

BUSITEMA UNIVERSITY

Pursuing excellence

FACULTY OF NATURAL RESOURCES AND ENVIRONMENTAL SCIENCES

DEPARTMENT OF FISHERIES AND WATER RESOURCES MANAGEMENT

SOCIO-ECONOMIC CONTRIBUTION OF INTEGRATED RICE-FISH FARMING SYSYTEMS FOR SMALL HOLDER FARMERS IN ERUTE SOUTH, LIRA DISTRICT

BY

OGWAL MOSES

BU/UP/2023/1378

A dissertation submitted to the Faculty of Natural Resources and Environmental Sciences in partial fulfillment of the requirements for the award of a Bachelor's Degree in Fisheries and Water Resources Management.

AUGUST, 2026

DECLARATION

I, **OGWAL MOSES,** declare that this research report submitted to the faculty of Natural Resources and Environmental Sciences is my original work and to the best of my knowledge. It has not been submitted by any other person to any institution for any academic qualification.

Signature…… Date: 29th/09/2026

BU/UP/2023/1378

APPROVAL

This is to certify that this research report titled “Socio-economic contribution of Integrated Rice-Fish Farming systems for small holder farmers in Erute South, Lira district Uganda” is the original work for Ogwal Moses, and has been under my supervision and it is ready to be submitted to the Faculty of Natural Resources and Environmental Sciences.

MR. KIFUMBA DAVID NSAJJU

BUSITEMA UNIVERSITY

Signature…….. Date: 29th/09/2026

DEDICATION

With much pleasure I would like to dedicate this report to my beloved parents who have always been there for me in every kind of need and circumstances.

ACKNOWLEDGEMENT

I thank the Almighty God, for giving me the endurance and patience in accomplishing this piece of work. I acknowledge the patience and efforts offered by my family members- Joshua, Emmanuel and Rhoda. In addition, I want to acknowledge my dear course mates of NRE and FWR class 2023/2024 intake for the cordial relationship and cooperation rendered through moral, mental and physical support during my academic journey.

Special thanks go to my supervisor, Mr. Kifumba David Nsajju for the guidance and comments that has shaped this work. I also express my deepest sense of gratitude and indebtedness for his scientific guidance and ceaseless support throughout the course of the research work.

Finally, I would like to express my gratitude to the Busitema University, Namasagali campus' Faculty of Natural Resources and Environmental Sciences for supporting me all through this course. I am determined to use the knowledge I have received and make a meaningful contribution to my field.

TABLE OF CONTENTS

DECLARATION i
APPROVAL ii
DEDICATION iii
ACKNOWLEDGEMENT iv
TABLE OF CONTENTS v
LIST OF FIGURES viii
LIST OF ACRONYMS xi
ABSTRACT xii
CHAPTER ONE 1
1.0. INTRODUCTION 1
1.1. Background 1
1.1.1. The concept of IRFF. 1
1.1.2. Global perspective of IRFF 2
1.1.3. The African context 2
1.1.4. IRFF in Uganda 3
1.2. Problem statement 3
1.3. Significance of the study 4
1.4. Research aims and objectives 4
1.4.1. Research aim 4
1.4.2. Study objectives 4
1.5. Research questions 5
1.6. Justification of the study 5
1.7. Conceptual framework 6
CHAPTER TWO 7
2.0. LITERATURE REVIEW 7
2.1. Overview of Integrated Rice-Fish Farming (IRFF) 7
2.1.2. Models of IRFF systems 7
2.1.3. The ecological basis of IRFF 8

2.2. Sustainable livelihoods and agricultural diversification 8
CHAPTER THREE 12
3.0. METHODOLOGY 12
3.1.2. Economic activities 12
3.1.3. Study sites 13
3.2. Scope and content 13
3.3. Research design 13
3.4. Study population and sampling 14
3.4.1. Target population 14
3.4.2. Sample size determination 14
3.5. Data collection and analysis 14
3.5.1. Quantitative methods 14
3.5.2. Qualitative methods 15
3.5.3. Data quality control 15
3.5.4. Data analysis 15
CHAPTER FOUR 17
4.0. ANALYSIS AND PRESENTATION OF RESULTS 17
4.1. Demographic information of the respondents 17
4.2. Farming systems identification (IRFF versus conventional monoculture). 20
4.3. House hold income from farming systems 26
4.4 LABOUR REQUIREMENTS AND GENDER DYNAMICS AMONG BOTH IRFF FARMERS AND CONVENTIONAL RICE FARMERS. 29
4.5. PERCEIVED SOCIAL RISKS, CONSTRAINTS AND BENEFITS. 37
CHAPTER FIVE 48
5.0 DISCUSSION OF FINDINGS 48
5.1. Contribution of IRFF Systems on household income and livelihood diversification 48
5.2 Gender labor requirements in IRFF Systems versus Conventional rice monoculture 52
5.3 Perceived benefits, constraints, opportunities, and social risks of IRFF 55
CHAPTER SIX 60

6.0. CONCLUSIONS AND RECOMMENDATIONS 60
6.1. CONCLUSION 60
6.2 RECOMMENDATIONS 61
REFERENCES 62
APPENDICES.APPENDIX I: RESEARCH QUESTIONNAIRE 66
APPENDIX II: Key Informant Interviews held with the respondents 79

LIST OF FIGURES

Figure 4.1 Gender of the respondents 17
Figure 4.2 Age bracket of the respondents 17
Figure 4.3 Level of education of the respondents 18
Figure 4.4 Marital status of the respondents 18
Figure 4.5 Main occupation of the respondents 19
Figure 4.6 Household size of the respondents 19
Figure 4.7 Religion of the respondents 20
Figure 4.8 Comparison between the proportion of farmers engaged in IRFF and conventional Rice Monoculture. 20
Figure 4.9 . Comparison of proportion of respondents in conventional rice monoculture and that in IRFF by duration. 21
Figure 10 Comparison between proportion of respondents with land under conventional rice farming and IRFF. 22
Figure 4.11 species integrated with rice under IRFF systems. 22
Figure 4.12 comparison of species integrated with rice and period spent in irff. 23
Figure 4.13 Keeping of livestock by the respondents. 23
Figure 4.14 Year to integrate livestock with rice- fish and poultry. 24
Figure 4.15 Comparison of livestock and period spent in IRFF and Conventional Rice monoculture. 24
Figure 4.16 Year to first integrate livestock with rice- fish and pigs 25
Figure 4. 17 Beliefs, taboos, religion totems affect or social factors that keeping these animals. 25
Figure 4.18 comparison Rice sales only among conventional rice farmers and IRFF farmers. 26
Figure 4.19 Approximate income from fish sales only among IRFF farmers. 26
Figure 4.20 Comparison of approximate income from livestock/poultry among Conventional Rice farmers and IRFF farmers. 27
Figure 4.21 Effect of IRFF on household income of the respondent. 27

Figure 4.22 switching to IRFF if given training or support 28
Figure 4.23 why the respondent would not consider switching to IRFF. 29
Figure 4.24 People in the household that participate in farming 30
Figure 4.25 household participation in land preparation 30
Figure 4.26 household participation in planting rice 31
Figure 4.27 Household participation in fish monitoring. 32
Figure 4.28 household participation in monitoring fish ponds 32
Figure 4.29 household participation in harvesting rice 33
Figure 4.30 household participation harvesting fish 33
Figure 4.31 Household participation in selling rice in the market 34
Figure 4.32 Management of income 34
Figure 4.33 IRFF and conventional rice monoculture increasing women workload 35
Figure 4.34 comparison of women to men in making decisions related to fish farming 36
Figure 4.35 Hiring of labour by respondents in farming activities in IRFF and conventional rice monoculture. 36
Figure 4.36 Activities performed by the hired labor 37
Figure 4.37 Nature of payment for the hired labour 37
Figure 4.38 Increased food security as a benefit of IRFF and Conventional Rice farming 38
Figure 4.39 Reduce pest problem in rice 39
Figure 4.40 Reduced need for chemical fertilizers 39
Figure 4.41 high cost of fish fingerlings as challenge associated with IRFF 40
Figure 4.42 Lack of knowledge 40
Figure 4.43 Conflict with neighbors over water usage 41
Figure 4.44 Fear of fish damaging rice 42
Figure 4.45 Fish diseases 42
Figure 4.46 Social risks associated with IRFF 43
Figure 4.47 Opportunities of IRFF in improving farmers livelihoods 43
Figure 4.48 Beliefs related to fish farming 45
Figure 4.49 Recommendation of IRFF to other farmers 46

Figure 4.50 Support provided by community cooperatives in regard to fish farming 46
Figure 4.51 Roles provided by local leaders in regard to fish farming 47
Figure 4.52 support provided by government in relation to fish farming 47

LIST OF ACRONYMS

DFID-Department for International Development

FAO-Food and Agriculture Organization of the United Nations

IDS-Institute of Development Studies

IPCC-Intergovernmental Panel on Climate Change

IRFF-Integrated Rice-Fish Farming

LC-Local Council

MAAIF-Ministry of Agriculture, Animal Industry and Fisheries

TAAT-Technologies for African Agricultural Transformation

UBOS-Uganda Bureau of Statistics

UGX-Uganda Shillings

USD-United States Dollar

ABSTRACT

Integrated Rice-Fish Farming (IRFF) is an ancient agro-ecological practice where fish and rice are cultivated together on the same piece of land, leveraging the symbiotic relationship between the two organisms to enhance overall productivity

The study assessed the socio-economic contribution of Integrated Rice-Fish Farming (IRFF) systems for smallholder farmers in Erute South Constituency, Lira District, Uganda. The specific objectives were to establish the contribution of IRFF systems on diversification of sources of household income and livelihood among smallholder rice farmers; to compare the gender labor requirements associated with IRFF systems and rice monoculture; and to evaluate perceived social risks, constraints, opportunities, and benefits associated with IRFF and rice monoculture practices among smallholder farmers. A mixed-methods research design was used. A structured questionnaires, key informant interviews, and focus group discussions were used to collect data from 60 respondents. The data was analysed using descriptive statistics to show variation in livelihoods, compare variation in labour required among different livelihoods conducted, and find out the main social risks, constraints, opportunities and benefits related to practicing IRFF systems rather than conventional rice farming. . Findings show that IRFF significantly contributes to household income diversification, with all IRFF practitioners (100%) reporting diversified income sources and increased food security. The total annual household income from farming among IRFF practitioners showed marked improvement, with 57.4% earning between 1-3 million UGX, compared to the pre-adoption period where 55% earned below 500,000 UGX. 68.1% of respondents reporting that IRFF has increased women's workload, and 70% indicating that men primarily manage income from sales. challenges included predation on fish (93.7%), low market prices for fish (87.2%), and lack of technical knowledge (85.1%). 97.9% of IRFF practitioners would recommend the system to other farmers. Subsidized fish fingerlings, training on rice-fish integration, market integration assistance, low interest loans, extension services support, and subsidized fish feeds were identified as the primary form of government assistance, constituting 18.9%, 16.2%, 16.21%, 15.02%, 11.86%, 14.23% respectively. Support for water management infrastructure was not a critical need by the 7.5%.

CHAPTER ONE

1.0. INTRODUCTION

1.1. Background

1.1.1. The concept of IRFF.

Integrated Rice-Fish Farming (IRFF) is an ancient agro-ecological practice where fish and rice are cultivated together on the same piece of land, leveraging the symbiotic relationship between the two organisms to enhance overall productivity (Zhang et al., 2025). This system, which dates back over 2,000 years, originated in China and has since spread across Asia, representing one of the oldest known examples of integrated agriculture-aquaculture systems (Ana, O.S. et al., 2025).

The fundamental mechanism of IRFF operates on mutual benefit: rice plants provide shade, attract insect pests, and organic matter that serve as food sources for fish, while fish, in turn, oxygenate the water, stir nutrients throughout the field, and consume pests and weeds that would otherwise harm rice crops (Ana, O.S. et al., 2025). Fish waste also acts as a natural fertilizer, enriching the soil with essential nutrients and reducing the need for synthetic inputs Technologies for African Agricultural Transformation (TAAT Africa, 2025). This biological synergy effectively creates a closed-loop system where waste products from one component become resources for the other.

In practice, the system requires specific field modifications, including the construction of reinforced bunds (embankments) to retain water, the digging of refuge channels or ponds that provide fish with habitat during dry periods or harvesting, and the installation of mesh screens at water inlets to prevent fish escape (TAAT Africa, 2025). The classic process begins with field preparation, followed by rice transplanting into flooded paddies, after which fingerlings typically tilapia or African catfish (*Clarias gariepinus*) are introduced (Ana, O.S. et al., 2025). Throughout the growing cycle, water levels must be carefully managed to simultaneously support rice growth and fish survival.

The environmental benefits of this system are substantial. Research has demonstrated that rice-fish co-culture reduces herbivore insect populations by 24 percent, decreases weed abundance by 58 to 68 percent, and eliminates the need for chemical pesticides (Ana, O.S. et al., 2025). The

system enhances soil fertility and biodiversity while reducing the environmental footprint of agricultural production (Dubois et al., 2021). However, some studies have noted that IRFF may increase methane emissions by approximately 29 percent due to decreased oxygen concentrations in standing water, though this trade-off is often offset by the elimination of synthetic fertilizer-related emissions (Ana, O.S. et al., 2025).

From an economic perspective, IRFF consistently outperforms rice mono-cropping. The benefit-to-cost ratio for rice-fish systems has been calculated at 2.2, compared to 1.6 for sole rice cropping, representing a substantial improvement in profitability (TAAT Africa, 2025). Global projections suggest that widespread adoption of rice-fish co-cultures could increase farmers' income by USD 175–197 billion annually, reduce nitrogen loss by 0.3 million tons per year, and avoid 7 percent of atmospheric methane emissions (Ana, O.S. et al., 2025).

1.1.2. Global perspective of IRFF

IRFF represents an ecological intensification approach that combines rice cultivation with fish production in the same paddy field system (Ahmed & Garnett, 2011). This farming system has gained recognition globally as a sustainable agricultural practice that enhances productivity, improves resource use efficiency, and provides multiple benefits to farming households (Hu et al., 2016). In Asian countries, particularly China, Vietnam, and Bangladesh, IRFF has demonstrated substantial socio-economic benefits including increased household income, improved food security, and enhanced nutritional diversity (Halwart & Gupta, 2004).

Sustainable Agricultural Intensification (SAI) practices, such as Integrated Rice Fish Farming (IRFF), offer a promising pathway. IRFF is an agro-ecological practice where fish (e.g., tilapia, catfish) are cultivated concurrently with rice in the same paddy field, creating a synergistic relationship that can optimize resource use (Frei & Becker, 2005).

1.1.3. The African context

Sub-Saharan Africa has been slower to adopt IRFF, but momentum is building. Nigeria represents the continent's most significant success story, where rice-fish integration has been implemented on over 10,000 hectares through more than 35 demonstration projects using various models, patterns, and fish species (Zolani, 2022).

Egypt has developed substantial rice-fish capacity, while countries including Ghana, Liberia, Mali, Senegal, and Sierra Leone have tested or adopted the technology (TAAT Africa, 2025). The Technologies for African Agricultural Transformation (TAAT) program has identified rice-fish culture as a pre-validated, ready-to-scale technology suitable for tropical, warm-subtropical, and humid agro-ecological zones across the continent (TAAT Africa, 2025).

1.1.4. IRFF in Uganda

In Uganda, agriculture employs over 70% of the population and contributes significantly to GDP and food security (MAAIF, 2020). In Lira District, smallholder farmers constitute most agricultural producers, primarily engaging in subsistence farming with limited diversification opportunities (Mubiru et al., 2018). The district's favorable wetland conditions and increasing interest in aquaculture present unique opportunities for innovative farming systems.

The Government of Uganda has promoted aquaculture development through various policies and programs aimed at improving food security and household incomes (MAAIF, 2020). However, the adoption and implementation of IRFF systems remain limited, particularly in the northern region where rice production is expanding.

This study seeks to assess the socio-economic contribution of IRFF systems on smallholder farmers in Erute South, Lira District, Northern Uganda. The district, with its significant wetland (rice-growing) areas and history of agricultural interventions, presents a pertinent case study for understanding the adoption and impacts of this integrated system.

1.2. Problem statement

Lira District has potential for IRFF, yet smallholder farmers predominantly practice conventional rice monoculture. Smallholder farmers in Lira District have traditionally relied on wetland rice monoculture as their primary source of livelihood. However, this one-crop system is increasingly failing to provide a sustainable income. Farmers are struggling with declining soil fertility, high costs of chemical fertilizers, and a heavy reliance on a single harvest that is highly vulnerable to fluctuating market prices and climate change. This has led to stagnation in the standard of living and leaves many households in a cycle of seasonal poverty. While Integrated Rice-Fish Farming (IRFF) has been introduced in sub-counties like Barr, Itek, Agali, Amac, and Wiodyek as a

promising solution to boost and diversify household income, its actual adoption in Lira remains limited and its comprehensive socio-economic impacts are not well documented.

There is no information on whether the extra labor and high initial costs of digging fish trenches are justified by the profits from fish sales. It is also unclear how this system changes the workload for women and youth, who already bear the burden of manual farm work. There is a knowledge gap regarding the contribution of IRFF and livelihood diversification to household income among existing smallholder farmers, the labor requirements and gender dynamics associated with IRFF, and the perceived challenges and opportunities associated with the practice from the farmers' perspective. Without this empirical evidence, policymakers and extension services in the district cannot make informed decisions to support effective scaling of IRFF among other farmers, potentially missing an opportunity to improve rural livelihoods and ecological sustainability in the district under such a system.

1.3. Significance of the study

The study provides information on the socio-economic contributions, labor demands, and perceived risks of IRFF, which will guide smallholders in making informed decisions before they adopt the technology. Local government extension workers provided with practical information needed to effectively guide and promote IRFF among smallholder farmers in Erute South Constituency, Lira District.

1.4. Research aims and objectives

1.4.1. Research aim

The study aims to evaluate the socio-economic contribution of Integrated Rice-Fish Farming systems for smallholder farmers in Erute South, Lira District, Uganda.

1.4.2. Study objectives

- ✓ To establish the contribution of IRFF systems on diversification of sources of household income and livelihood among smallholder rice farmers
- ✓ To compare the gender labor requirements associated with IRFF systems and rice monoculture

- ✓ To evaluate perceived social risks, constraints, opportunities, and benefits associated with IRFF and rice monoculture practices among smallholder farmers

1.5. Research questions

- What is the contribution of IRFF systems on household income and livelihood diversification among smallholder farmers in Lira District?
- How do labor requirements and gender roles in IRFF systems differ from those in conventional rice monoculture farming?
- What opportunities, benefits, constraints, and risks do smallholder farmers perceive and experience in practicing IRFF systems?

1.6. Justification of the study

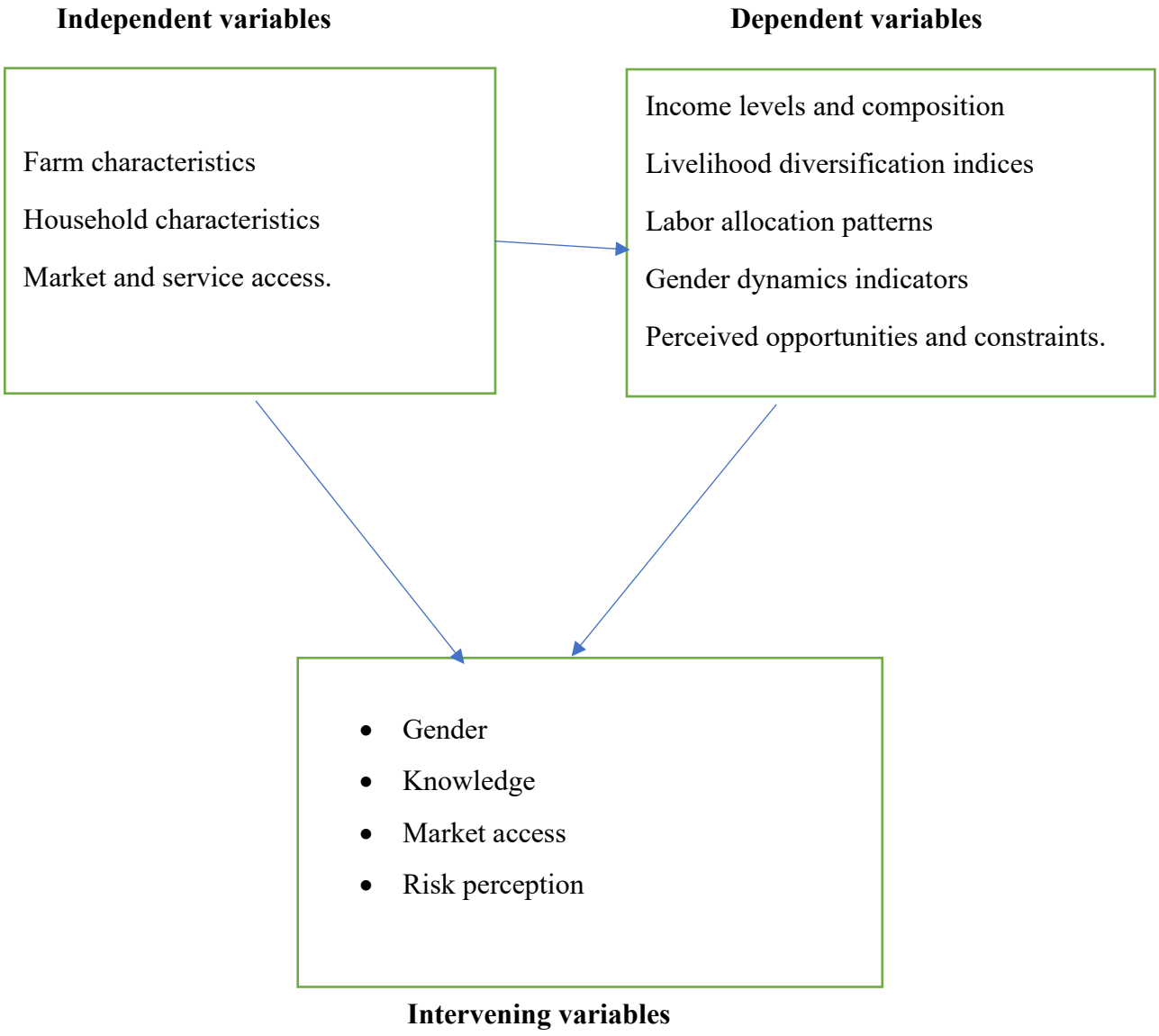
This study is justified by the urgent need to provide practical, evidence-based solutions for smallholder farmers in Lira who are currently struggling with low returns from traditional rice monoculture. While Integrated Rice-Fish Farming (IRFF) is often promoted for its high yields, there is a significant lack of local information regarding how it actually changes a household's standard of living and social dynamics.

The findings will directly benefit smallholder farmers in Lira by documented the real-world costs and profits of the system, that will help local farmers in the district decide if the high initial investment in fish trenches is truly worth the effort. For local government extension workers and NGOs, the study will provide a clear picture of the labor requirements and gender roles, allowing them to design training programs that do not unfairly increase the workload of women and youth.

For policymakers in the Lira District Local Government, the evidence on income diversification and risk management will guide policy makers in the local government administration plan targeted support, including provision of fingerling subsidies or water management infrastructure. The findings Ultimately, this study is a vital step towards ensuring that agricultural innovations in Northern Uganda.

1.7. Conceptual framework

The conceptual framework for this study illustrates the relationship between independent variables (farm characteristics, household characteristics, and market and services access), intermediate variables (gender, knowledge, market access, and risk perception), and dependent variables (income levels and composition, livelihood diversification indices, labor allocation patterns, gender dynamics indicators, and perceived opportunities and constraints). The interaction between these variables determines the socio-economic outcomes of IRFF adoption among smallholder farmers.



CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Overview of Integrated Rice-Fish Farming (IRFF)

2.1.1. Historical context

Integrated Rice-Fish Farming represents an ancient agricultural practice with origins in China dating back over 2,000 years (Li, 1988). The system has evolved into various models adapted to different agro-ecological and socio-economic contexts across Asia and, more recently, in parts of Africa (Fernando & Halwart, 2000). The fundamental principle involves cultivating rice and rearing fish simultaneously in paddy fields, creating mutually beneficial ecological relationships where fish contribute to pest control, nutrient cycling through their excreta, and soil aeration through their movements, while rice plants provide shade, shelter, and supplementary food sources for fish (Halwart & Gupta, 2004).

2.1.2. Models of IRFF systems

Hu et al. (2016) classifies IRFF into concurrent cultivation model which involves simultaneous rice and fish production within the same growing season, requiring careful water management to maintain suitable conditions for both organisms the rotational model which alternates between rice and fish production across seasons, with rice grown during one period and fish during another, and mixed systems that combine various integration approaches, sometimes incorporating multiple fish species or integrating other organisms such as ducks or snails. The choice of model depends on multiple factors including climate, water availability and control, rice varieties, fish species compatibility, market opportunities, and farmer preferences and management capacity (Ahmed & Garnett, 2011).

IRFF systems typically utilise fish species selected for compatibility with rice cultivation practices. Common species include common carp (*Cyprinus carpio), Nile tilapia (Oreochromis niloticus), grass carp (Ctenopharyngodon idella), silver carp (Hypophthalmichthys molitrix),* and various catfish species (Prein, 2002). Species selection considers factors such as tolerance to varying water depths, ability to survive in rice paddies with periodic drainage, feeding habits that complement rather than compete with rice production, and market demand and prices *(Personal Comment)* .

Stocking density, feeding practices, and management intensity vary considerably across contexts, ranging from extensive low-input systems relying primarily on natural food sources to semi-intensive systems with supplementary feeding, influencing both productivity levels and economic returns (Lightfoot et al., 1993).

2.1.3. The ecological basis of IRFF

IRFF rests on synergistic interactions between rice and fish. Fish consume insect pests, weed seeds, and aquatic weeds, reducing the need for pesticides and manual weeding (Halwart, 2006). Their movements increase water turbidity, limiting light penetration and thereby inhibiting weed growth. Fish excreta provide nutrients for rice plants, partially substituting for chemical fertilizers. *(personal comment).* In return, rice plants moderate water temperature through shading, provide habitat structure for fish, and support diverse invertebrate communities that serve as natural food sources (Frei & Becker, 2005). These ecological synergies potentially enhance system sustainability while reducing external input requirements and associated costs.

2.2. Sustainable livelihoods and agricultural diversification

2.2.1. A sustainable livelihood

A sustainable livelihood is comprised of the capabilities, assets, and activities required for a means of living (Scoones, 1998). Diversification, such as integrating aquaculture with crops, is a key risk-management and income-enhancing strategy for smallholders in vulnerable environments (Ellis, 2000). IRFF represents a form of on-farm diversification that can potentially reduce vulnerability by creating multiple outputs from a single parcel of land.

2.2.2. IRFF and livelihood outcomes: income and diversification evidence

IRFF can increase total farm productivity and profitability compared to rice monoculture.

Then cite literature (Frei & Becker, 2005). In Bangladesh, IRFF households showed higher net income and more stable annual earnings (Ahmed & Garnett, 2011).

2.2.3. Income diversification as a livelihood strategy

Agricultural diversification is widely recognized as a key strategy for risk management and income enhancement among smallholder farmers in vulnerable environments (Ellis, 2000). Diversification takes multiple forms, including crop diversification, integration of livestock and aquaculture with

crop production, and engagement in off-farm income-generating activities. IRFF represents a specific form of on-farm diversification that creates multiple outputs from a single parcel of land, thereby reducing the household's dependence on a single commodity and its associated market and climatic risks.

The theoretical rationale for diversification rests on the logic that income portfolios composed of multiple, imperfectly correlated sources exhibit lower aggregate variance than those dependent on a single source (Ellis, 2000). Rice prices fluctuate significantly due to seasonal supply patterns and weather events affect yields unpredictably, diversification through IRFF can stabilize household income by introducing a secondary commodity fish whose price and production dynamics differ from those of rice.

2.2.4. IRFF and food security

Beyond income diversification, IRFF makes significant contributions to household food security through multiple pathways. Fish provides a direct source of high-quality protein and essential micronutrients including iron, zinc, vitamin A, and vitamin B12, which are often deficient in cereal-based diets common among smallholder farming households (Bogard et al., 2015). The availability of fish within the farming system means that households can access nutritious food without depending entirely on market purchases, which is particularly important during lean seasons when rice stocks are depleted and market prices peak. Akester et al., 2020).

Research in Myanmar showed that rice-fish farming families had 26% higher dietary diversity scores and significantly higher intakes of animal-source proteins compared to non-integrating households (Akester et al., 2020). In the Ugandan context, where protein-energy malnutrition and micronutrient deficiencies remain persistent public health challenges, particularly among children and women of reproductive age, the nutritional contribution of IRFF is especially significant (UBOS, 2025). The integration of fish with rice production can directly address the hidden hunger of micronutrient deficiencies while simultaneously improving caloric availability through enhanced rice yields. (*personal comment)*

2.3. Gender and labor dynamics in IRFF Systems

2.3.1. Gender and Agriculture in Sub-Saharan Africa

Agriculture in Sub-Saharan Africa is characterized by significant gender disparities in labor allocation, resource access, and income control. Women contribute an estimated 40–60% of agricultural labor across the region, yet they consistently have less access to productive resources including land, credit, improved technologies, and extension services (Doss, 2018; Palacios-Lopez et al., 2017). According to The Food and Agriculture Organization (FAO, 2011) if women had the same access to productive resources as men, farm yields could increase by 20–30%, and total agricultural output in developing countries could rise by 2.5–4%. These disparities are rooted in complex socio-cultural norms that define gender roles, responsibilities, and entitlements within households and communities. (personal comment)

In rice farming specifically, the gender division of labor varies significantly across African contexts. Kinkingninhoun-Medagbe et al. (2020 “Kinkingninhoun-Medagbe et al. (2020) observes that women spend less time across rice cultivation activation, except for rice parboiling, than men and hence earn less thus increasing labour requirements for them does not result earning higher income without addressing underlying structural inequalities in resources access and market participation

2.3.2. Gender implications of IRFF adoption

The introduction of IRFF systems can significantly reshape gender labor dynamics within farming households. Flaherty et al. (1999) documented that in Thailand rice-fish systems, women bore the primary responsibility for fish feeding, pond maintenance, and post-harvest fish processing tasks added to their existing agricultural and reproductive labor obligations. In Bangladesh, women's involvement in rice-fish farming often involved labor-intensive activities such as weeding, feeding fish, and harvesting, while men-maintained control over major decisions and income from fish sales (Ahmed et al., 2010).

A critical finding across multiple studies is the gendered pattern of income control in IRFF systems. Scott et al. (2019)

2.3.3. Women's workload and labor burden in IRFF systems

The concept of women's double burden simultaneous responsibility for productive agricultural work and reproductive household labor is central to understanding the gender implications of IRFF. SOFA Team and Doss (2011) emphasized that women face a work burden that men do not, including household activities, caring for children, and elderly household member.

In Ghana's integrated irrigation-aquaculture systems, women reported spending an additional 1–2 hours per day on fish-related tasks without corresponding reductions in other responsibilities (Prein et al., 1999). In Mali, the introduction of rice-fish systems increased women's labour input by approximately 25% without proportionate increases in women's income, as men controlled the sale of fish at markets (Koide et al., 2015).

2.3.4. Youth labor in IRFF systems

In many smallholder farming communities in sub-Saharan Africa, youth constitute a significant portion of the agricultural labor force, yet their contributions are often invisible in labor statistics and policy discussions (FAO, 2019). In the context of IRFF, youth may be engaged in tasks such as digging fish trenches, guarding against predators, and assisting with fish harvesting physically demanding activities that may or may not be compensated. (Doss, 2018).

The FAO-China-Uganda SSC project's third phase explicitly targets increased youth involvement in aquaculture by (FAO, 2025).

CHAPTER THREE

3.0. METHODOLOGY

3.1. Location of study area

Lira District is located in the Northern region of Uganda between latitudes 2°15' N and 2°45' N and longitudes 32°50' E and 33°20' E (Figure 3.1.). The district covers approximately 1,796 square kilometers and has a population of about 245,132 people according to the 2024 National Population and Housing Census (NPHC) projections (UBOS, 2025). The district headquarters is located in Lira Town, approximately 350 kilometers north of Kampala, Uganda's capital city.

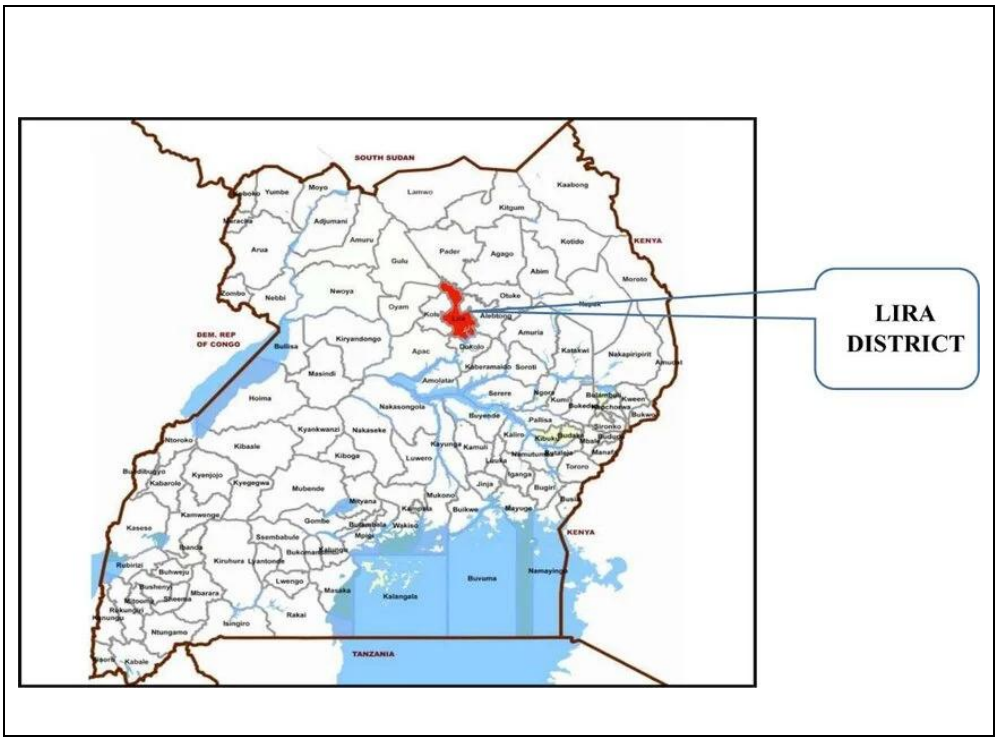


Figure 3.1. Location of Lira District on map of Uganda.

3.1.2. Economic activities

Agriculture is the primary economic activity, employing over 85% of the district's population (Lira District Local Government, 2020). The main crops include rice, cassava, sweet potatoes, beans, groundnuts, sesame, and maize. Rice cultivation has expanded significantly in recent years, with Lira emerging as one of the major rice-producing districts in Uganda.

3.1.3. Study sites

The study focused on sub-counties with significant rice production activities, including Amac, Barr, Agali, Itek, and Awiodyek sub-counties, which have extensive wetland areas utilised for rice cultivation. These areas had been targeted by various agricultural development programs and demonstrate varying levels of awareness and adoption of integrated farming practices.

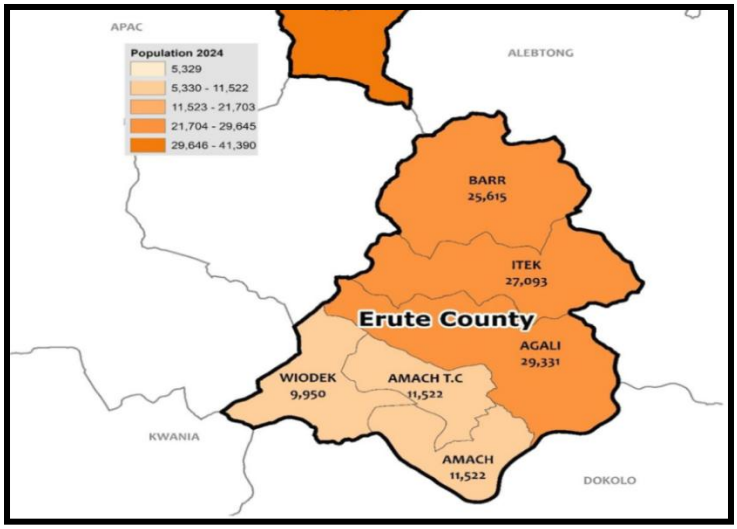


Figure 3.2. Location of the study area

3.2. Scope and content

The study focused on smallholder farmers (cultivating 2 hectares or less) engaged in or having the potential for rice production and fish farming. It covered socio-economic, agronomic, and perceptual variables related to IRFF. The geographical scope was purposively selected sub-counties in Lira District known for rice cultivation and fish farming.

The study employed a cross-sectional research design, collecting data during a single period covering both the rice-growing season and fish production cycle to capture comprehensive information on farming activities, income generation, and household outcomes. Data collection was done for the period between July and August 2026, coinciding with the main rice and fish production season in the district.

3.3. Research design

The research employed a mixed-methods research design, combining different approaches to provide comprehensive insights into the socio-economic impacts of IRFF systems. This

convergent parallel design allowed for quantitative data to measure and compare impacts, while qualitative data provided depth and context to the numerical findings (Creswell & Plano Clark, 2017).

3.4. Study population and sampling

3.4.1. Target population

The target population comprised smallholder farmers engaged in rice and fish production in the selected sub-counties of Lira District. For this research, smallholder farmers were defined as those cultivating less than 2 hectares of rice land.

3.4.2. Sample size determination

The sample size for the quantitative survey was calculated using Yamane's (1967) formula for finite populations.

$$n = racN1 + N(e \quad)$$

Where:

- n = sample size
- N = total population of rice farmers in the study area (estimated at 100 based on district agricultural office records).
- e = margin of error (0.05)

Applying this formula: n = 100 / (1 + 100(0.05²)) = 80 farmers however 60 respondents were considered for data analysis after data cleaning.

3.5. Data collection and analysis

3.5.1. Quantitative methods

A structured questionnaire (Appendix I) was administered to household heads (male and female separately where possible). It captured data on: demographics, farm characteristics, adoption history of IRFF and non-IRFF, income sources, and food security.

3.5.2. Qualitative methods

- Key Informant Interviews (KIIs) (Appendix II): With agricultural officers, NGO staff, and local leaders (approximately 8–10 persons).
- Focus Group Discussions (FGDs): Separate FGDs for male and female farmers in both adopter and non-adopter categories (4–6 FGDs total) to explore perceptions, risks, and gender roles.
- Field Observations: Direct observation of IRFF plots to assess management practices and physical challenges among others

3.5.3. Data quality control

The questionnaire was pre-tested and translated into Langi (local language). Qualitative guides were developed with open-ended, non-leading questions. Triangulation of methods (survey, FGD, KII) enhanced validity.

3.5.4. Data analysis

Quantitative: Data was entered into SPSS, and descriptive statistics like tables, graphs and pie charts

Qualitative: Thematic analysis was conducted on transcribed FGD and KII data. Codes were generated and grouped into themes related to benefits, constraints, and gender dynamics.

3.6. Limitation Bad weather especially the hot sun was a huge discomfort to data collectors that caused delay. This was later, however later combatted by hiring motorcycles for easy commuting.

3.7. Ethical considerations-

- Approval was sought and permission obtained from Lira District Local Government and local leaders in the study areas.
- Informed consent was obtained from all participants after clearly explaining the research purpose, procedures, potential risks and benefits, voluntary nature of participation, and the right to withdraw at any time without consequences.

- Confidentiality and anonymity were maintained throughout the data collection process. Personal identifiers were removed from data records, and participants were assigned codes.
- The study poses minimal risks to participants, primarily the time investment required for interviews and surveys. To minimize this burden, interviews were scheduled at participants' convenience and kept to reasonable durations of 25-35 minutes.

CHAPTER FOUR

4.0. ANALYSIS AND PRESENTATION OF RESULTS

4.1. Demographic information of the respondents

4.1.1. Gender of the respondents.

73.3% of the respondents were male compared to 26.7% of female, (figure 4.1)

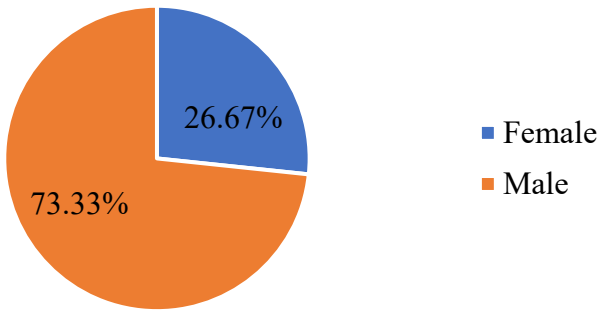


Figure 4.1. Gender of the respondents

4.1.2. Age bracket of the respondents.

40% of the respondents lay within 31-40 years and 41-50 years range compared to 11.7% and 8.3% who lay above 50 years and 20-30 years range respectively, (Figure 4.2)

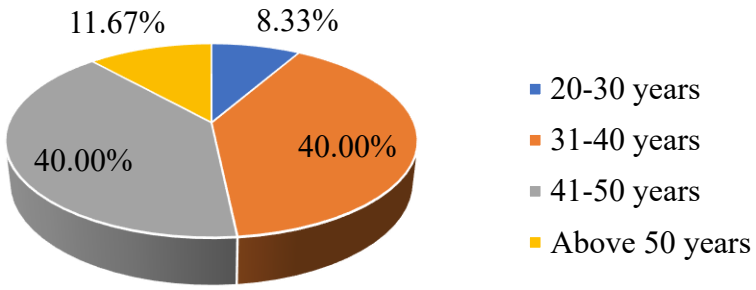


Figure 4.2. Age bracket of the respondents

4.1.3. Level of education of the respondent

61.7% of the respondents had attained primary level compared to 15%, 11.7%, 3.3% and 8.3% who attained A-Level, Diploma, Graduate / university level O-Level respectively, (Figure 4.3).

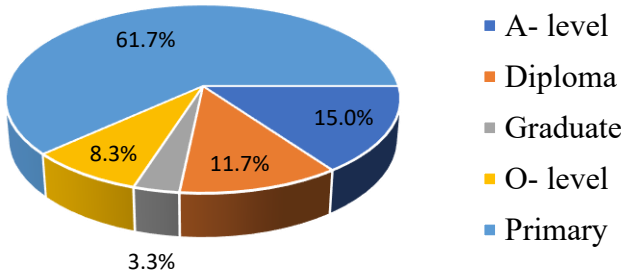


Figure 4.3. Level of education of the respondents

4.1.4. Marital status of the respondents

70% of the respondents were married compared to 13.3%, 8.3%, 6.7% and 1.7% who were single, widowed, divorced and separated respectively, (Figure 4.4).

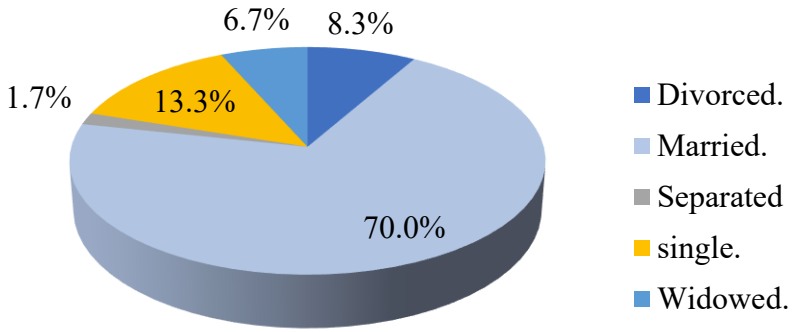


Figure 4.4. Marital status of the respondents

4.1.5. Main occupation of the respondents

60% of the respondents were carrying out farming only as the main occupation compared to 26.7% who are in farming plus business and 6.7% who were in farming plus casual labour and farming plus formal employment as the main occupation, (Figure 4.5).

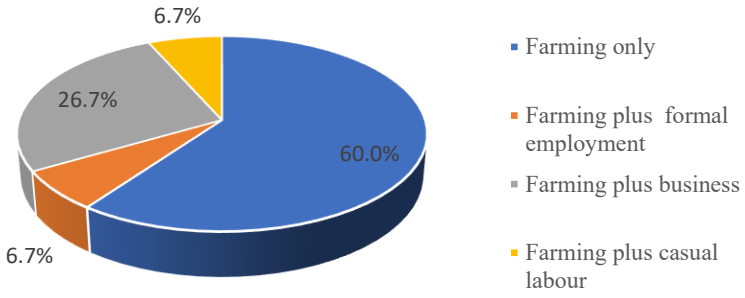


Figure 4.5. Main occupation of the respondents

4.1.5. Household Size

55% and 25% of the respondents had a household size of 4-6 people and 1-3 people respectively compared to 13.3% and 6.7% of the respondents that had 7-9 and 10 and above respondents in their households. (Figure 4.6)

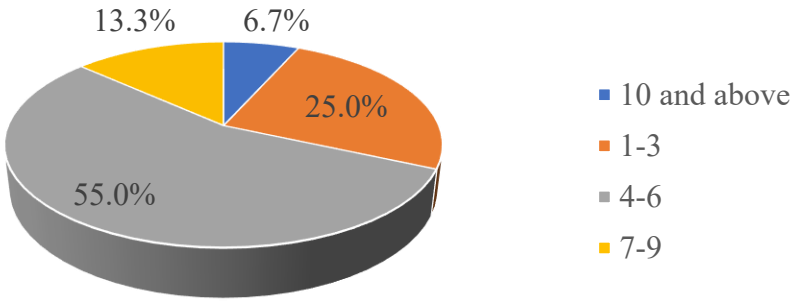


Figure 4.6. Household size of the respondents

4.1.6. Religion

93.3% of the respondents were Christians compared to 6.7% of the respondents who were Muslims, (Figure 4.7)

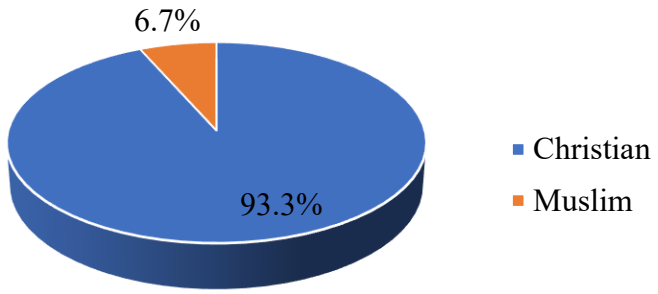


Figure 4.7. Religion of the respondents

4.2. Farming systems identification (IRFF versus conventional monoculture).

4.2.1. Type of rice farming practiced by the respondents.

78.3% of the respondents carried integrated rice-fish farming (IRFF) compared to 21.7% of the respondents carried out conventional rice monoculture (CRM). (Figure 4.8).

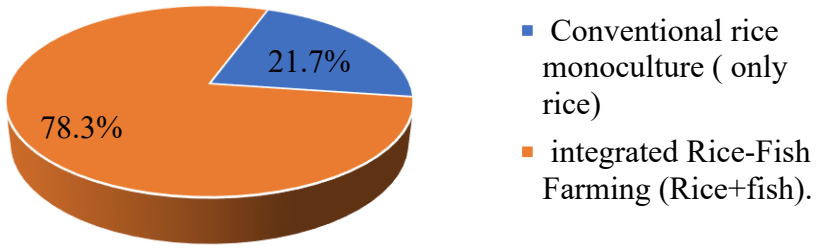


Figure 4.8. Comparison between the proportion of farmers engaged in IRFF and conventional Rice Monoculture.

4.2.2. Period spent in conventional rice cultivation/monoculture and IRFF.

51.1% and 46.15% of the respondents had carried out Integrated Rice-Fish Farming and conventional rice monoculture for 1-2 years respectively, 53.85% and 38.30% of the respondents who had carried out Integrated Rice-Fish Farming and conventional rice monoculture for 3-5 years and 10.6% carried out Integrated rice fish farming for less than a year, (Figure 4.9).

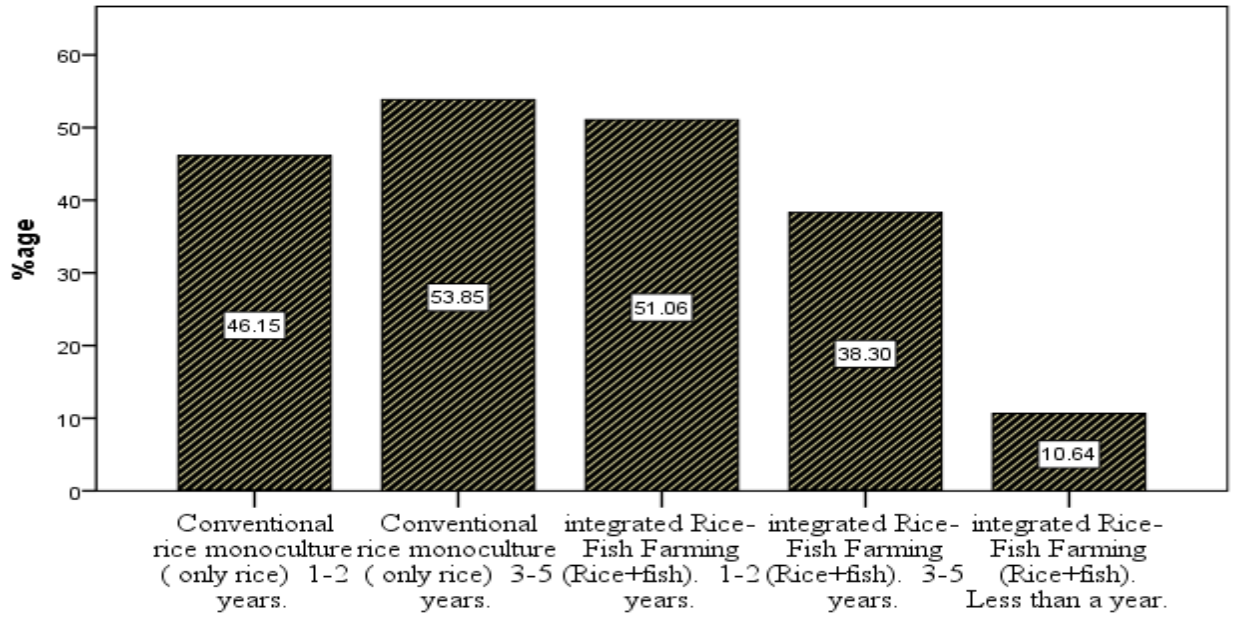


Figure 4.9. Comparison of proportion of respondents in conventional rice monoculture and that in IRFF by duration.

4.2.3. Size of land under rice farming among conventional rice cultivators and IRFF

41.7% and 43.3% of the respondents were carrying out IRFF on land of 1-2 acres and 0.5-1 acre respectively compared to 8.3% and 8.3% o who carried out IRFF on land of above 2 acres and less than 0.5 acres respectively. (Figure 4.10).

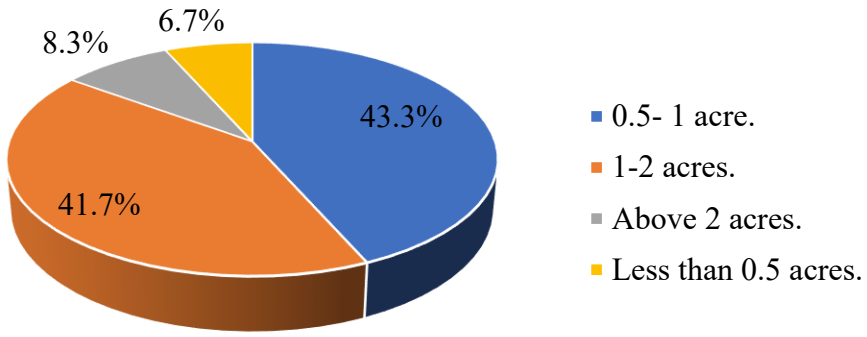


Figure 10. Comparison between proportion of respondents with land under conventional rice farming and IRFF.

4.2.4. Species integrated with rice in IRFF systems

40.5% of the respondents integrated Nile Tilapia their IRFF systems compared to 37.8% and 21.6% who integrated catfish and mixed species in their IRFF systems respectively. (Figure 4.11).

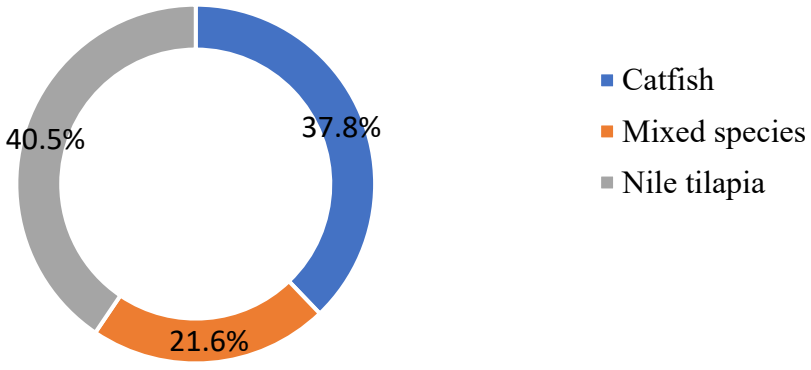


Figure 4.11. Species integrated with rice under IRFF systems.

4.2.5. Species integrated with rice and period spent in IRFF

51.7% and 657% of the respondents have integrated rice and Nile tilapia for 1-2 years, 3-5 years and less than a year respectively, 41.3%, 45.4% and 42.8% had integrated rice and cat fish for 1-2 years, 3-5 years and less than a year respectively compared to 6.8% and 22.7% had integrated rice and mixed species respectively, (Figure 4.12).

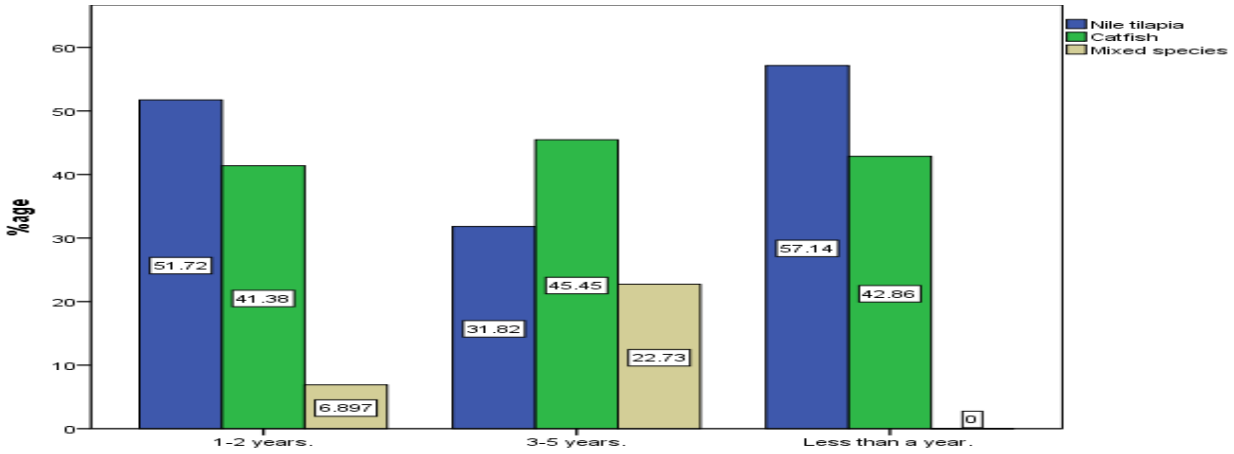


Figure 4.12 comparison of species integrated with rice and period spent in IRFF

4.2.6. Livestock kept IRFF. like pigs, goats, cattle.

64.6% of the respondents reported to keep livestock like pigs, goats and cattle compared to 35.4% who didn't keep livestock, (Figure 4.13)

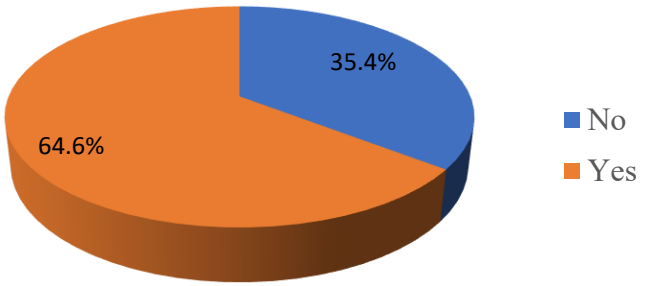


Figure 4.13 Keeping of livestock by the respondents.

4.2.7. Year of first integration of livestock with rice-fish and poultry.

34.5% and 20.7% of the respondents started to integrate fish and pigs 2024 and 2026 respectively compared to 17.2%, 20.7%, 3.4% and 3.4% who started in 2025, 2023,2022 and 2020 respectively. (Figure 4.14).

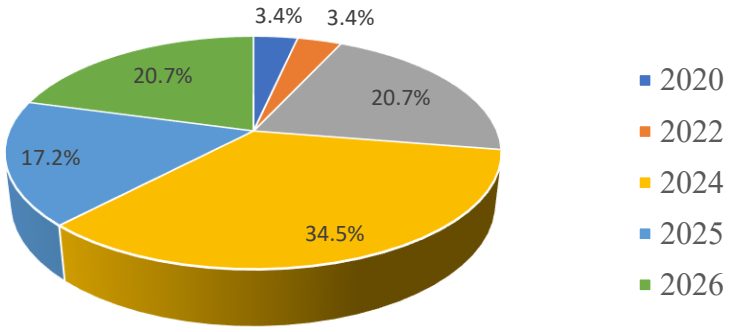


Figure 4.14. Year to integrate livestock with rice- fish and poultry.

4.2.7. Comparison of livestock and period spent in IRFF and Conventional Rice monoculture, (Figure 4.15)

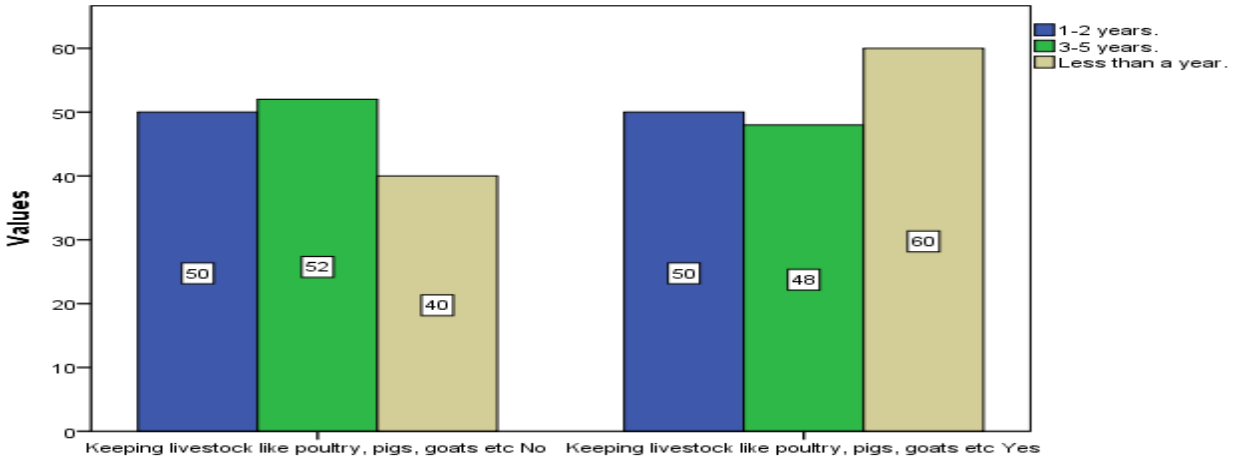


Figure 4.15. Comparison of livestock and period spent in IRFF and Conventional Rice monoculture.

4.2.8. Year of first integration of livestock with rice-fish and (pigs).

29.4% and 23.5% of the respondents started to integrate fish and pigs 2026 and 2025 respectively compared to 17.6%, 11.8%, 11.8% and 5.9% of the respondent who started in 2023, 2022,2024 and 2020 respectively. (Figure.4.16).

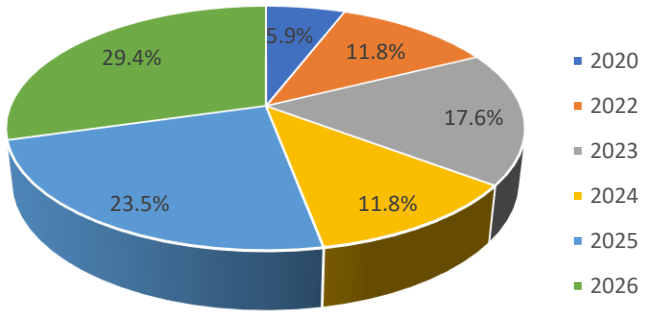


Figure 4.16. Year to first integrate livestock with rice-fish and pigs

4.2.8. Beliefs, taboos, religion totems affect or social factors that keeping these animals.

Respondents who said that there were no beliefs, taboos, totems, or social factors that affect keeping these animals constituted 62.9% compared to 37.1% who said there were beliefs, taboos, totems or social factors that affect the keeping of these animals, (Figure 4.17).

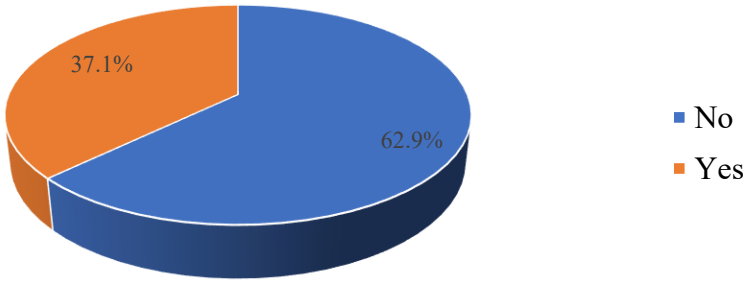


Figure 4. 17. Beliefs, taboos, religion totems affect or social factors that keeping these animals.

4.3. House hold income from farming systems

4.3.1. Rice sales only among conventional rice farmers and IRFF farmers.

45% and 46.7% of the respondents reported to earn 1-2M and 500000-1000000UGX respectively compared to 8.3% earned as their rice sales only respectively, (Figure 4.18)

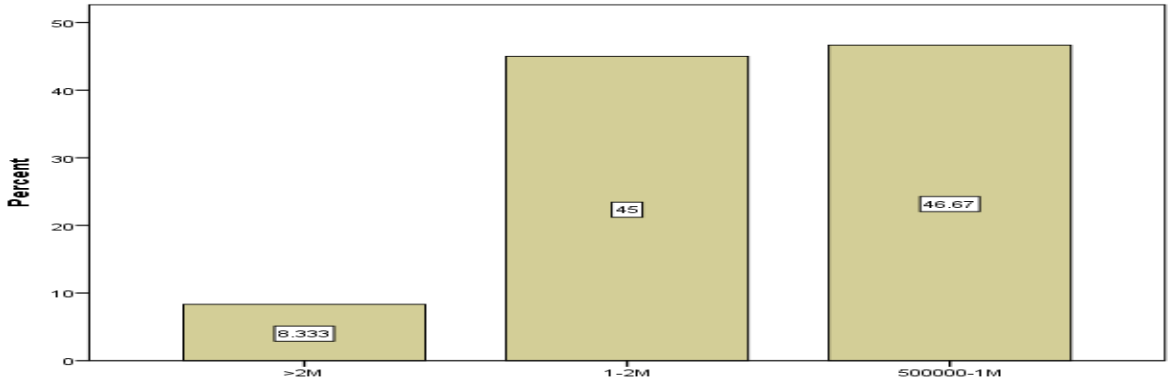


Figure 4.18. Comparison rice sales only among conventional rice farmers and IRFF farmers.

4.3.2. Fish sales among IRFF farmers

48.3% and 41.7% of the respondents reported to earn 1-2M and 500000-1000000 respectively compared 6.7% and 3.3% of who earned <500000 and >2M respectively as their fish sales only respectively, (Figure 4.19).

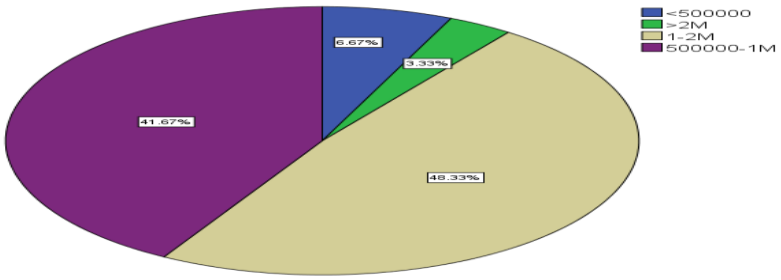
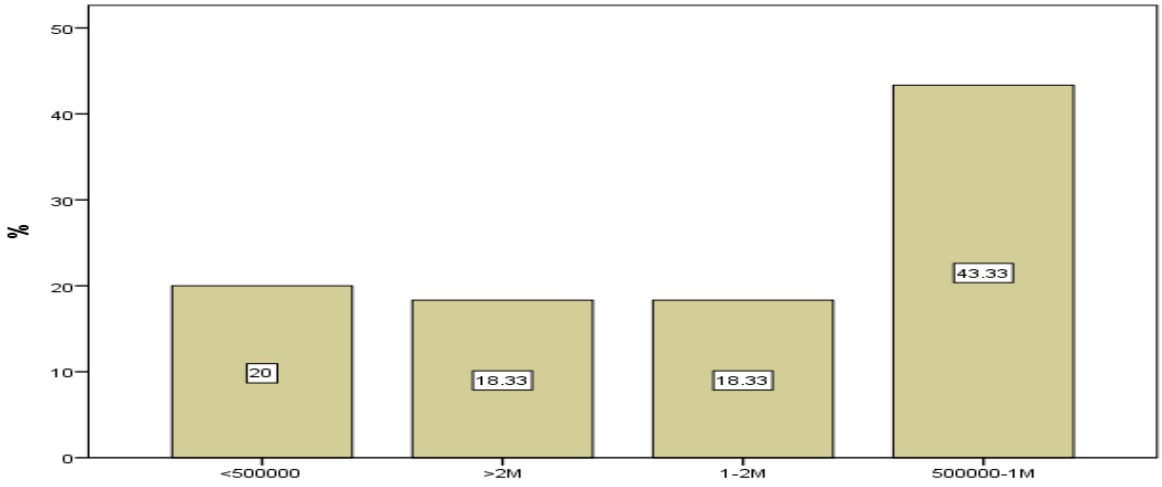


Figure 4.19. Approximate income from fish sales only among IRFF farmers

4.3.1.3. Livestock/poultry among 1RFF farmers and conventional rice monoculture

43.3%, 20% of the respondents reported to earn 500000-1000000 and <500000 compared to and



18.3%, 18.3% who earned 1-2 M and >2M respectively as their poultry/livestock sales among conventional rice farmers and IRFF farmers respectively. (Figure 4.20)

100% of the respondents reported that IRFF has greatly increased their household income (Figure 4.21)

Figure 4.20 Comparison of approximate income from livestock/poultry among Conventional Rice farmers and IRFF farmers.

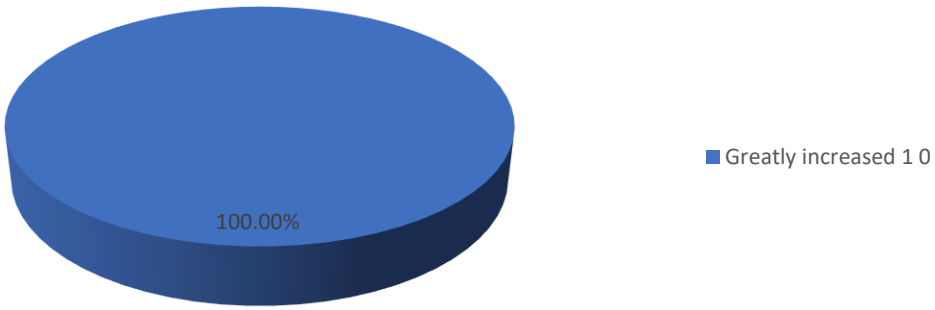


Figure 4.21 Effect of IRFF on household income of the respondent.

4.3.3 How IRFF affected household income

The commonly reported improvement was eating more diversified food, including fish at home (22.5%), followed by ability to save money (19.3%), compared to ability to pay school fees regularly (17.1%), better access to health care (16.6%), ability to buy household assets such as bicycles, radios, and smartphones (14.4%), and improved housing including iron roofs and cemented floors (8.5%) (Figure 4.22)

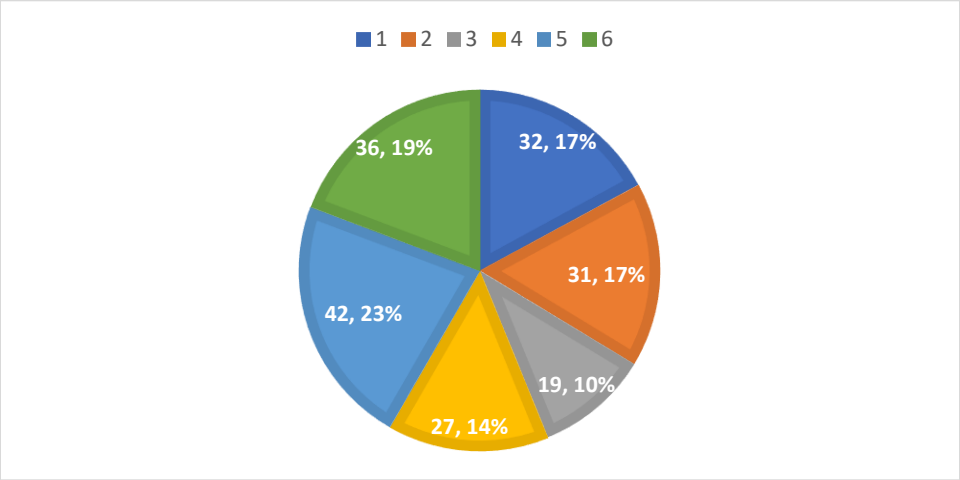


Figure 4.22. Effect of IRFF on household income

4.3.4. Consideration switching to IRFF if given training and support

80% of the respondents reported that they would consider switching to IRFF given training and support compared to 20% who would not consider switching to IRFF if given straining and support (Figure 4.22).

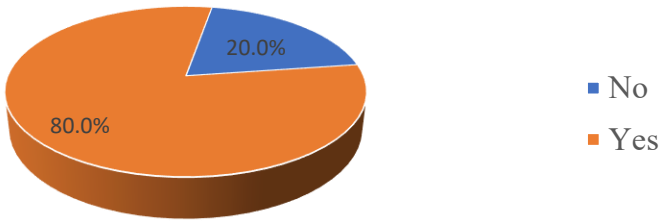


Figure 4.22 switching to IRFF if given training or support

4.3.4. Failure to consider switching to IRFF

22.2%, 22.2%, 22.2% and 14.8% of the respondents reported they would not consider to switch to IRFF because of lack of knowledge, no access to fish seed, fear of increased workload and fear of losing rice yield respectively compared to 14.8% and 12.5% reported not to consider switching to IRFF because of lack of capital, and land tenure insecurity respectively. (Figure 4.23).

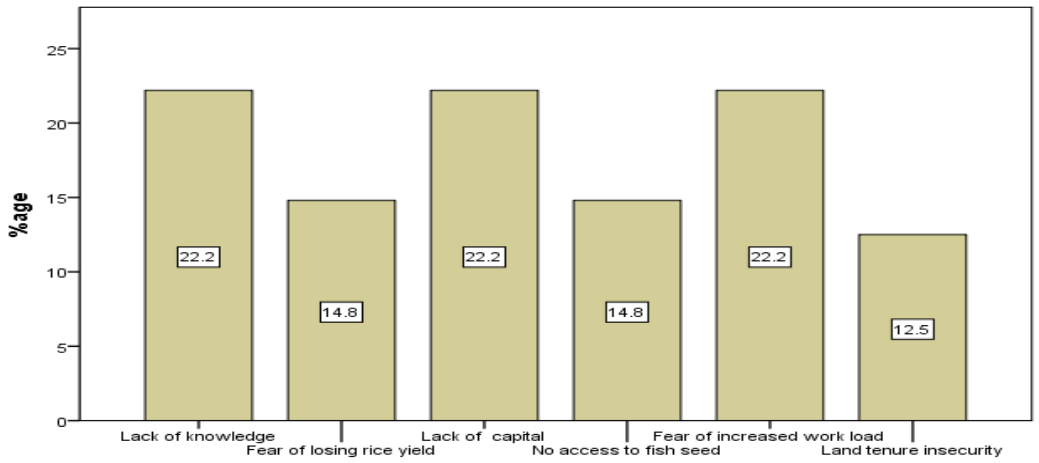


Figure 4.23 Why the respondent would not consider switching to IRFF.

4.4 LABOUR REQUIREMENTS AND GENDER DYNAMICS AMONG BOTH IRFF FARMERS AND CONVENTIONAL RICE FARMERS.

4.4.1 Number of people in household participating in farming activities among conventional rice farmers and IRFF farmers

Respondents who participated in farming activities accounted for 45%, compared to 36.7% and 18.3 % with 2 and 3 members respectively in their households respectively. (Figure 4.24).

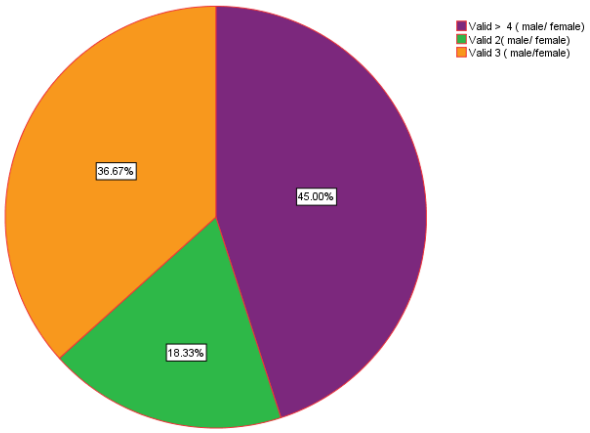


Figure 4.24. People in the household that participate in farming

4.4.2.1 ACTIVITIES

4.4.2.1. Land preparation among IRFF and conventional farmers.

Among respondents, land preparation was reported to be carried out by mostly men who constituted 53.3% compared to 41.7% and by both equally and children respectively, (Figure 4.2.5)

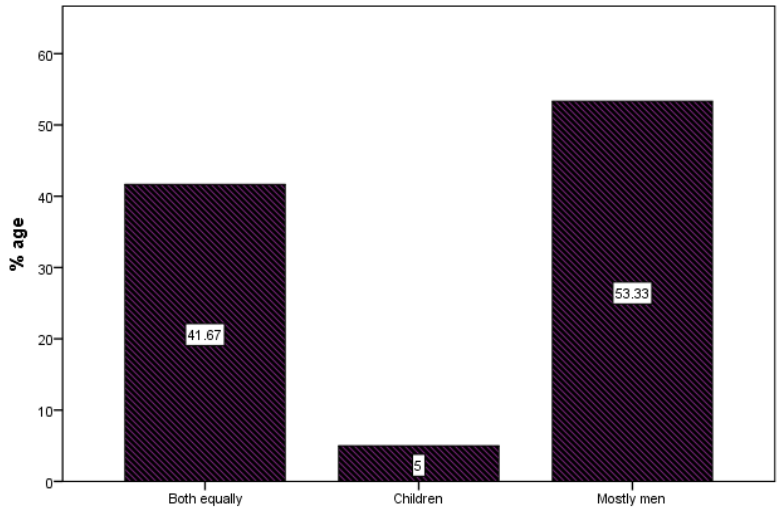


Figure 4.25 household participation in land preparation

4.4.5.2. Planting rice

Planting rice was reported to be carried out by both equally (men and women) constituting 78.3% compared to 16.7% and 5% by mostly men and children respectively. (Figure 4.26)

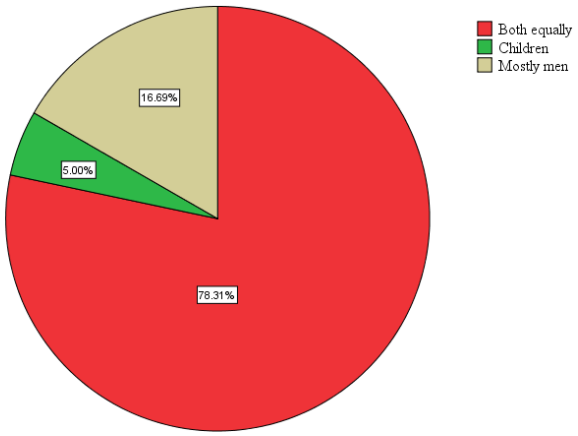
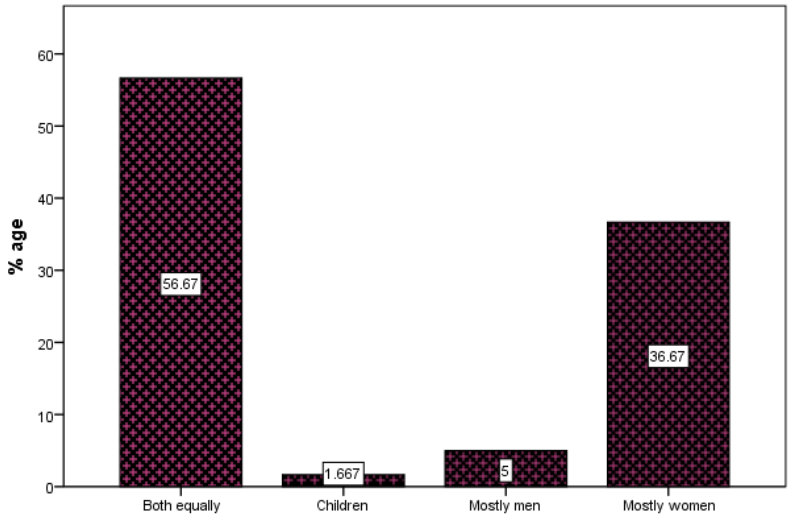


Figure 4.26. Household participation in planting rice

4.4.2.1 Weeding

Weeding was reported to be carried out by both equally (men and women) (56.7%), compared to 36.7%, 5% and 1.7% by mostly women, mostly men and children respectively.



4.4.2.1.4. Monitoring fish

Fish monitoring was reported to be done by mostly men constituting 65% compared to 36.7% and 3.3% by both equally (men and women) and children respectively, (Figure 4.27).

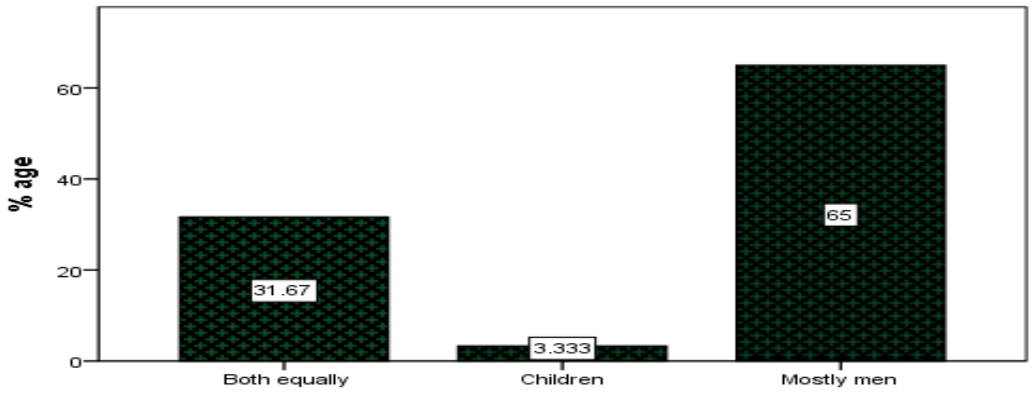


Figure 4.27 Household participation in fish monitoring

4.4.2.1. Monitoring fish ponds

Monitoring fish ponds was reported to be done by mostly men (61.7%) compared to (38.3%) by both equally respectively. (Figure 4.28)

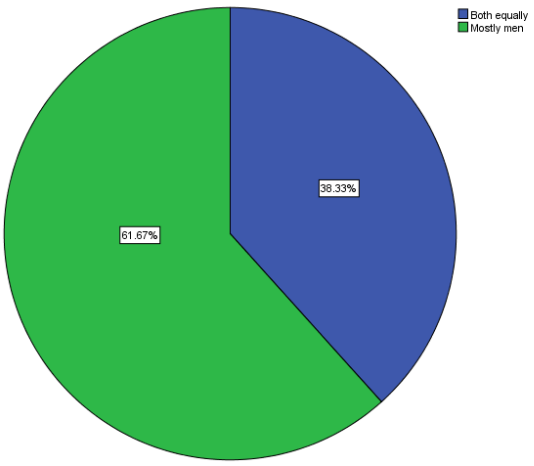


Figure 4.28 household participation in monitoring fish ponds

4.4.2.1. Harvesting rice.

Rice harvesting was reported to be carried out by both equally (55%) compared to 28.3% and 16.7% by mostly women and mostly men respectively. (Figure 4.29).

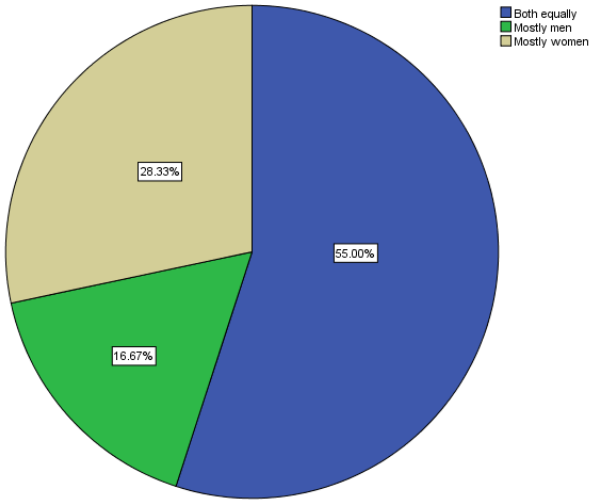


Figure 4.29 household participation in harvesting rice

4.4.2.1. Harvesting fish.

Fish harvesting was reported to be done by mostly men 76.7% compared to 21.7% by both equally. (Figure 4.30).

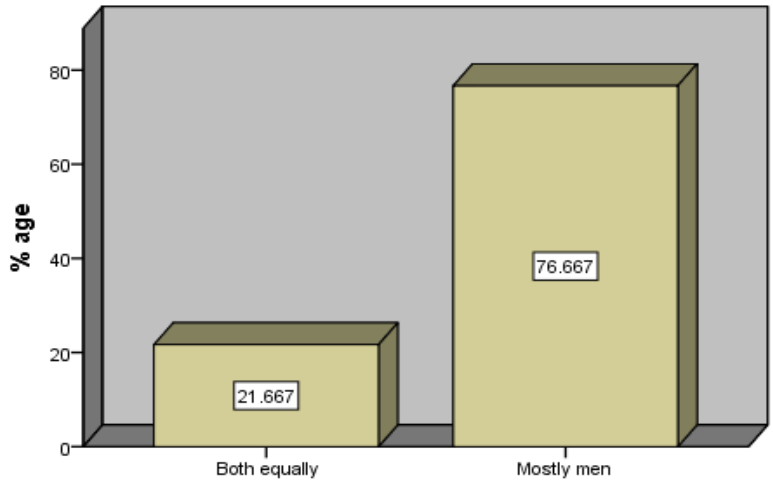


Figure 4.30 household participation harvesting fish

4.4.2.1. Selling rice in the market among IRFF and conventional rice monoculture farmers

Rice selling in the market was carried out by mostly men (66.7%) compared to 28.3% and 5% by both equally and mostly women respectively. (Figure 4.31)

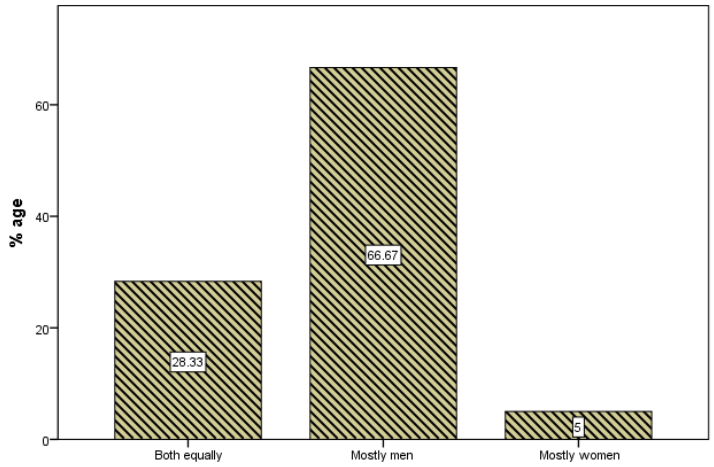


Figure 4.31 Household participation in selling rice in the market

4.4.2.1. Management of income among IRFF and conventional rice monoculture farmers

Management of income was reported to be done by mostly men (70%) compared 30% by both equally. (Figure 4.32)

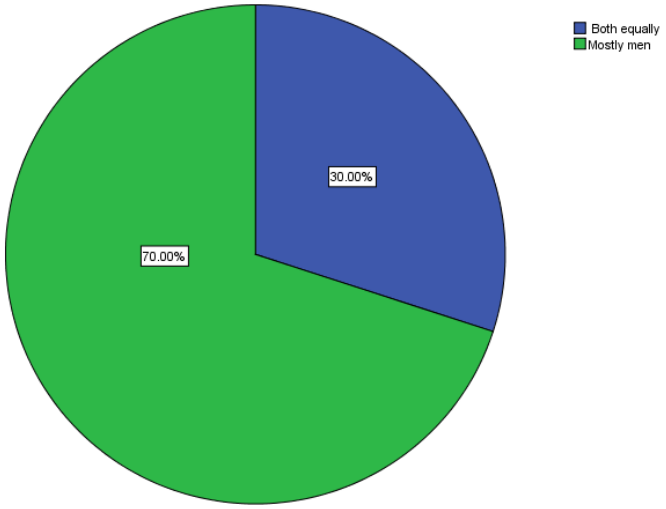


Figure 4.32 Management of income

4.4.3 IRFF and Conventional rice monoculture impact on women workload

62.7% of the respondents reported that IRFF and conventional rice monoculture has increased women workload compared to 17.6% and 19.6% who said that IRFF has decreased women workload and no change. (Figure 4.33)

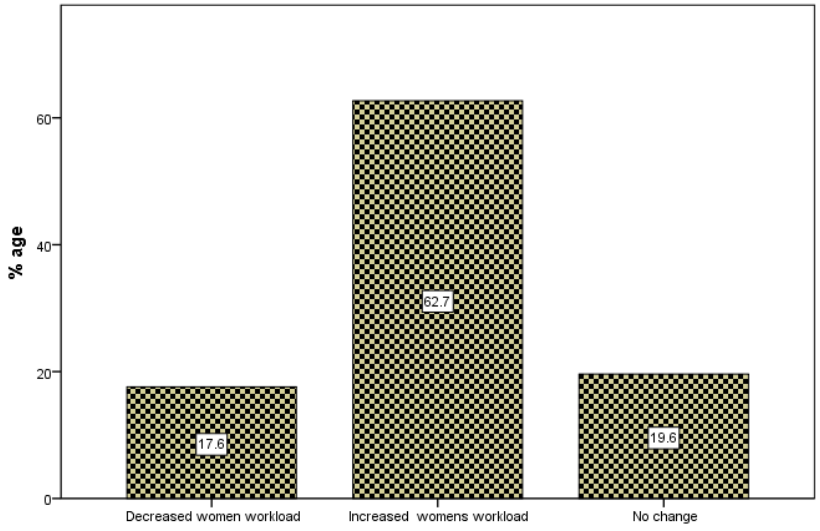


Figure 4.33 IRFF and conventional rice monoculture increasing women workload

4.4.4. Women in households having a say in decisions related to fish farming

52.9% compared to 41.2%, 3.9% and 2% of the respondents who said women have a say in decisions regarding fish farming equally with men, only men decide and not applicable to IRFF respectively. (Figure 4.34)

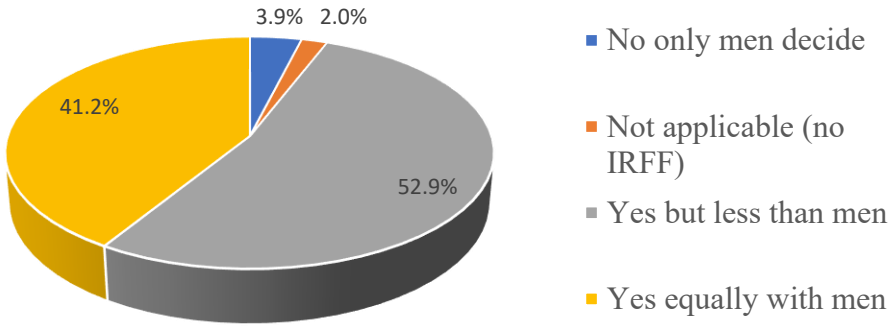


Figure 4.34. Comparison of women to men in making decisions related to fish farming

4.4.5 Hire of external labor in the system

82.8% of the respondents said that they hired labour for their farm activities compared to 17.2% of the respondents who did not hire labour. (Figure 4.35)

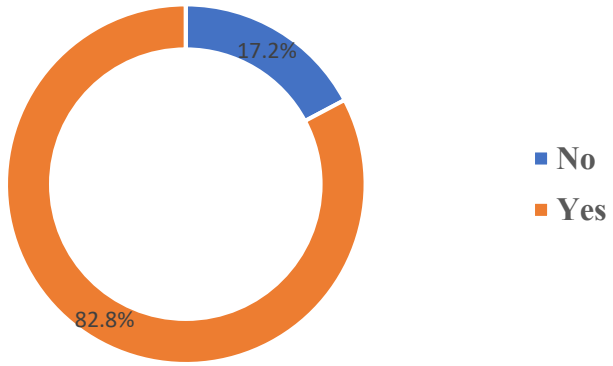


Figure 4.35. Hiring of labour by respondents in farming activities in IRFF and conventional rice monoculture.

4.4.5.1. Activities

23.15%, 20.74% of the respondents hired labour in land preparation and planting respectively compared to 20.74%, 19.5% and 15.8% in harvesting, construction/maintenance and weeding respectively. (Figure 4.36).

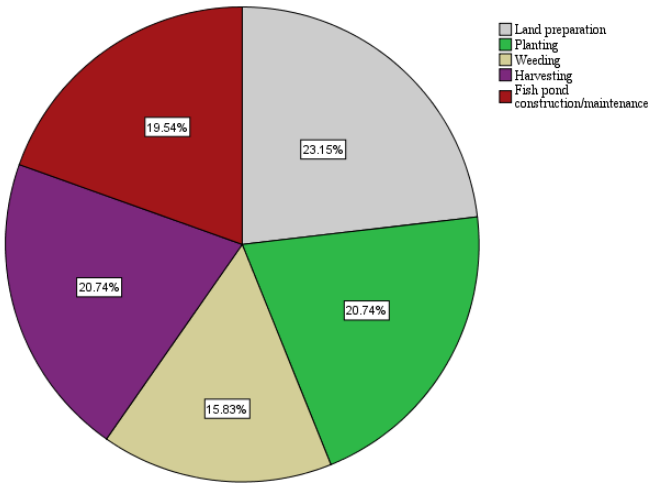


Figure 4.36. Activities performed by the hired labor

4.4.6. Nature of payment

77.1% of the respondents pay per task compared to 22.9% of the respondents who pay per day for the hired labour in their farming activities. (Figure 4.37).

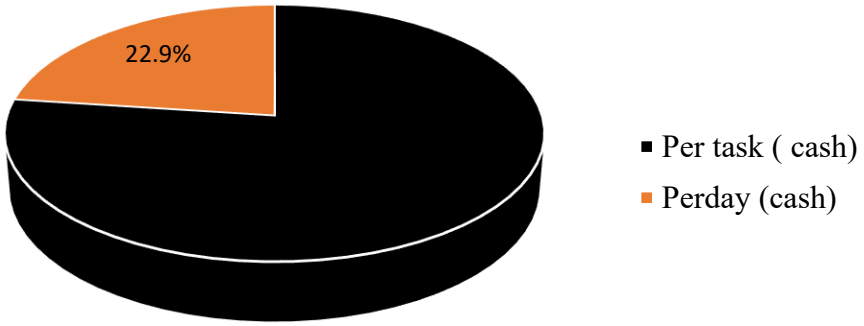


Figure 4.37. Nature of payment for the hired labor

4.5. PERCEIVED SOCIAL RISKS, CONSTRAINTS AND BENEFITS.

4.5.1. Benefits experienced from IRFF and conventional rice farming

4.5.1.1. Increased food security

100.0% of the respondents reported experiencing increased food security as a benefit of IRFF conventional rice monoculture respectively. (Figure 4.38).

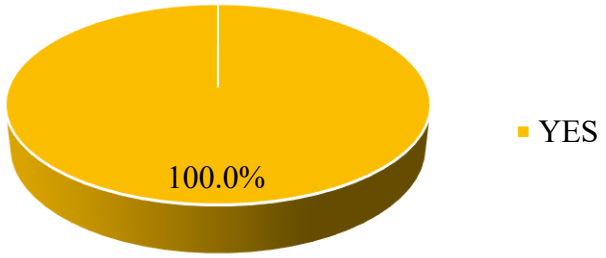
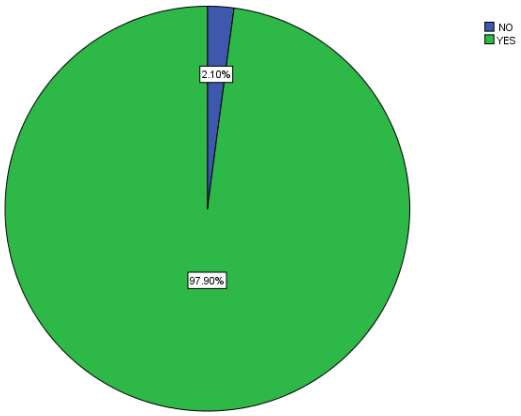


Figure 4.38 Increased food security as a benefit of IRFF and Conventional Rice farming

4.5.1.3. Better nutrition for children among IRFF and conventional rice monoculture.

97.9% of the respondents reported that IRFF and conventional rice monoculture provided better nutrition for children compared to 2.1% who noted no change.



4.5.1.4. Reduced pest problem in rice

97.9% of the respondents observed a reduced pest problem in their rice fields compared to 2.1% who did not see a reduction in their IRFF and conventional rice monoculture respectively. (Figure 4.39).

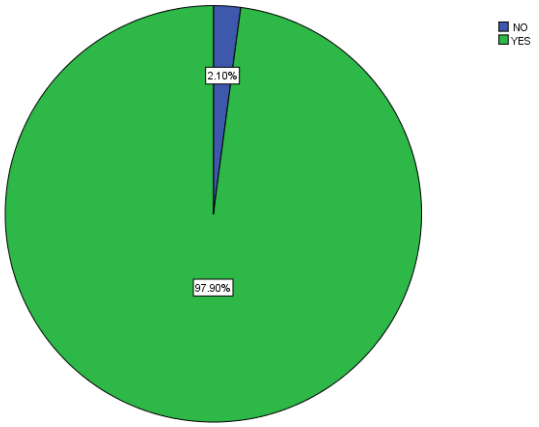


Figure 4.39. Reduce pest problem in rice

4.5.1.5. Reduced need for chemical fertilizers

95.8% of the respondents reported a reduced need for chemical fertilizers compared to 4.2% who did not experience a reduction in their systems. (Figure 4.40)

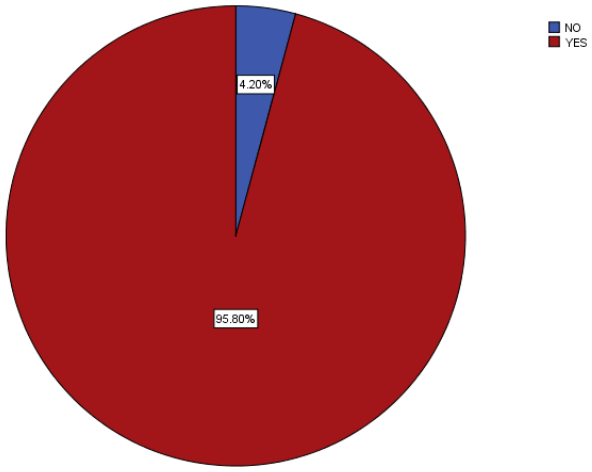


Figure 4.40. Reduced need for chemical fertilizers

4.5.2. Challenges/constraints faced with IRFF compared to non IRFF

4.5.2.1. High cost of fish fingerlings

76.86% of the respondents reported the high cost of fish fingerlings as a limiting factor compared to 23.14% who did not face this issue. (Figure 4.41)

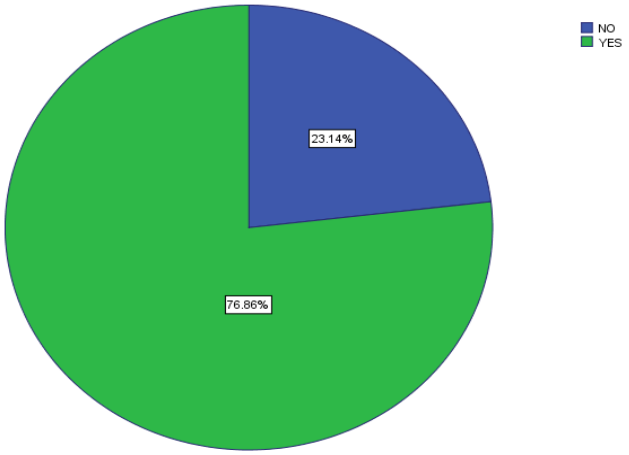


Figure 4.41. High cost of fish fingerlings as challenge associated with IRFF

4.5.2.2. Lack of knowledge in IRFF and conventional rice monoculture

85.2% of the respondents identified a lack of knowledge as a major constraint compared to 14.8% who did not view it as a constraint in their IRFF and conventional rice monoculture. (Figure 4.42)

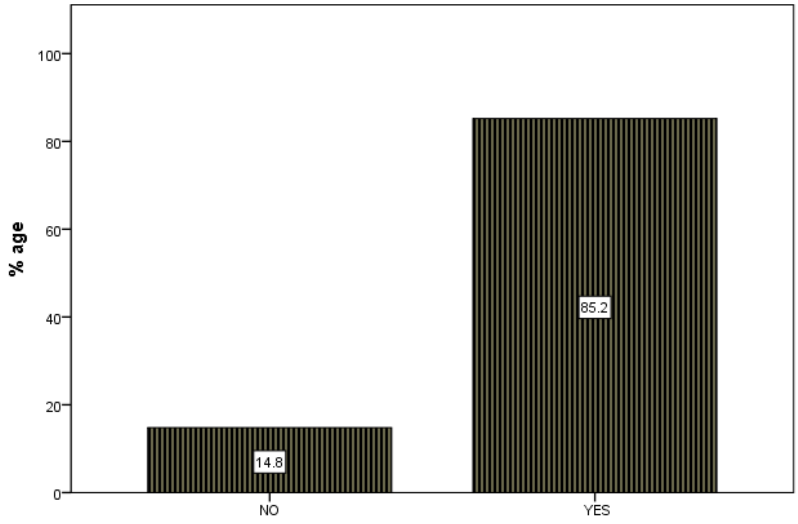
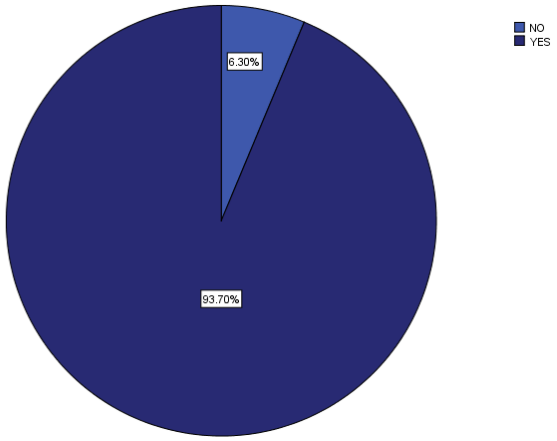


Figure 4.42. Lack of knowledge

Predators (birds, snakes etc.) eating fish in their IRFF systems.

93.7% of the respondents encountered issues with predators (such as birds and snakes) eating their fish compared to 6.3% who did not face this challenge



4.5.2.3. Conflict with neighbors over water usage in their IRFF systems.

66.00% of the respondents faced conflicts with neighbors over water usage compared to 34.00% who reported no conflicts. (Figure 4.43)

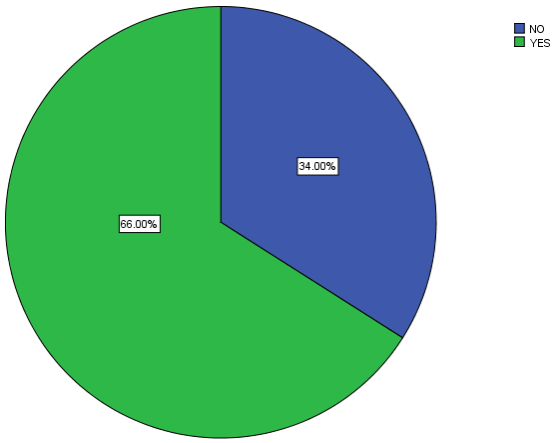


Figure 4.43. Conflict with neighbors over water usage

Fear of fish damaging rice plants in the IRFF systems.

49.0% of the respondents reported a fear of fish damaging their rice crops compared to 51.0% who did not share this concern. (Figure 4.44)

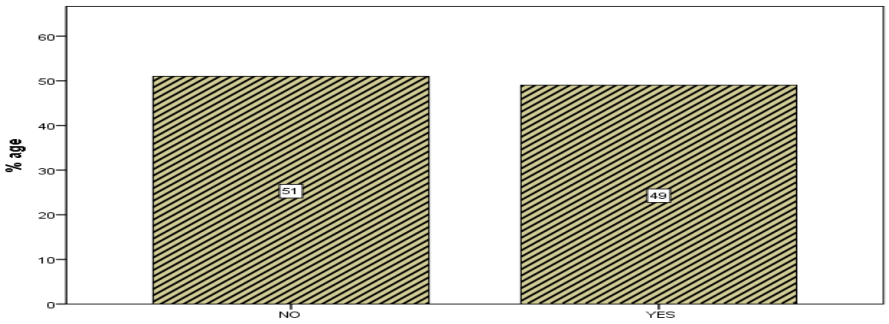


Figure 4.44 Fear of fish damaging rice

4.5.2.4. Fish diseases.

53.2% of the respondents reported fish diseases compared to 51.0% who did not share this concern. (Figure 4.45)

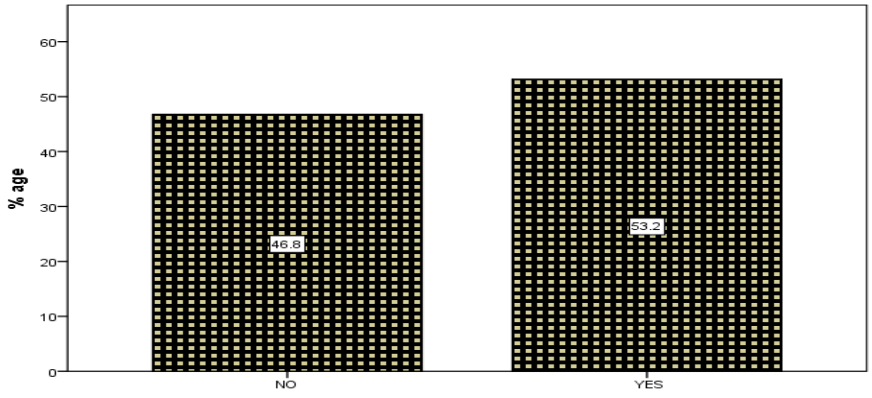


Figure 4.45 Fish diseases

4.5.3. Social risks associated with IRFF

53.2% of the respondents associated various social risks with the adoption of IRFF compared to 46.8% who did not perceive any social risks. (Figure 4.46).

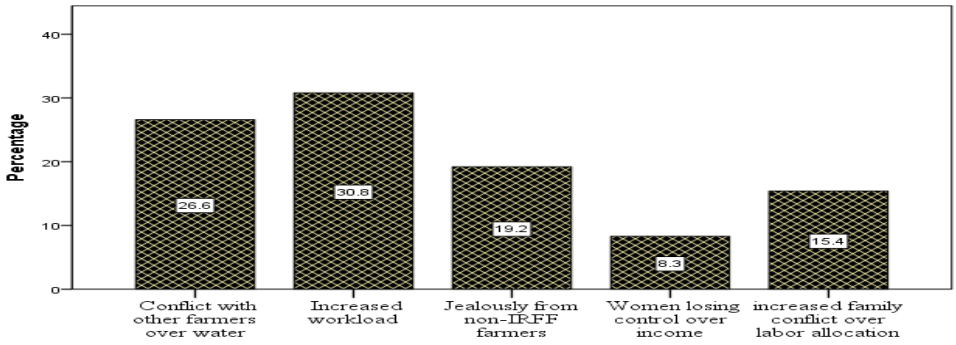


Figure 4.46 Social risks associated with IRFF

4.5.4. What opportunities do you see in IRFF for improving your livelihood

20.52% recognized increased income from fish sales, which sits equal with 20.52% who emphasized improved nutrition from eating fish at home. These were valued compared to 17.02% for better use of available water resources, 16.62% for youth and women employment, 13.11% for year-round food availability, and 12.21% for reduced input costs like fertilizers and pesticides. (Figure 4.47)

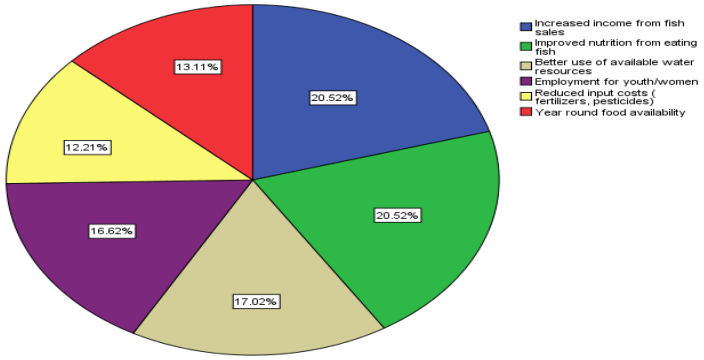
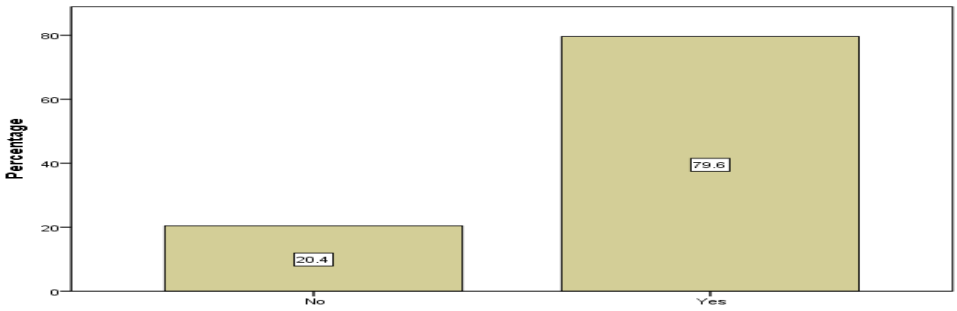


Figure 4.47. Opportunities of IRFF in improving farmers livelihoods

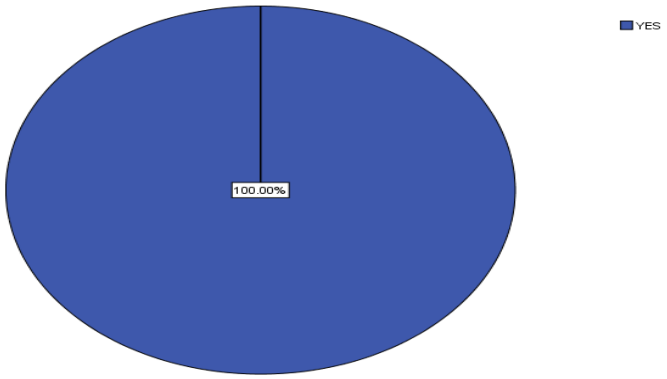
4.5.5. Received any training or extension support specifically for IRFF compared to Conventional rice monoculture.

79.6% of the respondents reported that they received training or extension support specifically for IRFF compared to 20.4 % of the respondents who had not received training or extension support specifically for IRFF.



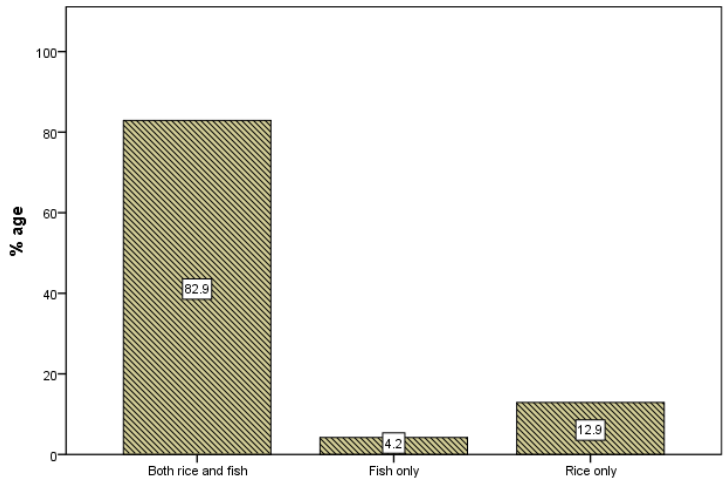
If interested in receiving training specifically for IRFF

79.6% expressed a strong interest in receiving training specifically tailored to IRFF compared to 20.4% who stated they were not interested



4.5.6. Access to market for fish and rice

82.9% of the respondents reported having stable market access for both their rice and fish products compared to 12.9% who had access to rice markets only, and 4.2% who had access to fish markets only.



4.5.7. Beliefs that affect decisions to integrate fish with rice

All respondents said that there were no beliefs that affected their decisions to integrate fish with rice. (Figure 4.48)

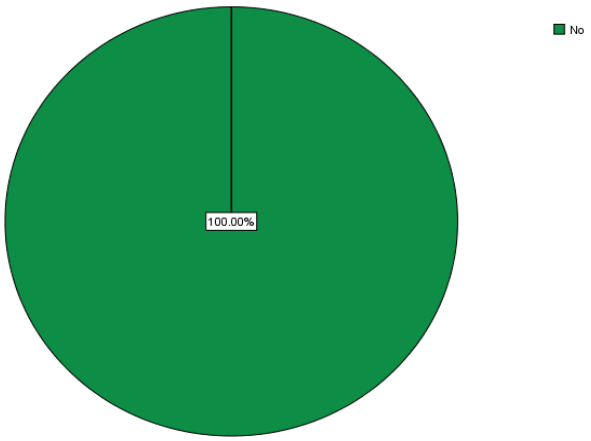


Figure 4.48. Beliefs related to fish farming

4.5.8. Recommendation of IRFF to other farmers

97.9% of the respondents stated they would highly recommend IRFF to other farmers in their communities compared to 2.1% who remained unsure. (Figure 4.49)

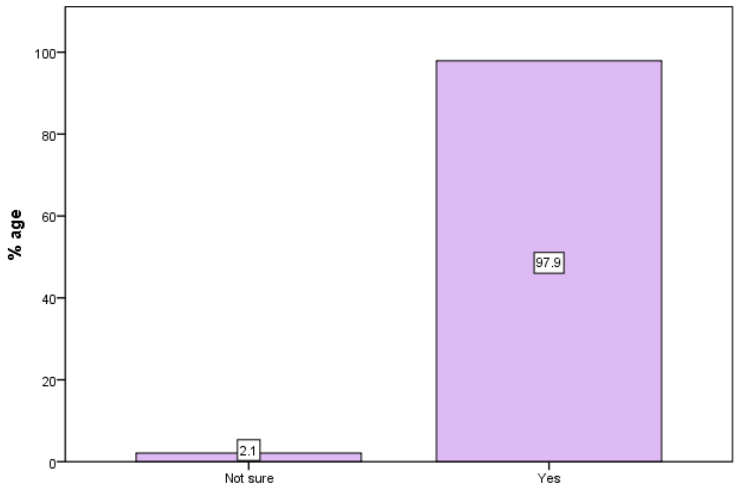


Figure 4.49 Recommendation of IRFF to other farmers

4.6.2. Kind of support provided by cooperatives by Conventional rice farmers and IRFF

Cooperative support received by farmers was led by technical training at 33.0%compared to 29.2% for access to output markets, 21.7% for formal savings mobilization, and 16.1% for direct access to fish fingerlings among conventional rice farmers and IRFF farmers.

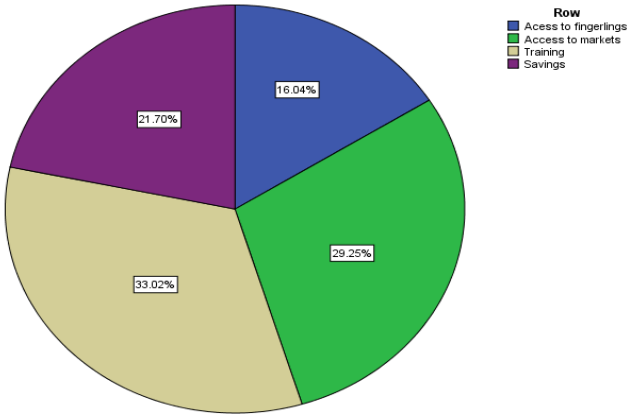


Figure 4.50. Support provided by community cooperatives in regard to fish farming

4.6.3. Roles provided by local leaders to both IRFF farmers and Conventional Rice farmers.

Linking farmers to extension was reported as the primary support provided by local leaders, constituting 30.20% of the responses compared to 26.1% for providing training, 22.8% for helping in accessing credit, and 20.8% for helping in water management conflicts, (Figure 4.51)

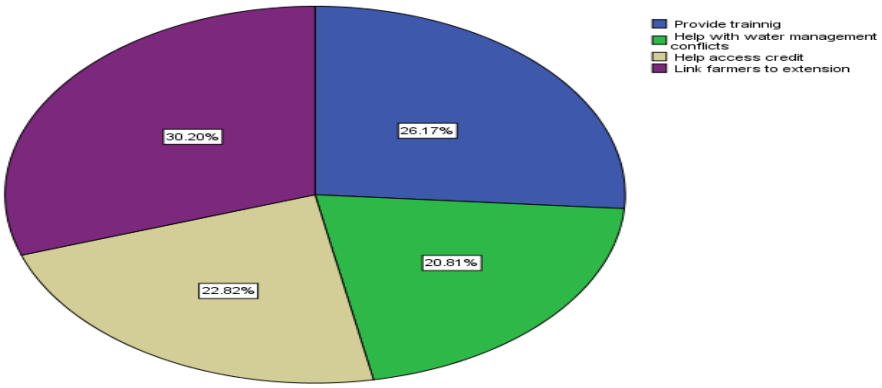


Figure 4.51. Roles provided by local leaders in regard to fish farming

4.6.4. Kind of support from government to Conventional Rice farmers and IRFF farmers

Subsidized fish fingerlings, training on rice-fish integration, market integration assistance, low interest loans, extension services support, and subsidized fish feeds were identified as the primary form of government assistance, constituting 18.9%, 16.2%, 16.21%, 15.02%, 11.86%, 14.23% respectively compared to 7.5% who, by surprise, suggested support for water management infrastructure (Figure 4.52)

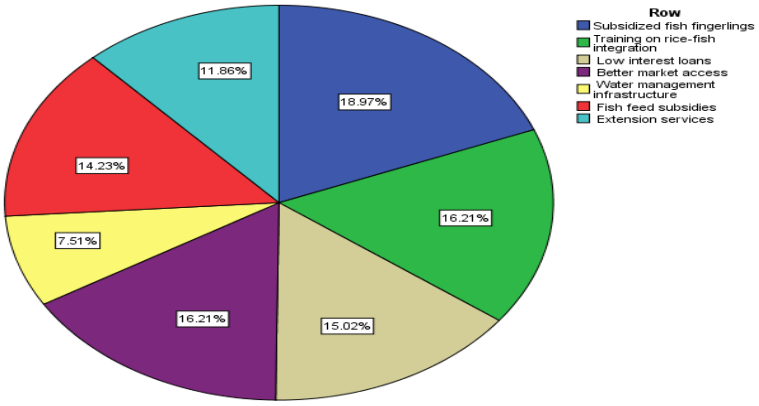


Figure 4.52 support provided by government in relation to fish farming

CHAPTER FIVE

5.0 DISCUSSION OF FINDINGS

5.1. Contribution of IRFF Systems on household income and livelihood diversification

5.1.1. Income diversification through IRFF

The study found that all IRFF practitioners (100%) reported diversified income sources as a benefit of the integrated system. This finding is consistent with the broader literature on agricultural diversification as a risk management and income-enhancing strategy for smallholders (Ellis, 2000; Barrett et al., 2001). The Sustainable Livelihoods Framework posits that livelihood diversification is a fundamental strategy through which rural households reduce vulnerability to shocks and improve their well-being (Scoones, 1998; DFID, 1999). In the context of Erute South, where 55% of farmers previously earned below 500,000 UGX annually from farming before adopting IRFF, the integration of fish into rice paddies has created a critical additional income stream.

The finding that 100% of IRFF practitioners experienced income diversification supports the assertion by Ahmed and Garnett (2011) that rice-fish systems provide multiple revenue streams that reduce household dependency on a single crop. Before IRFF adoption, the predominant reliance on rice monoculture exposed farmers to the vagaries of fluctuating rice prices, seasonal income cycles, and climate-related production risks. The introduction of fish sales as a complementary income source fundamentally alters the household economic portfolio, providing both a safety net during rice price depressions and an independent revenue stream during the fish harvest period.

The dual income streams from rice and fish were corroborated by the finding that 46.8% of IRFF farmers earned above 1 million UGX annually from fish sales alone, while current total household income from farming showed that 57.4% earned between 1-3 million UGX and 14.8% earned 4-6 million UGX. This represents a substantial improvement from the pre-adoption income distribution, where only 1.67% of farmers earned between 1-2 million UGX. These results align with the global projections by Ana et al. (2025) that widespread adoption of rice-fish co-cultures could increase farmers' income by USD 175-197 billion annually. The benefit-to-cost ratio of 2.2

for rice-fish systems compared to 1.6 for sole rice cropping, as reported by TAAT Africa (2025), provides further evidence of the economic superiority of the integrated approach.

The livestock integration dimension adds another layer to the diversification picture. The study found that 64.8% of IRFF practitioners also integrate livestock, predominantly poultry, pigs, goats, and cattle, into their farming systems. Livestock contribute through manure provision for rice (28.1%), income diversification to support rice-fish operations (25.2%), and waste products used for fish feeding (22.3%). This multi-enterprise integration reflects what Little et al. (2012) described as the "integration ladder," where farmers progressively add complementary enterprises to create synergistic production systems. The accelerated adoption of poultry-rice-fish integration from 2023 onward, peaking at 30.0% in 2024, indicates that farmers are actively seeking and experimenting with further diversification opportunities beyond the basic rice-fish model.

5.1.3 Food security and nutritional outcomes.

The finding that 100% of IRFF practitioners reported increased food security represents the most universally experienced benefit of the integrated system. This result is consistent with the extensive body of literature documenting the food security contributions of rice-fish systems across Asia and Africa (Halwart & Gupta, 2004; Hu et al., 2016; Ahmed & Garnett, 2011). In Bangladesh, for instance, Ahmed et al. (2010) found that rice-fish farming households consumed significantly more fish and had higher dietary diversity scores compared to rice monoculture households.

The nutritional dimension is particularly important in the Ugandan context, where micronutrient deficiencies remain prevalent among rural populations (UBOS, 2021). The finding that 95.8% of IRFF farmers reported a reduced need to buy fish directly demonstrates the contribution of IRFF to household protein and micronutrient intake. In the household effects analysis, eating more diversified food, including fish at home, was the most commonly reported improvement (22.5%), surpassing even financial benefits such as the ability to save money (19.3%) and pay school fees (17.1%). This prioritization of nutritional benefits over purely financial gains suggests that farmers value IRFF not only as an income-generating activity but as a food security strategy, a finding consistent with Nwirittanyomua et al. (2021), who noted that smallholder farmers in Sub-Saharan Africa often prioritise food self-sufficiency over market-oriented production.

The year-round food availability reported by 13.0% of respondents as a perceived opportunity of IRFF further reinforces the food security argument. While rice provides seasonal caloric sufficiency, fish from integrated systems can provide protein throughout much of the year, particularly when refuge ponds are maintained between rice growing seasons. This finding echoes the observations of Frei and Becker (2005) that the fish component of IRFF acts as a "living larder" providing a ready source of high-quality protein that can be accessed as needed rather than only at harvest time.

5.1.4 Improved household welfare indicators

The study documented substantial improvements in household welfare indicators following IRFF adoption. Beyond food security and nutrition, farmers reported the ability to pay school fees (17.1%), better access to healthcare (16.6%), ability to purchase household assets such as bicycles, radios, and smartphones (14.4%), and improved housing including iron roofs and cemented floors (8.5%). Crucially, no respondents reported "no improvement," indicating that IRFF has universally benefited adopting households in Erute South.

These welfare improvements are consistent with the findings of Mohanty et al. (2014) in India, who demonstrated that rice-fish farming households had significantly higher expenditure on education, healthcare, and durable goods compared to rice monoculture households. The ability to pay school fees is particularly significant in the Lira District context, where school dropout rates remain high due to financial constraints (UBOS, 2021). The reinvestment of IRFF income into education represents a long-term investment in human capital that may contribute to intergenerational poverty reduction.

The 80.8% of IRFF practitioners who reported better social standing in the community points to an often-overlooked dimension of IRFF's socio-economic contribution: social capital and status. In the closely-knit communities of northern Uganda, where social standing influences access to community resources, credit networks, and political voice, the economic success associated with IRFF may generate positive spillover effects that extend beyond the immediate household. This finding aligns with the social capital component of the Sustainable Livelihoods Framework, which recognizes that social networks and relationships constitute a valuable asset that households can mobilize for livelihood improvement (DFID, 1999).

5.1.5 Ecological and economic synergies

The overwhelming 95.8% of farmers who reported reduced need for chemical fertilizers underscores the ecological-economic synergy at the heart of IRFF. Fish excreta serve as a natural fertilizer, partially substituting for synthetic inputs and representing both an economic saving and an ecological benefit. This finding corroborates the research by Xie et al. (2011), who demonstrated that rice-fish co-culture significantly reduces nitrogen fertilizer requirements while maintaining or improving rice yields. In the Erute South context, where 60% of respondents rely on farming as their sole occupation and chemical fertilizer costs represent a significant burden, the fertilizer substitution effect of fish waste translates directly into cost savings and improved profit margins.

Similarly, 73.0% of IRFF practitioners reported reduced pest problems in rice, consistent with the ecological literature documenting the role of fish in consuming insect pests and weed seeds (Halwart, 2006; Ana et al., 2025). The 83.0% who reported improved soil and water quality further attests to the environmental benefits of the integrated system. These ecological synergies create what Dalsgaard and Prein (2001) termed a "positive feedback loop," where the biological interactions between rice and fish reduce the need for external inputs, lower production costs, and simultaneously enhance environmental sustainability, a particularly important consideration in the ecologically sensitive wetland areas of Lira District where most rice production occurs.

However, the 27.0% who did not observe reduced pest problems and the 17.0% who did not perceive improved soil or water quality suggest that the ecological benefits of IRFF are not uniformly experienced. This variation may be attributable to differences in fish species selection, stocking density, water management practices, or the specific pest complexes present in different farms. The finding that Nile tilapia (44.0%) and catfish (42.3%) are the dominant species in Erute South is significant in this regard, as these species differ in their feeding habits and ecological contributions. Tilapia are primarily algivorous and detritivorous, while catfish are benthic feeders and more effective predators of insect larvae (Mbugua et al., 2018). The 16.7% practicing mixed-species integration may be better positioned to capture the full range of ecological benefits, a hypothesis consistent with the findings of Hu et al. (2016) that polyculture systems in rice-fish farming generate greater ecological synergies than monoculture fish systems.

5.1.6. Willingness to adopt among non-practitioners.

The strong interest in IRFF among conventional rice monoculture farmers, with 76.9% expressing willingness to switch if given training and support, indicates substantial latent demand for the integrated system. This finding is encouraging for scaling efforts and aligns with the Technology Adoption and Diffusion literature, which emphasizes the role of perceived relative advantage and observability in the adoption decision (Rogers, 2003). The high adoption rate (78.3%) among the study sample and the predominance of farmers in the 1–2-year experience category (51.1%) suggests that IRFF adoption in Erute South is on an upward trajectory; likely driven by extension services, peer learning, and the observable benefits from early adopters.

The primary barriers cited by reluctant conventional farmers, including lack of knowledge (22.2%), lack of capital (22.2%), and fear of increased workload (22.2%), mirror the challenges experienced by current IRFF practitioners, confirming the consistency of these constraints across adopters and non-adopters. Notably, land tenure insecurity was not cited as a barrier by any conventional farmer, contradicting the common assertion in the literature that land tenure insecurity is a primary obstacle to IRFF adoption (Ahmed &Timsina, 2014; Nwirittanyomua et al., 2021). The absence of land tenure concerns among conventional farmers may reflect the relatively secure customary land tenure systems in Lango sub-region, or it may indicate that farmers do not perceive IRFF as requiring a fundamentally different land tenure arrangement than rice monoculture.

5.2 Gender labor requirements in IRFF Systems versus Conventional rice monoculture

5.2.1 Gendered division of labor in IRFF

The study revealed a pronounced gendered division of labor in IRFF systems. Land preparation was predominantly performed by men (53.3%), with no respondents reporting this task as mostly performed by women. This reflects the physically demanding nature of land preparation, which involves digging, ploughing, and constructing fish trenches, tasks that require significant upper-body strength and are culturally coded as male activities in northern Uganda (Bantebya-Kyomuhendo &Mwine, 2020). The construction and maintenance of fish ponds, a task specific to IRFF, similarly fell within the male domain, with 61.7% of fish pond monitoring performed mostly by men.

Monitoring of fish in the field (65.0% mostly men) and fish pond monitoring (61.7% mostly men) reveal the gendered control over the fish component of IRFF. This male dominance in fish-related activities is consistent with the findings of Weeratunge et al. (2010), who documented that in many Sub-Saharan African communities, aquaculture is perceived as a male domain despite women's significant contributions to fish processing and marketing. The commercial orientation of fish production, since fish are primarily grown for sale rather than home consumption, may further entrench male control, as men are more likely to manage income-generating enterprises in the patriarchal household structures prevalent in Lango sub-region (Kabeer, 2016).

Planting rice showed a more balanced gender distribution, with 83.3% reporting both genders participating equally, though men still dominated (15.0% mostly men) compared to women (1.67%). Weeding presented a more equitable pattern, with both genders participating equally, followed by mostly women (36.7%) and mostly men (5.0%). This aligns with the broader literature on gender and agriculture in Sub-Saharan Africa, which consistently identifies weeding as a predominantly female agricultural task (Doss, 2018; Palacios-Lopez & Lopez, 2015).

Rice harvesting showed the most balanced gender distribution of any task, with both genders participating equally in 55.0% of cases, mostly women in 28.3%, and mostly men in 16.7%. This is the only farming activity where women had a notably higher participation rate than men, reflecting women's traditional role in post-harvest activities. However, the commercial aspects of rice production remained male-dominated: selling rice at market was performed mostly by men (66.7%), and selling fish was similarly male-dominated (56.7% mostly men). The finding that 70.0% of respondents reported that men primarily manage income from sales represents the highest level of male dominance across all farming activities.

5.2.2. IRFF and the intensification of women's labor

The most concerning finding regarding gender and IRFF is that 68.1% of practitioners reported that the introduction of IRFF has increased women's workload, while only 19.4% reported a decrease and 12.7% reported no change. This finding raises fundamental questions about the equity implications of IRFF adoption and challenges the assumption that integrated farming systems automatically benefit all household members equally.

The intensification of women's labor in IRFF can be attributed to several factors. First, IRFF adds new tasks, including fish feeding, pond monitoring, fish processing, and predator surveillance that are typically added to women's existing agricultural responsibilities. Second, while the gendered division of labor assigns many IRFF-specific tasks to men (particularly pond construction and fish monitoring), women are often responsible for the daily maintenance activities such as feeding fish and checking water levels, tasks that require consistent daily attention rather than intermittent physical exertion (Weeratunge et al., 2010). Third, the 80% of respondents who hire external labor for activities including land preparation (23.2%), planting (20.7%), harvesting (20.7%), and fish pond construction (19.5%) suggest that household labor is insufficient for IRFF demands, and this insufficiency disproportionately affects women who cannot afford or access hired labor to supplement their workload.

This finding is consistent with the broader literature on agricultural intensification and gender in Sub-Saharan Africa. Doss (2018) argued that agricultural intensification often increases women's labor burden without proportionally increasing their control over the resulting income or benefits. Similarly, Kabeer (2016) observed that new agricultural technologies and practices tend to be adopted within existing gendered structures, meaning that women's existing labor obligations are extended rather than redistributed. In the Erute South context, the additional workload from IRFF comes on top of women's existing responsibilities in rice weeding, rice harvesting, and household reproductive labor, a phenomenon Njuki et al. (2016) termed the "double burden" of productive and reproductive work.

5.2.3. Decision-making power and income control

The gender disparities in IRFF extend beyond labor allocation to decision-making and income control. The finding that 59.6% of respondents indicated that women have a say in fish farming decisions but less than men, and that only 14.9% reported that women participate equally with men, reveals a significant gender gap in IRFF governance. Furthermore, 25.5% reported that only men decide on fish farming matters, effectively excluding women from decision-making about an enterprise to which they contribute significant labor.

The concentration of income management among men (70.0%) represents perhaps the most critical gender equity finding. Despite women's substantial labor contribution, particularly in rice harvesting (28.3% mostly women), weeding (36.7% mostly women), and daily fish feeding, the

financial returns from their work are predominantly controlled by men. This disconnect between labor contribution and income control is well documented in the gender and agriculture literature (Quisumbing et al., 2014; Doss, 2018) and represents a structural barrier to women's economic empowerment through IRFF.

The social risk analysis further revealed that 8.3% of respondents identified women losing control over income as a social risk of IRFF, while 15.0% cited increased family conflict over labor allocation. Although these were not the most frequently cited social risks, their presence indicates that gender-based tensions are emerging as a consequence of IRFF adoption. The low reporting of women losing income control may reflect normalization of male income management rather than its absence, a phenomenon documented by Kabeer (2016) in patriarchal farming communities where male control over household income is culturally expected and therefore not perceived as a "risk." The social risk of increased workload leading to stress (30.8%) disproportionately affects women; given the earlier finding that 68.1% reported IRFF has increased women's workload. The intersection of increased labor burden and limited decision-making power creates what Njuki et al. (2016) described as a "participation without empowerment" scenario, where women are integrated into new agricultural systems as laborers but excluded from the governance and financial benefits of those systems.

5.3 Perceived benefits, constraints, opportunities, and social risks of IRFF

5.3.1 Benefits of IRFF

The benefits of IRFF reported by practitioners paint a comprehensive picture of the system's positive contributions. Food security (100%), diversified income (100%), reduced need to buy fish (95.8%), reduced need for chemical fertilizers (95.8%), improved soil and water quality (83.0%), better social standing (80.8%), and reduced pest problems (73.0%) collectively demonstrate that IRFF delivers economic, nutritional, ecological, and social benefits to adopting households.

The universality of food security and income diversification benefits is particularly noteworthy. Unlike many agricultural technologies that benefit some farmers while leaving others unaffected, IRFF appears to deliver these core benefits across all adopting households. This may be attributable to the fundamental biological logic of the system: fish in rice paddies inevitably generate additional food and income, regardless of management intensity or scale. The finding

supports the characterisation of IRFF by Frei and Becker (2005) as a "low-threshold" technology that generates benefits even under basic management conditions.

5.3.2 Constraints and challenges of IRFF

Despite the strong benefits, the study identified substantial constraints that threaten the sustainability and scalability of IRFF in Erute South. Predation on fish emerged as the most widely experienced challenge (93.7%), with birds, snakes, and other animals representing a significant production risk. This finding is consistent with studies across Sub-Saharan Africa, where predation is consistently identified as a major constraint to pond-based aquaculture (Mbugua et al., 2018; Brummett et al., 2010). The near-universal experience of predation in Erute South likely reflects the location of rice-fish farms in wetland areas that are natural habitats for predatory birds and reptiles, combined with the absence of protective infrastructure such as netting and fencing.

The low market prices for fish (87.2%) represent the third most widely experienced challenge and indicate a structural constraint in the local fish market. Even when farmers have market access (82.9% reported access to both rice and fish markets), the prices received may be insufficient to adequately reward the investment of labor and capital in fish production. This finding is consistent with the observations of Jagger and Pender (2001) that smallholder fish farmers in East Africa frequently face price suppression due to competition from capture fisheries, limited market infrastructure, and the perishability of fish products in the absence of cold chain facilities. The 12.9% of IRFF practitioners who could only access rice markets (not fish markets) are particularly disadvantaged, as they cannot monetize the fish component that justifies the additional labor and capital investment of IRFF.

The lack of technical knowledge (85.1%) represents a critical constraint that has implications across multiple dimensions of IRFF management. Technical knowledge gaps likely contribute to suboptimal water management (cited by 66.0%), fish disease problems (53.2%), and the fear of fish damaging rice plants (49.0%). This finding corroborates the extensive literature documenting the role of knowledge and information in the adoption and performance of integrated farming systems (Ahmed &Timsina, 2014; Nwirittanyomua et al., 2021). The gap between the 85.1% who lack technical knowledge and the 80.9% who reported having received some training suggests that existing training programs may be insufficient in depth, frequency, or practical relevance.

The 57.4% who reported a lack of extension support, mirroring the 57.4% who cited insufficient labor, indicates a gap between the need for and provision of extension services. This gap is concerning given the earlier finding that 85.1% lack technical knowledge, suggesting that the extension system is failing to meet the information and support needs of IRFF practitioners. The finding that 57.4% did not perceive land tenure insecurity as a challenge, while 42.6% did, presents a nuanced picture. Although land tenure insecurity is often cited in the literature as a major barrier to IRFF adoption (Ahmed &Timsina, 2014), the majority of current practitioners in Erute South do not experience it as a significant constraint, possibly reflecting the relative security of customary land tenure in Lango sub-region.

5.3.3 Social risks of IRFF

The social risk analysis revealed a spectrum of concerns related to communal harmony and intra-household dynamics. Increased workload leading to stress (30.8%) was the most frequently cited social risk, followed by conflict with other farmers over water (26.7%), jealousy from non-IRFF farmers (19.2%), increased family conflict over labor allocation (15.0%), and women losing control over income (8.3%).

The communal water conflicts reflect the fact that IRFF requires reliable water access, which in shared wetland farming systems can create competition between IRFF practitioners and conventional rice farmers or other water users. This finding has important implications for IRFF scaling, as widespread adoption could exacerbate water conflicts unless collective water management arrangements are established. The jealousy from non-IRFF farmers (19.2%) suggests that IRFF may be creating social differentiation within the community, where the visible economic benefits enjoyed by adopters generate resentment among non-adopters. This social risk has been documented in other contexts where agricultural innovations create wealth gaps within previously homogeneous communities (Tschirley et al., 2015). The absence of cultural or religious barriers to IRFF (100% of practitioners reported no cultural or religious beliefs negatively affecting their decision) is a significant positive finding that distinguishes Erute South from some other contexts where cultural taboos or religious restrictions limit aquaculture adoption. This absence of cultural barriers represents an important enabling condition for IRFF scaling, as it means that the primary constraints are economic, technical, and infrastructural rather than cultural.

5.3.4 Perceived opportunities in IRFF

Farmers identified multiple opportunities in IRFF for livelihood improvement. Increased income from fish sales and improved nutrition from eating fish were equally ranked (each 20.5%), followed by better use of available water resources (17.0%), employment for youth and women (16.6%), year-round food availability (13.0%), and reduced input costs (12.2%). The equal ranking of income and nutrition opportunities reflects the dual economic and food security value that farmers attribute to IRFF, confirming the "win-win" characterisation of integrated farming systems in the sustainable intensification literature (Pretty et al., 2011; Garrity et al., 2012).

The identification of employment for youth and women (16.6%) as a key opportunity suggests that IRFF is perceived as having potential to address unemployment and underemployment, which are pressing concerns in rural northern Uganda (UBOS, 2021). However, this opportunity must be interpreted cautiously in light of the earlier finding that IRFF has increased women's workload (68.1%) without proportionally increasing their decision-making power or income control. The employment opportunity for youth is potentially more equitable, as young people of both genders may benefit from new skills and income opportunities associated with fish production and marketing.

5.3.5 Extension services, community groups, and support needs

The study found that 80.9% of IRFF practitioners had received some training or extension support, and all who had not received training (100%) expressed interest in doing so. This near-universal demand for training indicates both the perceived value of extension services and the existing gap in support provision. Among the 63.3% of respondents who belonged to community groups or cooperatives, the types of support received included training (33.0%), access to markets (29.0%), savings and credit (21.0%), and access to fingerlings (16.0%). These community groups play a vital role in filling the gap left by formal extension services, functioning as platforms for knowledge exchange, collective marketing, and financial services.

Local leaders (LCs and sub-county officials) play multiple supportive roles, including linking farmers to extension services (30.2%), providing training (26.2%), helping access credit (22.8%), and assisting with water management conflicts (20.8%). Notably, no respondents reported receiving "no support" from local leaders, indicating that local governance structures are actively

engaged in IRFF promotion. This finding is encouraging for scaling efforts, as it suggests that institutional support mechanisms already exist and could be strengthened.

CHAPTER SIX

6.0. CONCLUSIONS AND RECOMMENDATIONS

6.1. CONCLUSION

Integrated Rice-Fish Farming holds substantial and demonstrable potential for improving the socio-economic conditions of smallholder farmers in Erute South, Lira District. The system delivers economic, nutritional, ecological, and social benefits that are universally experienced by adopting households and are sufficiently compelling that virtually all practitioners would recommend IRFF to other farmers. However, the realization of this potential is constrained by significant technical, economic, institutional, and gender-related challenges that, if left unaddressed, could undermine the sustainability and equity of IRFF as a development strategy.

Findings show that IRFF significantly contributes to household income diversification, with all IRFF practitioners (100%) reporting diversified income sources and increased food security. The total annual household income from farming among IRFF practitioners showed marked improvement, with 57.4% earning between 1-3 million UGX, compared to the pre-adoption period where 55% earned below 500,000 UGX. 68.1% of respondents reporting that IRFF has increased women's workload, and 70% indicating that men primarily manage income from sales. challenges included predation on fish (93.7%), low market prices for fish (87.2%), and lack of technical knowledge (85.1%). 97.9% of IRFF practitioners would recommend the system to other farmers. Subsidized fish fingerlings, training on rice-fish integration, market integration assistance, low interest loans, extension services support, and subsidized fish feeds were identified as the primary form of government assistance, constituting 18.9%, 16.2%, 16.21%, 15.02%, 11.86%, 14.23% respectively. Support for water management infrastructure was not a critical need by the 7.5% .

With appropriate support, IRFF can serve as a pathway toward sustainable agricultural intensification, rural livelihood improvement, and inclusive economic development in Lira District.

6.2 RECOMMENDATIONS

- ✓ Subsidized fingerling supply program: The Lira District Local Government should establish a subsidized fingerling supply program to reduce the high initial input costs that constrain IRFF adoption. Given that subsidized fingerlings were the most desired form of support (18.9%), a public-private partnership model involving the district fisheries office, private hatcheries, and farmer cooperatives could improve fingerling availability and affordability.
- ✓ Strengthening extension services for IRFF: The finding that 85.1% of IRFF practitioners lack technical knowledge, while 57.4% lack extension support, calls for a significant expansion of IRFF-specific extension services. The district production department should recruit and train additional extension workers in IRFF management, prioritizing practical skills in water management, fish feeding, disease control, and integrated pest management. Extension services should be delivered through regular farmer field schools and demonstration plots rather than one-off training sessions.
- ✓ Climate adaptation integration; integration of climate adaptation measures into IRFF promotion to address drought and flood challenges by IRFF farmers

REFERENCES

1. Ahmed, N., & Garnett, S. T. (2011). Integrated rice-fish farming in Bangladesh: Meeting the challenges of food security. Food Security, 3(1), 81-92. https://doi.org/10.1007/s12571-011-0115-
2. Ahmed, N., &Timsina, J. (2014). Integrated rice-fish farming in Bangladesh: A perspective on agroecosystem management. In Advances in Agronomy (Vol. 125, pp. 267-309). Academic Press. https://doi.org/10.1016/B978-0-12-800137-0.00006-4
3. Ahmed, N., Wahab, M. A., &Thilsted, S. H. (2010). Integrated rice-fish culture in Bangladesh: A perspective on food security and nutrition. Journal of Hunger & Environmental Nutrition, 5(2), 169-185. https://doi.org/10.1080/19320248.2010.484716
4. Ana, O. S., Oyege, I., Opoola, A., &Omitoyin, B. (2025). Rice-fish farming: A review of principles, models and prospects in Sub-Saharan Africa. Aquaculture and Fisheries, 10(1), 45-62. https://doi.org/10.1016/j.aaf.2024.09.003
5. Bantebya-Kyomuhendo, G., &Mwiine, A. (2020). Gender and agricultural labour in Sub-Saharan Africa: Continuity and change. Journal of Eastern African Studies, 14(3), 475-494. https://doi.org/10.1080/17531055.2020.1783268
6. Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. Food Policy, 26(4), 315-331. https://doi.org/10.1016/S0306-9192(01)00014-5
7. Brummett, R. E., Lazard, J., &Moehl, J. (2010). African aquaculture: Realizing the potential. Food Policy, 35(3), 191-192. https://doi.org/10.1016/j.foodpol.2010.01.004
8. Dalsgaard, J. P. T., &Prein, M. (2001). Integrated agriculture-aquaculture systems in the Mekong Delta: An ecological approach. In Proceedings of the IFS/NLV Workshop on Integrated Agriculture-Aquaculture Systems (pp. 65-78). IFS.
9. DFID. (1999). Sustainable livelihoods guidance sheets. Department for International Development.
10. Doss, C. R. (2018). Women and agricultural productivity: Reframing the issues. Development Policy Review, 36(1), 35-50. https://doi.org/10.1111/dpr.12243
11. Ellis, F. (2000). Rural livelihoods and diversity in developing countries. Oxford University Press.

12. Frei, M., & Becker, K. (2005). Integrated rice-fish culture: Coupled production saves resources. Natural Resources Forum, 29(2), 135-143. https://doi.org/10.1111/j.1477-8947.2005.00122.x
13. Garrity, D. P., Filius, F. M., &Majule, A. (2012). Sustainable intensification of smallholder systems in Africa. In Sustainable Agricultural Intensification: A Handbook for Practitioners (pp. 1-34). Earthscan.
14. Halwart, M. (2006). FAO and integrated rice-fish farming. In Rice-Fish Culture in China (pp. 1-12). FAO.
15. Halwart, M., & Gupta, M. V. (2004). Culture of fish in rice fields. FAO and The WorldFish Center.
16. Hu, L., Zhang, J., Ren, W., Guo, L., Cheng, J., & Chang, J. (2016). Sustainability of the rice-fish farming system in China. Agriculture, Ecosystems & Environment, 221, 145-153. https://doi.org/10.1016/j.agee.2016.01.027
17. IPCC. (2022). Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
18. Jagger, P., & Pender, J. (2001). Land tenure and adoption of soil conservation in Ethiopia. Environment and Development Economics, 6(4), 497-518. https://doi.org/10.1017/S1355770X01000182
19. Kabeer, N. (2016). Gender equality, economic growth, and women's agency: The "endless variety" and "monotonous similarity" of patriarchal constraints. Journal of Human Development and Capabilities, 17(1), 62-87. https://doi.org/10.1080/19452829.2015.1120923
20. Little, D. C., Barman, B. K., &Bhujel, R. C. (2012). Scaling up aquaculture for poverty alleviation and food security. In Proceedings of the Global Conference on Aquaculture (pp. 1-20). FAO.
21. MAAIF. (2020). Ministry of Agriculture, Animal Industry and Fisheries: Annual report 2019/2020. Government of Uganda.
22. Mbugua, H., Nyandat, B., &Opiyo, R. (2018). Status of aquaculture in East Africa: Challenges and opportunities. African Journal of Food, Agriculture, Nutrition and Development, 18(2), 13323-13340. https://doi.org/10.18697/ajfand.82.16050

23. Mohanty, R. K., Verma, H. N., &Brahmanand, P. S. (2014). Performance evaluation of rice-fish integration system in rainfed medium land ecosystem. Journal of Agricultural Science, 6(6), 71-82. https://doi.org/10.5539/jas.v6n6p71
24. Mubiru, D. N., Radeny, M., &Kyazze, F. B. (2018). Uganda: Climate variability, climate change, and food security. In Climate Variability and Extremes in Sub-Saharan Africa (pp. 123-145). Springer.
25. Njuki, J., Parkins, J. R., &Kaler, A. (2016). Transforming gender and food security in the Global South. Routledge.
26. Nwirittanyomua, F. R., Effiom, E. A., & Ali, F. (2021). Socio-economic determinants of integrated rice-fish farming adoption in Sub-Saharan Africa: A systematic review. Journal of Agricultural Economics, 72(2), 375-394. https://doi.org/10.1111/1477-9552.12407
27. Palacios-Lopez, A., & Lopez, R. (2015). The gender gap in agricultural productivity: The role of market imperfections. Journal of Development Studies, 51(9), 1175-1192. https://doi.org/10.1080/00220388.2015.1028537
28. Pretty, J., Toulmin, C., & Williams, S. (2011). Sustainable intensification in African agriculture. International Journal of Agricultural Sustainability, 9(1), 5-24. https://doi.org/10.3763/ijas.2010.0583
29. Quisumbing, A. R., Rubin, D., &Manfre, C. (2014). Closing the gender gap in agricultural productivity. In Gender in Agriculture (pp. 95-118). Springer. https://doi.org/10.1007/978-3-319-08551-7_5
30. Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.
31. Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis (IDS Working Paper 72). Institute of Development Studies.
32. TAAT Africa. (2025). Technologies for African Agricultural Transformation: Rice-fish culture technology compact. African Development Bank.
33. Tschirley, D., Reardon, T., Dolislager, M., & Snyder, J. (2015). The rise of a middle class in East and Southern Africa: Implications for food system transformation. Journal of International Development, 27(5), 628-646. https://doi.org/10.1002/jid.3102
34. UBOS. (2021). Uganda National Household Survey 2019/2020. Uganda Bureau of Statistics.

35. Weeratunge, N., Snyder, K. A., & Choo, P. S. (2010). Gleaner, fisher, trader, processor: Understanding gendered employment in fisheries and aquaculture. Fish and Fisheries, 11(4), 405-420. https://doi.org/10.1111/j.1467-2979.2010.00368.x
36. Xie, J., Hu, L., Tang, J., Wu, X., Li, N., Yuan, Y., & Chen, X. (2011). Ecological mechanisms underlying the sustainability of the traditional rice-fish co-culture system in China. Proceedings of the National Academy of Sciences, 108(50), E1381-E1387. https://doi.org/10.1073/pnas.1111043108
37. Zhang, J., Hu, L., & Ren, W. (2025). Rice-fish co-culture: A sustainable agroecosystem for the future. Agricultural Systems, 198, 104180. https://doi.org/10.1016/j.agsy.2025.104180

APPENDICES.APPENDIX I: RESEARCH QUESTIONNAIRE

Title of study: Socio-economic contribution of Integrated Rice-Fish Farming (IRFF) System for smallholder farmers in Erute South, Lira District

Researcher: OGWAL MOSES
Institution: Busitema University, Faculty of Natural Resources and Environmental Science, Namasagali Campus
Program: Bachelor of Science in Fisheries and Water Resources Management

INTRODUCTION:

Dear respondent,

I am **OGWAL MOSES**, a student at Busitema University. I am conducting a research study titled Socio-economic contribution of Integrated Rice-Fish Farming (IRFF) system for smallholder farmers in Erute South, Lira District as part of my course requirement.

You are kindly invited to participate in this study. The purpose is to understand how rice-fish integration affects household income, labor, gender roles, and social well-being compared to conventional rice farming.

Your responses will be kept strictly confidential and used for academic purposes only. Your identity will not be disclosed.

INSTRUCTIONS:

1. Place a tick [✓] in the brackets where appropriate.
2. Provide detailed answers in the spaces provided where required.

Section A: Demographic characteristics of the respondent

1. Gender:
    - Male
    - Female
2. Age bracket:

- 20–30
- 31–40
- 41–50
- Above 50

3. Highest education level attained:

    - None
    - Primary
    - O-Level
    - A-Level
    - Diploma
    - Graduate
    - Post graduate
    - Other (Specify)

4. Marital status:

    - Single
    - Married
    - Divorced
    - Widowed
    - Other (specify):……

5. Main occupation:

    - Farming only
    - Farming plus business
    - Farming plus casual labor
    - Farming plus formal employment
    - Other (specify):

      ……

6. Household size (number of people living in your home):

- 1–3
- 4–6
- 7–9
- 10 and above

7. Religion:

    - Christian
    - Muslim
    - Other (specify):

      ……

Section B: Farming system identification (IRFF vs. Conventional rice monoculture)

8. Which type of rice farming system do you currently practice?

    - Conventional rice monoculture (only rice) [ ] → *Skip to Section C (Q19)*
    - Integrated Rice-Fish Farming (rice + fish together) [ ] → *Continue to Q9*

9. How long have you been practicing IRFF?

    - Less than 1 year
    - 1–2 years
    - 3–5 years
    - More than 5 years

10. What is the total size of your land under rice farming?

    - Less than 0.5 acre
    - 0.5–1 acre
    - 1–2 acres
    - Above 2 acres

11. What fish species do you integrate with rice?

    - Nile tilapia
    - Catfish

- Mirror carp
- Mixed species

12. Do you also keep livestock (e.g., poultry, pigs, goats) integrated with rice-fish?

- Yes → Specify which……
- No

13. In what year did you first integrate livestock with rice-fish?

- Poultry ……
- Pigs……..
- Goats……
- Cattle…….
- Others: ……..

14. When you started how many did you begin with for each type?

- Poultry ……
- Pigs……..
- Goats……
- Cattle…….
- Others: ……..

15. Why did you choose to start with those numbers and at that time?

- Had enough capital/resources
- To test/experiment
- Advice from extension officer/NGO/Neighbor
- Others (specify)……..

16. How do the livestock help your rice-fish system? (*Tick all that apply*)

- Provide manure/fertilizer for rice
- Livestock wastes used for fish feeding
- Livestock eat pests/weeds in rice
- Reduce feed cost for feeds
- Diversify income to support rice-fish

- No specific help
- Others (Specify) ……

17. Are there any beliefs, taboos, religion, totems or social factors that affect keeping these animals?
    - Yes (Specify) ……(Clan totem, religion, gender roles, land size, other…)
    - No

18. Why did you choose IRFF over conventional rice farming?
    - Higher expected income
    - Better use of water/land
    - Diversified food for home
    - Advice from extension worker
    - Other(specify)……

Section C: Economic effects on household income and standard of living

This section compares IRFF and conventional rice monoculture.

19. What was your approximate average annual household income from farming BEFORE adopting your current system?
    - Below 500,000 UGX
    - 500,000 – 1,000,000 UGX
    - 1,000,001 – 2,000,000 UGX
    - Above 2,000,000 UGX
    - Don't remember

20. What is your approximate average annual household income NOW from your current farming system?

Source of income	**Income (Shs.) per year (Tick one box per row)**			
	<500,000	**500,000-1M**	**1M-2M**	**>2M**
Rice sales only	[ ]	[ ]	[ ]	[ ]
Fish sales (if IRFF)	[ ]	[ ]	[ ]	[ ]

Livestock/poultry	[ ]	[ ]	[ ]	[ ]
Other income	[ ]	[ ]	[ ]	[ ]

21. How has IRFF influenced your total household income? (*For IRFF only*)

- Greatly increased
- Slightly increased
- No effect
- Decreased

22. How has this affected your standard of living? (*Tick all that apply*)

- Able to pay school fees regularly
- Better access to health care
- Improved housing (e.g., iron roof, cemented floor)
- Able to buy household assets (bicycle, radio, smartphone, etc.)
- Eat more diversified food (including fish at home)
- Able to save money
- No improvement
- Other (specify)…….

23. On a scale of 1–5, how would you rate your current standard of living compared to before adopting your current system?

- 1 = Much worse
- 2 = Worse
- 3 = Same
- 4 = Better
- 5 = Much better

For conventional rice farmers only:

24. Would you consider switching to IRFF if given training and support?

- Yes

- No
- Not sure

25. Why would you not consider switching to IRFF? (Tick all that apply)

- Lack of knowledge
- Fear of losing rice yield
- Lack of capital
- No access to fish seed
- Fear of increased workload
- Land tenure insecurity
- Lack of market for fish
- Other (specify):

  ……

Section D: Labor requirements and gender dynamics

26. How many people in your household participate in farming activities?
    - 1 (Males/Females)
    - 2 (Males/Females)
    - 3 (Males/Females)
    - >4 (Males/Females)

27. Please estimate the average labor hours per week for each activity in your farming system:

Activity	**Conventional rice only (Hours/week)**	**IRFF system (hours/week)**
Land preparation		
Planting/transplanting rice		
Weeding		
Fertilizer/feed application		
Fish pond/Field management	N/A	
Harvesting rice		
Harvesting fish	N/A	

Processing/marketing		
Total hours		

28. Who performs the following tasks in your farming system? (*Tick gender role*)

Task	**Mostly men**	**Mostly women**	**Both equally**	**Children**
Land preparation	[ ]	[ ]	[ ]	[ ]
Planting rice	[ ]	[ ]	[ ]	[ ]
Weeding	[ ]	[ ]	[ ]	[ ]
Applying fertilizer/manure	[ ]	[ ]	[ ]	[ ]
Feeding fish (if IRFF)	[ ]	[ ]	[ ]	[ ]
Monitoring fish ponds	[ ]	[ ]	[ ]	[ ]
Harvesting rice	[ ]	[ ]	[ ]	[ ]
Harvesting fish	[ ]	[ ]	[ ]	[ ]
Selling rice at market	[ ]	[ ]	[ ]	[ ]
Selling fish (if IRFF)	[ ]	[ ]	[ ]	[ ]
Managing income from sales	[ ]	[ ]	[ ]	[ ]

29. Has the introduction of IRFF changed the labor burden for women in your household?

- Increased women's workload
- Decreased women's workload
- No change

30. Do women in your household have a say in decisions related to fish farming?

- Yes, equally with men
- Yes, but less than men
- No, only men decide
- Not applicable (no IRFF)

31. Do you ever hire external labor? If yes, for which activities?

- Land preparation
- Planting
- Weeding
- Harvesting
- Fish pond construction/maintenance
- No hired labor

32. If you hire labor, what is the typical payment?

- Per day (cash)
- Per task (cash)
- Share of harvest
- Food/meals only

Section E: Perceived social risks, constraints, and benefits

33. What benefits have you experienced from IRFF compared to conventional rice farming? (Tick all that apply)

Benefit	**Yes**	**No**
Increased food security	[ ]	[ ]
Reduced need to buy fish	[ ]	[ ]
Better nutrition for children	[ ]	[ ]
Diversified income sources	[ ]	[ ]
Reduced pest problems in rice	[ ]	[ ]
Better social standing in community	[ ]	[ ]
Improved soil/water quality	[ ]	[ ]
Reduced need for chemical fertilizers	[ ]	[ ]
Other (specify):…….	[ ]	[ ]

34. What challenges/constraints have you faced with IRFF? (Tick all that apply)

Constraint	Yes	No
High cost of fish fingerlings	[ ]	[ ]
Lack of technical knowledge on rice-fish integration	[ ]	[ ]
Difficulty managing water levels for both rice and fish	[ ]	[ ]
Predators (birds, snakes, etc.) eating fish	[ ]	[ ]
Conflicts with neighbors over water use	[ ]	[ ]
Lack of access to markets for fish	[ ]	[ ]
Low market price for fish	[ ]	[ ]
Lack of extension support	[ ]	[ ]
Insufficient labor during peak seasons	[ ]	[ ]
Fear of fish damaging rice plants	[ ]	[ ]
Land tenure insecurity (fear of losing land if investing in ponds)	[ ]	[ ]
Fish diseases	[ ]	[ ]
Flooding or drought affecting production	[ ]	[ ]
Other (specify):……	[ ]	[ ]

35. What social risks (if any) do you associate with IRFF? (Tick all that apply)

- Conflict with other farmers over water
- Increased workload leading to stress
- Jealousy from non-IRFF farmers
- Women losing control over income
- Increased family conflict over labor allocation
- No social risks
- Other (specify): …….

36. What opportunities do you see in IRFF for improving your livelihood? (*Tick all that apply*)

Increased income from fish sales

Improved nutrition from eating fish

Employment for youth/women

Better use of available water resources

Reduced input costs (fertilizers, pesticides

Year round food availability

Other (Specify): ……

37. Have you received any training or extension support specifically for IRFF?

- Yes → From who?……..
- No

38. If no training, would you be interested in receiving training on IRFF?

- Yes
- No

39. Do you have access to markets for both rice and fish?

- Rice only
- Fish only
- Both rice and fish
- Neither

40. Are there any cultural or religious beliefs that affect your decision to integrate fish with rice?

- Yes (specify): ……
- No

41. Would you recommend IRFF to other farmers in Erute South?

- Yes
- No
- Not sure

  Why?.....

Section F: Community and policy support

42. Have you been involved in any community group or cooperative related to rice or fish farming?

- Yes

- No

43. If yes, what support does the group provide?

- Access to fingerlings
- Access to markets
- Training
- Savings/credit
- Other (specify):

  …….

44. What role do local leaders (LCs, sub-county officials) play in supporting rice-fish farming?

- Provide training
- Link farmers to extension
- Help with water management conflicts
- Help access credit
- No support
- Other

  (specify):……

45. What kind of support from government or NGOs would help you improve IRFF? (*Tick all that apply*)

Subsidized fish fingerlings

- Training on rice-fish integration
- Low-interest loans
- Better market access (e.g., fish collection centers)
- Water management infrastructure
- Fish feed subsidies
- Extension services
- Other (specify): ……

Section G: Final thoughts

46. What are your main recommendations to promote IRFF among smallholder farmers in Erute South?

……
……

……..

47. Any additional comments or suggestions regarding rice-fish farming?

……
……
……

THANK YOU FOR YOUR PARTICIPATION!

APPENDIX II: Key Informant Interviews held with the respondents



(a) Researcher interacting with farmers during data collection in Agali sub-county



(b) Data collection assistant with a farmer in Itek sub-county









(c) Photos taken from the field during data collection