchange Capacity (CEC) in tropical soils using four different analytical methods, Journal of Agricultural Science; 4, 6.

[6] Hiranmai, Y. R. and Anteneh Argaw, 2016. Manurial value of khat waste vermicompost from Awday, Harar town, Ethiopia. *International Journal of Recycling Organic Waste Agriculture*, 5: 105–111.

[7] Jafarpour, M., Pessarakli, M., and Kazemi, E. 2017. Effects of Raw Materials on Vermicompost Qualities. Journal of Plant Nutrition.

[8] Jouquet E. P, Bloquel E, Thu D. T, Ricoy M, Orange D, Rumpel C and Tran D. T. 2013. Do Compost and Vermicompost Improve Macronutrient Retention and Plant Growth in Degraded Tropical Soils? *Compost Science and Utilization,* 19 (1), 15-24.

[9] Kalantari S, Hatami S, Ardalan M, Alikhani H. and Shorafa M. 2009. The effect of compost and vermicompost of yard leaf manure on growth of corn. *African Journal of Agricultural Research*, 5 (11), 1317-1323.

[10] Khwanchai, K. and S. Kanokkorn, 2018. Effect of agricultural waste on vermicompost production and earthworm biomass. J. Environ. Sci. Technol., 11: 23-27.

[11] Kovacik, P., P. Šalamún and J. Wierzbowska, 2018. Vermicompost and *Eisenia foetida* as factors influencing the formation of radish phytomass. Agriculture (Poľnohospodárstvo), 64: 49-56.

[12] Moustafa, Y.T.A., T.R. Elsayed, M.F. El-Dahshour, S.A.A. Gomah, L. Zhang and N.S.A. Mustafa, 2020. Effect of aquatic plants (Duck weed and water hyacinth) on physico-chemical and microbial activities of vermicompost. Biosci. Res., 17: 1511-1520.

[13] Mustafa, N.S., I.A. Matter, H.R. Abdalla, M.F. El-Dahshouri, Y.A.T. Moustafa and N.S. Zaid, 2019. The promotive effects of some natural extracts (algal, yeast and vermiwash) on vegetative characteristics and nutrients status of citrus lemon (*Citrus aurantifolia*) seedlings. Net. J. Agric. Sci., 7: 43-49.

[14] Rajiv K. Sinha, Sunita Agarwal, Krunal Chauhan, Vinod Chandran and Brijal Kiranbhai Soni. 2010. Vermiculture Technology: Reviving the Dreams of Sir Charles Darwin for Scientific Use of Earthworms in Sustainable Development Programs. Technology and Investment, 1: 155-172.

[15] S K K, Ibrahim M H, Quaik S and Ismail S. 2013. Vermicompost, Its Applications and Derivatives, *Prospects of Organic Waste Management and Significance of Earthworms*, 199-130.

[16] Santamaria R. S, Ferrera C. R, Almaraz S. J. J, Galvis S. A, Barois B. I. 2001. Dynamics and relationships among microorganisms, C-organic and N-total during composting and vermicomposting. *Agrociencia-Montecillo*, 5 (4), 377-384.

[17] Tadele Geremu, Habtamu Hailu, Alemayhu Diriba. 2020. Evaluation of Nutrient Content of Vermicompost Made from Different Substrates at Mechara Agricultural Research Center on Station, West Hararghe Zone, Oromia, Ethiopia. *Ecology and Evolutionary Biology*. 5 (4), 125-130.

[18] Tajbakhsh, J., E.M. Goltapeh and A. Varma, 2011. Vermicompost as a Biological Soil Amendment. In: Biology of Earthworms. Karaca, A. (Ed.)., Springer, Berlin, Heidelberg, ISBN: 978-3-642-14636-7 pp: 215-228.

[19] ThiruneelaKandan and Subbulakshmi. 2015. Chemical Nutrient Analysis of Vermicompost and Their Effect on the Growth of SRI Rice Cultivation. *International Journal of Innovative Research in Science, Engineering and Technology,* 4 (6), 4382 – 4388.

Exploring the Effect of Fadama III Project on Food Security in Abuja, Nigeria

Njoku, Nkechi Vivian[1]; Fadiji, Taiye Oduntan[2*]; Ajah, Julius[3]

Department of Agricultural Extension and Rural Sociology, Faculty of Agriculture, University of Abuja, FCT, P.M.B. 117, Abuja, Nigeria
*Corresponding Author

Received:- 21 December 2021/ Revised:- 05 January 2022/ Accepted:- 01 February 2022/ Published: 28-02-2022

Abstract— *The study explores the effect of Fadama III project on food security in terms of: availability, affordability, accessibility and nutritional quality in Abuja. Primary data were used. The data were collected using questionnaires administered to 360 beneficiaries in the selected communities using multi-stage sampling method. The data were analyzed using descriptive statistics, a three and four- point likert scale and correlation model. The selected Fadama areas include: Gwagwalada, Abaji, Amac and, Bwari. The results of the socio-economic characteristics showed that the beneficiaries were mainly male with 69%, married with 82% and relatively old with a mean score of 51 years. The result showed that the beneficiaries had a large size of household with a mean score of five persons, with crop production as the major agricultural production carried out by the beneficiaries (53.1%) and followed by livestock farmers (17.5%). About 92.2% of the beneficiaries had formal education. The results of the effectiveness of Fadama III project on food security shows that the project moderately affected the beneficiaries' food security which increased the level of food availability and increased the use of agro-input which all ranked first. The result also reveals that lack of government support (ranked 1st) and availability of resource (ranked 2nd) were the institutional factors that affected the effectiveness of the Fadama III project. However, it is recommended that feeder roads be constructed in the study areas in other to make food more accessible and affordable, more young farmers should be encouraged by agricultural extension agents to participate in agricultural development projects and monitoring and evaluation system should be put in place in other to ensure the effectiveness of the projects.*

Keywords— Fadama, food security, availability, affordability, accessibility.

I. INTRODUCTION

Food security, according to Neill (2010), is a multi-dimensional phenomenon. National and international political action seems to require the identification of simple deficits that can be the basis for setting of targets, thus necessitating the adoption of single, simplistic indicators for policy analysis. Something like the "State of global food insecurity" analysis has to be undertaken. Since food insecurity is about risks and uncertainty, the formal analysis should include both chronic sub-nutrition and transitory, acute insecurity that reflects economic and food system volatility. Such formal exploration is usefully complemented by multi-criteria analysis (MCA) of food security. Similarly, Community Food Security has been defined as follows: Community food security exists when all citizens obtain a safe, personally acceptable, nutritious diet through a sustainable food system that maximizes healthy choices, community self-reliance and equal access for everyone."

Cook and Frank (2008), also defined food security as an optimal physical, cognitive, and emotional development and function in humans requires access to food of adequate quantity and quality at all stages of the lifespan. Sustainable food security has been defined in various ways by different scholars. According to FAO (2013), food security is access to the food needed by all people to enable them live a healthy life at all times. A country is said to be food secured when there is access to food of acceptable quantity and quality consistent with decent existence at all times for the majority of the population (Idachaba, 2004). This means that food must be available to the people so as to meet the basic nutritional standard needed by the body. But it should be noted that availability of food does not mean accessibility to food. Availability depends on production, consumer prices, information flows and the market dynamics. Food security is determined by various socio-economic, natural and political factors. These factors include income, education, age, availability of infrastructure,

availability of extension services, government policies on trade, and agricultural land area under cultivation, availability of Agro-inputs and social safety net (FAO, 2013).

In Nigeria, determinants of food security are stability of access, household economic status, household income variability, quality of household human capital, degree of producer and consumer price variability, food storage and inventory, household size, and access to social capital (Amaza *et al*, 2007; Oni *et al*, 2011). Food security has also been found to be both temporal and spatial in nature (*Anderson, 2009*; Ayantoye *et al*, 2011). World Bank (1986), defined sustainable food security as an access to enough food for an active, healthy life at present as well as ability to provide enough in the future. Furthermore, Abudullahi (2008), defined sustainable food security as when people have physical and economic access to sufficient food to meet their dietary needs for a productive healthy life at present as well as in the future. This definition outlines some indices for measuring the extent or degree of food security to be achieved by any country and the indices are adequate national food supply, nutritional content, accessibility, affordability and environmental protection. Absence of food security is food insecurity; food insecurity on the other hand represents lack of access to enough food and can either be chronic or temporary. Adeoti (1989) opine that chronic food insecurity arises from lack of resources to acquire and produce food thereby leading to persistent inadequate diet. FAO (2013) refers to food insecurity as the consequences of inadequate consumption of nutritious food bearing in mind that the physiological use of food is within the domain of nutrition and health. When individuals cannot provide enough food for their families, it leads to hunger and poor health. Poor health reduces one's ability to work and live a productive healthy life. Poor human development destabilizes a country's potential for economic development for generations to come (Otaha, 2013).

FAO (2013), explains that the core determinants of food security are availability, accessibility, utilization and stability.

Food Availability: Availability of food plays a conspicuous role in food security. Having enough food in a nation is necessary but not adequate to ensure that people have satisfactory access to food. Over the years, population has increased faster than the supply of food thus resulting in food unavailability per person.

Food Accessibility: The ability to have access to food depends on two major conditions; Economic access and physical access. Economic access depends on one's income, the price of food and the purchasing power of the people. Physical access depends on the availability and quality of infrastructure needed for the production and distribution of food. Lack of economic access to food is as a result of the increase in the rate of poverty.

Food Utilization: Food utilization is measured by two outcomes indicators which reflect the impact of inadequate food intake and utilization. The first outcome is measured by under-five years of age nutrition level while second measurement is quality of food, health and hygiene.

According to FAO (2013), measuring the nutritional status of under-five years of age is an effective approximation for the entire population. The indicators for the measurement of under-five years of age are wasting (too thin for height); underweight (too thin for age) and stunting (too short for age). Most times, progress in terms of having accessing to food is not always accompanied by progress in the utilization of the food. A more direct indicator of food utilization is underweight because it shows improvement more promptly than stunting and wasting whose improvement can take a longer time to be noticeable. Since 1990, the prevalence rates of under-five stunting and underweight have declined in some developing countries, while some countries still report a prevalence rate of 30% or more and World Health Organization categorizes this as being high (WHOUNICEF, 2011).

Stability: Stability has to do with exposure to short-term risks which have a way of endangering long-term progress. Key indicators for exposure to risk include climate shocks such as droughts, erosion and volatility in the prices of inputs for food production. The world price shocks leads to domestic price instability which is a threat to domestic food producers as they stand the chance of losing invested capital. Nigerian farmers are mainly smallholders farming mainly for subsistence, this makes it difficult for them to cope with changes in the prices of inputs, and it also lowers their ability to adopt new technologies thereby resulting in reduced overall production. Changing weather patterns as a result of climate change have played a part in reducing food supply, for instance flood in the southern parts of the country and drought in the northern parts leads to substantial losses in production and income. The interplay of all these variables determines whether an individual, household, state or nation is food secured or not. This is because sustainable food security at the household level does not guarantee sustainable food security at the state or national level. Therefore, the purpose of this study is to examine the effect of Fadama III project on food security in terms of: availability, affordability, accessibility and nutritional quality of food in Abuja.

The specific objectives of this study are to:

i) Describe the socio-economic characteristics of the Fadama III beneficiaries in Abuja;
ii) Identify the Fadama III Projects available in the study area;
iii) Assess the effectiveness of Fadama III Project on beneficiaries in the study area.

II. MATERIALS AND METHODS

The study was carried out in Abuja, Nigeria. It is the Federal Capital Territory of Nigeria. It was formed in 1976 from parts of the states of Nasarawa, Niger and Kogi. It is within the middle belt region of the country. It has an estimated population of 2,440 200 (NPC, 2015). Abuja lies between latitude 9.072264 and longitude 7.491302 and also covers an area of 7,315km (latlog, 2018). In terms of vegetation, Abuja falls within the Guinean Forest Savannah Mosaic Zone of the West African Sub-region. Patches of rain forest, however, occur in the Gwagwa plains, especially in the rugged terrain to the southeastern parts of the territory, where a landscape of gullies and rough terrain is found. The territory is currently made up of six area councils namely; Abaji, Abuja Muncipal, Gwagwalada, Kuje, Bwari, Kwali. The major occupation of people in the area includes; civil servants, farming, artisans, trading, teaching among others. Major crops cultivated by farmers in Abuja includes; maize, sorghum, rice, cassava, millet and miscellaneous crops such as; okra, pepper, and garden egg which are grown in large quantities. It has a population of 2,245,000 in 2010 (NPC, 2011). Abuja is one of the fastest growing urban settlements in the world that need adequate food to feed rapidly growing population. In recent time, the land available for farming has decreased drastically due to urbanization of the territory. There is need to increase or at least maintain the production of crops per unit land area on the remaining over-cropped lands so as to meet the increased demand for food given the rapid population increase.

2.1 Sampling Techniques and Sample Size

For the purpose of the study, multi-stage random sampling and a combination of purposive and random sampling techniques were used in selecting the sample size for the study. Abuja is made up of six Area Councils; Abuja Municipal, Gwagwalada, Abaji, Kuje, Bwari and Kwali, which represented the first stage. In the second stage, four councils were purposively selected from the six councils because of the Fadama Community Associations (FCA), Fadama User Groups, presence of Fadama III Projects and high number of beneficiaries in those areas which are Abaji, Gwagwalada, AMAC and Bwari. In the third stage, three Fadama communities were randomly selected from each of the four councils making it a total of twelve Fadama communities that were studied. In the fourth stage five Fadama User Groups were selected randomly from each Fadama community making it a total of sixty user groups that were studied. In the fifth stage, 10 farmers were randomly selected from each of the sixty Fadama User Groups to give a population of 600 farmers and in the final stage, 6 farmers representatives were randomly selected from each of the 60 User Groups to give a sample size of 360 for the study.

2.2 Data Collection

The research instruments used for the study include; structured questionnaire, interview schedule and personal observation. The content of the instruments used for the study were validated. The prepared questionnaire was given to the project supervisors and some research experts, who validated the content to ensure that the validity of the instruments is not questioned. After the content was validated, 10% of the questionnaire was administered to group of farmers outside the study area as a pilot test. The questions not answered by the respondents used for the pre-testing were assumed as ambiguous, complex and misunderstood, thus modified and re-structured. The structured questionnaire was used to collect information from the target groups having established its validity.

Primary and secondary data were collected by the researcher herself with the help of three enumerators who were properly trained on the objectives of the study. The data were collected with the aid of structured questionnaire and interview schedule based on the objectives of the study. The structured questionnaires were used to collect data from literate respondents while the interview schedules were used to collect data from less literate respondents. Occasional visits were made to the areas covered by the enumerators to ensure that the work was done in line with the objectives of the study. The data collection lasted for eight weeks.

2.3 Data Analysis

Descriptive statistics such as frequency distribution, means, percentages, weighed mean score and ranking was used to analyze objective one. 3 point likert-type scale was used to measure objective two and three. 4 point likert-type scale was used to measure objectives four, while analytical tool such as logistic regression and 4 point likert-type scale was used to

measure objective five. The hypothesized relationship was analyzed using correlation for both hypothesis H_1 and H_2. The Data generated from the field were analyzed using Statistical Package for Social Science (SPSS) as described by Adekoya and Ogunfitimi (2004). Also, descriptive statistics (frequencies, percentages, means, weighed means and Ranking) and 4 point Likert-type scale.

III. RESULTS AND DISCUSSION

3.1 Distribution of Respondents According to Socio-economic characteristics

3.1.1 Gender

Figure 1 presents the results on Gender of respondents in the study area. The result revealed that 31.1% were female while 68.9% were male. This finding indicates that both genders were well represented in the survey. Although women participation in the Fadama III project as seen is low, which is in line with the findings from Muhammah, Umar, Abunakar and Abdullahid (2011) that both gender benefited from Fadama III projects in Abuja. Inferences from this study would therefore be gender friendly.

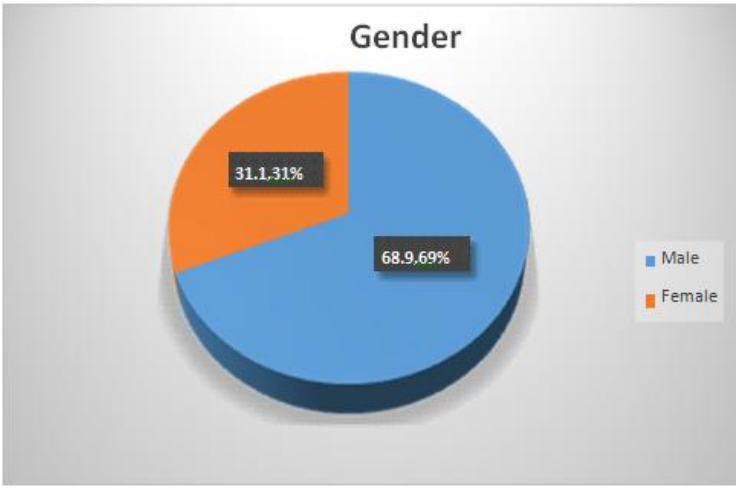


FIGURE 1: Pie chart showing the gender of the respondents
Source: Computed from field data, 2019

3.1.2 Marital status

Result on Figure 2, shows that majority (82.8%) of the respondents were married, 7.8% and 6.4% were divorced and widowed respectively, while only 1.7% and 1.4% were single and separated respectively. In the traditional African society high value is attached to marriage relationships especially when individual are matured. Therefore, marriage responsibilities prompt commitments among the Fadama farmers in their farm productions. This is in line with the findings of Kaloi, Tayebwa, and Bashaasha (2005), that marital status and food security had positive relationship in Uganda and Ethiopia respectively.

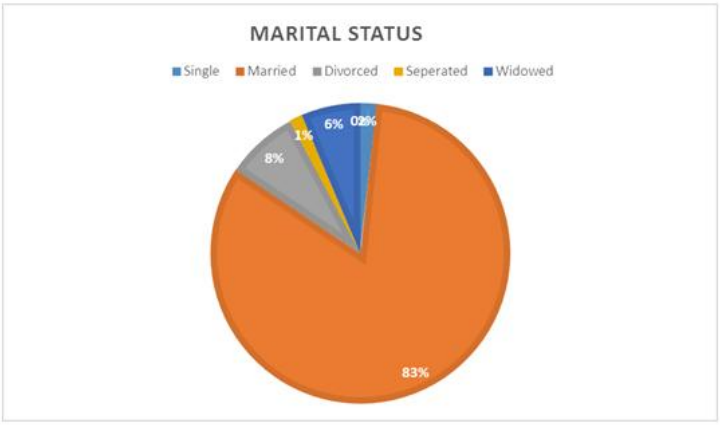


FIGURE 2: Pie chart showing the Marital Status of the respondents
Source: Computed from field data, 2019

3.1.3 Age

Figure 3 revealed that the mean age of the respondents was found as 51.2. This shows that the Fadama III project beneficiaries in the study area were old enough to take full responsibility of the project funding and also had better control and maintenance of the projects. The result is also in line with Muhammah, Umar, Abunakar and Abdullahid (2011), findings which revealed that 54.7% of the respondents were between the age brackets of 45-59 years. Therefore, the results suggest that a good proportion of the youths and elderly benefitted from the Fadama III project.

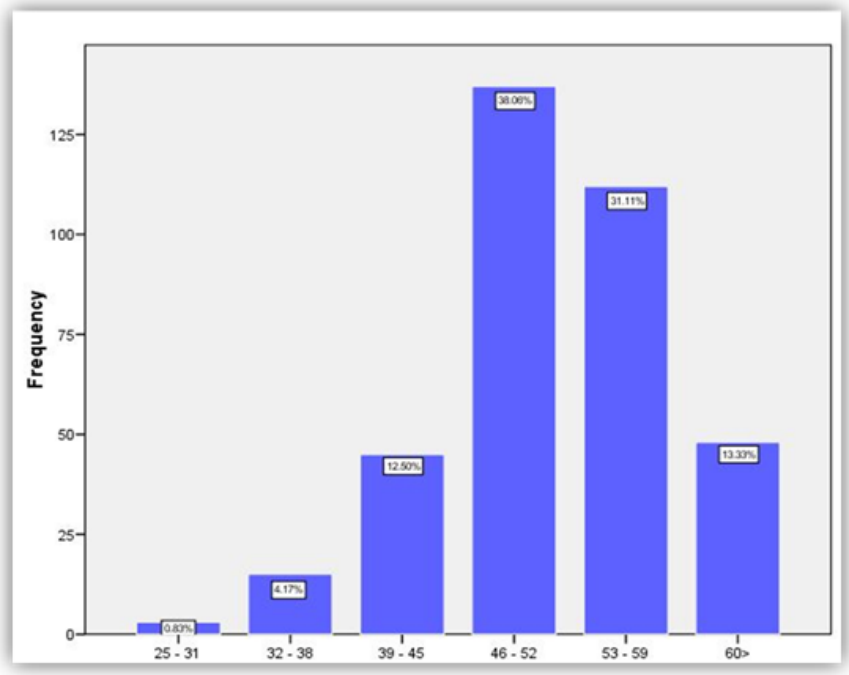


FIGURE 3: Bar chart showing the Age of the respondents
Source: Computed from field data, 2019

3.1.4 Educational Qualification

Figure 4 shows that less than half 48.3% of the respondents had primary school leaving certificates, 34.7% had secondary school certificates, and 5.3% had HND/B.Sc certificates, 3.9% had OND/NCE while 7.8% had no formal education. This implies that most (92.2%) of the respondents had varying degrees of formal education which should have significant effect on their food access and household food security status. This is in line with Aidoo *et al.* (2013) who found 42% of sampled farmers in Ghana as having junior high school/middle school qualification as contrary to the 73% of sampled farmers in Niger state that had no formal education (Zakari *et al.*, 2014).

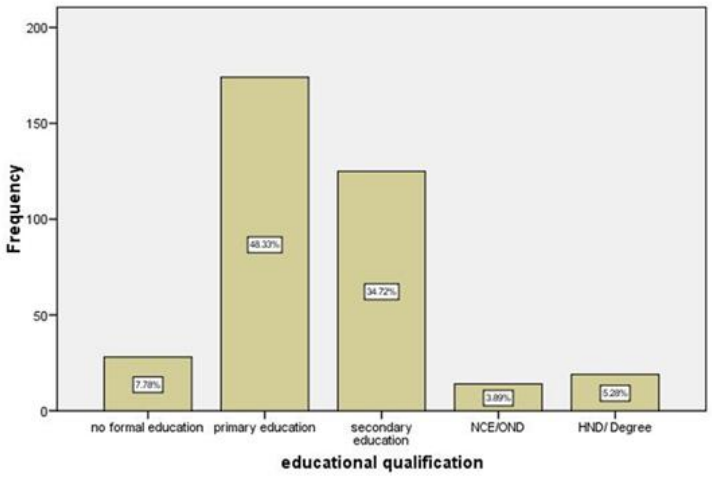
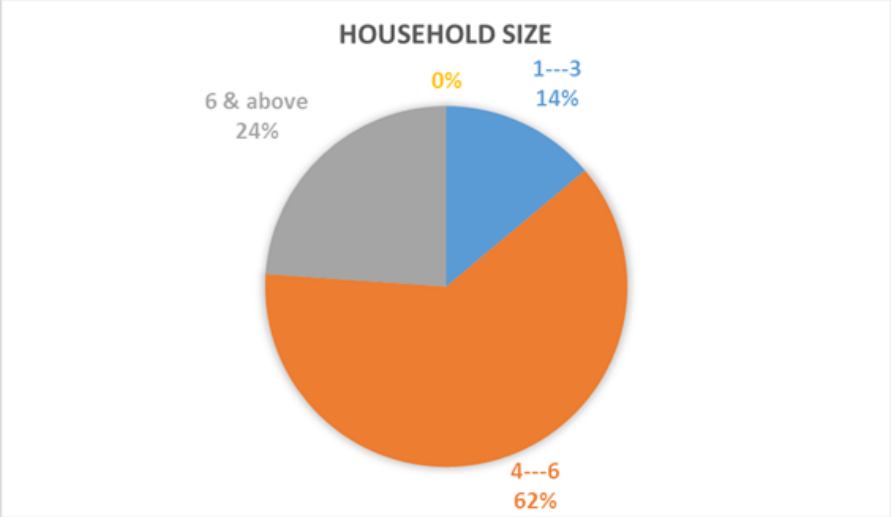


FIGURE 4: Bar chart showing the Educational qualification of the respondents
Source: Computed from field data, 2019

3.1.5 Household size

As revealed in Figure 5, the mean household size was found as 5 persons. Agbo *et al*. (2015) and Ndegwa (2016) found the mean household size of farm families as 6 and 5 persons Nigeria and Kenya respectively. This implies that the Fadama III project beneficiaries had more farm power to help increase their farm production, which will also lead to food security.



Mean = 5 persons

FIGURE 5: Pie chart showing the Household size of the respondents

Source: Computed from field data, 2019

3.1.6 Income per annum

Table 1 shows the distribution of the farmers based on their annual income. The result reveals that majority (60%) of the respondents earned between ₦300,000 – ₦499,999. This is preceded by more than one third 35.0% of the respondents who earned between ₦100,000 – 299,999 while only 5% of the respondents earned ₦500,000 and above. The mean annual income earned was ₦338,522.2. This amount is considerably appreciable when compared with what is obtainable in other farming households within and outside Nigeria. Therefore, the farmers are expected to enjoy a reasonable standard of living. This may be attributed to their multiple sources of livelihood from on-farm and off-farm and also due to the Fadama III projects intervention. Ndegwa (2016) found the total annual income of sampled farm families in Kenya as 47,292K/Sh. This counters the study of Nesamvuni (2014), who found that rural households in South Africa had low income and therefore have difficulty in purchasing safe food for their households.

TABLE 1

DISTRIBUTION OF RESPONDENTS BASED ON INCOME PER ANNUM

Income/annum	F	%	Mean
100,000 - 299,999	126	35	338522.2+91559.6
300,000 – 499,999	216	60	
500,000 and above	18	5	

Source: Computed from field data, 2019.

3.1.7 Source of financial Assistance

Figure 6 reveals that almost half (46%) of the farmers accessed financial assistance through co-operative societies, more than one third 32% received grants from government, 16% sort financial assistance from thrift/*esusu/akawo* organizations while only 5% and 1% had assistance from family and friends and loans from bank respectively. This implies that the farmers did not have enough farm credit which incapacitates their effort to expand their scope of farm operation. However, this may equally explain the reason farmers in the study area embraced fadama III project.

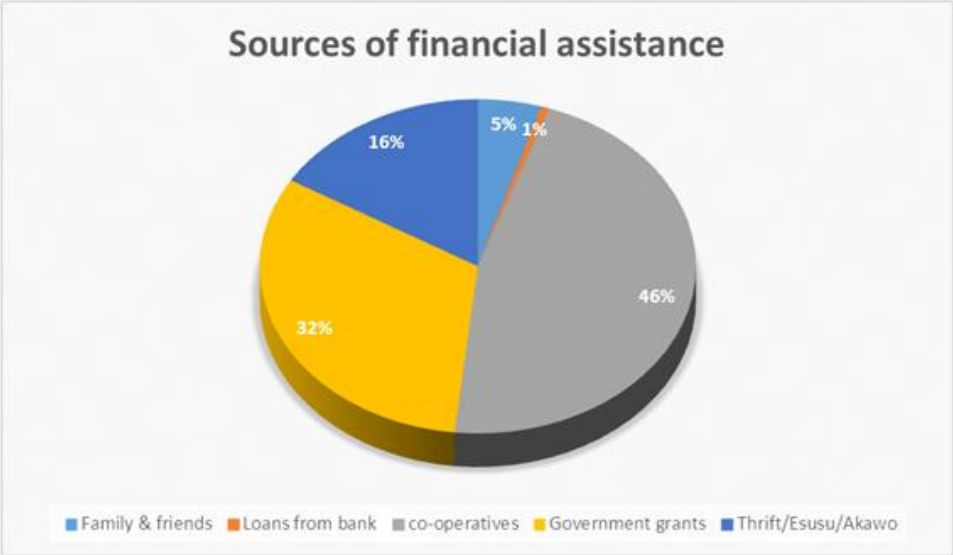


FIGURE 6: Pie chart showing the Source of financial assistance of the respondents
Source: Computed from field data, 2019.

3.2 FADAMA III Projects available in the study area

Table 2 shows that ADP support and research was the most available FADAMA III project in the study area as it was ranked first ($\bar{x}$ = 1.93), followed by free training ($\bar{x}$ = 1.92). ADP plays a prominent role as it concerns agriculture throughout the country and also in the implementation of FADAMA III, partly through linking farmers with new agricultural innovations. ADP is equally responsible for the provision of public extension services to farmers, conveys farmers' problems to research for solution to be proffered. They also help to provide technical support to farmers in form of trainings on sustainable and best farming practices which can go a long way in boosting agricultural production and thus enhancing the food security of farmers.

Supply of agro-input was ranked 3rd ($\bar{x}$ = 1.89) as the most available Fadama III project. Different range of agro-inputs such as seeds, fertilizers, insecticides, herbicides, etc. are crucial to agricultural production circle (Ogunlade *et al.*, 2012), as successful agricultural production is highly dependent on them. Thus their availability to farmers under FADAMA III project was a plus. Construction of feeder roads ($\bar{x}$ = 0.46) was the least available and completed project in the study area. This one way or the other contradicts the submission that the construction of feeder roads made food more accessible to people (World Bank, 2016).

TABLE 2
AVAILABILITY OF FADAMA III PROJECTS IN THE STUDY AREA (N=360)

FADAMA projects	Rank completed	Available and Completed	Available and Completed	Not Available	Mean
ADP support and Research	93.3	6.1	0.6	1.93	1st
Free training	93.6	4.4	1.9	1.92	2nd
Supply of agro-input	91.1	6.9	1.9	1.89	3rd
Asset acquisition	76.4	16.1	7.5	1.69	4th
Construction of livestock Pen	65.3	29.4	5.3	1.6	5th
Construction of fish pond	33.3	35.6	31.1	1.02	6th
Construction of borehole	31.1	29.7	39.2	0.92	7th
Supply of storage facilities	14.2	32.5	53.3	0.61	8th
Construction of markets Stalls	10.6	30.6	58.9	0.52	9th
Construction of feeder	7.5	30.6	61.9	0.46	10th

Source: Computed from field data, 2019

3.2.1 Effectiveness of Fadama III project on Food Security

Results of the effectiveness of Fadama III project on food security shows that the project increased the level of food availability ($\bar{x}$ = 1.57). Food availability is quite important because food must be available before one can think of purchasing it. Food availability relates to the supply of food through production, distribution, and exchange (FAO, 2009). When food is available, that is when someone can be bothered about the nutrition quality of food , which was ranked 2nd ($\bar{x}$ = 1.36). The result also shows that other food security variables expect food availability were moderately effective. This implies that the Fadama III projects had a moderate effect on food security. This calls for more effort on the part of the government to establish more projects centered on achieving food security. The concern over the nutritional quality of food was part of the primary objective of FADAMA III, which is partly in response to widespread under- nutrition and growing concern about the capacity of agriculture to meet future food needs.

TABLE 3
EFFECTIVENESS OF FADAMA III PROJECT ON BENEFICIARIES' IN THE STUDY AREA (N=360)

Food security variables	Extremely Effective	Highly Effective	Moderately Effective	Not Effective
Availability of Food	10.6	36.1	53.3	0
Nutritional quality of Food	1.1	35.3	62.2	1.4
Accessibility of Food	0.0	24.7	73.9	1.4
Affordability of food	0.0	20.3	78.1	1.7

Source: computed from field data, 2019.

IV. CONCLUSION

The Fadam III project was established by government of Nigeria through the pool of worldbank loan. The project was targeted to improve the Agricultural production of Farmers. Food security is one of major elements of development and poverty alleviation and has been a goal of many international and national public organizations. It is in line with this that the study assessed the effects of Fadama III project on beneficiaries' food security.

From the findings of this study, it can be concluded that the beneficiaries of the Fadama III were predominantly males and married. Greater proportion of the beneficiaries had average household size of five persons beneficiaries earned between ₦300, 000.00 and ₦499, 999.00 per annum. The study revealed that ADP support and research was the most available Fadama III project in the study area. In terms of agricultural enterprise, most of the beneficiaries were crop farmers. The results of the effectiveness of Fadama III project on food security shows that the project has moderately increased the level of food availability. Therefore, Fadama III project moderately affected the farm income and also enhance the standard living of the beneficiaries, therefore more projects should be established in other to achieve food security. The study also made appropriate recommendations on how to improve Farmers productive effectiveness of Agricultural programmes in other to achieve food security in Nigeria. However, the result reveals that lack of government support and availability of resource are the most institutional factors that affected the effectiveness of the Fadama III project in the study area.

RECOMMENDATIONS

Based on the findings of this study, the followings recommendations were made in an attempt to improve the Fadama III project in the study area.

The study revealed that the projects moderately affected the food security variables listed. Therefore, it recommends more effort by government agencies to establish more projects targeted at achieving food security in Nigeria.

1. The study revealed that most projects were available and not completed, especially construction of feeder roads. Thus, it recommends that government should endeavour to create more social amenities such as accessible feeder roads and market in order to encourage farmers' participation and to aid extension service. This will help to make food more accessible and affordable.
2. The study revealed that the mean age of the beneficiaries were 51 years. It recommends that more youths be encouraged to participate in Agricultural Development Programmes, this will also help to achieve food security in Nigeria.
3. Monitoring and evaluation of projects are very crucial to the success of the project. The study revealed that it was one of the institutional factors that affected the effectiveness of Fadama III projects. Therefore, it recommends that

effective monitoring and evaluation system be put in place, in other to achieve the aims and objectives of the project. Financial support could be granted to the farmers for participating in the Fadama III project, as one of their challenges is economical.

4. The study recommends that the communities where agricultural projects are cited should assist the government to protect and maintain these projects.

5. The study revealed that Fadama III project had a moderate effect on food security. This calls for more effort on the part of the government to establish more projects centered on achieving food security

REFERENCES

[1] Abdullahi, A. (2008). Food Security in Nigeria: How close are we? [A paper presented at the Federal Radio Corporation's Annual Lecture- Abuja]. Pp. 4-6.

[2] Adekoya, A.E and Ogunfiditimi, T.O. (2004). The use of SPSS in Agricultural Extension Research. In Olowu, T.A. (Ed). Research Methods in Agricultural Extension. Agricultural Extension Society of Nigeria (AESON), Ilorin, Nigeria: pp282-302.

[3] Adeoti, J. (1989). Economic crises in developing countries: The food dimension Ilorin *Journal of Business and Social Sciences*. 2(4):150-155.

[4] Agbo, M., Rousseliere, D. and Julien, S. (2014). Agricultural marketing cooperatives with direct selling: A cooperative-non-cooperative game. Halshs-01098762.

[5] Aidoo, R., Mensah, J.O., and Tuffour, T. (2013). Determinant of food security in the sekeyere-afram plains district of Ghana. *European Scientific Journal, ESJ,* 9(21)

[6] Amaza, P.S., Olayemi, J.K., Adejobi, A.O., Bila,Y., and A. Iheanacho. (2007). Baseline Socio-economic Survey Report: Agriculture in Borno State, Nigeria. International Institute of Tropical Agriculture, Ibadan, Nigeria.

[7] Cook, J. T. and Frank, D. A. (2008). Food security, poverty, and human development in the United States. Annals of the New York Academy of Sciences, 1136, 193-209.

[8] FAO (2009). Food and Agricultural Organization. Fifth pillar of food Security. Global strategic framework for food security and nutrition. Rome.

[9] FAO (2013). Food and Agricultural Organization. The food system and factors affecting household food security and nutrition. "Agriculture, food and nutrition for Africa: a resource book for teachers of agriculture. Rome: Agriculture and Consumer protection department. Retrieved 15, October, 2020

[10] Idachaba, F.S (2006). Strategies and policies for food security and economic development in Lagos, Nigeria: CBN.

[11] Kaloi, E., Tayebwa, B and Bashaasha, B. (2005). Food Security Status of Households in Mwingi District, Kenya. Department of Agricultural Economics and Agribusiness. Makerere University, Uganda.

[12] Latlong (2018). Longitude and Latitude of Abuja. Retrieved May 15, 2020 from http://www.latlong.net.

[13] Muhammah, H. U., Umar, B.F., Abunakar, B.Z. and Abdullahid A.S. (2011). Assessment of factors influencing beneficiary participation in Fadama III project in Niger State Nigeria. *Nigerian Journal of Basic and Applied Science* 19(2): 248-252.

[14] Ndegwa, K.M. (2016). Effectiveness and economics of hermatic bags of maize storage: Results of a randomized controlled trail in Kenya. Crop protection. 90:17-26.

[15] Neill, O. (2010). Faces of Hunger: Answer to question following the Second Reith Lecture, BBC Radio 4, April 2002.

[16] Nesamvuni, A.E. (2014). Towards an improved competitiveness of tea industry in South Africa. A case study of Tshivhase-Mukumbani Tea Estate in Limpopo Province. MBA Dissertation, Management College of South Africa (Mancosa), Polokwane, South Africa.

[17] Ogunlade, I., Atiboke, O.A., Ladele, A.A. and Adumadekun, A.G. (2012). Capacity of agro input dealers in advisory services delivery to maize farmers in Kwara State, Nigeria. *International Research Journal of Agric and Soil Science*.

[18] Oni, O.A., Salman, K.K., and Idowu, B.O. (2011). "Social capital dimension and food security of farming households in Ogun State, Nigeria." *Journal of American Science*, 7(8): 776-783.

[19] Otaha, I.J. (2013). Food insecurity in Nigeria: Way forward, An International Multidisciplinary *Journal Ethiopia*, 7(4): 523-530.

The Influence of Urban Population Growth on Agricultural Land Degradation "Case Study of Kinyinya Sector in Gasabo District, Kigali City"

Ndihokubwayo Levi[1*], Bimenyimana Alexandre[2]

University of Lay Adventists of Kigali (UNILAK), P.O. Box 6392 Kigali-Rwanda
*Corresponding Author

Received:- 25 January 2022/ Revised:- 04 February 2022/ Accepted:- 10 February 2022/ Published: 28-02-2022

Abstract— *Kigali city is recently expanded over the peripheral areas due to combined factors like potential land in the area in attracting investments activities, proximity to the national market and accessibility for various types of infrastructures. Therefore, the need of this article to assess the influence of urban population growth on agricultural land degradation. The results of urban population growth on agricultural land leading to the conversion of agricultural land to infrastructure development which lead to the shortage of land designed for agriculture and lead to the hunger and increment in cost for basic need especially food. A multi-method data collection approach incorporating household survey, key informant interviews and personal observation has been used to assess urbanization process of the Kigali city and the changing livelihoods. Hence, the result of findings revealed that expansion of the city during the last 5 years made significant impacts on livelihood of farming community on peripheral areas: agricultural land fragmentation, land reduction, and loss of farmer's property on the land. On the other hand, the non-farm economic sector developed in the area was not capable to absorb evicted households. In addition, rehabilitation mechanisms used by the city mainly an arrangement of cash compensation has found to be inadequate to replace their resource base, which is land. As a result, most of the families exposed to further economic, social and cultural impoverishment. Therefore, Kigali city's expansion seems inevitable, to ensure sustainable urban development, government should make sound planning prior to displacement without treating livelihood of vulnerable groups of people living on peripheral area.*

Research findings show that 90% of the respondents agreed and affected by urban expansion. Especially people whom have expropriated due to public infrastructures such as roads, schools, markets, industries, institutions and estates, like families from Murama cell, Kinyinya sector who has relocated and expropriated while 10% of respondents have not yet affected by urban expansion The affected people are mostly living in slums (Gasharu and Murama) and have low income compared to those living in urban parts of Kinyinya(Kagugu and Gacuriro).

Keywords— Kinyinya Sector, Kigali City, Population Growth, agricultural land degradation.

I. INTRODUCTION

The urban population of the world is increasing rapidly, the rapid increase of population is causing urban sprawl especially in the cities of developing world. It is an undesirable form of urban development as it is unsustainable (Sudhir S., 2018). Rapid urbanization has increasingly become a major developmental issue, particularly in developing countries. The global urban population has grown from 751 million in 1950 to 4.2 billion in 2018, and it is projected to increase further to 6 billion by 2050 (UN-Habitat (2011). Highly urbanized regions include Northern America (82% living in urban areas), Latin America and the Caribbean (81%), Europe (74%) and Oceania (68%). Although Africa remains the least urbanized region, with 43% of its population living in cities, it is currently urbanizing at a faster pace. The continent's urban population is estimated to more than triple in the next 40 years, reaching 1.339 billion in 2050, corresponding to 21% of the world's projected urban population (UN-habitat, 2011).

In Rwanda, the socio-economic and demographic trends such as population growth, industrialization, land consumption and infrastructure development, have impacted on the state of the Kigali city expansion (REMA, 2013). The City of Kigali has been grown rapidly after the 1994 Genocide compared to the previous years when Rwanda gained its independence in 1962. Kigali city's expansion is a result population growth due to Rural-Urban migration, economical and socio-political factors (Penine U, 2011).

This is mainly due to favorable reform in the country in terms economic policy that has created conducive environment for private investments and the proximity of these areas to national market. However, in Rwanda urban expansion programs are not supportive to farmers in periphery, and thus has negative impact on people livelihood. AS the urban population increase, the land used for growing food and cash crops in peripheral zones is highly reduced, the need for the study seeks to analyze the influence of urban Population Growth on agricultural land degradation, Case study of Kinyinya sector in Gasabo district of Kigali city.

II. MATERIALS AND METHODS

2.1 Population of the study

The target population of the study was composed by the people living in Kanyinya, all categories of population were taken into account by considering marital status, education background and level, sexes, ages, 46 female respondents and 50 male respondents to make 96 respondents from different households were selected in the cells of Kanyinya Sector. Technical sampling was used to determine the sample size from 57,189 populations. 24 respondents were selected in each 4 cells comprising Kinyinya sector to make 96 respondents and fill the distributed questionnaires. Before filling the questionnaire, the questionnaires were previously revised using chief of villages in the 4 cells of Kinyinya sector of Gasabo District in Kigali city, the respondents were also selected basing on the people living in urbanized and rural area whom depend on different economic activities especially agricultural sector.

2.2 Sample size

William (2004) noted that sampling is a device or a way that is used in selecting of the members is able to question, or who are a fair presentation of all the members in a union. Sampling techniques may be defined as the method used to select sample elements in the population. At this time the researcher will use purposive sampling technique in order to come up with the relevant information to the study. This technique of purposive sampling will be applied to 96 respondents from selected in 4 cells of Kinyinya Sector Gasabo District in Kigali City.

However, the formula of Taro Yamane was used to calculate the sample size

Therefore, the fact that it is not possible to meet the whole population to achieve the research objectives, for the purpose of collecting detailed information that can lead to paramount decision making, a sub-set of the total population (sample size) would be selected. From the population of 2123 respondents of Kigali kitchen fires, the sample size of 96 respondents will selected. As such, Sloven's formula for determining sample size was applied as illustrated below:

$$n = \frac{N}{1+(N)\,e^2} \quad (1)$$

Source: Yamane, 1967 Where N= Total population, n=Sample size, and e= Error margin, e^2 is 0.01 level of significance

Applying the above formula, the sample employed for this study was calculated from the total 2123 households using gases in both Gitega and Nyarugenge sectors of Nyarugenge District. The sample was calculated as follows:

$$n = \frac{57189}{1+57189\,e^2} \quad (2)$$

$$n = \frac{57189}{1+57189\,(0.1)^2} \quad (3)$$

$$n = \frac{57189}{1+57189\ (0.01)} \quad (4)$$

$$n = \frac{57189}{1+ 57.189} \quad (5)$$

$$n = \frac{57189}{58.189} \quad (6)$$

N = 95.8 which makes approximately 96 participants ; whereby, n is the sample size, N stands for population and e^2 is 0.01 level of significance.

III. RESULTS AND DISCUSSIONS

3.1 People affected by urban expansion

From the respondents' views regarding to the above question, 90% of them have said "YES" and agreed that there were many people affected by urban expansion. They said that those people were expropriated due to public infrastructures such as roads, schools, markets, industries, institutions and estates. For instance, there were families from Murama cell, Kinyinya sector who were expropriated and went to live in other parts of Gasabo District. 10% of respondents have said NO. It was remarked that the respondents who said YES are those who live in slums (Gasharu and Murama) and have few income while those who said No are those who live in urban parts of Kinyinya(Kagugu and Gacuriro).

Like in Ethiopia, the rate of urban growth often strains the capacity of local and national government to provide urban residents with even the most basic services of housing, water supply, sewerage and solid waste disposal (MWUD, 2008). In Addis Ababa, a report in 2008 also found that 80% of the houses in the city were classed as slums due to the physical deterioration of its housing, overcrowding, high density, poor access and lack of infrastructure services (Tolon, 2008).

This means that the people are affected differently. Some are obliged move to other areas; others struggle to live in bad conditions of lacking basic services due to their livelihood depends on daily paid jobs in the city.

3.2 Reduction of agricultural production

The agricultural production has greatly reduced due to land reduction. 30 % of the respondents gave Beans,20% gave maize,15% gave sorghum 10 % gave 15 sweet potatoes and 10% gave cassava. The decrease agricultural production has been justified by the comparison of the previous harvests to the current years. Most land reserved for agriculture it is being converted to settlement area and if there is no immediate action, the people of Kigali city and kanyinya will be face by famine in the near future.

3.3 Activities practiced contributing to environmental degradation

From the respondents' views, it has been indicated that 70 % of the respondents used the existing land for agricultural for quarrying activities. and this are accelerating environmental destruction. And lead to generation of pest, and reduce the production from agriculture.

3.4 The unappropriated implementation of Kigali city master plan.

40% of respondents from slums have said NO meaning that they don't know its role while 60% of the respondents mostly coming from urban part said YES to mean that they know Kigali city master plan and its role. It means that those who are unaware the role of Kigali master plan keeps developing slums /unplanned settlements once they are not controlled. Kigali Master Plan is known through awareness of Kigali city master plan; Sensitizing planned settlement in public meetings, establishing model villages and internet, the failure in implementation of master plan is highly affecting the area reserved for agriculture.

IV. CONCLUSION AND RECOMMENDATION

4.1 Conclusion.

The study conducted in Gasabo district, Kinyinya Sector with the core objective of assessing the influence of urban population growth on agricultural land degradation. For attaining the purpose, the researcher tried to point out the specific objectives in achieving the stated objectives and to generate data findings that can be used by natural resources management, policy makers and other leaders on advocacy for rapid urban population growth and agricultural land reduction in general. Findings indicated that urban population growth influences agricultural land degradation found in the peri-urban areas of

Kigali city as whole. Briefly 54.4.0 % of respondents agreed that urban population growth influences agricultural land negatively within peri-urban area.

RECOMMENDATION

Rereferring on the findings from consulted respondents, the following recommendations were addressed:

1. Government institution should adopt a sustainable approach of limiting horizontal construction by adapting mansions construction that occupy a small space, setting long term goals for urban development, and improving life of people living in slums areas by strengthening the **Integrated Development Program** (IDP model villages) which accommodate high number of citizens. (KARAMA and BUSANZA are the typical example in Kigali city)
2. Urban population growth is unavoidable; the urban planners should strongly consider agricultural land in the periphery of the city because it is the main source of food for survival.
3. It has been revealed that high population density in urban areas live in unplanned settlements and it is at risk of disasters like floods, landslides, soil erosion as a result of much rainfall, wastes management challenges and the spread of diseases/epidemics. Therefore, the Government encourages planned settlement and accelerates the relocation of families living in high-risk areas like steep slopes and wetlands.
4. Governments should develop rural areas by spreading all basic infrastructures for the sake of reducing rural -urban migration of the people.ie developing secondary cities.
5. Finally, Government should sensitize the Rwandans to use family planning for the sake of reducing high birth rate that increases population which is a very big burden to the country

REFERENCES

[1] A.D.Thou (2010) Rapid Urban Expansion and its Implications on Livelihood of farming Communities in Peri urban Area: The Case of Sebeta Town.

[2] Adeboyejo et al (2007). Household responses to urban encroachment on the rural Hinterland in the ogbomoso urban fringe, Nigeria.

[3] Bizoza and Havugimana (2013). Land Use Consolidation in Rwanda: A Case Study of Nyanza District, Southern Province.

[4] ECA and UN-Habitat, (2008). The state of African cities: a framework for addressing urban challenges in Africa. UN-Habitat, Nairobi.

[5] Esther, B.M., (2009). Assessing the level of community participation in a resettlement project and its impact on project successfulness: a case of Ubumwe-Batsinda project Kigali- Rwanda.Msc thesis. Rotterdam. Netherlands.

[6] Eugene Rurangwa (2007). Land Tenure Reform: Case study of Rwanda.

[7] GASABO. (2008). Gasabo District Development Plan, DDP.KIGALI.

[8] GASABO. (2013). Detailed district physical plan for Kicukiro and Gasabo Kigali, Rwanda. Kigali: City of Kigali.

[9] Hitayezu et al (2018). The dynamics of unplanned settlements in the City of Kigali.

[10] Ilberg, A. et al., 2008, Housing in Kigali, Informal Housing Survey 2007 Report, Kigali City/ RISD/ DED.

[11] James Cleophace Sano (2007). Urban environmental infrastructure in kigali city Rwanda (Challenges and Opportunities for ModernisedDecentralised Sanitation Systems in Poor Neighbourhoods).

[12] John Mugisha, et al (2015). Kigali City Peri-Urbanization and its Implications on Peri-Urban Land Use Dynamics: Cases of Muyumbu and Nyakaliro.

[13] Martin Ruwa (2015). Factors Influencing Improvement of Livelihood of Slum Dwellers by Projects Funded by Non-governmental Organizations: The case of Kibera Slum in Nairobi County, Kenya.

[14] MININFRA, (2007). Kigali City Master Plan: Existing Condition Analysis; Prepared by the Master Plan Team for the Ministry of Infrastructure; Kigali.

[15] PenineUwimbabazi et al (2011). Compelling Factors of Urbanization and Rural-Urban Migration in Rwanda.

[16] REMA (2009). Rwanda State of Environment and Outlook Report." Kigali, Rwanda.

[17] The Kigali State of Environment and Outlook Report 2013.

[18] UN-Habitat, (2011). Housing the poor in African cities: Alternatives to the destruction of urban poor communities. UNON publishing services section. Nairobi.

[19] Vincent Manirakiza (2012). Urbanization issue in the Era of Globalization; Perspectives for urban planning in Kigali.

Overview on Nutritional and Phytochemical Composition of Finger Millet (*Eleusine Coracana*): A Review

Rhythm Kalsi[1], Ankita Sakra[2], Aryaman Modak[3], Bhumika Choudhary[4]

[1]School of Agriculture, department of Food and Nutrition, Lovely Professional University Phagwara, Jalandhar
[2,3,4]School of Agriculture, Lovely Professional University Phagwara, Jalandhar
*Corresponding Author

Received:- 27 January 2022/ Revised:- 05 February 2022/ Accepted:- 11 February 2022/ Published: 28-02-2022

Abstract— *This review focuses on overview of nutritional and phytochemical composition of Finger millet (Eleusine coracana). Finger millet is also known as Ragi or mandua in India, which is one of the minor cereal crop largely grown in Asian and African regions of the world. It is well known for its health benefits due to the presence of macro and micro nutrients (carbohydrates, fats, proteins, dietary fibers, vitamins, minerals) as well as phytochemicals (Tannins, steroids, polyphenols, alkaloids, terpenoids, cardiac glycosides, balsams, lignans, phytooestrogens, phytocyanins, Gallic acid, ferulic acid, quercetin, vanillic acid, caffeic acid, sinapic acid, quercetin and proanthocyanidins) in correct proportion. Being staple food in India, it is highly advantageous to low income group people. Studies have concluded its effectiveness against lipid per oxidation, ageing, diabetes, hyperactivity, wounds, cancer and osteoporosis. Therefore, the need of value addition of finger millet is highly needed to combat growing issues in children as well as in aged people*.

Keywords— Finger millet, nutritional, phytochemical, health benefits, value addition.

I. INTRODUCTION

Millets are small seeded annual cereal crop species belonging to family "poaceae". Millet is a French derived word "mille" which means thousand (Ramashia *et al*., 2019). One of the wonder varieties of millet family is Finger millet (*Eleusine coracana*) which is commonly popular as *Ragi* or *mandua*in India belonging to grass family Gramineae or Poaceae (Singh, 2012). It is native from Ethiopia region but largely grown in Asia and Africa regions of the world.It is a self pollinated crop species with chromosome no. 36 (allotetraploid) distributed in about 10 genera and 20 species in all (Kakri *et al*., 2020). Finger millet grains are globular in shape of 1.0 to 1.5 mm in diameter. The finger millet kernel consists of 3 main parts namely; seed coat, endosperm and embryo. The outermost layer of the millet is known as pericarp or glume (Ramashia *et al*., 2019) which has little nutritional significance. The seed coat or the testa of finger millet is multilayered (five layered) making it unique as compared to other members of the millet family. The seed coat, germ, and the endosperm cell walls of the millet are endowed with poly phenols making it rich in phytochemicals (Shobana *et al*., 2013). The crop was cultivated around 5000 years BC and still is one of the most produced grain species worldwide. Finger millets stands sixth in production in India and fourth in the world after major crops such as wheat, rice, maize, sorghum and bajra (Chandra *et al*., 2016). India is the largest producer of finger millet accounting to about 60% of world production followed by Ethiopia (Gull *et al*., 2014). Finger millet is a staple food to many parts of the world primarily in developing countries. It is popular among the low income groups of society and is considered as poor man's food (Maharajan *et al*., 2021). It is majorly grown in dry areas in tropical and sub tropical regions with temperature requirement of 8-10 degree Celsius (Singh, 2012) with acidic soil (alluvial, loamy, and sandy) and higher rainfall of 600- 1200 cm, matures within a time span of 100-130 days (Gull et al., 2014). It has several varieties (yellow, white, tan, red, brown, or violet color) and apart from all the varieties, red colored variety is mostly cultivated all over the world (Chandra *et al*., 2016). Finger millet is associated with number of health benefits such as antioxidant, anti-ageing, anti- diabetic, hyperactivity, healing property, anticancer property (Antony Cesar *et al*., 2018) and

maintaining bone health for which it is gaining importance in the field of health and nutrition. This review focuses to get insights of nutritional and health prospects of finger millet (*Eleusine coracana*) so that value added products can be made out of it.

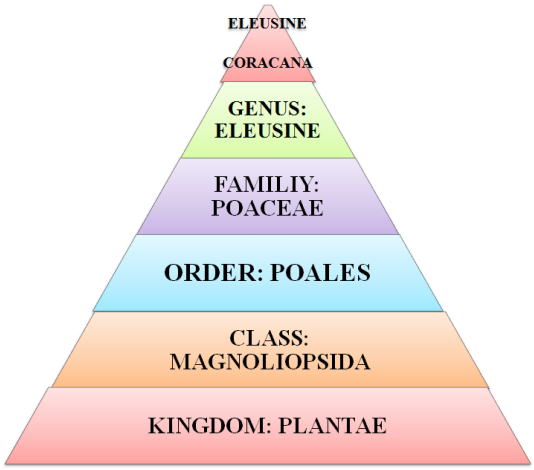


FIGURE 1: Hierarchical classification of finger millet

FIGURE 2: Finger millet

1.1 Nutritional significance of Finger millets:

Finger Millets are nutritionally superior to other cereal crops of same variety such as rice and wheat because it serves as an excellent source of carbohydrate (80%), proteins (7–9%) with essential amino acids as well as non essential amino acids like valine, methionine, and tryptophan, minerals (calcium, phosphorus, potassium, and iron) as well as vitamins (thiamine, niacin, and riboflavin), and fats for which they are extensively been researched (Murtaza *et al.*, 2014).

TABLE 1
GENERAL COMPOSITION OF FINGER MILLETS PER 100G

Sr. No.	Parameter	Composition (g)	Sources
1	Carbohydrates	72.6	Kakri *et al*., 2020
2	Proteins	7.7	
3	Fats	1.5	Kumar *et al*., 2016
4	Crude fiber	3.6	
5	Dietary fiber	15-22	Ramashia *et al*., 2019
6	Energy (Kcal)	336	

1.2 Mineral and vitamin profile of finger millets:

Finger millet is found to be rich in vitamins as well as some minerals, which prove its significant utilization in human diets as well. Vitamins such as vitamin A (Retinol), vitamin B1 (Thiamine), vitamin B2 (Riboflavin), vitamin B3 (Niacin), vitamin C (Ascorbic acid) and minerals (phosphorous, potassium, magnesium, calcium, sodium, iron and zinc) are abundantly found in finger millet at valuable composition.

TABLE 2
MINERAL AND VITAMIN COMPOSITION OF FINGER MILLETS (*ELEUSINE CORACANA*) PER 100G

Sr. No.	Nutrients	Composition mg/100g	Sources
1	Phosphorus	130-250	USDA, 2016
2	Potassium	430- 490	
3	Magnesium	78- 201	
4	Calcium	398	Patel *et al*., 2014
5	Sodium	11	
6	Iron	3.9	Muthamilarasan *et al*., 2016
7	Zinc	2.3	
	Vitamins		
1	Vitamin B2 (Thiamine)	0.12- 0.42	Ramashia *et al*., 2019
2	Vitamin B1 (Riboflavin)	0.2-0.48	
3	Vitamin B3(Niacin)	1.0-1.30	Devi *et al*., 2011
4	Vitamin C (Ascorbic acid)	1.0	
5	Vitamin A (Retinol)	6.0	

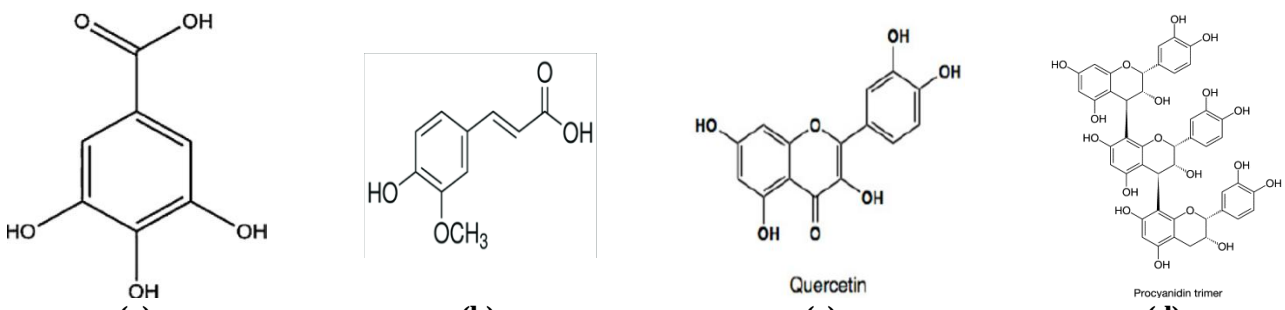
1.3 Amino acid profile of Finger millet (*Eleusine coracana*):

Finger millet is a complete source of essential as well as non essential amino acids which are required by human body in sufficient amount for proper growth and development of body cells. Essential amino acids such as Valine (4.9-6.9g), methionine (2.5-3.1g), tryptophan (1.1-1.5), Phenyalanine (4.1- 5.2g), histidine (2.2), isoleucine (4.3g), leucine (6.6-9.5g), threonine (3.4- 4.2g) and non essential amino acids such as Aspartic acid (6.5- 7.9g), glutamic acid (20.3- 27.1g), alanine (6.1- 6.2g), arginine (2.77- 4.5g), cystine (1.7- 2.6g), glycine (2.14- 4.0), proline (7.0- 9.9), serine (3.6- 5.1g) and tyrosine (2.79- 3.6g) are found in Finger millet (Ramashia *et al*., 2019; Thapliyal and Singh, 2015).

1.4 Phytochemical composition:

Finger millet is found to be rich in certain phytochemicals such as Tannins, steroids, polyphenols, alkaloids, terpenoids, cardiac glycosides, balsams, lignans, phytooestrogens and phytocyanins. Some phenolic acid derivatives (Hydroxybenzoic Gallic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, syringic acid), hydroxycinnamic acid derivatives (Ferulic acid, trans—cinnamic acid, p- coumaric acid, caffeic acid, sinapic acid) and some flavonoids such as Quercetin , Proanthocyanidins and condensed tannins (Devi *et al*., 2011), which are important in healing, aging, prevents deterioration of human health, lowers blood pressure, lowers risk of diabetes, and helps combating the metabolic syndromes (Thilagavathi *et al*., 2015).

1.5 Chemical structures of major phytochemicals present



(a) (b) (c) (d)

FIGURE 3: a) Galic acid, b) Ferulic acid, c) Quercetin d) Proanthocyanidins

1.6 Potential health benefits of Finger millet (*Eleusine coracana*):

1.6.1 Anti-oxidant activity

Studies have concluded that, oxidation of cellular molecules (by reactive oxygen and nitrogen species) has been linked with chronic diseases such as diabetes, heart disease, cancer, and several other normal functions in humans. Dietary plant polyphenols act for reduced risk of cancer, cardiovascular and neuro-degenerative diseases, infections, ageing, and diabetes (Kumar *et al*., 2016). Seed coat of finger millet grains is high in phenolic compounds (mostly benzoic acid derivatives) that have been shown to have "antioxidant activity". On average, white finger millet contains 0.04–0.09% polyphenols, while brown finger millets contain 0.08–3.47 %. A major fraction of benzoic acid derivatives (gallic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, syringic acid), while the rest was either cinnamic acid derivatives (ferulic acid, trans-cinnamic acid, p-coumaric acid, caffeic acid, sinapic acid) or flavonoids (Chethan and Malleshi, 2007) are derived, which are found to be effective against cancer, cardiovascular and neuro-degenerative diseases, infections, ageing, and diabetes. Finger millet is also reported to have inhibition of collagen cross- linking property which reduces the stiffness of elastic tissues in tendons, skin and blood vessels as well (Kumar *et al*., 2016).

1.6.2 Anti-diabetic properties

Diabetes also known as "Diabetes mellitus" is a major health concern that is rapidly increasing in India and several other developing as well developed countries. In a study, chemical synthetic inhibitors of "glucosidase" and "pancreatic amylase" can be effectively used to treat hyperglycemia and finger millet seed coat phenolic extracts were found to be effective inhibitors of these enzymes. (Shobana *et al*., 2009).Food formulations and preparations based on finger millet have a lower glycemic index and cause a lower glycemic response (Kumar *et al*., 2016). Certain anti-nutritional factors found in whole finger millet fractions (such as tannins, phenolics, and phytates) may help to reduce glycemic response by reducing starch digestibility and absorption. Independent rat studies have successfully demonstrated that a finger millet diet fastens the wound healing process and delays cataractogenesis (Shobana *et al*., 2010).

1.6.3 Cardio-protective and Anti-hyperlipidemic properties

Cardiac diseases are one of the most severe problems suffered by people worldwide. Risk factors such as high blood pressure, high cholesterol, hypertension, depression, obesity, and diabetes are associated with the problem (Kumar *et al*., 2016). Finger millet rich diet lowers lipid per oxidation reaction, which reduces the risk of arteriosclerosis and thus provides important protection against strokes and heart attacks. A similar recent study has found that a multigrain formulated diet containing finger millet was effective in controlling lipid and antioxidant metabolism in high cholesterol intake rat models. (Vasant *et al*., 2014).

1.6.4 Prevention of GIT Disorders

Celiac disease (caused by consumption of gluten protein) is one of the most common auto-immune genetic disorders that affect people worldwide. The treatment includes consumption of flour that is free from gluten protein and similar protein structure and non-glutinous nature can be found in finger millet instead of wheat. Chandrasekara and Shahidi, 2012).Finger millet is high in soluble and insoluble dietary fibers, which are resistant to digestion and help in prevention of gastrointestinal problems, colon cancer, cardiovascular diseases and diabetes. Polyphenols, present in outer skin, can help to reduce peptic inflammation and ulcers too (Kumar *et al*., 2016). Consumption of food products made from finger millet can increase the satiety level, lower calorie intake, and aids weight loss.

1.6.5 Prevention of Osteoporosis bone defects

Osteoporosis is a "silent" disease that causes bone loss and is related with porous bones. The prevention of bone diseases such as osteoporosis is aided by a high dietary intake of naturally available calcium. Finger millet is a good source of calcium, with the seeds containing up to 350 to 400 mg/100 g of calcium, which is nearly 5–10 times more than other cereals.(Sanwalka *et al*., 2011; Kumar *et al*., 2013).Concluding, finger millet-derived products can be used to promote bone mass development in growing children as well as to prevent osteoporosis and other bone diseases in adults and the elderly (Kumar *et al*., 2016).

II. APPLICATION IN FOOD INDUSTRIES:

By going through, a number of health benefits can be figured out and a number of value added products can be made out of Finger millet (*Eleusine coracana*) which can further prove to be effective for growth, development and repair of children as well as adults irrespective of age, sex and gender. Flour of finger millet can be used for the preparation nutria dense recipes for toddlers as well as adults. Finger millet flour provide many health benefits like finger millet for losing weight, bone health, lowering blood cholesterol and treating anemia. Products available in market are multi-grain noodles, millet rich drinks, Ragi cookies and biscuits, vermicelli, etc (Kakri *et al*., 2020)

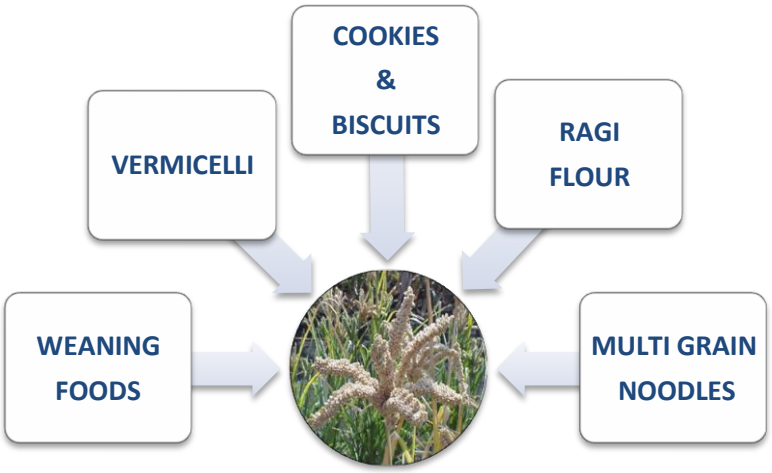


FIGURE 4: Application of finger millet in food industries

III. CONCLUSION AND FUTURE PROSPECTS

Finger millet (*Eleusine coracana*) or *Ragi* or *mandua* in belongs to grass family Gramineae or Poaceae. Finger millet is rich in several phytochemicals as well as nutrients which serves advantageous for it to be utilized in food industries as supplements. Apart from food applications, its bioactive compounds (Tannins, steroids, polyphenols, alkaloids, terpenoids, cardiac glycosides, balsams, lignans, phytooestrogens, phytocyanins. Gallic acid, ferulic acid, quercetin, vanillic acid, caffeic acid, sinapic acid, quercetin and proanthocyanidins) can be extracted for medicinal purposes. More and more research is needed for proper utilization and value addition of cereal crop.

REFERENCES

[1] Karki, A., Chandra, A., Joshi, S., Rawat, S., and Sharma, S. (2020). An overview of Finger millet (*Eleusine coracana L.*). *J Pharmacogn Phytochem*;9(4):866-869.

[2] Antony Ceasar, S., Maharajan, T., Ajeesh Krishna, T. P., Ramakrishnan, M., Victor Roch, G., Satish, L., & Ignacimuthu, S. (2018). Finger Millet [*Eleusine coracana (L.) Gaertn*.] Improvement: Current Status and Future Interventions of Whole Genome Sequence. Frontiers in *Plant Science*, 9. doi:10.3389/fpls.2018.01054

[3] Chandra, D., Chandra, S., Pallavi, & Sharma, A. K. (2016). Review of Finger millet *(Eleusine coracana (L.) Gaertn)*: A power house of health benefiting nutrients. *Food Science and Human Wellness*, 5(3), 149–155. doi:10.1016/j.fshw.2016.05.004

[4] Chandrasekara, A., and Shahidi, F. (2012). Bioaccessibility and antioxidant potential of millet grain phenolics as affected by simulated in vitro digestion and microbial fermentation. *J. Funct. Foods* 4, 226–237. doi: 10.1016/j.jff.2011.11.001.

[5] Chethan, S., and Malleshi, N. G. (2007). Finger millet polyphenols optimization of extraction and the effect of pH on their stability. *Food Chemistry* 105, 862–870. doi: 10.1016/j.foodchem.2007.02.012

[6] Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. (2011). Health benefits of finger millet (*Eleusine coracana L.*) polyphenols and dietary fiber: a review. *Journal of Food Science and Technology*, 51(6), 1021–1040. doi:10.1007/s13197-011-0584-9 downloaded on 2020-08-08

[7] Gull, A., Jan, R., Nayik, G.A., Prasad, K., Kumar, P., & Longowal, S. (2014). Significance of Finger Millet in Nutrition, Health and Value added Products: A Review.

[8] Kumar, A., Goel, B. K., Karthikeyan, S., Asgar, S., Gedda, A. K., Choudhary, K. K., *et al*. (2013). Protein and calcium rich malted health drink power. *J. Food Process. Technol.* 4, 214. doi: 10.4172/2157-7110.1000214.

[9] Kumar, A., Metwal, M., Kaur, S., Gupta, A. K., Puranik, S., Singh, S., Yadav, R. (2016). Nutraceutical Value of Finger Millet [*Eleusine coracana (L.) Gaertn.*], and Their Improvement Using Omics Approaches. *Frontiers in Plant Science*, 7. doi:10.3389/fpls.2016.00934

[10] Maharajan T, Antony Ceasar S, Ajeesh Krishna TP and Ignacimuthu S (2021) Finger Millet [*Eleusine coracana (L.) Gaertn*]: An Orphan Crop With a Potential to Alleviate the Calcium Deficiency in the Semi-arid Tropics of Asia and Africa. Front. Sustain. *Food Syst.* 5:684447. doi: 10.3389/fsufs.2021.684447

[11] Murtaza, N., Baboota, R. K., Jagtap, S., Singh, D. P., Khare, P., Sarma, S. M., *et al*. (2014). Finger millet bran supplementation alleviates obesity-induced oxidative stress, inflammation and gut microbial derangements in high-fat diet-fed mice. *Br. J. Nutr.* 112, 1447–1458. doi: 10.1017/S0007114514002396.

[12] Muthamilarasan, M., Dhaka, A., Yadav, R., & Prasad, M. (2016). Exploration of millet models for developing nutrients rich graminaceous crops. *Plant Science*, 242, 89-97. http://dx.doi. org/10.1016/j.plantsci.2015.08.023. PMid:26566827.

[13] Patel, S., Naik, R. K., Sahu, R., & Nag, S. K. (2014). Entrepreneurship development through finger millet processing for better livelihood in production catchment. *American International Journal of Research in Humanities, Arts and Social Sciences*, 8(2), 223-227. Retrieved from http://iasir.net/AIJRHASSpapers/AIJRHASS14-711.pdf

[14] Ramashia, S. E., Anyasi, T. A., Gawata, E. T., Meddows-Taylor, S., and Jideani, A. I. O. (2019). Processing, nutritional composition and health benefits of finger millet in sub-saharan Africa. *Food Science and Technology*. doi:10.1590/fst.25017

[15] Sanwalka, N. J., Khadilkar, A. V., and Chiplonkar, S. A. (2011). Development of non-dairy, calcium-rich vegetarian food products to improve calcium intake in vegetarian youth. *Curr. Sci.* 101, 657–663.

[16] Shobana, S., Harsha, M. R., Platel, K., Srinivasan, K., and Malleshi, N. G. (2010). Amelioration of hyperglycaemia and its associated complications by finger millet (*Eleusine coracana* L.) seed coat matter in streptozotocin-induced diabetic rats. *Br. J. Nutr.* 104, 1787–1795. doi: 10.1017/S0007114510002977.

[17] Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N. G., Anjana, R. M., Palaniappan, L., & Mohan, V. (2013). Finger Millet (Ragi, *Eleusine coracana L.). Advances in Food and Nutrition Research,* 1–39. doi:10.1016/b978-0-12-410540-9.00001-6

[18] Shobana, S., Sreerama, Y. N., and Malleshi, N. G. (2009). Composition and enzyme inhibitory properties of finger millet (*Eleusine coracana* L.) seed coat phenolics: mode of inhibition of a-glucosidase and pancreatic amylase. *Food Chem.* 115, 1268–1273. doi: 10.1016/j.foodchem.2009.01.042.

[19] Singh, p. (2012). Finger millet for food and nutritional security. *African Journal of Food Science*, 6(4). doi:10.5897/ajfsx10.010

[20] Thapliyal, V., & Singh, K. (2015). Finger millet: potential millet for food security and power house of nutrients. *International or Research in Agriculture and Forestry*, 2(2), 22-33. Retrieved from http://www.ijraf.org/pdf/v2-i2/4.pdf

[21] Thilagavathi, T., Banumathi, P., Kanchana, S., &Ilamaran, M. (2015). Effect of heat moisture treatment on functional and phytochemical properties of native and modified millet flours. Plant Archives, 15(1), 15-20. Retrieved from https://org/PDF%2015%20-%201/15-21%20(2953).pdf

[22] USDA National Nutrient Database for Standard Reference, Release 28 (2016). US Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory. Available at:

https://ndb.nal.usda.gov/ndb/foods?fgcd=&manu=&lfacet=&count=&max=&sort=&qlookup1074=&offset=&format=Abridged&new=&measureby=

[23] Vasant, R. A., Patel, N. D., Karn, S. S., and Narasimhacharya, A. V. R. L. (2014). Physiological role of a multigrain diet in metabolic regulations of lipid and antioxidant profiles in hypercholesteremic rats-Multigrain diet in hyperlipemia. *J. Pharmacopuncture* 17, 34–40. doi: 10.3831/KPI.2014.17.014

Forest and Environmental Fires in Sustainable Palm Oil for Independent Smallholders

Mulono Apriyanto[1*], Marlina[2], Yoyon Riono[3], Hermiza Mardesci[4], Elfi Yenny Yusuf[5]

[1,4]Department of Food Science, Agriculture of Faculty, Islamic University of Indragiri
[2,3,5]Department of Agroteknologi, Agriculture of Faculty, Islamic University of Indragiri
*Corresponding Author

Received:- 12 February 2022/ Revised:- 18 February 2022/ Accepted:- 24 February 2022/ Published: 28-02-2022

Abstract— *Farmers' understanding of several Indonesia Sustainable Palm Oil (ISPO) parameters, including land legality and forest fires, is the focus of this study. ISPO certification poses a risk to households with a diverse income structure. The threat posed by oil palm plantations to natural resources and the environment will continue to be significant challenges.*

Keywords— ISPO; Oil Palm; Independent Smallholders; sustainability; environment; Forest fires.

I. INTRODUCTION

The plantation sector in Indonesia has developed into one of the country's most important non-oil and gas sources of foreign exchange[1]–[3]. In 2016, the total production of oil palm plantations in Indonesia was 33.23 million tons. Large private companies manage 54.64 percent of the nation's oil Palm plantations [4], [5]. The pattern of self-help productivity is lower than that of large corporations. The expansion of oil palm plantations is an important keyword to understand the scope of the oil palm problem in Indonesia. CPO production centers in the provinces of Riau and North Sumatra account for 23.75 percent and 16.24 percent of total CPO output [6].

The Indonesian oil palm plantation industry is confronted with a number of challenges [7], [8]. A common accusation leveled against the palm oil industry is that it is unsustainable [9]–[11]. Using the Indonesia Sustainable Palm Oil (ISPO) certification, the Indonesian government seeks to mitigate the negative perception of palm oil. Indragiri hilir region has three distinct patterns of oil palm plantation management [12], [13]. Lower Indragiri is characterized by land typologies, tides, and coastal areas that characterize the downstream geographical conditions of the river [14]. The selling price of FFB received by independent smallholders is significantly lower than that received by PIR pattern farmers (people's core company). Based on the description above the research aims to identify the role of farmers in the sustainable palm oil industry [15], [16].

II. RESEARCH METHOD

1. Research Sites

The research was carried out on smallholder oil palm plantations (smallholders) in three villages in the Indragiri Hilir Regency. The goal of this study is to determine how well independent oil palm farmers are prepared to deal with the Indonesian Sustainable Palm Oil (ISPO) policy. The expansion of oil palm plantations into forest areas poses a significant threat to the long-term viability of palm oil production, with the majority of the threat stemming from deforestation activities.

2. Data Analysis

Data was gathered through a survey method involving a questionnaire as well as in-depth interviews. There were as many as 30 respondents per village chosen at random, with a margin of error of 20%, assuming that this number met the minimum number of respondents required to be surveyed. The researchers carried out their investigation from November 2019 to March 2020. They are primarily concerned with the livelihood aspects of land, seeds, and the environment. This study is limited in scope because it is only concerned with implementation of the ISPO assessment principles for smallholders.

III. RESULT AND DISCUSSION

There are very few independent household farmers whose livelihoods are dependent solely on the support of oil palm plantations in the field, according to the facts on the ground [3], [17], [18]. The greater the importance of the oil palm plantation sector as a source of livelihood within the structure of the farmer's livelihood, the greater the likelihood that they will be more prepared to implement ISPO certification [19], [20].

Figure 1 shows that the livelihood structure of independent smallholders in three non-oil palm villages does not generate the majority of their income, despite the fact that they are self-sufficient [10], [21]. It can be seen that the real source of income from oil palm plantations is not significant enough to support the claim that these three villages are the hubs of community oil palm plantation [22]. Unless the independent oil palm farmer household expands their land (which will result in extremely serious environmental consequences), they will not be able to increase the economic contribution of the oil palm [21]

FIGURE 1: Household infrastructure in Kempas Jaya Village, Teluk Continue Village, and Plangiran Village that is self-sustaining.

Indonesia's Ministry of Agriculture, Permentan OT.140 3/2011, issued a decree prohibiting the use of genetically modified organisms (GMOs) in food production [23]. Independent palm oil farmers in Indonesia will be able to become certified under the ISPO certification scheme [1]. Having oil palm plantations in the Forestry Cultivation Zone indicates that you are in the second status, which is indicated by the presence of these plantations (KBK) [24]. Planting oil palm on land with this designation is prohibited by law and does not comply with the principles of sustainability in plantation cultivation [25].

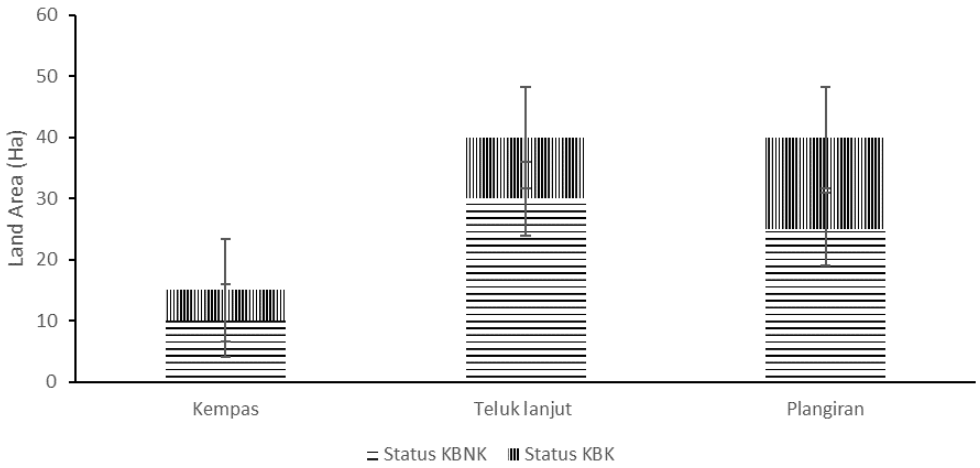


FIGURE 2: Individual independent palm oil farmer households in three research villages had a varying average area of mastery, which was measured in hectares, depending on their location and legal status (Ha).

As depicted in Figure 2, the agrarian structure of illegal oil palm plantations (oil palm in the Forestry Cultivation Area / KBK) in three villages is extremely low when compared to oil palm plantations on legal land (oil palm in the Non-Forestry Cultivation Area / KBNK), which is extremely high when compared to oil palm plantations on illegal land (oil palm in the Non-Forestry Cultivation Area). As evidenced by this finding, independent farmers in the three villages have had no problems with the legality or status of their cultivated land [7], [26]. Moreover, this fact implies that all oil palm production originating from the three villages is not at risk from agrarian conflicts, degradation of environmental quality, or unsustainability, thus enabling it to be certified by the International Sustainable Palm Oil Organization [27]. Many oil palm plantations are being established in conservation areas (forest conservation land) or production forest areas, resulting in the area being labeled as illegal land by the local authorities [28]. It is common knowledge that illegal land is associated with the pattern of oil palm expansion carried out by independent oil palm farmers as a result of a scarcity of available land in the area during a particular period in time [29]. The possession of land certificates can also serve as evidence of legal ownership of land in certain circumstances [30]

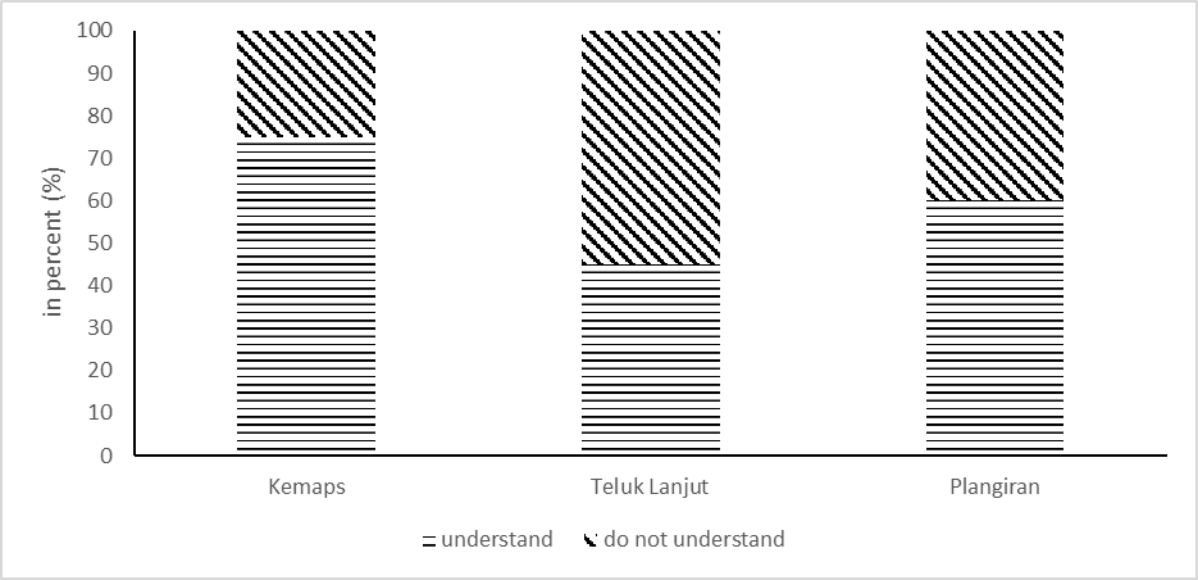


FIGURE 3: Farmers' Knowledge in Environmental Management

A gap analysis is being conducted in three villages as part of this study [31]. From the farmer's perspective, chasm differences are enforced in multiple interpretations of ISPO certification principles [20]. The level of knowledge that farmers have about palm oil that is independent of the ISPO principles is referred to as diversity. Self-help groups apply pesticides to oil palm plantations at varying dosage levels [32], [33]. While pesticides are used to control pests, they also have the potential to cause environmental damage [34]. The use of independent palm oil for gardening purposes is still not being implemented intensively or extensively in third-world countries.

In the three research locations, fire prevention activities were deemed less important because villages were rarely affected by land fires [27], [35]. As a result of the expansion of monoculture palm plantations on the lands of coconut plantations, several types of plants are becoming increasingly scarce. The deliberate extermination of more than a dozen species of animals was carried out [16]. Government efforts to help smallholders to strengthen principles of natural resource management and environment adequately, very crucially, and critical.

Independent smallholders are encouraged to participate in certification processes because of the dominance of oil palm products [16], [36]. Farmers in rural areas of developing countries have three sources of income: farm income, off-farm income, and nonfarm income [37]. This study will be simplified into three sources in order to make classification easier. These conditions include ensuring that smallholders are not disadvantaged by the low proportion of their income derived from oil palm farming, and that lands are not excluded from certification [16].

Indonesia's CPO credibility in international markets will remain low or gloomy as long as the livelihood structure of independent oil palm farmer households does not improve fundamentally [38]. The current livelihood condition is not ready for ISPO certification process unless fundamental improvements are made to the productivity aspect first [39].

Land certificates [40], [41], which are one of the requirements for ISPO certification, had not yet been obtained in all cases, according to the findings [24], [42]. In the three study locations, land certificates were not available to nearly all independent coconut farmers. Instead, they were restricted to Land Certificates (SKT) or Compensation Certificate (SKGR).

IV. CONCLUSION

Independent oil palm farmers are not prepared to face ISPO implementation, according to research carried out in Indonesia. The income from palm oil is not their primary or dominant source of income, the findings found. It is possible to establish the legality of independent smallholders because the majority of oil palm cultivation plantations have received compensation letters.

REFERENCES

[1] A. Syahza and B. Asmit, "Development of palm oil sector and future challenge in Riau Province, Indonesia," *J. Sci. Technol. Policy Manag.*, vol. 11, no. 2, pp. 149–170, 2020, doi: 10.1108/JSTPM-07-2018-0073.

[2] V. Higgins and C. Richards, "Framing sustainability: Alternative standards schemes for sustainable palm oil and South-South trade," *J. Rural Stud.*, vol. 65, no. July, pp. 126–134, 2019, doi: 10.1016/j.jrurstud.2018.11.001.

[3] M. Apriyanto, Partini, H. Mardesci, G. Syahrantau, and Yulianti, "The Role of Farmers Readiness in the Sustainable Palm Oil Industry The Role of Farmers Readiness in t he Sustainable Palm Oil Industry," *J. Phys. Conf. Ser.*, vol. 1764, no. 1, p. 012211, 2021, doi: 10.1088/1742-6596/1764/1/012211.

[4] Marlina, I. Sari, E. Y. Yusuf, Y. Riono, and M. Apriyanto, "Utilization Of Industrial Waste Pulp And Palm Oil On Growth And Results Of Corn (Zea Mays L) On Peat," *Int. J. Sci. Technol. Res*, vol. 9, no. 1, pp. 109–112, 2020.

[5] M. Arpah, Marlina, and M. Apriyanto, "Effect Of Grant Palm Oil Ash To The Growth And Production Of Two Corn Varieties (Zea Mays L) In Peatland," *Int. J. Sci. Technol. Res*, vol. 9, no. 4, pp. 990–993, 2020.

[6] Hartono, *Kabupaten Indragiri Hilir Dalam Angka 2020*. 2020.

[7] R. R. M. Paterson and N. Lima, "Climate change affecting oil palm agronomy, and oil palm cultivation increasing climate change, require amelioration," *Ecol. Evol.*, vol. 8, no. 1, pp. 452–461, 2018, doi: 10.1002/ece3.3610.

[8] M. Apriyanto *et al.*, "A SWOT Analysis to Improve The Marketing of Young Coconut Chips," *Ann. Rom. ...*, vol. 25, no. 4, pp. 13232–13240, 2021, [Online]. Available: http://annalsofrscb.ro/index.php/journal/article/view/4337.

[9] N. K. Hidayat, A. Offermans, and P. Glasbergen, "Sustainable palm oil as a public responsibility? On the governance capacity of Indonesian Standard for Sustainable Palm Oil (ISPO)," *Agric. Human Values*, vol. 35, no. 1, pp. 223–242, 2018, doi: 10.1007/s10460-017-9816-6.

[10] O. Apriyanto, Irham, J. Handoyo Mulyo, and S. Hardyastuti, "Analysis of Social Economy Sustainable Palm Oil Plantations Management based on Indonesian Sustainable Palm Oil (ISPO) Criteria in Riau," in *IOP Conference Series: Earth and Environmental Science*, 2020, vol. 518, no. 1, doi: 10.1088/1755-1315/518/1/012049.

[11] E. Commission, *Study on the environmental impact of palm oil consumption and on existing sustainability standards*. 2018.

[12] P. Dauvergne, "Studying Global Environmental Meetings," *Glob. Environ. Polit.*, vol. 13, no. August, pp. 46–64, 2013, doi: 10.1162/GLEP.

[13] R. Cazzolla Gatti, J. Liang, A. Velichevskaya, and M. Zhou, "Sustainable palm oil may not be so sustainable," *Sci. Total Environ.*, vol. 652, pp. 48–51, 2019, doi: 10.1016/j.scitotenv.2018.10.222.

[14] T. Silalertruksa *et al.*, "Environmental sustainability of oil palm cultivation in different regions of Thailand: Greenhouse gases and water use impact," *J. Clean. Prod.*, vol. 167, pp. 1009–1019, 2017, doi: 10.1016/j.jclepro.2016.11.069.

[15] H. Mardesci, Santosa, N. Nazir, and R. A. Hadiguna, "Identification of prospective product for the development of integrated coconut agroindustry in Indonesia," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 9, no. 2, pp. 511–517, 2019, doi: 10.18517/ijaseit.9.2.7172.

[16] E. Erniwati, E. A. M. Zuhud, I. Anas, A. Sunkar, and Y. Santosa, "Independent Smallholder Oil Palm Expansion and Its Impact On Deforestation: Case Study in Kampar District, Riau Province, Indonesia," *J. Manaj. Hutan Trop. (Journal Trop. For. Manag.*, vol. 23, no. 3, pp. 119–127, 2017, doi: 10.7226/jtfm.23.3.119.

[17] M. I. Said, "The Role of the Livestock Farming Industry in Supporting the Global Agricultural Industry." intechopen.com, 2021, [Online]. Available: https://www.intechopen.com/online-first/the-role-of-the-livestock-farming-industry-in-supporting-the-global-agricultural-industry.

[18] M. Apriyanto, P. Diawati, L. Fangohoi, F. Azuz, and E. Sutrisno, "Small-scale Coconut Farmers in Indragiri Hilir District as a Model of Youth Entrepreneurship in the Plantation Sector," vol. 205, no. Icsebe 2021, pp. 69–72, 2022.

[19] B. Widyatmoko, "THE IMPLEMENTATION OF INDONESIAN SUSTAINABLE PALM OIL CERTIFICATION (ISPO): OPPORTUNITY FOR INCLUSION OF PALM OIL SMALLHOLDER IN RIAU PROVINCE," *Masy. Indones.*, vol. 45, no. 2, pp. 219–228, 2019.

[20] N. Agatha and R. R. Rijanta, "Adopsi Prinsip Indonesian Sustainable Palm Oil (ISPO) Dalam Perkebunan Kelapa Sawit Rakyat Di Kecamatan Sei Menggaris, Kabupaten Nunukan," *J. Bumi Indones.*, 2020, [Online]. Available: http://lib.geo.ugm.ac.id/ojs/index.php/jbi/article/view/1218.

[21] C. Brandi, T. Cabani, C. Hosang, S. Schirmbeck, L. Westermann, and H. Wiese, *Sustainability Certification in the Indonesian Palm Oil Sector: Benefits and challenges for smallholders*, no. January 2013. 2013.

[22] M. Van Noordwijk, P. Pacheco, M. Slingerland, and S. Dewi, "Palm Oil Expansion in Tropical Forest Margins or Sustainability of Production? Focal Issues of Regulations and Private Standards," 2017.

[23] B. A. R. WULANDARI, "Sustainable Development Goals Dalam Upaya Penguatan Pembangunan Kelapa Sawit Indonesia Melalui Indonesian Sustainable Palm Oil (Ispo)," *repository.unej.ac.id*, [Online]. Available: https://repository.unej.ac.id/handle/123456789/104155.

[24] Cecilia Luttrell Heru *et al.*, "Implementing sustainability commitments for palm oil in Indonesia: Governance arrangements of initiatives involving public and private actors," *Implementing sustainability commitments for palm oil in Indonesia: Governance arrangements of initiatives involving public and private actors*. 2018, doi: 10.17528/cifor/006901.

[25] M. E. Harrison *et al.*, "Tropical forest and peatland conservation in Indonesia: Challenges and directions," *People Nat.*, vol. 2, no. 1, pp. 4–28, 2020, doi: 10.1002/pan3.10060.

[26] K. Ngo, "Land cover mapping of the Mekong Delta to support natural resource management with multi-temporal Sentinel-1A synthetic aperture radar imagery," *Remote Sens. Appl. Soc. Environ.*, vol. 17, 2020, doi: 10.1016/j.rsase.2019.100272.

[27] W. Rodthong, J. K. M. Kuwornu, A. Datta, A. K. Anal, and T. W. Tsusaka, "Factors Influencing the Intensity of Adoption of the Roundtable on Sustainable Palm Oil Practices by Smallholder Farmers in Thailand," *Environ. Manage.*, vol. 66, no. 3, pp. 377–394, 2020, doi: 10.1007/s00267-020-01323-3.

[28] Skye Glenday and G. Paoli, "Overview of Indonesian Oil Palm Smallholder Farmers: A Typology of Organizational Models, Needs, and Investment Opportunities," *Daem. Consult.*, no. November, p. 21, 2015, [Online]. Available: www.daemeter.org.

[29] H. Purnomo *et al.*, "Reducing forest and land fires through good palm oil value chain governance," *For. Policy Econ.*, vol. 91, no. March 2017, pp. 94–106, 2018, doi: 10.1016/j.forpol.2017.12.014.

[30] L. Zheng and W. Qian, "The impact of land certification on cropland abandonment: evidence from rural China," *China Agric. Econ. Rev.*, vol. ahead-of-p, no. ahead-of-print, Nov. 2021, doi: 10.1108/CAER-12-2020-0292.

[31] M. Apriyanto, "Latar Belakang Masalah Penelitian," in *Metodologi Penelitian Pertanian*, Nuta Media, Yogyakarta, 2021.

[32] D. Żyżelewicz, G. Budryn, W. Krysiak, J. Oracz, and ..., "Influence of roasting conditions on fatty acid composition and oxidative changes of cocoa butter extracted from cocoa bean of Forastero variety cultivated in Togo," *Food Res. ...*, 2014, [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0963996914003020.

[33] L. M. Ayompe, M. Schaafsma, and B. N. Egoh, "Towards sustainable palm oil production: The positive and negative impacts on ecosystem services and human wellbeing," *J. Clean. Prod.*, vol. 278, no. November, pp. 1–11, 2021, doi: 10.1016/j.jclepro.2020.123914.

[34] R. D. la C. Quiroz, S. Roussos, and ..., "Challenges and opportunities of the bio-pesticides production by solid-state fermentation: filamentous fungi as a model," *Crit. Rev. ...*, 2015, doi: 10.3109/07388551.2013.857292.

[35] A. F. Boy, "Implementasi Data Mining Dalam Memprediksi Harga Crude Palm Oil (CPO) Pasar Domestik Menggunakan Algoritma Regresi Linier Berganda (Studi Kasus Dinas …," *J. Sci. Soc. ...*, 2020, [Online]. Available: http://jurnal.goretanpena.com/index.php/JSSR/article/view/421.

[36] A. Valentina and N. Kusumawardani, "Indonesian Sustainable Palm Oil (ISPO), A Way to Reach The European Union Renewable Energy Directive (EU RED) 2009 and Boosting Indonesian Palm Oil Market to European Union (EU) 2009-2014," *AEGIS, J. Int. Relations*, vol. 1, no. 1, pp. 2009–2014, 2016.

[37] M. Apriyanto *et al.*, "Penyuluhan Tentang Peremajaan Kelapa Sawit dan Legalitas Lahan Di Kecamatan Kempas Kabupaten Indragiri Hilir," *Arbitr. J. Econ. Account.*, vol. 1, no. 1, pp. 1–6, 2020, doi: 10.31219/osf.io/7j4sy.

[38] C. Dislich *et al.*, "A review of the ecosystem functions in oil palm plantations, using forests as a reference system," *Biol. Rev.*, vol. 92, no. 3, pp. 1539–1569, 2017, doi: 10.1111/brv.12295.

[39] N. Kuznetsova, "Small business environment and development problems in the Russian Federation," *E3S Web of Conferences*, vol. 244. 2021, doi: 10.1051/e3sconf/202124410043.

[40] P. Paduloh *et al.*, "Sustainability Analysis of Palm Oil as Implications for Price Decreasing of FFB Sei Kepayang Region," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 3S, pp. 78–82, 2020, doi: 10.35940/ijitee.c1017.0193s20.

[41] C. Dias, "Small agricultural businesses' performance—What is the role of dynamic capabilities, entrepreneurial orientation, and environmental sustainability commitment?," *Bus. Strateg. Environ.*, vol. 30, no. 4, pp. 1898–1912, 2021, doi: 10.1002/bse.2723.

[42] A. Yulianur Bc, Azmeri, and Khairuddin, "The effect of rainfall interception loss by Palm-Oil tree towards flood discharge in Seunagan watershed of Nagan Raya district of Aceh Province," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 523, no. 1, 2019, doi: 10.1088/1757-899X/523/1/012041

AD Publications
Sector-3, MP Nagar, Rajasthan, India
www.adpublications.org, www.ijoear.com, info@ijoear.com