WELFARE IMPACT OF IFAD VALUE CHAIN DEVELOPMENT PROGRAMME ON RICE FARMERS IN EBONYI STATE: AN ENDOGENOUS TREATMENT

AMADI, MARK UMUNNA (B.Agric, M.Sc.)
20164024478

A THESIS SUBMITTED TO

THE DEPARTMENT OF AGRICULTURAL ECONOMICS

POSTGRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY (PhD) DEGREE IN AGRICULTURAL ECONOMICS

December, 2025

CERTIFICATION

This is to certify that this thesis,'Welfare Impact of IFAD Value Chain Development Programme on Rice Farmers in Ebonyi State:An Endogenous Treatment'was carried out by **Mark Umunna** Amadi(Reg.No.:20164024478)in partial fulfillment of the requirements for the award of Doctor of Philosonhv(PhD)Degree in Agricultural Economics

07/01/2026

Prof.(
(Principal Supervisor) **Date**

07/01/2026

Prof.S.U.0.Onyeagocha Date
(Co-Sunervisor)

07/01/2026

Prof.C.A.Emenyonu Date
(Co-Supervisor)

Dr.F.O.Nwosu Date
(HOD,Department of Agricultural Economics)

Prof.O.O.Emenalom Date
(Dean,School of Agriculture and Agricultural Technology)

Prof.Mrs.J.N.Nwosu Date
(Dean,Postgraduate School)

Prof.A.I.Achike Date
(External Examiner)

ji

DEDICATION

This research work is dedicated to Almighty God, the greatest philosopher, and the beginning and end of all knowledge, for seeing me through the process.

ACKNOWLEDGEMENTS

I extend my immense gratitude to my principal supervisor, Prof. C.C. Eze, for his astute guidance and support, and to the dedicated co-supervisors, Prof. S.U.O. Onyeagocha and Prof. C.A. Emenyonu, who demonstrated great professional disposition in the creation of this research exposition. May God continue to bless you all with the wisdom to promote academic excellence.

I must acknowledge the invaluable contributions of Prof. J.S. Orebiyi, Prof. P.C. Obasi, Prof. M.A.C.A. Odii, Prof. U.C. Ibekwe, Prof. J.I. Lemchi, Prof. O.C. Korie, Prof. N.C. Ehirim, Prof. I.U.O. Nwaiwu, Prof. C.S. Onyemauwa, Dr. (Mrs.) G.N. Ben-Chendo, Dr. I.I. Osugiri, Dr. (Mrs.) M. Osuji, Dr. (Mrs.) C. Chikezie, Dr. U.A. Essien, Dr. O.B. Ibeagwa, Dr. I. I. Ukoha, Mr. I.G. Ime and all academic staff in the Department of Agricultural Economics for their assessment and improvement of my work and research personality. May God reward all your efforts.

I am grateful to the Dean of the School of Agriculture and Agricultural Technology, Prof. O.O. Emenalom and the Head of the Department of Agricultural Economics, Dr. F.O. Nwosu, for leading from the front in a faculty dedicated to growing professionals. I cannot thank you enough.

I must appreciate the dexterity of the Dean of Postgraduate School, Prof. (Mrs.) J.N. Nwosu, for upholding the efficiency of research work procedures at this level. Also, I extend my gratitude to her team, the Associate Dean - Prof. C.C. Egwuonwu, the PGS Secretary – Mrs. Stella Chioma Nwadike, and my Schedule Officer – Mrs. Nkechi-Remy Chukwu, who assisted in smoothening my journey through the postgraduate school in academics and administrative matters. May God continue to bless your efforts and reward you richly.

I acknowledge the contributions all individuals who participated in the research field work; the extension agents (Mr. Sunday Itumo, Mr. Charles Eze, Mr. Nwambam Iruka), Mr. Samuel Obinna

Ucha, Mr. Kingsley Ezeogo, and the farmers who committed time and expertise to ensure the success of the meetings, sampling process, surveys, questionnaire administration and interviews. May God meet you at your point of need, individually.

To my colleagues and supervisors at my workplace, who were patient with me throughout the postgraduate journey while also providing professional advice and encouragement to keep me motivated, you are invaluable assets. Thanks a million.

To my classmates during the postgraduate, you provided another support system away from home, filled in for me when I could not, kept me updated and informed. Your impacts are well acknowledged.

I deeply acknowledge the unwavering emotional, mental, and financial support of my parents, Sir and Lady R.O. Amadi, my siblings and my wife, for encouraging me through the ups and downs of this unique height of research and academic advancement. I am eternally grateful to all of you.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

ABSTRACT

The study analyzed the welfare impact of the IFAD value chain development programme (VCDP) on rice farmers in Ebonyi State. Its specific objectives were to evaluate; the impact of the VCDP on the income of rice farmers, the impact of the VCDP on the productivity of rice farmers, the impact of the VCDP on the food and nutrition security of rice farmers, the impact of the VCDP on access to education of the rice farmers and the impact of the VCDP on access to healthcare of the rice farmers, in Ebonyi State. A multi-stage sampling procedure was employed, using a combination of simple and stratified random sampling techniques to select the rice VCDP farmer beneficiaries and non-beneficiaries from the local government areas, then primary data were collected using a well-structured questionnaire. The data were analyzed using a double robust treatment model – inverse probability weighted regression adjustment (IPWRA) – for the impact of participation in the rice VCDP on the welfare outcomes of the farmers. Results of the analyses showed that rice VCDP had positive and significant impacts on the net farm income (1.79% points increase), on the total factor productivity (1.014 increase), on the food & nutrition security (8.69 score increase), and on the children's average years of schooling (0.54 years increase), for the rice farmer participants. Also, the rice VCDP intervention had a negative and significant impact on the healthcare expenditure (66.7% decrease) of the rice farmer participants. The key determinants of farmer participation in the rice VCDP were membership in an agricultural association, participation in agricultural training, access to extension and access to inputs from agricultural associations. In addition, the welfare outcomes of farmers were influenced by farm size, household size, farming experience, and the frequency of extension visits. The study recommends that: the VCDP intervention be scaled up to cover more LGAs; the formation and formalization of agricultural associations/cooperatives be facilitated through a working relationship between Departments of Agriculture and Registrars of Cooperatives to the benefit of farmers; the local authorities assist in domesticating agricultural trainings at the community levels to ease farmer participation; establishment of extension services outpost in all communities be implemented while also mobilizing extension service providers adequately; the local authorities should assist in scaling rice farmer market participation capacity by developing land-banks which will make agricultural land readily available and accessible at low-cost for farming purposes only. The study contributes to impact evaluation literature by utilizing quantitative and qualitative measures to explore plausible relationships between farming decisions and education and health outcomes of households.

Keywords: Agricultural intervention; Value chains; Rice Farmers; Welfare outcomes; Treatment effects

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

In Nigeria, the agricultural sector constitutes a cornerstone of the economy, contributing approximately 24–26% to the Gross Domestic Product (GDP) in recent years (National Bureau of Statistics [NBS], 2023). Given that the sector is predominantly comprised of smallholder farmers, targeted developmental interventions possess the potential to substantially enhance its GDP contribution and promote inclusive economic growth. Augmented cereal production, particularly rice, has been demonstrably linked to agricultural advancement, which is intimately associated with overall economic development in the region (Fanifosi, Asiru and Rauf, 2025). Rice cultivation, as an integral component of broader cereal and staple crop farming, plays a pivotal role in economic expansion, poverty alleviation, and food security across Sub-Saharan Africa. Agricultural growth, especially in critical activities such as rice production, exerts significant multiplier effects on rural incomes, particularly benefiting the most impoverished households and aiding in poverty reduction, albeit the impact is more pronounced in rural settings than in urban ones (Sassi, 2023).

Recent investigations (CABI, 2024) underscore that fortifying local rice production, processing, and marketing systems can enhance access to affordable food while simultaneously generating employment opportunities throughout the value chain, thereby improving nutritional and health outcomes for rural communities. Despite Nigeria's status as one of the largest rice producers on the African continent, the nation remains one of the foremost importers of milled rice, indicative of enduring deficiencies in processing capacity, infrastructure, and market efficiency (Food and

Agriculture Organization [FAO], 2023). Nevertheless, countries in Sub-Saharan Africa, including Nigeria, are increasingly adopting rural transformation strategies that capitalize on agri-food value chains and the burgeoning demand for higher-value products to stimulate growth (Nigeria Agribusiness Group [NABG], 2024). Staples such as rice persist as vital conduits through which productivity enhancements can translate into improved living standards for vulnerable populations, thereby highlighting the necessity of sustained investment in the sector. Investments in agricultural innovation, research, and the adoption of improved agronomic practices (e.g., fertilizers and organic inputs) are essential for augmenting rice productivity and yield stability, which in turn bolster food security and facilitate poverty alleviation (Awio, Senthilkumar, Ibrahim, Corbeels and Saito, 2025; Malec, Rojik, Maitah, Abdu and Abdullahi, 2024).

Over the years various programs have been introduced in Nigeria by the government and development partners with efforts geared towards breaking down the structural and financial barriers that hinder the agricultural sector from thriving to strategically unlock the sector potentials and stimulate the growth in local production. Rice is a major staple food crop for Nigeria, and was also selected for the Value Chain Development Programme.

In Nigeria, a Value Chain Development Programme (VCDP) was initiated in 2010. The International Fund for Agricultural Development (IFAD) supported-VCDP was a six-year project plan for the Federal Government of Nigeria (FGN) in conjunction with the States and Local Governments within (using a counterpart funding approach). The VCDP which was approved for loan & grant in 2012 but finally took-off from 2013 was piloted in six States (Anambra, Ebonyi, Benue, Niger, Ogun and Taraba) of Nigeria and targeted a total of 20 LGAs. It is centered on the value chain of two crops – rice and cassava – to address the current production, productivity and

marketing constraints in a holistic manner using a participatory rural approach (PRA). The sought after major development objective of the FGN-IFAD-VCDP is basically to enhance the income and food security levels of Nigerians, starting with the program output target of 15,000 smallholder farming households, 1680 processors and 800 traders engaged in production, processing and marketing of rice and cassava across the states.

Rice is a key crop in Ebonyi State as reflected in the Ebonyi State Agricultural Policy objectives from 2010 – "provision of an enabling environment for rice production in particular and for other crops in general". The rice crop is cultivated in all the agricultural zones of the state where also the government ensured the establishment of modern large capacity rice mills since 2013. Ebonyi State is recognized for its high rice yields, with mean production values reaching up to 7,805 kg/ha, making it a leading rice-producing area in southeastern Nigeria (Mba, Ajaero and Obetta, 2021).

1.2 Statement of the Problem

Recent research indicates that global food insecurity persists as a formidable challenge, with estimates suggesting that between 691 and 900 million individuals worldwide currently endure food insecurity, and these figures are anticipated to escalate, particularly in Africa (Fotakis et al., 2024; Iannotti, Kleban, Fracassi, Oenema, and Lutter, 2024). Africa remains the most afflicted continent, exhibiting the highest prevalence of undernourishment and food insecurity, a trend that is projected to deteriorate due to rapid population growth, climate change, and protracted conflicts (Dasgupta and Robinson, 2022; Iannotti et al., 2024).

Nigeria is faced with serious issues of food security and economic challenges, because the rising demand of its important staples like rice is not met with domestic supply due to the low quality, unreliable supply chains and limited market linkages, especially for smallholder farmers (Chiaka,

Zhen, Hu, Xiao, Muhirwa and Lang 2022; Odewole, Sanusi, Sunmonu, Yerima, Mobolaji and Olaoye, 2024).

The rapid escalation of population, urbanization, and income continues to surpass domestic rice production and distribution capabilities, culminating in enduring deficiencies that necessitate heightened rice imports and exert pressure on foreign exchange reserves (Chiaka et al., 2022; Odewole et al., 2024). Quality disparities between imported and locally produced rice remain a pivotal determinant shaping consumer preference, underscoring challenges in production technology, value addition, and processing standards (Odewole et al., 2024). Additional impediments include limited access to inputs, credit, and output markets, alongside gender disparities in productivity and market intelligence, which further constrain the competitiveness of domestic rice (Chiaka et al., 2022; Ojo and Baiyegunhi, 2023). Recent investigations underscore the imperative for digitalization and enhanced infrastructure within the rice value chain to augment productivity, market accessibility, and transparency, while concurrently advocating for targeted policy interventions aimed at empowering women and smallholder farmers (Ojo and Baiyegunhi, 2023; Odewole et al., 2024). Addressing these systemic challenges through the adoption of advanced technologies, optimization of the value chain, and implementation of inclusive policies is crucial for Nigeria to satisfy escalating demand and diminish dependence on rice imports (Ojo and Baiyegunhi, 2023; Chiaka et al., 2022; Odewole et al., 2024). Evidence suggests that targeted poverty alleviation strategies—such as those integrated within VCDPs—can engender a "virtuous spiral," wherein the reduction of poverty itself further catalyzes economic growth, particularly when interventions are meticulously tailored to address the specific needs of the impoverished (Thorbecke and Ouyang, 2022). Notwithstanding, various problems abound from the foregoing.

First, there are debates on the effectiveness of the outcomes or impact of value chain interventions on both the academic and policy-making scene, due to the context peculiarities, the constraints of cultural and institutional barriers, the gender challenges and the inability to secure access to profitable markets (Malhotra et al., 2024; Malhotra et al., 2023; Gurmessa et al., 2022).

Some studies indicated that interventions such as local food systems, regional food hubs, and enhanced value chain coordination can bolster food security, augment fruit and vegetable consumption, and facilitate poverty alleviation, particularly when they incorporate financial incentives, community engagement, and support for smallholder farmers (Biggeri, Carraro, Ciani and Romano, 2022; Garrity et al., 2024; Hermiatin, Handayati, Perdana and Wardhana, 2022; Vos and Cattaneo, 2021; Wang, Wang, Sarkar and Qian, 2021). However, the evidence is not uniformly affirmative or guaranteed positive because, other studies (Garrity et al., 2024; Guerra et al., 2021) have underscored enduring obstacles such as limited accessibility, insufficient program awareness, and cultural discrepancies, which may impede the efficacy of interventions, particularly among low-income or marginalized populations. Furthermore, (Garrity et al., 2024; Hermiatin et al., 2022) accentuates the necessity for more extensive, longitudinal studies to comprehensively ascertain the impacts of value chain interventions across diverse contexts and to delineate best practices for implementation. Thus, while value chain interventions exhibit potential for enhancing food security and mitigating poverty, their outcomes are inherently context-dependent, necessitating further inquiry to elucidate their effectiveness and scalability (Biggeri et al., 2022; Garrity et al., 2024; Hermiatin et al., 2022; Wang et al., 2021).

Second, there is the problem of validity and reliability of models used to assess agricultural value chain interventions, and these concerns are well founded based on the appropriateness of analytical

tool (Ouya et al., 2023; Wang et al., 2021). Whereas tools such as Propensity Score Matching (PSM) are frequently employed to estimate population effects and welfare outcomes, they may inadequately address endogeneity stemming from unobservable factors, thereby potentially biasing results (Ouya et al., 2023; Rajkhowa and Qaim, 2021). This limitation prompted the use of Instrumental Variable (IV) regression models, which can accommodate both observed and unobserved heterogeneity; however, these models encounter their own set of challenges— most notably, the arduous task of identifying valid instruments that fulfil the requisite statistical assumptions (Ouya et al., 2023; Ullah et al., 2021).

Recent investigations in related domains have delved into more advanced econometric modelling methodologies to enhance estimation precision. For instance, the integration of Markov Chain Monte Carlo algorithms with random coefficient quantile autoregression has demonstrated a marked improvement in predictive accuracy and model fidelity within economic forecasting; however, this technique has yet to gain widespread traction in agricultural value chain analyses (Wang, 2025). In a nutshell, despite the complexities surrounding the impact evaluation of such value chain interventions, econometric models remain indispensable, their limitations only underscore the necessity for methodological innovation and meticulous analysis selection based on the peculiarity of the intervention and data available thereof, to ensure credible impact assessments in value chain interventions. The FGN-IFAD VCDP implementation procedure is such that selection into the programme is non-randomized. Hence, the estimation of the outcome effects for the programme based on the welfare attributes of participants is most likely affected by some observed and unobserved characteristics which informed selection of participants into the programme intervention.

Third, there is paucity of studies on the impact of the VCDP on farmers, more especially for farmers in Ebonyi State. No research papers were found that specifically evaluated impact level effects of the IFAD-VCDP on the economic welfare of smallholder rice producers in Ebonyi State, particularly with focus on the larger community effects beyond immediate beneficiaries. The study by Chidiebere-Mark (2017) focused on an analysis of the rice value chain in Ebonyi State, and it revealed the various constraints on farmers in the value chain, thus necessitating an in-depth inquiry on the possible transformations for the farmers after receiving the VCDP intervention. On the other hand, a study on the effects of IFAD-VCDP on the economic welfare of smallholder rice and cassava producers in Anambra State Nigeria (Tenabe, Olayide and Nwadihu, undated), was more or less a descriptive analysis of the immediate output of farmer beneficiaries of the VCDP intervention, devoid of elucidating impacts of the intervention.

Ebonyi State is home to various rice production support and development programs/policies (Anchor Borrowers Program, Growth Enhancement Scheme, FGN Agricultural Transformation Agenda, FADAMA projects, Zero Hunger Initiative, Presidential Rice Initiative, One-Man OneHectare Program, etc.) because of its most important role in rice production and processing, and also with the vision of ensuring sufficiency and scaling up exportation capacity for the country. These government programs/development partner programmes have played a significant role in promoting modern farming techniques and supporting smallholder rice farmers, and continued support and policy refinement are recommended for sustained growth (Chima, Gberevbie, Duruji, Osimen and Abasilim, 2024). In the same vein, the pilot phase of the FGN-IFAD VCDP was drawn to its determined project end in 2019 after being in place for more than five years; it is then of utmost importance considering the aforementioned debates (sustainable effect of the VCDP intervention and the validity of the analytical procedure for its evaluation), the future of the

programme and future policy recommendations to evaluate the programme given the major goals and researchable outcomes for which it was set-up to achieve.

Therefore, this study is novel because there is no acknowledged detailed research work carried out on the range of welfare outcomes of this intervention for smallholder farming households in Ebonyi State (a primarily recognized recipient of the pilot programme in Southeast, Nigeria).

1.3 Objectives of the Study

The main objective of this research is to evaluate the welfare impact of the IFAD Rice Value Chain Development Programme on farmers in Ebonyi State.

The specific objectives are to:

i. assess the socio-economic characteristics of the rice farmers in Ebonyi State; ii. estimate the income of rice VCDP participant and non-participant farmers in Ebonyi State; iii. evaluate the impact of the VCDP on the income of the rice farmers in Ebonyi State; iv. estimate the food and nutrition security level of rice VCDP participant and non-participant farmers in Ebonyi State;
v. evaluate the impact of the VCDP on the food and nutrition security of the rice farmer households in Ebonyi State; vi. estimate the productivity of rice VCDP participant and non-participant farmers in Ebonyi

State; vii. evaluate the impact of the VCDP on the productivity of rice farmers in Ebonyi State; viii. evaluate the impact of the VCDP on the access to healthcare by the rice farmers in Ebonyi

State; and ix. evaluate the impact of the VCDP on the access to education of the rice farmers household in

Ebonyi State.

1.4 Hypothesis of the Study

The study is based on the hypothesis that:

1. **H_0:** the Rice VCDP has no significant impact on the income of rice farmers in Ebonyi State.
2. **H_0:** the Rice VCDP has no significant impact on the productivity of rice farmers in Ebonyi State.
3. **H_0:** the Rice VCDP has no significant impact on the food and nutrition security of rice farmers in Ebonyi State.
4. **H_0:** the Rice VCDP has no significant impact on the healthcare of rice farmers in Ebonyi State.
5. **H_0:** the Rice VCDP has no significant impact on the education of rice farmers households in Ebonyi State.

1.5 Justification for the Study

It can be deduced that the intentions of the government are basically to support efficiency in the productive activities of farmers in the rice sub-sector from input supply through to distribution of the products in the best form, time and place; and also, to stimulate private sector investment in agriculture (Nwankwo, Ikehi, Ejiofor and Ifeanyieze, 2024).

Rice over the years emerged no more as a luxury food but as an important commodity across all income levels, raising demand levels way above supply. The development of the rice sector serves to horn its potentials towards driving economic growth; eliminating extreme poverty and food insecurity; improving the social wellbeing of the populace while ensuring economic

competitiveness by improving the terms of trade. The VCDP for rice was considered a potential means of achieving the aforementioned objectives, hence implemented in Ebonyi State (among the most recognized cultivators of rice in the southern part of the Nigeria), with the programme focus on the rice value chain to stimulate markets, industries and the private sector.

This study assessed the intended developmental goals of the programme with a view to elucidating practical policy action pathways in the interest of the country. The focus of this work on the rice farmers is due to the place of rice in the economy and its importance for Ebonyi State which is yet to fulfill her remarkable potential for extensive commercialization and the wide range of the VCDP policy beneficiaries across the country.

The rice sector development contributes to programs to enhance food production, food security and reduce poverty indices. Also, it contributes to the competitiveness of the Nigerian economy by highlighting the best approach to food supply systems and encourage an export driven economy. This study helped stakeholders deduce the extent of value chain development interventions for bettering the welfare of the activity actors (e.g. the farmers) through improved marketing channels in rice producing region like Ebonyi State.

An impact study presents evidence to build on the gains of integrating synergy in local production, processing and marketing to create huge employment opportunities using the value chain approach especially to encourage the structural transformation of the agricultural and rural sector. Research in this domain contributes to literature on the outcome of value chain development of food systems in developing economies. It is also beneficial to programme managers, policy formulators and development partners in identifying the most effective organization of interventions, plans and resources allocation projects which lead to desirable long-run outcomes.

Furthermore, the study highlighted the relationship in using agricultural innovations to improve education and pro-health practices of rural people. It helps policy makers by revealing salient way of using agricultural interventions to improve the basic needs of society while also helping value chain actors to harness the advantages of social capital by creating such food supply networks. **1.6 Scope of the Study**

The study investigated the welfare impact of agricultural value chain interventions on rice farmers. It focused on the first phase of the rice value chain development programme (VCDP) done in Ebonyi State from 2012 to 2019, with the objective of estimating its impacts in terms of income, productivity, food and nutrition security, education and healthcare, on the rice farmers. The study involved only rice farmers in Ebonyi State and information was obtained from the farmers through questionnaires and interviews for those within and outside of local government areas that participated in the rice VCDP.

The study used an ex-post survey data, due to the limiting nature of information available in baseline data of the rice farmers before the VCDP intervention to be aligned with the objectives of the research. Hence, the use of impact evaluation tools capable of estimating impact based on only post-intervention observational data.

The study was focused on only rice farmers as beneficiaries of the rice value chain intervention, without investigating their functional linkage activities with other nodes/actors in the rice value chain. Hence, the activities of other rice value chain actors were not considered.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Literature Review

2.1.1 The Value Chain Concept

A value chain concerns "all the important value-adding activities required while bringing a product or service through the different phases of production, including the procurement of raw materials and other inputs, assembly, physical transformation, acquisition of required services such as transport or cooling and ultimately response to consumer demand" (United Nations Industrial Development Organization [UNIDO], 2009; Kaplinsky and Morris, 2002). The idea behind this system is that, based on the sequential flow pattern each activity or actor along the chain tends to add to the gains of the product (Russel and Hanomanjee, 2012). The value chain approach is otherwise a system or robust tool with which governments and/or private donors try to protect threatened links in business, facilitate the upgrading for better returns and also aid the development of small and medium enterprises (SMEs). The typical value chain as expressed by Porter (1985) comprises of two chains of activities: the Primary activities made up of input supply logistics, operations/transformation of inputs, output/distribution systems, marketing/sales and services; the Supporting activities made up of procurements, human resource management, technological development and infrastructures. Generally, a value chain system consists of linkage components including: Input suppliers – Producer/Farmers – Processors – Marketers/Distributors – Consumers; however, there are also variations based on the commodity specifications. Hence, the adoption of value chain development in agriculture where the various agencies are faced with the task of involving the small holder farmers and businesses in modern value chains to enhance their participation in global markets.

2.1.2 The Rice Value Chain

Rice as an agricultural commodity exhibits a value chain system "comprising of activities and actors involved in moving agricultural products from input suppliers to farm fields and lastly to the consumers (Miller and Jones, 2010). Such systematic sequence generally applies to the rice produce right from the input supply to farm production to assembly (paddy collections) to processing and to delivery at the local or international markets (Keyser, 2006).

In Svay Rieng province of Cambodia, the rice value chain comprised of input suppliers, producers, rice collectors, rice millers, traders and wholesalers/retailers (Serey and Lee, 2018). Elsewhere in Indian provinces of East Champaran and Davangere, the rice value chain identified involved; producer - commission merchant/itinerant merchant/paddy wholesaler – miller – wholesaler – retailer - consumer (Pavithra, Singh, Ahmad, Sinha and Mishra, 2018).

Tinsley (2012) on the evidence of rice value chain analysis for Sokoto State Nigeria found that the value chain like businesses of the developing world follows the structure of small family enterprises. The actors include: the farmer, contract (tractor) mechanization people, agro-dealers buying the produce, transporter agents for the paddy, community paddy processors, rice processors for milling, transporter agents to the wholesalers, then the retailers.

According to Evbuomwan and Okoye (2017) the rice value chain in Nigeria starts with the paddy producers who move it down to cottage/commercial millers then down to the domestic markets.

They found that there are sub-chains which may arise within the linkages like farm gate paddy buyers who come in as middlemen to create markets for paddy.

Chidiebere-Mark (2017) in her study of rice production in Ebonyi State found that the structure of the value chain involved the common stages of; Input Supply to Production (smallholder rice farmers and farms involved in paddy trades) to Processing (dominated by traditional parboilers and community clusters of millers and also private/government owned mills) to Marketing (involving trades in milled/paddy rice at wholesale or retailer quantities and the facilitators like transporters).

2.1.3 IFAD Rice Value Chain Development Programme in Nigeria

Value chain development is a set of actions such as providing training or technical or financial assistance to smallholders, their business organizations and other value chain actors with the intent to build capacities and strengthen market linkages.

The IFAD-VCDP is aligned with; the National Agriculture and Food Security Strategy, the National Policy on Integrated Rural Development/Rural Development Sector Strategy and the National Agricultural Investment Plan (NAIP) of the Federal Government of Nigeria (FGN). The International Fund for Agricultural Development (IFAD) an agency of the United Nations (UN) was established in 1997 as one of the major outcomes and recommendations from the 1974 World Food Conference. IFAD was created as a means of putting a check on food insecurity and poverty in developing countries due to structure of their food systems. It mainly subscribes to the use of country-specific solutions.

The Nigeria IFAD-VCDP operates within the ambit of its Strategic Framework for 2016-2025 which is to enable the rural poor improve their food security and nutrition, raise income and strengthen their resilience. Hence, IFAD is focused on interventions in agriculture by enhancing productivity and access to market.

For the purpose of this study, it is important to know the specific aims/objectives of the FGNIFAD-VCDP which is categorized into three (3) Components (and their sub-components).

Component 1 – Agricultural Market Development aimed at enhancing profitability of smallholder farmers and small/medium scale agro-processors through activities of: (i) support to value addition and market linkages; (ii) support to market infrastructure.

Component 2 – Smallholder Productivity Enhancement through the activities of: (i) strengthening of farmer organizations; (ii) support to smallholder production.

Component 3 – Programme Coordination and Management to ensure efficient and effective achievement of expected results. The subject matter of particular interest is with the first two (2) components, as that is the motivation for this research.

2.1.4 Value Chain Development Related Programmes and Strategies

Value chain development is a form of innovation and coordination endeavour. The innovative function concerns the improvement of existing processes that channels a product from input, production and preparation stages until its end point distribution to the ultimate consumer as a finished product. A well-developed value chain otherwise enhances the creation of value across the process right from production ensuring the efficiency of the output, the profitable relationship of the actors and the competitive advantage of the end product in market pricing relative to substitute goods.

Rugema, Sseguya and Kibwika (2018) are of the opinion that smallholder farmers' participation in value chain programmes is for the purpose of the gains and incentives it possesses; they are also motivated by a participatory approach (PRA) in the programme plan with a reliable value chain

leader in charge of their affairs. This may have informed the Farmer Organisation (FO) group's strategy of the FGN/IFAD-VCDP. Since the smallholder farmers are most likely to participate in the intervention programmes, it is only proper to assess the impact of such leveraging activities to their welfare.

Maertens and Velde (2017) in their study of the contract farming scheme in the rice food chain of Benin, revealed very positive outcomes for the farmer welfare in the form of: expansion of the rice field area, intensification of rice production, increased commercialization of rice, higher farm gate prices and ultimately higher rice output growth and increased household income. However, Laroche-Dupraz and Huchet-Bourdon (2016) made objections relating to the higher farm gate prices which normally affects nominal rate of assistance especially for the developing countries leading to price distortions which do not in essence favour food security in global trade activities; this is rather at the macro-level analysis.

The Himalayan nettle of Nepal value chain was developed by way of: promotion of the local institutions, promotion of the linkages through private sector engagement, community level capacity building, enterprise development and product value addition development (Shah, Khadka, Ahmad, Budhathoki and Shrestha, 2017). These are identical to the features of the programme plan of implementation of the FGN/IFAD-VCDP. Evident from their analysis (Shah et al., 2017) realized a positive perceptible influence on the annual household income of the participants which is also related to the improved productivity. Shah, Nepal, Rasul and Ahmad (2018) also observed this positive impact on the production & income variables and some significant percentage drop in poverty for household participants in the bay leaf VCDP of Nepal. Similarly, a positive relationship

was deduced from participation in Global Value Chain activities (at an international level) and the firms' performance through their productivity (Montalbano, Nenci and Pietrobelli, 2018a).

Elsewhere in paper reviews by Terdoo and Feola (2016), they found that limited government support for rice farmers, lack of investment in post-harvesting and market inefficiencies are the main contributors to Rice Value Chain (RVC) vulnerability making it difficult for the SSA rice sector to meet up with the domestic demands of quality and external competition in the global market. They also found that the bulk of researches on RVCs are rice production biased.

This study concerns itself with the rice VCDP impacts on farmers' welfare thus, it is designed to help address the policy disconnects wherein such agricultural market growth improvement systems may bring about increased production, and yet produce negative effects on other aspects of farmer livelihood. Such unexpected negative dynamics was observed for rural India by Bhaskar, Nithya, Raju and Bhavani (2017), and often more pronounced in cases whereby the agricultural development programmes targeted staple foods. Hence, Sibhatu and Qaim (2017) used the household dietary diversity score (HHDS) to check the food security level of smallholder farmers of Ethiopia. Their results, though suggestive of the opinion of Bhaskar et al. (2017) however, tends to emphasize the importance of the income aspect of the welfare of farmers which can better improve the market purchase ability of the farmers as a more tenable solution to the problem compared to diversifying food crops production.

2.1.5 Agricultural Value Chains and the Transformation of Developing Economies

The income growth of developing economies has been found to not only contribute strongly in the development of AVCs but also to transcend its effects in the livelihood of the people. Growing income even from increased farm revenue rather increases consumer demand for high-quality foods

and foods which has undergone processing at the upper part of the AVCs (Yi et al., 2021). Income growth increases farmer demand foods outside their homes, also stimulating growth in the post farmgate agri-food value chains. Notwithstanding, farmer crop diversification, increases in their income comes with increased expenses in food expenditure outside their own production for the purpose of achieving good household dietary diversity (Liu, Barrett, Pham and Violette, 2020).

Market-oriented policies and reforms have in one way or another revolutionized the AVCs. These policies have in recent times made significant changes in the market regulation and dynamics to reduce government control and encourage private investment and more competitive markets. For instance, the rice importation bans in Nigeria during the Buhari regime and the value chain development program policies, scaled and transformed the domestic rice value chain in Nigeria to export levels. Some of these market policy reforms enhanced productivity and standardization in AVCs which subsequently led to trade globalization, birthing the global value chains (GVCs) in agricultural products for the developing countries (World bank, 2020). Participation in GVCs creates routes for AVCs to enter new markets, adopt new product standards and management practices hence, leading to technology diffusion, adoption, adaptation and development all the way to the farm-level for effectiveness (Foster and Rosenzweig, 2010; Barrett, Reardon, Swinnen and Zilberman, 2022).

Other extraneous factors or historical antecedents like crisis situations may influence the spatial outcomes of these agricultural interventions, however, the findings are not so different. Al Daccache, Abi Zeid, Hojeij, Baliki, Brück and Ghattas (2024) conducted a review to understand the impact of agricultural interventions post-crisis period in complex humanitarian emergency settings. They realised that whereas agricultural interventions for development purpose may differ from crisis situations; both of these supply-side projects basically involve the provision of

agricultural inputs. Realisations of these interventions' influence were only on the level of agricultural input use and techniques, without plausible impact on neither food & nutrition security and health nor on impact pathways of agricultural production, yield and income (Al Daccache et al., 2024). It is therefore imperative to understand the contexts in which interventions like the AVCs were implemented to better model the possible causal pathways for target outcomes.

2.1.6 Welfare as a Holistic Approach to Agricultural Value Chain Assessments

Generally, AVCs are targeted at developing market linkages to improve the farmer or value chain actors' income hence reducing the incidence of poverty (Ruel, Quisimbing and Balagamwala, 2018). However, such agricultural interventions are expected to improve food and nutrition through the income pathway. This is reflected in the several studies which analyse the impact of AVCs on food and nutrition security (Mossie, Gerezgiher, Ayalew and Elias, 2021; Nicholson, Monterrosa, and Garrett, 2021; Ndlovu, Thamaga-Chitja and Ojo, 2022; Al Daccache et al., 2024; Iordekighir, Biam, Abu and Ezihe, 2025).

Agricultural value chains are seen as viable strategies for poverty reduction (and possible elimination), probably because majority of the poor populations in the world depend on the agricultural sector hence, the AVC impacts especially on the income of farmers can lift them from poverty (Barrett et al., 2022). This narrative is valid considering the diversified strategy of AVCs which adopts combinations of investment at farm, processing and agro-processing levels, thus performs better than just investing in the smallholder farmer activity (Dorosh and Thurlow, 2018).

In literature, some studies have used the poverty measures to analyse the impacts of AVCs (Wang et al., 2021; Iordekighir et al., 2025) whereas, many others use farmer incomes in their evaluation

(Kissoly, Faße and Grote, 2017; Adediran, Osabuohien, Silberberger, Osabohien, and Adebayo, 2024; Iordekighir et al., 2025). The IFAD-VCDP had as one of its main objectives the alleviation of poverty by improving farmer income (Eissler and Heckert, 2024). Notwithstanding, most of these measures are keenly related, in other words serve the purpose of estimating the effects on farmer welfare.

The reference to welfare assessment is recurrent in literature, whereas it in fact refers to subtle variations of the usually measures of well-being. For instance, household food expenditure and household total expenditure have been used to assess welfare outcomes of farming households; such that data was obtained on 12-month food consumption spending and total spending on nonfood items of rice farming households, on per capita basis, to assess their welfare improvement from an agricultural program (Daudu, Abdoulaye, Bamba, Shuaib and Awotide, 2023). Yang, Zhang, Liu and Zeng (2021) analyzed farmers' welfare in terms of agricultural income and low- and high-income ranks. Martey, Etwire and Mockshell (2021) assessed welfare effects of comprehensive agricultural training programs in terms of productivity (yield) and income measures, a definition shared by (Baiyeghuni, Akinbosoye and Bello, 2022).

It is a fact that the income is the pathway through which the poverty status and most other welfare outcomes are influenced. Poverty is a major threat to world economies and global advancement, reason always captured in development goals like the Sustainable Development Goals (SDGs). However, poverty status is an aggregated index often computed from household income or household expenditures. Interestingly, Wang et al. (2021) analyzed the impact of participation in AVC on multidimensional poverty of households. The multidimensional poverty index was made

up of variables of; net income, years of education, children school enrolment rate, medical insurance coverage, fixed asset, housing condition, etc.

These variables are welfare outcomes which will rather be uniquely assessed singly in this study, in order to individually elucidate the extent of the impact of the rice VCDP on the various aspects of the livelihood of the farmers.

2.1.7 Conceptual Framework of the Value Chain Development Outcomes Evaluation

The VCDP is a market-led and participatory intervention designed to increase income and reduce poverty through enhanced market access. The conceptual framework captures the logical and expected cause-effect relationships among the inputs, outputs, intermediate results or outcomes and impact of the rice VCDP intervention, outlining the strategic objective of the project, highlighting the key linkages in the theory of change involved, particularly with respect to the sample of interest, the farmers. On a graphical basis the flow of inputs and specific activities is shown to transform the farmers' state from stage of value to a higher one in terms of welfare through their service of production. It goes to recreate the ideals intended for the intervention to create value which is diagrammatically expressed in the Fig 2.1.

In a similar context, Ogundipe, Oduntan, Ogunniyi and Olagunju (2017) posits that developmental actions orchestrated by enhancing the interplay of; income empowerment, market expansion and livelihood enhancement in order to improve the agricultural production systems (productivity) of smallholder farmers in developing (agrarian) economies provides among other gains; increase in rural income, food affordability, enhanced agricultural linkages, elimination of trans-generational poverty. Their research lends support from the reports and the works of; Department for

International Development (DFID) (2004), Thirtle, Lin and Piesse (2003), Bresciani and Valdes (2007), Schneider and Gugerty (2010).

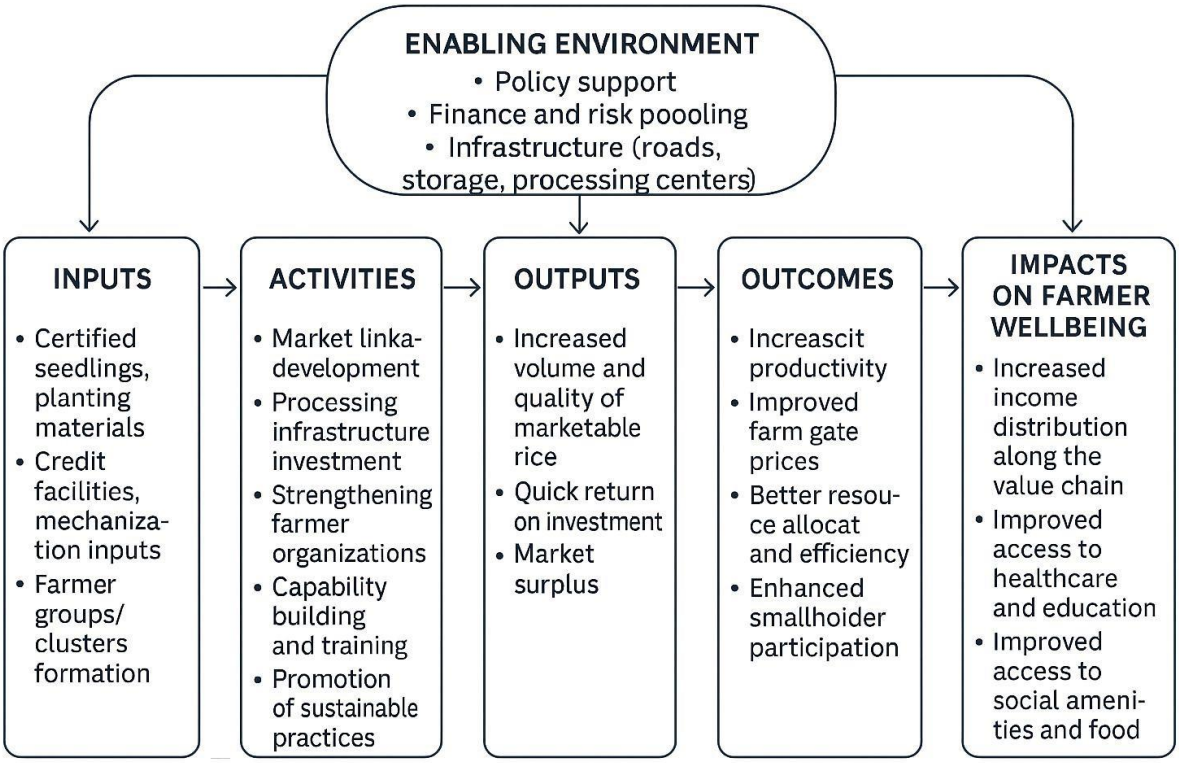

Figure 2.1 A conceptual framework of the pathway for outcomes to the farmer in the Rice Value Chain.
Source: Adapted from the VCDP Design (IFAD, 2012)

2.1.8 Farmer-Inclusive Participation Approach of Agricultural Value Chains

Research on the agricultural sector value chains predominantly centres on the analysis of participation models, efficiency of participation, the measurement and advancement of value chain

positioning, financing models for the value chain, and the performance evaluation of value chain participation (Islam, 2021; Yang and Chen, 2019; Balié, Prete, Magrini, Montalbano, and Nenci, 2019). The proliferation of innovative agricultural business entities and social service organizations significantly facilitates farmers' integration into the agricultural value chain.

Farmer participation in the agricultural value chain is predominantly confined to the intermediary mechanisms that connect them with downstream traders, including specialized cooperatives and niche markets. Otherwise, the farmers grapple with a tenuous market position, compounded by inadequate production capabilities and a dearth of financing options within the value chain. Farmer participation in AVCs is a form of technology adoption because it involves a process by which farmers or agricultural practitioners integrate new technologies or innovations into their farming practices. Agricultural value chains play a crucial role in facilitating technology adoption. It involves the generation of knowledge, testing and validation of technologies, dissemination of information to farmers, and ultimately, the uptake and utilization of technologies on the ground. This is essential for improving productivity and sustainability in the agriculture sector. Smallholder farmers can be seamlessly integrated into the value chain by the industry organizations using a variety of interest linkage mechanisms (Alexander et al., 2020).

This sub-section sheds light on the complexities and challenges of technology adoption, value chain participation, and trade policy in agriculture, highlighting the importance of promoting sustainable and inclusive agricultural development for smallholder farmers.

2.1.9 Agricultural Value Chains as an Instrument of Welfare Advancement

Agricultural value chains (AVCs) are market-based strategies which encourage the development of improved production methods link to modern marketing, supply, and distributional channels (Ola

and Menapace, 2020). In recent times, AVCs are aimed at supporting smallholder rural farmers, facilitating their integration into larger market frameworks and providing a pathway for the enhancement of their socioeconomic well-being (Wang et al., 2021). This means that AVCs have its core the enhancement of the welfare of the participants, making it possible to engender profound effects on post-poverty alleviation in rural regions and massive agricultural development.

The analyses of welfare contributions of AVCs could be quite complex, hence research can be focused on any level of the value chain. This study focuses on the producer/farmer level whereby the farmers participation was based on organization into groups or cooperatives as a key strategy, an observation also shared by (Bizikova et al., 2020).

2.2 Theoretical Literature Review

2.2.1 Agricultural Value Chains (AVCs) in Developing Countries

Agricultural value chains (AVCs), also known as agri-food value chains involve "the entire postfarmgate range of processing, storage, transport, wholesaling, retailing, food service, and other functions that transform agricultural outputs that farms produce into the foods humans consume daily" (Barrett et al., 2022). The developing economies are believed to conform to a certain pattern of development for economic advancement, which is the classical dual economy model of Lewis (1954) such that the agricultural/rural sector transforms to release factor resources to allow for the manufacturing and industrial sector to thrive, more especially in the urban regions. As the agricultural sector transforms through improved technologies, structural transformations result in factor reallocation, reducing labour needs in farms as people move into the urban areas to take up

jobs in the manufacturing and services sector. This urbanization creates opportunities in the agrifood value chain, given the whole lot of processes required to get food items readily available at cities from rural regions, enhancing the lot of the AVC actors all the more (Barrett et al., 2022). This is understandably so because, as urban population and income exceed the rural regions, the agri-food value chain activities at the farm level and to a greater extent beyond the farmgate increases significantly in quantity and quality of food product to serve consumer needs in the cities.

Barrett et al. (2022) argues that AVCs was conceived to play the valid and crucial role in the structural transformation of developing economies through the large agricultural sector. They reckon that productivity growth at the farm level revibrates as price changes and growth in the post farmgate value chain activities. The AVC market/trade policies can influence the level of integration of economies into global value chains, which has implications for food security, economic development, competitiveness, and welfare of the agriculture sector and beyond.

We must understand that value addition in the entire agri-food value chain system kick-starts from the farm firm and improves other economic activities as young economies develop.

2.2.2 Welfare Measurement Dimension

Welfare as an economic as well as statistical construct (based on the objectivity of measurement) is essentially identical and strongly drives application through economic theory (Deaton, 1980).

Welfare is well-founded on the economic theory of preferences and utility derived from an individual's satisfaction from the consumption of goods.

The theory of preference and utility here considers welfare based on choice of the individual for market or non-market goods and services. In this respect, a reference or standard bundle of commodities is considered for individuals based on consumers own taste, hence are seen as possessing preference ordering which can be represented by a utility function, u (q); for the commodity q, which has the property such that if a bundle commodity q_1 is preferred to another bundle commodity q_2, then, $U(q_1) \geq U(q_2)$. This follows for any f (u(q)) with a positive first derivative. Albeit the challenges of unit measurement of utility, the use of preference guarantees that the welfare measure increases as consumer moves from a less to a more preferred position, hence the indifference curve is a graphical representation.

Deaton (1980) theorized the measures of welfare into quantity metric utility (which conceptualizes welfare based on consumption preferences and quantities) and money metric utility (an indirect utility function market measure based on minimum cost at some reference prices). Further to this, Hick's conceptualizations of the utility function of Equivalent variation (EV) and Compensating variation (CV) also provides welfare measure, which can estimate cost of living differences or at index levels (Hicks, 1956).

Welfare can also be considered in the context of intertemporal choice (or full intertemporal welfare basis) where the life cycle analysis (stemming from the life-time utility) is used to theorize its relationship to income, consumption and assets of individuals. Stocks of durable goods (e.g. housing, landed property, etc.) are also used in welfare measures on the basis of the neo-classical theory of durable goods (Diewert, 1974). The labour-leisure dimension also provides estimates for welfare based on utility in the household production function combining time with goods to yield desired outputs (Becker, 1965). Furthermore, labour supply dimensions such as the stock of human

capital acquired through education and training is suggested for consideration in welfare measures given its contribution to household production and earnings (Stigler and Becker, 1977; Mincer, 1976).

In summary, Deaton (1980) found that the theoretical foundations of welfare measures and determination involves the key income-consumption interactions as they affect the distribution of needs, private and public goods (water, drainage, housing, education, health system, social security, etc.) and other economic factors. Welfare measures make cognitive demands with respect to subject of interest and choice of what to measure, and also in relation to what is obtainable and acceptable in the society. In the aspect of measurement of social welfare certain goods are a precondition and these constitutes the real welfare factors consisting of nutrition, housing, education, health, life expectations, environmental quality, crime and poverty levels; the monetary aspect is often downplayed under this caveat of welfare (Offer, 2000).

In a well-structured system, rice production creates employment along the value chain and in related sectors which will lead to improvement in nutrition and health status of the rural poor involved, helping them with finance for better education and improved opportunities for the future (AfricaRice, 2011).

Pigou (1920) was a trailblazer in the field of welfare economics, adeptly distinguishing between economic and non-economic welfare. Subsequently, Sen (1970) advanced the theory of functional and capacity welfare, emphasizing human freedom and decision-making capabilities as metrics for assessing the quality of life, thereby ushering welfare research into a new and profound phase.

Therefore, in this study, welfare of farmers specifically refers to their income, productivity, food and nutrition security, education and health outcomes. Hence, measures of these five mentioned aspects are the premise upon which farmers' welfare will be analyzed.

The choice of these five measures is based on their relevance in development activities for developing countries, and the interrelationship that exists between them with productivity at the lead. This relationship is also the basis of goal 2 of the Sustainable Development Goals (SDGs) – end hunger, achieve food security and improved nutrition, and promote sustainable agriculture – given the idea that agricultural productivity delivers an effective contribution to poverty reduction through food security and higher farm incomes (Kassie, Tekalegne and Tjabeha, 2020; Berha, Mogess and Wassie, 2021). The Malabo Declaration of 2014 also identifies agricultural productivity as a central objective towards achieving food and nutrition security. These choices of measures for assessment are more importantly guided by the main development objectives of the VCDP and the performance aspects for which the programme is intermediately evaluated (Value Chain Development Programme Supervision Reports 2015 & 2017). However, considering the structure of the flow of outcomes from the programme, the welfare indicators of education and health are indirect or presumed to be at the secondary level of effects in the long-run.

2.2.3 The Theory of Productivity Measures in Agricultural Practice

Productivity is “the ratio of the volume measure of output to a volume measure of input use” (OECD, 2001); it simply measures the amount produced by a farm given a set of resources and inputs. Productivity originates from the “theory of the firm”, which takes into consideration optimal allocation of inputs/scarce resources by profit maximization of outputs or cost minimization of

inputs. Productivity measures are divided into Partial or Total productivity. Partial productivity focuses on the output with respect to one factor aspect such as land or labour or capital productivity. For instance, productivity as a measure of farm efficient use of resources can be measured in yield per hectare. This measure of output per hectare for instance, grams/hectare or kilograms/hectare or tonnes/hectare is widely applied in agricultural research (Abdul-Rahaman, Issahaku and Zereyesus, 2021; Martey et al., 2021; Daudu et al., 2023; Wanzala, Marwa and Lwanga, 2024). It indicates how well the land space is utilized (but implicitly considers the efficiency of the other inputs applied to the land). Output per hectare measure is also adopted as a way to standardize or provide equivalent measurement across all observations/farmer units in order to control for discrepancies from differing scales of production.

Notwithstanding, the partial measure of productivity may underestimate the efficiency in factor use in the farm system hence, there is the Total Factor Productivity otherwise known as the Multi-Factor Productivity which is more holistic in its approach. TFP is "the difference between production and input changes or what remains after estimating the contribution of inputs to production change (OECD, 2001). TFP is the ratio of an index agricultural output (value-weighted sum of agricultural production components) to an index of agricultural inputs (value-weighted sum of convention agricultural inputs). This study will employ the TFP measure due to its advantage to assess productivity of rice farmers (producers). This approach is valid because changes in productivity measures observed gives an indication of the technological progress changes attributable to the aspects of agricultural research and development, extension services, human capital development, commercial infrastructure, government policies or even environmental degradation (Ahearn, Yee, Ball and Nehring, 1998). In other words, the TFP measures gives an

indication of the influence of rice VCDP on the level of output of the farmers after putting all inputs used into consideration.

Cordelia and Edwin (2020) analysed the factors influencing rice farm productivity in Ebonyi State using the total factor productivity measures, and found that extension services, household size and farm size positively influenced productivity whereas age of farmer and herbicide use negatively affected the rice farmer total factor productivity. For this study, the total factor productivity measures used, focused on farm-commodity levels (as against productivity growth) to ease the comparison of the production units (i.e. from farmer to farmer), given that there is still a lot of room for improvement in agriculture sector of a developing country as Nigeria.

2.2.4 Agricultural Practices, Household Food & Nutrition Security and Health

Household food & nutrition security represents knowledge, availability, access and psychologically comfortable situation of a family towards food they need for a healthy living on regular basis. It is important to note that household food (in)security is neither an easy estimate nor is it amenable to external validity, due to its dynamic and multi-dimensional issue (Webb, Coates, Fraongilo, Swindale and Blinsky, 2006). Measurements of food security are hinged on four (4) pillars: availability, access, utilization and risk (Barrett, 2010). Further to that, is the categorization of food security indicators into: dietary diversity and food frequency; spending proportion on food to total household income; consumption behaviours measurements; experimental measures combining behavioural measures with psychological measures; and selfassessment of food security (Barrett, 2013).

Multiple links have been established between the impact of agriculture practice and health outcomes of the farmer. Chavez, Sonneveld, Yaghmaei, Francesconi and Alba (2022) analyzed the

relationship using the SHARE (Strengthening Health and Agriculture for Resilience) framework. This framework assessed the relationship based on four impact pathways (Farmer health & agricultural labour; Agricultural practices & health; Agricultural production & food security, nutrition and healthy diet; Health & household resources). The framework pathways relay the direct and indirect patterns of agriculture practice and health. Deductions from the pathways suggest an integration within the framework which further affirms the relevance of understanding the agricultural practices and health relationship.

This study concerns itself with health outcomes as a welfare dimension of the farmer and farmer household. This aspect of the study's objective implicitly draws credence from Chavez et al. (2022) framework. Firstly, agricultural practices may influence farmer health. Hence, agricultural value chain interventions, such as the rice VCDP, could improve farmers' technology and technical awareness, thereby influencing their health. Secondly, the appropriate practices/techniques scale production, thereby affording farmers the means and resources to nourish themselves with healthy nutrition. A well-nourished farmer and farmer household provides good labour and hence improves productivity (Berha et al., 2021). This productivity results in increased income which provides farmers with resources to improve their livelihood and welfare, including health. This improvement of livelihood may not have been possible without food and nutrition security, and this is only premised on the assumption that the agricultural practices, farmer health & agricultural labour pathways are positive (Chavez et al., 2022).

2.3 Empirical Literature Review

2.3.1 Impact of the Value Chain Dependent Agricultural Interventions

Wang et al. (2021) investigated the effects of smallholder farmers' engagement in the agricultural value chain, based on broad objectives of rural development and poverty alleviation. Using data procured from a micro survey of farmers, they employed PSM, probit and OLS models to examine the multidimensional impact of participation in agricultural value chains on poverty reduction. An analysis which showed that farmers' involvement in agricultural value chain activities exerts significant effects on poverty reduction. Specifically, the multidimensional poverty levels of farmers involved in a range of value chain activities (utilizing improved fertilizers, engaging in organizational acquisition, and employing storage technologies) decreased by 30.1%, 46.5%, and 25.0%, respectively in comparison to their non-participating counterparts.

Focusing on youth demographics, Daudu et al. (2023) assessed the impact of participation in agricultural program on farm productivity and overall household welfare, using data from ricefarming households in northern Nigeria. They found that the agricultural program participants, based on rice farming, experienced superior outcomes compared to the program non-participants in both the rice farm productivity and household welfare status. Using the propensity score matching (PSM) and endogenous switching regression (ESR) models, Daudu et al. (2023) registered positive increases in yield/hectare, per capita household food expenditure and per capita household total expenditure for participation in the agricultural program both in the population of rice farmers in the study area and in the sub-population of rice farmer participants in the agricultural program intervention.

To evaluate the impact of participation in collective marketing on the earnings of smallholder farmers in Kenya, Kwizerimana, Mugwe, and Nigat (2023) employed the Propensity Score Matching (PSM) model to analyze data from 300 farmer respondents. The findings revealed that farmers involved in collective marketing experienced enhanced production and improved sales. Specifically, participation in avocado collective marketing resulted in an average income increase of 32.95% over the three consecutive years studied (2018, 2019, and 2020). In 2020, participants yielded significantly greater production, averaging 1251.3 kg, compared to non-participants, who produced 889.7 kg. Furthermore, participants commanded superior prices received per fruit, in contrast to non-participants.

Using the Household Food Insecurity Access scale (HFIAS) and the Instrumental Variable Poisson model Ndlovu et al. (2022) assessed the impact of smallholder farmer value chain participation. The results showed a negative relationship which implied that farmer participation in the value chain decreased the level of food insecurity hence, the low levels of food insecure households found (i.e. 66.7% of the farmers in the sample were food secure, 17.65% were mildly food insecure, 7.84% were moderately food insecure and 7.84% were severely food insecure).

2.3.2 Factor Determinants of Farmer Participation in AVC related Programmes

An analysis of agricultural program intervention for rice farmers revealed that, age had a negative influence as well as other factors such as education, household size, farm size, access to agricultural extension services, credit availability, and membership in social groups which were positively and significantly correlated with youth participation in the initiative (Daudu et al., 2023). These socio-economic characteristics especially their access to financial resources, association memberships and educational attainment determined the heterogeneity between the program participants and

non-participants. This means that the youths participation decisions were influenced by these and other inherent factors.

Similarly, Ndlovu, Thamaga-Chitja and Ojo (2021) found that key variables, age of the respondent (negative), marital status (positive), farm income (positive), household size (negative), cooperative membership (positive), market information (negative), asset radio (negative), extension services (positive), and formal education (positive) significantly influenced smallholder farmers decision to participate in agricultural value chains. Furthermore, they found that the degree or level farmer participation in AVCs is determined by the aforementioned factors including: off farm income, access to credit, access to irrigation facilities and contact with non-governmental organizations.

Results from the endogenous switching regression (ESR) selection equation showed that farmer participation in comprehensive agricultural training programme was significantly influenced by factors such as age, household size, affiliation with a farmer-based organization (FBO), membership in a village savings and loan association (VSLA), farm size, and access to a Member of Parliament or other political representatives.

2.3.3 Food and Nutrition Security Assessments in Agricultural Development Programmes

While agricultural value chains (AVCs) are popular agri-food interventions, some researches have focused on food value chains (FVCs) with the argument that it would serve better in addressing the food and nutrition security outcomes of households than AVCs (Gelli, Donovan, Margolies, Aberman, Santacroce, Chirwa, Henson and Hawkes, 2020). It is assumed this would rather compensate for addressing the nutrition-sensitive outcome impacts of value chain development projects. A review of studies by Nicholson, Monterrosa and Garrett (2021) revealed that there is paucity of empirical evidence on nutritional impacts of FVCs, highlighting potential pathways

which are rather complex due to the influence of health and care provision status. They recommended the need for studies on AVCs or FVCs to carry-out in-depth analyses, such as quantitative evaluations, of its impact on nutrition outcomes (Nicholson et al., 2021).

There are various useful measures of food and nutrition security, such as dietary diversity measures and food frequency, which are associated with the calorie consumption per capita. Babych and Kovalenko (2018) in their study of the state of food security in Ukraine rather adopted some nationally approved indicators (energy value of the daily diet of a person; consumption sufficiency indicator; indicator for food grain resources; economic availability of products indicator; food value differentiation indicator; capacity of domestic market of product and share of food import of product indices). (Sibhatu and Qaim, 2017; Rajendran, Afari-Sefa, Shee, Bocher, Bekunda, Dominick and Lukumay, 2017) employed the Household Dietary Diversity Score (HHDS) in their work. While the data on dietary diversity and food frequency are reliable and easy to collect as indicators of dietary quality and quantity, the findings of Wiesmann, Bassett, Benson and Hoddinott (2009) strongly suggest the superiority of food frequency scores (such as FCS) and its most appropriateness in food and nutrition security assessments.

To ascertain the nutritional outcomes of adults and adolescents in certain districts of India, Nithya and Bhavani (2017) compared some dietary diversity measures (Food Scores, Food Frequency, Dietary Diversity Index) with other measures of nutrient intake (Nutrition Adequacy Ratio and Mean Adequacy Ratio). Food scores are measured by the simple counting of food groups consumed by individuals, based on ICMR (2012) and Food and Agriculture Organization (2013) recommendations for a particular period of recall to provide information on dietary diversity. They

found that food scores ensured adequacy of most nutrients by the reason of its true positive association with NAR and MAR, hence acknowledges it as good proxy.

In order to measure the household food security index of communities in India, Aatish, Zhopnu and Sanjoy (2017) assessed six components of food security: Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), Coping Strategy Index (CSI), Self-Assessed Food Security Scale (SAFS), Household Hunger Scale (HHS) and Household Food Insecurity and Assess Scale (HFIAS), and found that all components expect SAFS proved relevant for proper measure of food security at least for that region. Hussein, Ahmed and Muhammed (2018) research were aimed at checking the validity of household food (in) security and household dietary diversity measures in assessing nutritional status of certain sample units. Upon conducting reliability, sensitivity and specificity analytical checks they found that the household food (in) security access scale and household dietary diversity scores are reliable estimates of the nutritional status.

2.3.4 Education and Health Outcomes of Agricultural Development Programmes

Takahashi and Barrett (2014) assessed the socio-economic impact of adopting the practice of the System of Rice Intensification (SRI) in rural Indonesia, considering farmer household welfare outcomes of income and education. They captured education using child years of schooling. Shal et al (2018) recognized the importance of education outcomes of farming households in assessing their livelihood and welfare improvement. The assessment this welfare outcome on basis of child schooling and change in child school enrollment, recognizes the possible influence through household income-expenditure pathway resulting from improvement in the value chain of bay leaf in Nepal. It is interesting to note in such agricultural production and distribution chain enhancement

innovations both (Takahashi and Barrett, 2014; Shal et al., 2018) found no significant effect on the child schooling and enrollment outcomes.

Health is "a state of complete physical, mental and social well-being and not merely the absence of disease or injury (Constitution of the World Health Organisation [WHO] as agreed in 1946), WHO further defines health outcomes measures as the "change in the health of an individual, group of people, or population that is attributable to an intervention or series of interventions." They implication is that outcome measures are the quality and cost targets various organizational set-ups are trying to improve. These outcome measures are usually determined by either National standards of measurement or the financial incentives which exist in the context. Such outcome models based on number of visits to the doctor/hospital and vice versa have been applied on country level datasets by some studies (Cameron, Trivedi, Milne and Piggott, 1988; Pohlmeier and Ulrich, 1995). Windmeijer and Santos Silva (1997) suggests a strong connection between changes in income and education on health outcomes, in other words such indicators of welfare ought to be assessed together; whereby they applied the number of patients visit to the doctor approach in their analysis. This implies an otherwise secondary effect on health outcomes for activities impacting on income.

This study will assess health outcome of the farmer households on the basis of: Number of visits to the health care centers and Expenditure on health care.

2.4 Analytical Literature Review

2.4.1 Analyzing the Impact of Value Chain and Agri-food Development Programmes

A valid measure of the impact of the VCDP would be to compare the outcomes (e.g. income) of farmers receiving the VCDP support with presumed outcomes of the same farmers had they not gotten the support. Assessing the impact (treatment effect) of any intervention thus requires making an inference about the outcome that would have been observed had the program participants not participated (counterfactuals), otherwise observing the same units of interest with and without the intervention/treatment. Indeed, the challenge with human behavioural impact study is the difficulty in assessing a 'worthy' counterfactual, thus such studies use the performance level of similar group units known as 'control group', otherwise the comparison group. However, this too often results in biased estimates of the effect of the treatment.

Evaluation of the impact/effects of treatment is faced with major the challenge of obtaining a comparison group that is as similar as possible to the treatment group (group that received intervention) except for the treatment. One certain way of surmounting the challenge of achieving similarity in treatment and comparison group is randomization of assignment of treatment and use of large unit of observation in the population. This is the randomized assignment methodology and it is common with natural experiments or Randomized Control Trials (RCTs). This method presents the best standard for impact evaluation analysis for reasons of its ability to adequately account for the treatment effects by contriving statistically equivalent averages of the characteristics (observed and unobserved) of treatment and comparison groups (Gertler, Martinez, Premand, Rawlings and Vermeersch, 2016). Nonetheless, such randomized assignment methodological approaches are

rarely put into consideration during the design and implementation of most interventions for populations due to its expensive and tasking nature such that experiments are clearly impractical.

Typically, the FGN-IFAD Rice VCDP intervention approach involved a range of market development and commercialization elements in its implementation which does not follow a randomized approach. Some of the interventions such as building of roads, market infrastructure, provision of water and provision of processing equipment & plant were done at community level. Other aspects such as provision of agricultural inputs to farmers and capacity building (trainings) in the same communities occurred at individual levels, with eligibility criteria (member of a recognized registered cooperative) which results in participants' self-selection into the intervention (treatment).

Due to the problems of self-selection arising from non-randomization of treatments, various impact evaluation methods are employed for instance, difference-in-differences, instrumental variable, matching methods, etc. Each method of impact evaluation analysis has identifying assumptions/limitations which determines the appropriateness of the usage for a particular situation or dataset. The major problem of assessing the impact (treatment effect) of the rice VCDP on the target population is that of endogeneity arising from both observed (unhidden) and unobserved (hidden) covariates, owing to the method of treatment (administration of intervention) highlighted above.

The difference-in-differences estimator is popular in impact evaluation analysis related to government programs on individual outcomes, however its use is appropriate only to the extent that such interventions are random and conditional on time and group fixed effects otherwise the standard errors become inconsistent (Bertrand, Duflo and Mullainathan, 2004). In other words, the

difference-in-difference analysis is also biased by the endogeneity of treatments, and the assumption that heterogeneity is time invariant (Khandker, Koowal and Samad, 2009). Furthermore, the Diff-in-Diff estimator is also not workable where good (balanced) panel data is lacking and the sample units are not observed before and after the treatment (intervention), which is the case with this study, considering the non-existence of baseline or good pre-intervention data, which provides more original information on the attributes of the individuals before treatment.

The Instrumental Variable (IV) technique is another plausibly impact evaluation methodology which is applicable to the study as used by Montalbano et al. (2018b), however this method also presents a strong limitation with respect to the determination a valid instrument (relevance and exclusion criteria). The process of identification of an instrument which is usually theoretical is a challenge, and in addition some study (Banerjee and Basu, 2021) also debates its estimates for bias and efficiency in cases of endogeneity. There is the faulting of instruments on the basis of contamination or association with outcomes independent of treatment thus unobserved unconfoundedness is not achieved (Basu and Chan, 2014). This becomes even more difficult in this study where the focus is on many different outcome variables hence requiring as many different valid instruments also notwithstanding the anticipated difficulties discussed within the IV method.

Propensity score matching (PSM) presents another valid means of assessing the causal effects of program interventions (Wu, Ding, Pandey and Tao, 2010), and the PSM has proven handy in models whereby there is deficiency of pre-intervention data (as in this study). Most of the related literature especially on agricultural intervention programs, technology innovation adoption in agricultural systems and the food value chain employed the use of the PSM technique in impact analysis (Bello, Baiyegunhi and Danso-Abbeam, 2020; Shah et al., 2018; Ogunniyi, Omonona, Abioye and

Olagunju, 2018; Shah et al., 2017, Takahashi and Barrett, 2014). However, PSM also has some pitfalls that need be improved on considering the mode of intervention involved in this study. The matching technique is such that it creates counterfactuals based on observed characteristics of the treatment and comparison groups using a propensity score (probability of treatment) in the target population. The matching method is as good as the data and the characteristics (observable) used in constructing the counterfactuals, this implies that there would be a significant level of bias when selection into treatment is based on certain important unobservable characteristics (Smith and Todd, 2005). Endogeneity in the regressors as suspected also lead to problems of selection on unobservables which bias the effect on the outcome variables.

Hence, empirical studies using the PSM model tend to follow-up with a second econometric model for double robustness checks. For instance, Kissoly et al. (2017) believed that integrating smallholders into Agricultural Value Chains (AVC) would help improve welfare, defined in terms of household food security, so they used the propensity score matching and inverse probability weighted regression adjustment (IPWRA) to analyze the extent to which participation in multiple AVCs affected the smallholders' food security. Daudu et al. (2023) used the propensity score matching (PSM) and endogenous switching regression (ESR) to mitigate biases that may emerge from both observed and unobserved variables. Yang et al. (2021) in analyzing the impact of farmers' cooperative participation used a double selectivity model to correct for sample selection bias and then the propensity score matching (PSM) applied to evaluate the agricultural income differences in a counterfactual analysis of the farmers. Martey et al. (2021) used a combination of the ESR and PSM and inverse probability weighted regression adjustment (IPWRA) to guarantee robustness checks in analyzing the effects of farmer participation in comprehensive agricultural training programme.

2.4.2 The Analytical Framework

Given the nature and modalities of the rice VCDP, a treatment effect model is required to truly evaluate the impact of the intervention on the different outcomes for the farmer households (rice producer). In fact, an improvement on the treatment effect model which is the endogenous treatment effect is required to estimate a better average treatment effect on the treated populations.

In order to achieve a consistent evaluation of the impact of the rice VCDP on the outcomes of interest, the endogenous treatment effect will be used. The endogenous treatment regression model is a linear potential outcome model which allows for a specific correlation structure between the unobservable that affects the treatment and the unobservable that affects the potential outcomes (Awotide Abdoulaye, Alene and Manyong, 2015). This can be done improving the treatment effects using a control function approach (Wooldrigde, 2010). Following Roy (1951) model of the potential outcomes:

$$Y_1 = X_1 \gamma_1 + \nu_1 \qquad \text{Eqn 2.1}$$

$$Y_0 = X_0 \gamma_0 + \nu_0 \qquad \text{Eqn 2.2}$$

Equations 2.1 and 2.2 are the two potential outcomes equations in the two possible states of the farmers (participant and non-participant).

$$T^* = Z_T + \Psi_T + V_T \qquad \text{Eqn 2.3}$$

If T(Z) represents the observed outcome, where T(Z) = 1 if the farmer received intervention, T(Z) = 0 if farmer did not receive intervention. The T* is a latent variable which generates T(Z) as follows:

$$T(Z) = 1\{ T^*(Z) \geq 0\} = 1\{X\phi + \nu\rho \geq 0\} \quad \text{Eqn 2.4}$$

For any z which is a potential realization of Z, the variable $T(z) = 1[Z_{\varphi} \geq V_T]$ is defined, showing whether or not the individual farmer received the intervention. The value of Z is externally set to z, holding constant the unobserved υT. This requires an exclusive restriction and denoted by Zn some element of Z which is not in X, it is then possible estimate an individual farmer's probability of receiving intervention without tampering with the potential outcomes. Then assume (υTυ1υ0) is independent of X and Z. If the observed outcome is:

$$Y = TY_1 + (1 - T)Y_0 \quad \text{Eqn 2.5}$$

The average treatment effect (ATE), defines the gain or impact of receiving the rice VCDP intervention on income, productivity, food and nutrition security, health and education outcomes, and this can be expressed as follows:

$$Y = Y_1 - Y_0 \quad \text{Eqn 2.6}$$

Therefore, the ATE conditional on X = x can be expressed as:

$$ATE\ (x) = E\ (\Omega|X = x) = x_1(\psi_1 - \psi_0) \quad \text{Eqn 2.7}$$

The average treatment effect on the treated (ATET), which is the welfare outcomes (income, productivity, food and nutrition security, health and education outcomes) to those farmers that actually received the rice VCDP intervention, can be expressed as follows:

$$ATET = (x, z\ T(z) = 1) = E\ (\Omega|X = x, Z = z, T(z) = 1) = x_1(\psi_1 - \psi_0) + E(v_1 - v_0|vT \geq -z1\eta) \quad \text{Eqn 2.8}$$

CHAPTER THREE

METHODOLOGY

3.1 Study Area

Ebonyi state is located in the southeast geopolitical zone of Nigeria and lies at approximately Latitudes 7º3'N and 8º3'N and Longitudes 5º4'E and 6º4'E (Onyeneke, 2020). The state was created out of the old southeastern states (Anambra, Enugu, Abia) in 1996 and is predominantly an Igbo speaking people. Administratively, Ebonyi State is made up of thirteen local government areas spread across three the geopolitical zones – Ebonyi North, Ebonyi Central and Ebonyi South (Figure 3.1). According to the last census in 2006 the population of the state is at 2,176,947 (NPC, 2006) whereas in more recent times (2016 estimate) the population is approximated at 2,880,400 persons using a growth rate of 2.84% (City population, 2017).

The State occupies a landmass of 5,932 km^2, and the vegetation is a savanna and semi-tropical forest mix. It is characterized by a mean annual rainfall ranging from 1500mm to 2250mm with an average temperature of about 27ºC and high relative humidity at 85%, based on the 2012 report from Ebonyi State Agricultural Development Programme (EBADEP). The two main seasons prevalent in the region is the rainy season (late April to November) and the dry season (late November to April), although in recent times there has been slight distortions every now and then due to climate change. The major crops grow in this region includes rice, yam, groundnut, cocoyam, cassava, vegetable, maize etc., there are also low swampy lands (Fadamas) which serve for rice farming and dry season vegetable farming.

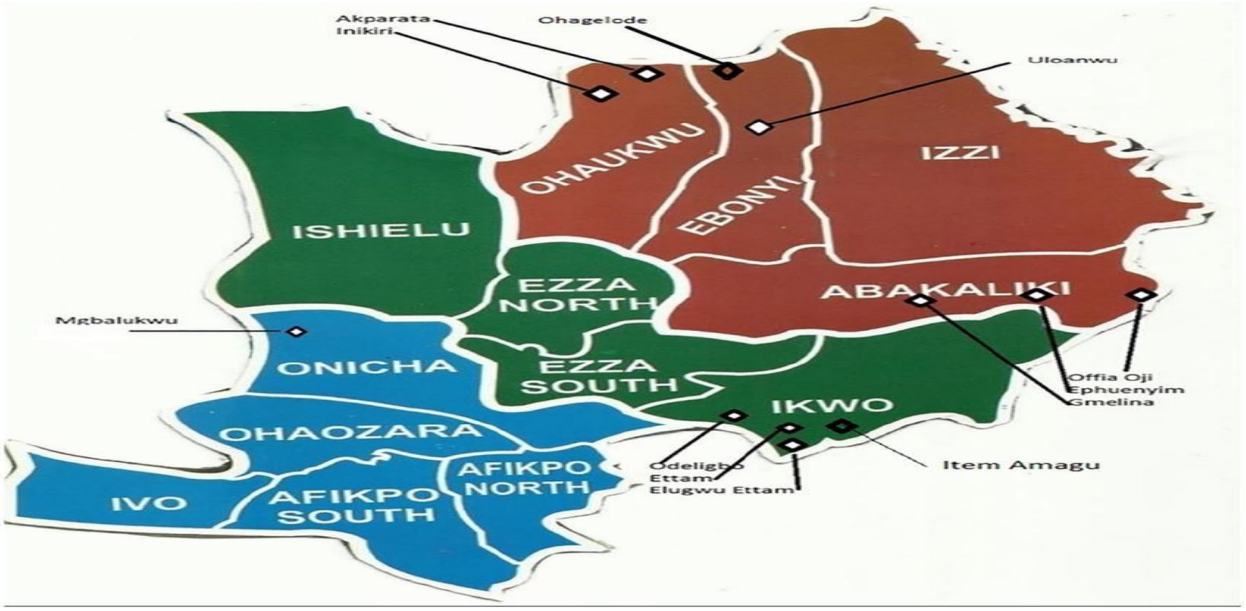

Figure 3.1: Map of Ebonyi State showing the Local Government Areas in each zone

Source: Ananda Marga Universal Relief Team, January 2021

In Nigeria, rice is a staple meal for everyone, consumed across the country (Raheem, Dayoub, Birech and Nakiyemba, 2021). However, the challenge of meeting the increasing demand persists (Danbaba, 2023). Ebonyi State, which is touted as one of the highest rice-producing states in the country, producing about 138,330 metric tons (MT) of rice in 2020 (NAERLS and FMARD, 2020), is expected to help Nigeria achieve self-sufficiency. Rice is the focus crop for the State, occupying a prominent position in the Ebonyi State Agriculture Policy over the years. Rice cultivation/processing is recognized as one of the three key value chains important to its agroindustrial hub, with rice cultivated in over 311,000 hectares of land by over 140,000 farmers across all the local government areas of the state (Ebonyi State Environmental and Social Impact Assessment SAPZ Final Report, 2024). Over the years, the state administrations have prioritized engagement in agricultural interventions involving rice production, and these programs have been said to be associated with the increase in rice yield experienced (Okereke, Ndukwe, Oroke and

Onwe, 2017). Hence, the choice of this state, whose rice value chain has improved in recent times (Okonkwo, Ukaogo, Kenechukwu, Nwanshindu and Okeagu, 2021), for the study.

3.2 Sample and Sampling Procedure

Ebonyi State was selected for the study because it is one of the pilot States involved in the FGN/IFAD-VCDP since its effective inception in 2013. The annual progress report of the intervention also shows that implementation proceedings have been outstanding and wellcoordinated according to the established goals. The rice VCDP intervention was initially implemented in five selected local government areas (LGAs) - Afikpo-South (now Edda), Ikwo, Ishielu, Izzi and Ohaozara (subsequently referred to as participant LGAs).

The targeted LGAs received various types of interventions in the form of road networks, market infrastructure development, input/output market linkages, pipe-borne water infrastructure, rice product processing plants, equipment, producer (farmer) inputs, funds and capacity development/training. There was an eligibility criterion that qualified farmers in the rice VCDP target LGAs for the reception of inputs and training. The farmers were required to be members of a formally registered and verifiable agricultural cooperative before they could be eligible to receive inputs. The unit of interest of the study in the value chain is the farmers and farmer households. The sample frame of VCDP participant rice farmers in the five participating LGAs shows a total of 4370 rice farmers in the proportion of: Afikpo-South – 9%; Ikwo – 31%; Isielu – 13%; Izzi – 28% and Ohaozara – 19%. Given the *modus operandi* of the VCDP intervention, a total of six (6) LGAs in Ebonyi State were sampled - three LGAs which participated in the IFAD-VCDP and another three LGAs which did not participate in the IFAD-VCDP. A multi-stage sampling procedure was

used. First, three (3) LGAs (Ishielu, Izzi and Ohaozara) were randomly sampled from the five LGAs known to have participated in the rice VCDP, then three (3) more LGAs (Ohaukwu, Ezza-North and Ivo) were selected using a stratified random sampling method across the three agro-ecological zones of the state, considering only the LGAs that did not participate in the rice VCDP. Second, five (5) communities were randomly selected from each of the rice VCDP participating LGAs, whereas three (3) communities were randomly selected from each of the rice VCDP non-participating LGAs, making a total of twenty-four (24) communities. Finally, ten (10) farmers were selected at random from each of the twenty-four (24) communities, making a total sample size of 240 rice farmers. After the questionnaires were collected and collated, it was found during the data cleaning that some respondents failed to make adequate and meaningful contributions to the issues in the questionnaires. Hence, 26 respondents' questionnaires were dropped. Only 214 respondents' questionnaires were used for further analysis.

3.3 Method of Data Collection

A well-structured questionnaire was used to interview and obtain quantitative and qualitative information from the farmer participants and non-participants. Data were collected on: the socioeconomic characteristics of the paddy farmers; farmer networks; the rice farming system; the various groups of buyers they sell to; their sources of inputs for rice farming; the participants' opinions of the VCDP, marketing costs; various foods consumption frequency by households, expenditure on health and education of farmer households, and the education status of the farmer children (average number of years of schooling of farmers' school-aged children). Information on

VCDP rice farmers and the value chain activities was obtained from the Value Chain Development Programme office at EBADEP, representatives in the communities, extension agents working in the communities and farmer organizations.

3.4 Method of Data Analysis

Net farm income analysis, Food Consumption Score analysis, econometric analysis (Treatment Effects Regression) and descriptive statistics (percentage, mean and standard deviation) were used for the study. Objective (i) was achieved using descriptive statistics; Objective iii, v, vii, viii and ix were achieved using the treatment effects regression model (Inverse Probability Weighted Regression Adjustment). Income of the rice farmer (objective ii) was estimated using the net farm income; their productivity (objective vi) was estimated using the total factor productivity; while objective iv, food and nutrition security of the rice farmer households were computed using the food consumption score (FCS).

3.4.1 Net Farm Income Measurement

Net farm income (NI) is the farmer net returns or profit from rice sales. Following Hardwick and Keyser (2010) model for a quantitative value chain analysis:

NFI = Total Revenue (TR) – Total Cost (TC) Eqn 3.1

TR (rice) = (Quantity of rice sold in kg) x (selling price)

Total cost = Total Variable Cost (TVC) + Fixed Costs

$$NFI = TR - (TVC + FC) \quad \text{Eqn 3.2}$$

Various variable and fixed costs apply to the farmer, and it includes all the costs involved in paddy rice production up until it is sold to the rice paddy/milled rice buyers, processors or consumers. It involves all costs related to inputs (seedlings, fertilizers, agro-chemicals) used in the cultivation of rice, post-harvest costs to facilitate sales and labour costs. The elements of fixed costs included were; the cost of capital (funds borrowed for the rice farming), lease cost of land, depreciation costs of machinery and equipment.

3.4.2 Measuring Food and Nutrition Security

The World Food Programme (WFP) developed a proxy measure for food and nutrition security. This involved the collection of data, based on a 7-day recall of the consumption of several food groups at the household level, which is then used to construct the Food Consumption Scores (FCS), and classified accordingly. Food Consumption Score (FCS) is "a food frequency measure developed by the World Food Programme (WFP) that is based on weighted dietary diversity, food frequency, and relative nutritional importance of different food groups" (WFP, 2008; Aatish, Zhopnu and Sanjoy, 2017). Its dual-purpose advantage is the reason it is a widely recognized good proxy for food and nutrition security.

The rice farmers' food and nutritional security will be measured using the Food Consumption Score (FCS). FCS is a composite indicator that takes into account food diversity, frequency of consumption and the nutritional inputs of various groups of foods eaten by a household (WFP, 2009). In this study, FCS was calculated from the sample as follows:

$$FCS = \sum P_i X_i = P_{staples}X_{staples} + P_{pulses}X_{pulses} + P_{veg}X_{veg} + P_{fruits}X_{fruits} + P_{protein}X_{protein} + P_{dairy}X_{dairy} +$$

$P_{sugars}X_{sugars} + P_{fats}X_{fats} + P_{cond}X_{cond.}$ Eqn 3.3 Where:

Pi = Weight of the food group (using the WFP table of food measures/scale)

Xi = Average number of times per week foods in each group are consumed in the household (≤ 7 days).

The FCS has a weighting table (Table 3.1) for calculation of its measures which could range from 0 to 112. According to WFP (2009), the household score is compared with pre-established thresholds that indicate the status of the household's food consumption. These thresholds are applicable in a wide range of situations: Poor food consumption: 0 to 28; Borderline food consumption: 28.5 to 42; Acceptable food consumption: > 42 (in populations with high probability of daily consumption of oil and sugars) WFP (2008).

The mentioned food consumption ranking and threshold of 42 was used to classify households into food and nutrition secure (> 42) and food and nutrition insecure (< 42).

Table 3.1: Food Consumption Scores Guideline

Food groups	Weight	Justification
Main staples (Carbohydrate foods)	2	Energy dense, protein content lower and poorer quality (PER less) than legumes, micronutrients (bound by phytates).
Pulses (Protein foods)	3	Energy dense, high amounts of protein but of lower quality (PER less) than meats, micronutrients (inhibited by phytates), low fat.
Vegetables	1	Low energy, low protein, no fat, micro-nutrients
Fruit	1	Low energy, low protein, no fat, micro-nutrients
Meat and fish	4	Highest quality protein, easily absorbable micronutrients (no phytates), energy dense, fat. Even when consumed in small quantities, improvements to the quality of diet are large.
Milk	4	Highest quality protein, micro-nutrients, vitamin A, energy. However, milk could be consumed only in very small amounts and should then be treated as condiment and therefore reclassification in such cases is needed
Sugar	0.5	Empty calories. Usually consumed in small quantities

Oil	0.5	Energy dense but usually no other micronutrients. Usually consumed in small quantities.

Source: WFP-FAO Food Consumption Measures Table (WFP, 2009)

3.4.3 Productivity Measures

Total Factor Productivity (TFP) estimate was used to measure the productivity of the farmers for rice production. TFP index is given as:

$$TFP = \frac{Y}{\sum Pi\, Xi} \quad \text{Eqn 3.4}$$

where, Y = the value of the output (naira)

P_i = the price of the ith variable input (naira)

X_i = the quantity of the ith variable input

The output of the rice production was calculated based on farm gate or market sale price and the value given in Naira. This ensured that the productivity measure had a reasonable and comparable ratio value.

3.4.4 Access to Education and Access to Healthcare

The rice farmer household access to education was measured using the years of schooling of children in the household. The years of schooling metrics was used to capture basic education activity levels of the school-age group in households. The years of schooling is indicative of the education level attained. For instance, 6 years of schooling is equivalent to attainment of primary school education level, 12 years of schooling is equivalent to secondary school education level, etc.

The school-age group involved children in the farmer households of ages between 6 – 20years, with respect to their education enrollment from primary levels and above.

On the other hand, the rice farmer access to healthcare was measured by evaluating the healthcare expenditure of the farmer household. In addition, two other qualitative measures which accounted for active use of healthcare insurance and valid visits to healthcare centers when ill, were computed to assess their healthcare outcomes.

3.4.5 The Treatment Effects Regression Model

Estimating the impact of the rice VCDP intervention on rice farmer outcomes entails evaluating a causal relationship. Ordinarily, a treatment effect model is used to determine the average causal effect of a binary variable (the treatment or intervention) on an outcome variable of interest. This model was appropriate for the study, which aimed to evaluate the effect of rice farmer participation in rice VCDP on farmer income, productivity, food and nutrition security, education and health outcomes. In practice, it is difficult to estimate the effect of a program from observational/survey data, because it is impossible to observe a subject receive the treatment and the same subject not receive the same treatment under the same conditions. In other words, quality data on the population of interest are definitively obtained in only one period (as in this case), hence, there are no observations in the second period to make perfect comparisons of how much the program changed individuals in the target population. This may be possible in ideal experiments whereby treatments or program interventions are controlled and randomized, however, the core characteristic of observational data is that treatment status is not randomized (i.e. outcome and treatment are not necessarily independent).

This study employs a retrospective evaluation (ex-post) methodology because this impact evaluation was not built-in (accounted for) from the beginning of the VCDP intervention in a way that all outcomes being assessed are identified for both treated and comparison groups preintervention. Thus, in this observational/survey study, another group of individuals with similar characteristics to the target population are selected as a comparison group (rice farmers who did not participate in the rice VCDP) by the sampling of rice farmers in LGAs located away from LGAs where the rice VCDP intervention was implemented. This comparison group suffices as control group (counterfactuals) to the treatment group (farmers who participated in the rice VCDP). Thus, treatment effect models use various regression models to estimate the average treatment effects from observational data on the basis of counterfactual framework (potential outcome models) by Rubin (1974).

In this regard, this study employed a doubly-robust treatment effects regression method, specifically the inverse probability weighted regression adjustment (IPWRA) to estimate the effect of the rice VCDP on rice farmer welfare. This method utilizes the covariates to make treatment and outcome independent once conditioned on the observed covariates. This is in accordance with the Rubin causal model which recognizes the use of regression estimators, inverse probability weighting estimators and matching estimators, when potential outcomes do not depend on the treatment levels after conditioning on covariates (Rubin, 1974). The IPWRA model estimates both the treatment and outcome status in regression procedure using covariates, thus utilizing the eligibility criteria to actually select subjects who received a particular intervention and reducing the externalities which cannot be completely eliminated in non-experimental studies (bearing in mind that externalities affect both the participants and non-participants). Hence, different covariates which explains the different outcomes (income, productivity, food & nutrition security, children's

years of schooling and health expenditure) of interest to the study were evaluated using different IPWRA estimator equations. The IPWRA estimator uses the inverse of the estimated treatment-probability weights to estimate missing-data-corrected regression coefficients, thus creating valid counterfactuals for the regression and resolving selection bias issues. The pseudopopulation created by averaging individual heterogeneity (differences) across treatment and control groups helps deal with extraneous factors.

The IPWRA has the advantage of combining the propensity score and regression adjustment approaches to provide consistent estimates even in the event of misspecifications in either the treatment or outcome models of the regression (Caldera, 2019). According to Wooldridge (2010), the IPWRA model first estimates the propensity scores $p(x_i, \lambda)$, then obtains the inverse probability weights. The inverse probability weights are used to re-estimate the outcome model and its estimators (α_I, β_I) as follows:

$$\min_{(\alpha I,\beta I)} \sum_{N_{i=1}} (y_i - \alpha_1 - \beta_1 x_i)/\mathrm{p}(x_i, \lambda) \quad \text{if} \quad I_i = 1 \qquad \text{Eqn. 3.5}$$

$$\min_{(\alpha I,\beta I)} \sum_{N_{i=1}} (y_i - \alpha_0 - \beta_0 x_i)/(1 - \mathrm{p}(x_i, \lambda)) \quad \text{if} \quad I_i = 0 \qquad \text{Eqn. 3.6}$$

Furthermore, the average treatment effect on the treated (i.e. on the population of those who participated in the rice VCDP), $ATET_{ipwra}$ is estimated by taking the mean difference in predicted values over the treated sample as in Eqn. 3.7 below:

$$ATET_{ipwra} = N_T^{-1} \sum_{i=1}^{N_T} [(\hat{\alpha}_1 - \hat{\beta}_1 x_i) - (\hat{\alpha}_0 - \hat{\beta}_0 x_i)] \qquad \text{Eqn. 3.7}$$

where, I is the treatment assignment; $\hat{\alpha}_1$, $\hat{\beta}_1$ are estimated inverse probability weighted parameters for I = 0 and I = 1, respectively. N_T is the number of treated individuals in the sample, x_i is the set

of observable covariates, λ is the set of other covariates for selection into treatment, and y_i the potential outcomes.

To assess the impact of the rice VCDP, it is crucial to have an understanding of how the VCDP intervention was implemented. Clearly, the implementation was not at random, and several factors may have influenced the selection of the participating LGAs and farmers. These factors may interfere with the assessment of the true impacts due to endogeneity problems, hence the choice of the IPWRA model, as it is variously used in empirical studies (Sseguya et al., 2021; Kamanyire et al., 2024). The limitations of the model are based on the underlying assumptions: Conditional mean independence plus Overlap assumptions, also known as strong ignorability (Rosenbaum and Rubin, 1983) which holds true for this study based on postestimations to prove compliance using the overidentification test of covariates balance. Nonetheless, it is expected that the rice VCDP will bring about positive improvement in the farmer welfare outcomes assessed, first through the channel of increased income and then the income effects on the other outcomes.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Socio-Economic Characteristics of Rice Farmers

The socio-economic characteristics of all rice farmers respondents in the study are presented in Table 4.1.

Table 4.1: Socio-Economic Characteristics of Rice Farmers in Ebonyi State

Characteristic	Mean	Std Dev.	Min	Max
Age (in years)	44.51	9.35	20	68
Male (percentage)	71.50			
Married (percent=yes)	91.12			
Education level of Head of household (percent = no formal education)	2.80			
Number of persons in household	7.00	2.55	1	22
Experience in Cassava farming (in years)	15.16	9.94	2	46
Farm Size (hectares)	2.37	2.43	0.02	20
Food expenditure (in naira/month)	127440	117218.70	18000	700000
VCDP participants (percent=yes)	61.68			
Membership of Agric Association (percent)	72.43			
Borrowed funds (percent=yes)	43.46			
Attended Training (percent=yes)	70.09			
Extension visits (percent=yes)	61.68			
Other means of earnings (percent=yes)	74.77			
Farm land rented (percent=yes)	68.70			
Health insurance (percent=yes)	14.02			
Ownership of mobile phone (percent)	100			
Ownership of television (percent)	77.57			
Ownership of radio (percent)	88.32			
Ownership of motorcycle (percent)	71.03			
Ownership of car (percent)	21.03			
Ownership of tricycle (percent)	7.01			

Source: Field Survey Data 2024

Results of the farmer socioeconomic characteristics in Table 4.1 shows that the mean age of the rice farmers was approximately 45 years, with a good majority of them married (91.12%). Rice farming

in the study area was dominated by men (71.50% of the sample), with just a few of the farming household heads without formal education (2.80%). On average, the farmer household were not large (7 persons), although there are some households with as many as 22 persons living together. The farmers showed an adequate level of experience in rice farming (15.16 years), but with small farm holdings of about 2.37 hectares on average, and more than two-thirds of them (68.70%) rented farm lands either from family members, neighbours or paid arrangements, to augment. A quick glance at the profile of these farmers, is indicative that supports of the family system encourage rice production and farming (Wabi, Vanhove, Idohou, Hounkpèvi, Kakaï, and Van Damme, 2022).

In a nutshell, rice farmers in the study area were mostly married literate men of average age; with average family size, smaller parcels of land and reasonable hands-on experience to engage in the techniques of rice cultivation, resonating the opinion of (Bakare, Ogunleye and Kehinde, 2023) on the common characteristics of farmers within Nigeria. About 61.68% of the sampled rice farmers in the study area, participated in the value chain development programme (VCDP). These participants benefitted from the programme in various capacity, which includes: farm inputs like fertilizers, farm machineries and equipment, trainings, advisory services, funds and mobile phone devices. The large number of educated rice farmers in the sample may have informed increased participation in the VCDP intervention, because it is well educated people who are usually knowledgeable enough to discern the gains of an innovation and adopt earlier (Bakare et al., 2023).

The farmer household monthly expenditure on food was about ₦127,440 naira, and a good number of these farmers diversified their earning sources (74.77%). Few of the rice farmers (14.02%) had healthcare insurance coverage. This means that the food expenditure of the rice farming households (which extends beyond the current minimum wage in Nigeria) may not be easily met by their seasonal rice farming proceeds, hence, they also seek out other earning opportunities. Therefore,

the farmers had limited margin of earnings to indulge in paying health insurance premiums. More than 40 percent of the rice farmers (43.46%) had to borrow funds to facilitate their farming activities. Diversifying earnings may create better opportunities for food security and improving farm business (Wabi et al., 2022).

The rice farmers showed a degree of social capital development with 72.43% belonging to one farmer organization or agricultural group; 70.09% attended agricultural trainings or workshop, and about 61.68% had access to extension services or contacts with extension agents. Social contacts are important for information linkages, more opportunities and exposure to new techniques and innovations. Their relatively high rate of farmer groups participation and engagement in the VCDP can be related to the educational level of majority of the farmers which creates good environment for the spread of agricultural innovation (Zakari, Moussa, Ibro and Abdoulaye, 2021).

On the ownership of assets, the rice farmers showed high levels of ownership of basic information and communication devices (100% had mobile phones, 88.32% had radio devices, and 77.87% had television). The farmers also possessed some assets of mobility and transportation; the majority owned motorcycle (71.03%), while a lesser proportion owned car (21.03%) and tricycle (7.01%). It should be noted that these assets probably indicate the wealth status of the farmers and their possible involvement in business of transportation as way of diversifying earnings.

In Table 4.2, the sampled rice farmer respondents are disaggregated into those who participated in the rice VCDP (rice VCDP participant farmers) and those who did not participate in the rice VCDP (rice VCDP non-participant farmers). Also, the mean differences of the two groups based on their socio-demographic characteristics are presented.

Table 4.2: Descriptive Statistics of the Explanatory Variables in the Study

Variable	VCDP participant farmers mean (n = 132)	VCDP non-participant farmers mean (n = 82)	Mean difference
Household attributes Age (in years)	45.65	42.67	2.98**
Male	0.67	0.78	-0.11*
Married (yes=1, no=0)	0.93	0.88	0.05
Number of persons in household	7.20	6.65	0.55
Other means of earnings (yes=1, no=0)	0.80	0.67	0.13**
Health insurance (yes=1, no=0)	0.15	0.12	0.03
Ownership of television (yes=1, no=0)	0.81	0.72	0.09
Ownership of radio (yes=1, no=0)	0.92	0.83	0.09*
Ownership of motorcycle (yes=1, no=0)	0.70	0.72	-0.02
Ownership of car (yes=1, no=0)	0.22	0.20	0.02
Ownership of tricycle (yes=1, no=0)	0.11	0.01	0.09***
Farm/Farming attributes			
Cassava farming experience (in years)	16.13	13.61	2.52*
Farm Size (hectares)	2.05	2.87	-0.82**
Rented farmland (yes=1, no=0)	0.76	0.57	0.18***
Social Activities/Networks			
Membership of Agric Association (yes=1, no=0)	0.97	0.33	0.64***
Attended Training (percent=yes)	0.94	0.32	0.62***
Extension visits (percent=yes)	0.88	0.20	0.68***

*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

The results in Table 4.2 revealed that the rice VCDP participant farmers and the rice VCDP nonparticipant farmers were not similar across their socio-demographics, especially in their farming attributes and social networking. In fact, the rice VCDP participant farmers seemed to perform better than the rice VCDP non-participant farmers in most of these characteristic variables.

The differences in the two groups implied they were heterogeneous, and also the possibility of other unobservable characteristics which may have influenced their performances and selection into the programme. The likelihood of these differences, affects the reliability of ordinary regression results,

and informs the adoption of robust models (like the IPWRA) necessary to handle the aforementioned challenges.

4.1.2 Estimates of the Net Farm Income (NFI) of Rice Farmers in the Study Area

Table 4.3 presents the costs and returns analysis of the rice farmers in the study area, showing their pooled and disaggregated net farm income (NFI) and total factor productivity (TFC).

Table 4.3: Costs and Returns of Rice Farming in the Study Area

Items	Participant farmer	Non-participant farmer	Pooled farmers
Variable cost	**(₦)**	**(₦)**	**(₦)**
Seeds	99136.36	137243.90	113738.32
Fertilizer	207916.67	191454.27	201608.64
Agrochemicals	51133.33	65301.59	56562.29
Labour cost	553711.37	453376.84	515265.43
Facilitating costs	74068.56	51056.10	65250.70
Interest on loan	21285.61	37006.33	27171.56
Rent on land	88083.33	76893.90	83795.79
A. Total variable cost	**1095335.23**	**1012332.93**	**1063392.73**
Fixed cost	**(₦)**	**(₦)**	**(₦)**
Depreciation on farm implements	9948.44	4650.61	7918.43
B. Total fixed cost	**9948.44**	**4650.61**	**7918.43**
C. Total Cost (A+B)	**1105283.67**	**1016983.54**	**1071311.16**
Returns			
i. Rice output (kg)	3989.77	2485.67	3413.43
ii. Price/kg	812.15	885.15	832.52
D. Total Returns (i * ii)	**₦3240310.61**	**₦2200185.98**	**₦2841758.18**
E. Net Farm Income (D-C)	**₦2135026.94**	**₦1183202.44**	**₦1770447.02**
Total Factor Productivity (TR/TVC)	**2.96**	**2.17**	**2.67**

Source: Field Survey Data 2024

The Net Farm Income (NFI) of the rice farmers was computed by deducting from their revenue (i.e. the sale value of processed and unprocessed rice), the costs of farm inputs, capital, labour, land and depreciation costs of machineries. The average NFI of the rice farmers in the study area was about ₦1,770,447 Naira for the rice farming season, indicative of the profit levels of the enterprise (Table 4.3). This average value notwithstanding, few farmers in the dataset registered some losses. Table 4.3 also revealed the disaggregated amounts for the costs and returns of the rice VCDP participant and non-participant farmers. The rice VCDP participant farmers performed relatively better at a net farm income of ₦2,135,026.94 Naira annually, compared to rice VCDP non-participant farmers with an average net farm income of ₦1,183,202.44 Naira annually.

The component costs of production for the rice farmers activities up until they disposed of their rice products included all variable costs (seeds, fertilizer, agrochemicals, labour, interest on loan, rental payments for farmland, bagging, storing, processing and transportation logistics), and elements of fixed costs in terms of depreciation on farm implements/machinery. The revenue was computed from the farmer sale value of the rice produced.

Table 4.3 showed that the mean NFI of rice farmers who participated/benefited in the VCDP (approximately ₦2,135,027 Naira) was greater than the mean NFI of those rice farmers who did not participate/benefit in the VCDP (approximately ₦1,183,202 Naira). This signals higher profits for farmers if they participate in the rice VCDP intervention. Similar studies (Addison, OheneYankyera, Osei-Wusu Adjei, Mujawamariya and Asante, 2023; Akande, Tijani, Kehinde and Oyenpemi, 2023; Martey, Etwire and Mockshell, 2021) on interventions targeted at improving farmers farm activities through trainings, access to inputs and innovations, found that those who

participate realized higher farm incomes in comparison. A realization which informs the need to further verify if the farmer income differences was as a result of the VCDP intervention, and to what extent.

4.1.3 Estimates of the Total Factor Productivity of the Rice Farmers

The study estimated the total factor productivity of the rice farmers in order to ascertain the efficiency in the allocation of inputs by the farmers and rate the performance of these inputs/techniques as employed. The total factor productivity of rice farmers in the study area was 2.67 (Table 4.3). It was computed from estimates of the ratio of revenue to total factor costs for the rice farm enterprise. This means that every 1 naira spent on inputs for rice production, generated an output worth 2.67 naira of rice produced. In other words, the allocation of funds for inputs, returns its value in rice output by a factor of 2.67.

The total factor productivity was also estimated among the rice VCDP participants and nonparticipants. Table 4.3 also reveals the results of this disaggregation. The rice VCDP participants performed slightly better at 2.96 than the VCDP non-participants at 2.17. Similar to the NFI, this result is suggestive of the better allocation of resources by the beneficiaries of the VCDP intervention compared to the non-beneficiaries, a result shared by (Abdul-Rahaman, Issahaku, & Zereyesus, 2021) on rice farmer adoption of improved rice varieties. These findings further corroborate the argument of (Nakano et al., 2018) on the nexus of agricultural technology, agricultural productivity and agricultural income (directly or indirectly).

However, this performance which is the result of mere descriptive statistics among the rice farmers, may not be attributed to the rice VCDP intervention until the significance of the differences in productivity is confirmed through inferential econometric methods that determines causality.

4.1.4 Food and Nutrition Security of the Rice Farmers

The food and nutrition security status of rice farmers were estimated using the food consumption score (FCS) - a composite metric introduced by the World Food Programme. The FCS of the rice farmer households in the study area is presented on Table 4.4.

Table 4.4: Food Consumption Scores Estimates for Rice Farmers in the Study Area

Farmer groups	Mean	Std. Dev.	Minimum	Maximum
VCDP Participant farmer	54.79	15.74	15.00	81.50
VCDP Non-participant farmer	53.46	18.49	0.00	82.00
All Farmers	54.28	16.82	0.00	82.00

Source: Field Survey Data 2024

The FCS of all of the rice farmer households in the study area was 54.28. This signified an acceptable level of food and nutrition security (using the threshold or cut-off range of 42), according to the WFP (2008). Nonetheless, some rice farmer households recorded food consumption scores as high as 82. The purpose of the FCS estimation is to compute the food and nutrition security status of the various farmer groupings. Using the FCS threshold, the rice farmer households were categorized into two levels, the food secure (> 42) and food unsecure (≤ 42) households. This is presented in Table 4.5, showing the food and nutrition security results.

Table 4.5: Food and Nutrition Security Distribution among the Rice Farmers

VCDP Participation	Food and Nutrition Security Status		
	Food Unsecure	**Food Secure**	**Total**
Non-Participants	17 (20.73%)	65 (79.27%)	82 (100%)
Participants	34 (25.76%)	98 (74.24%)	132 (100%)
Total	51 (23.83%)	163 (76.17%)	214 (100%)

Source: Field Survey Data 2024

About 76.17% of the sampled rice farmers showed acceptable levels of food and nutrition security, whereas 23.83% did not. Furthermore, Table 4.5 shows the food and nutrition security distribution of the rice farmers based on the FCS categorization and rice VCDP participation. Among the VCDP non-participant farmer households, 20.73% were food unsecured, while 79.27% were food secured; whereas among the VCDP participant farmer households, 25.76% were food unsecured, while 74.24% were food secured. The expectation was that the VCDP participant farmer households would have more positive outcomes for food and nutrition security, and this was further accessed with all influencing factors put into consideration. Bellemare (2012) recognized the potentials of improving the welfare and food security levels of smallholder farmers by involving them actively in agricultural value chains. Also, (Akbar, Niaz and Amjad, 2020; Ndlovu, Thamaga-Chitja and Ojo, 2021) described how value chain development built a pathway to commercialization for farmers which contributed to their food security through income generation.

4.1.5 Access to Education by Rice Farmer Households

The study investigated access to education among rice farmer households by examining the characteristics of the active school-age group within these households. The years of schooling measure for children (6 - 20 years) in the rice farmer household was 6 years on average, although

a maximum of 14 years of schooling was recorded in the dataset. This means that school-age children would have completed 6 years of education which is equivalent to primary school attainment in the Nigeria educational system. Relatedly, the average age of the school-age children in the study area was 10.5 years, close to the age (12 years) appropriate for the completion of primary education (considering the universal basic education, UBE standard for Nigeria).

Furthermore, results of the analysis showed that education expenditure (per semester school fees) of school-age children of the rice farmers was about 38,953.54 naira, however, this is an aggregation of all the possible education levels for school-aged children. The education level of the school children is equivalent to their corresponding years of schooling. For a more informative assessment, the education expenditure was compared to the education levels of the school children, because it is assumed that the higher the educational level, the more the expenditure (school fees). The result is shown in Figure 4.1 which is a graph plot of the farmer school-age children's education expenditure against their educational level.

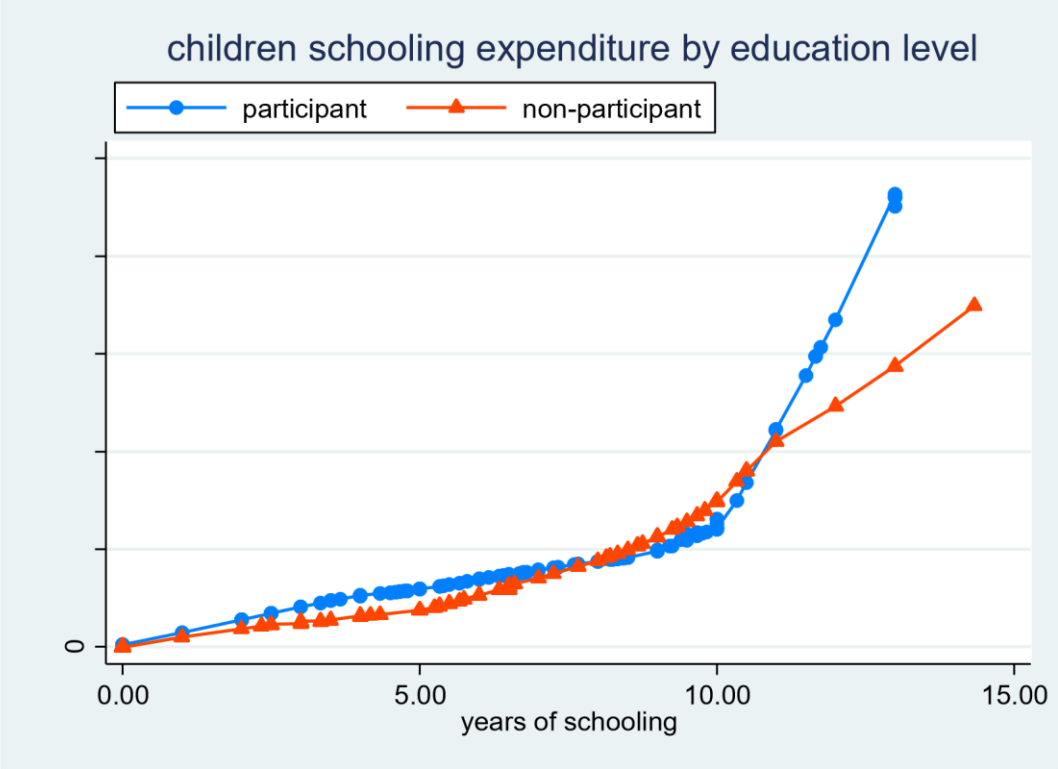

Figure 4.1 School-age children education expenditure by education level

As expected, generally their education expenditure increased as they move higher up the levels, with a noticeable spike at about 10 years of schooling (related to their transition into senior secondary school level). The graph also disaggregates the outcome for the school-age children by rice farmer VCDP participation. Figure 4.1 shows that the education expenditure of the school-age children of VCDP participants was slightly higher in their early years of schooling, but visibly higher in their later years of schooling (as from 11 years of schooling) compared to the VCDP non-participants. This means that the rice VCDP participant farmers were probably able to commit more resources in education of their children than the non-participant farmers. It follows the idea that improvement in farmers living standard is reflected in their outlook towards spending on home assets and children schooling needs (Rutherford, Burke, Cheung and Field, 2016). On the contrary, the farmer household characteristics in terms of children school enrollment, for receivers of bayleaf

value chain intervention vs the non-receivers, was statistically the same, post intervention (Shah et al., 2018).

4.1.6 Healthcare Outcomes of the Rice Farmer Households

The healthcare outcomes of the rice farmers were tracked using their expenditure on healthcare and two other qualitative variables (valid visits to healthcare center and active use of healthcare insurance). The field results showed that the mean monthly healthcare expenditure of the rice farmer household was 19,479.91 Naira. The data showed that approximately 79% of rice farmer households actually visit healthcare centres when they are ill, whereas only 13.55% of rice farmer households had insured access to healthcare. This implies that the majority of farmer households use healthcare facilities when the need arises, however, most of them make use of out-of-pocket expenditure because they do not have health insurance.

The two variables (valid visits to healthcare center and active use of healthcare insurance) were also combined to produce a qualitative variable for access to healthcare. Table 4.6 used the variable for access to healthcare to categorize the measures of healthcare access between rice VCDP participant farmer households and non-participant farmer households.

Table 4.6: Access to Healthcare Distribution of the Rice Farmer Households

	Access to Healthcare Status		
VCDP Participation	**No Access**	**Access**	**Total**
Non-Participants	15 (18.28%)	67 (81.71%)	82 (100%)
Participants	25 (18.94%)	107 (81.06%)	132 (100%)
Total	40 (18.69%)	174 (81.31%)	214 (100%)

Source: Field Survey Data 2024

It revealed that 81.06% and 81.71% of the rice VCDP participant farmer households and nonparticipant farmer households respectively, had access to healthcare. This result is similar to the descriptive analysis of actual visit to healthcare centers by household members as presented in Table 4.7.

Table 4.7: Rice Farmer Household Actual Use of Healthcare Centre

VCDP Participation	Visits Healthcare Centre		
	Does not Visit	**Does Visit**	**Total**
Non-Participants	17 (20.73%)	65 (79.27%)	82 (100%)
Participants	28 (21.21%)	104 (78.79%)	132 (100%)
Total	45 (21.03%)	169 (78.97%)	214 (100%)

Source: Field Survey Data 2024

Table 4.7 shows that 78.97% of the rice VCDP participant farmer households actually visited healthcare centers when ill, while also 79.27% of their compatriot rice VCDP non-participant farmer households actually visited healthcare centers when ill. These figures are approximately the same (with little or no difference) for the rice VCDP participants and non-participants.

Similarly, a second qualitative variable - insured healthcare access - used in describing farmerreported-healthcare-access, is presented in Table 4.8.

Table 4.8: Distribution of Rice Farmer Households with Insured Healthcare Access

VCDP Participation	Access to Insured Healthcare Status		
	No Access	**Access**	**Total**
Non-Participants	73 (89.02%)	9 (10.98%)	82 (100%)
Participants	112 (84.85%)	20 (15.15%)	132 (100%)
Total	185 (86.45%)	29 (13.55%)	214 (100%)

Source: Field Survey Data 2024

The results of Table 4.8 shows that 15.15% and 10.98% of the rice VCDP participant and nonparticipant households respectively, actively made use of healthcare insurance. The margin is clearly low for both groups of rice farmers.

Haby, Chapman, Clark and Galvão (2016) recognizes such measures of healthcare outcome as valid, because it involves health-related-costs (healthcare expenditure) and health-services-use (access to healthcare centre). Generally, these findings on healthcare access variables, reflects (Rutherford et al., 2016) who found positives but no clear-cut differences in household health outcomes for treatment and comparison groups, in the aftermath of the Agricultural Value Chains (AVC) project in Liberia.

Figure 4.2 shows a graphical relationship between the log of healthcare expenditure and log of revenue for the rice farmers in the study area. These estimates are interpreted as percentages.

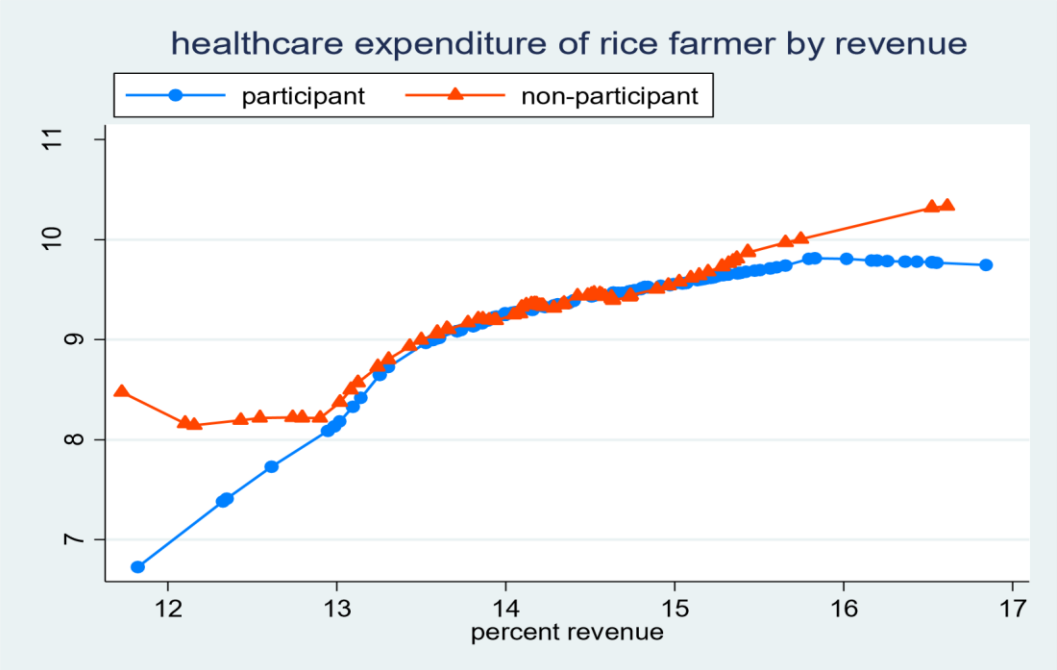

Figure 4.2 Relationship between healthcare expenditure and rice farmer revenue

It can be seen from the figure 4.2 that increased spending on healthcare tends to be associated with increases in the revenue for the rice farmers in the study area. This means that the farmer capacity to properly manage their household healthcare improved with their earnings from the rice production. Ordinarily, this is not unexpected given the aforementioned findings that most of the rice farmers relied on out-of-pocket spending for their household healthcare needs. The figure 4.2 disaggregated the healthcare-expenditure vs revenue relationship for rice VCDP participant and non-participant households. The graph shows that the rice VCDP non-participant farmers compared to the participant farmers, recorded a higher percentage of expenditure for their healthcare per increase in revenue from rice farming. This may imply that a larger portion of the rice enterprise earnings of the VCDP non-participant farmers was spent on healthcare. Also, it corroborates the lesser number of insured access-to-healthcare found among the VCDP nonparticipant farmers.

4.1.7 Factor Determinants of the Rice Farmer VCDP Participation and Welfare Outcomes

Table 4.9 shows the result of the logit regression estimates of the treatment effect model used - the inverse probability weighted regression adjustment (IPWRA). The use of this treatment effect model is based on the confirmation of no endogeneity, which allows for the assumption of conditional independence. This means that the assignment of the treatment is based on observable characteristics and is independent of the outcome. To ensure the validity of this assumption, the balance of the covariates in the IPWRA was checked using the overidentification test. The result of the overidentification test reported that we cannot reject the null hypothesis (p-value = 0.1194) that the covariates in the treatment model are balanced.

The treatment effect regression output also shows results for the factor determinants used to estimate the outcome means for the rice VCDP participant farmers (OME1) and rice VCDP nonparticipant farmers (OME0). Hence, output as presented in Table 4.9.

Table 4.9: Logit Estimates from the Inverse Probability Weighted Regression Adjustment

	Log NFI	TFP	FCS	Average Years of Schooling	Log Health Expenditure
Variable	**Coef**	**Coef**	**Coef**	**Coef**	**Coef**
OME (0)					
Farm size	0.790*** (0.236)	0.179*** (0.018)	2.942*** (0.917)		
Married (yes)	11.463*** (1.266)			-2.280*** (0.274)	
Household size	-0.439*** (0.095)		-1.124*** (0.381)	-0.141*** (0.014)	0.066** (0.029)
Rice farming experience	0.001 (0.040)	-0.062*** (0.022)		0.043*** (0.015)	
Ownership of car (yes)	2.090* (1.085)				
Duration of membership in Agric. Assoc.	-0.220* (0.127)	-0.109*** (0.023)			
Number of visits of extension	0.109 (0.141)	-0.090** (0.043)	0.544 (0.525)		
Age		0.055*** (0.019)			
Cost to output market		-0.0003* (0.0002)			
Cost to input market		-0.0003* (0.0002)			
Loan from friend (yes)		-0.866** (0.433)			
Number of school children			1.382 (1.833)		
Other earnings			0.000*** (0.000)		
Inputs from Agric. Assoc. (yes)			-10.636 (8.300)		0.332 (0364)
Gender (male)			-16.299* (9.195)		
Ownership of Television (yes)			-7.374 (9.324)		
Mean age of children				0.671*** (0.026)	
Food expenditure				0.000*** (0.000)	
Log Rice revenue				-0.435*** (0.072)	0.268* (0.141)
Farming as primary occupation (yes)				-0.839*** (0.213)	

Membership in Agric. Assoc.(yes)				-1.017*** (0.314)	
Visits healthcare (yes)					-0.349 (0.270)
Walking time to healthcare (mins)					0.006* (0,003)
Constant	4.837** (2.139)	1.876*** (0.328)	60.793*** (14.358)	8.641*** (1.236)	5.541** (2.228)
OME (1)					
Farm size	0.115*** (0.020)	0.048 (0.044)	-0.197 (0.520)		
Married (yes)	0.384 (0.255)			-1.252*** (0.326)	
Household size	0.012 (0.025)		-0.050 (0.605)	-0.054 (0.044)	0.067 (0.051)
Rice farming experience	-0.005 (0.006)	-0.020 (0.016)		0.029*** (0.009)	
Ownership of car (yes)	0.206* (0.111)				
Duration of membership in Agric. Assoc.	-0.014 (0.012)	-0.048** (0.024)			
Number of visits of extension	0.085*** (0.029)	0.104 (0.069)	-1.070* (0.632)		
Age		0.006 (0.017)			
Cost to output market		0.0001 (0.0004)			
Cost to input market		0.0001 (0.0003)			
Loan from friend (yes)		-0.928*** (0.227)			
Number of school children			0.249 (0.726)		
Other earnings			0.000*** (0.000)		
Inputs from Agric. Assoc. (yes)			2.477 (2.540)		0.297 (0.216)
Gender (male)			-7.933*** (2.305)		
Ownership of Television (yes)			9.497*** (2.747)		
Mean age of children				0.658*** (0.021)	
Food expenditure				0.000* (0.000)	
Log Rice revenue				0.044 (0.133)	0.398* (0.220)

Farming as primary occupation (yes)				-0.412 (0.326)	
Membership in Agric. Assoc.(yes)				-0.865 (0.852)	
Visits healthcare (yes)					0.841 (0.556)
Walking time to healthcare (mins)					0.005** (0.002)
Constant	14.009*** (0.295)	2.928*** (0.850)	51.358*** (4.772)	0.541 (1.905)	2.067 (3.880)
TME (1)					
Membership in Agric. Assoc. (yes)	1.855*** (0.698)	1.855*** (0.698)	1.855*** (0.698)	1.855*** (0.698)	1.855*** (0.698)
Attend agricultural training (yes)	1.663*** (0.632)	1.663*** (0.632)	1.663*** (0.632)	1.663*** (0.632)	1.663*** (0.632)
Inputs from Agric. Assoc. (yes)	1.808*** (0.690)	1.808*** (0.690)	1.808*** (0.690)	1.808*** (0.690)	1.808*** (0.690)
Extension services visit	1.840*** (0.504)	1.840*** (0.504)	1.840*** (0.504)	1.840*** (0.504)	1.840*** (0.504)
Constant	-3.525*** (0.652)	-3.525*** (0.652)	-3.525*** (0.652)	-3.525*** (0.652)	-3.525*** (0.652)
Observations	214	214	214	214	214

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

For the net farm income (log NFI), the variables of farm size, married, ownership of car and number of extension visits had significant and positive influences on the log net farm income, whereas the household size and duration of membership of agricultural association were significant and negatively associated with the log net farm income. The results showed that a hectare increase in farm size increased the net farm income of VCDP non-participant farmers by 79% points and that of VCDP participant farmers by 11.5% points. Married rice farmers had 11.5% higher net farm income than the unmarried ones among the VCDP non-participants. Ownership of car asset improved the net farm income by 2.1 and 0.21 percentage points for VCDP nonparticipant and participant farmers, respectively. An additional contact with extension service providers, increased the net farm income of the VCDP participant farmers by 8.5% points. On other hand, an increase in the number of persons living in the farmer household reduced the net farm income by 43.9% points for rice VCDP non-participant farmers. Similarly, an extra year of membership in agricultural associations for the rice VCDP non-participant farmer reduced their net farm income by 22%. These socio-economic factors are valid in explaining variations in rice farmer's net farm income (Ojo and Baiyegunhi, 2021).

For the total factor productivity measure, farm size and age were the only positively significant variables, whereas farming experience, duration of membership in agricultural association, number of extension visits, transportation cost to output and input markets, and loan from friends were significant and negatively related to the total factor productivity. Table 4.9 showed that per hectare increases in farm land size increased the total productivity of the VCDP non-participant farmers by a factor of 0.18, whereas a year increase in age of farmer improved productivity by a factor of 0.06 for the VCDP non-participant rice farmer. An extra year experience in rice farming was associated with a decrease in total factor productivity of 0.062 for the VCDP non-participant

farmer. An extra year of membership in agricultural association decreased the total productivity of the rice VCDP participant farmer and non-participant farmer by a factor approximately 0.05 and 0.11 respectively. An increase in the number of visits of extension agents reduced the total factor productivity by 0.09 for the VCDP non-participant rice farmer. Also, increment in transportation costs to both the output and input market reduced the total productivity of VCDP non-participant rice farmers by 0.0003 factor each. Taking loans from friends decreased the total factor productivity of the VCDP participant farmer by 0.93 and the VCDP non-participant farmer by 0.87, compared to when these farm loans are not accessed from friends. These findings revealed some key factors that affect the efficiency of inputs in the production activities of rice farmers in the study area. However, the signs on some of the variables are contrary to a priori expectations, considering the findings of Cordelia and Edwin (2020) for Ebonyi State. The negative sign of farm experience and duration of membership in an agricultural group could be related to a situation whereby farmers and their farmer groups have, over a long period, become contented with sticking to their usual farming systems, and ignoring innovations that improve productivity. Agricultural credit, in this case the informal loan from friends, should have positive effect on productivity; however, there is no guarantee that this credit will be utilized in a manner that promotes productivity especially with the peculiarities of smallholder farmers (Wanzala, Marwa and Lwanga, 2024).

The food consumption scores (FCS) of the farmer households was used to rank their food and nutrition security levels. The FCS is a metric well accepted for assessing the food security welfare status of households (Kissoly, Faße and Grote, 2017). The first stage of IPWRA model, produced the significant factor determinants of the farming households FCS as: farm size (positive), other earnings (positive), ownership of television (positive), household size (negative), gender

(negative) and number of extension visits (negative). The results on table 4.9 (column 4) shows that, an increment in farm size of one hectare was associated with a 2.94 score increase in the FCS of the VCDP non-participant farmer household.

Increase in farmer income/earnings from other none farm sources increased the household FCS for both the VCDP participant and non-participant rice farmers (although the increase was quite minimal in magnitude at 0.00003 scores each). Households who own television had the tendency to record approximately 9.50 scores more than those that had no television for the rice VCDP participant farmers. Conversely, an increase in number of persons living in the household was associated with approximately 1.12 decrease in the FCS of the VCDP non-participant farmer households. Male headed households were likely to record lower FCS than female headed households, such that the magnitude of decrease was approximately 7.93 score and 16.30 score for the rice VCDP participant and non-participant farmer households respectively. An increase in the number of visits of extension service providers was associated with a decrease of 1.07 score among the rice VCDP participant household. This result is contrary to (Ndlovu, Thamaga-Chitja and Ojo, 2022) findings on extension services, but in agreement on the positive influence of the asset of television in improving food security. Ownership of television improves access to multimedia information on diverse food and nutrition choices and its implications for households. The negative sign on household size can be related to the household dependency ratio which reduces farmer resources to provide. Thus, it follows that when farmers can diversify income (earnings from other sources), they can cushion challenging economic situations and improve household food consumption.

Regarding the educational outcomes for the rice farmer household (estimated using their children's years of schooling), table 4.9 (column 5) shows that the following factors were significantly associated with the children's average years of schooling viz: farm experience (positive), age of children (positive), household food expenditure (positive), married (negative), household size (negative), rice revenue (negative), farming as primary occupation (negative) and membership of agricultural association (negative). An extra year of rice farming experience was associated with approximately 0.04 and 0.03 increase in the farmer children's average years of schooling for the VCDP non-participant and VCDP participant rice farmers, respectively. Similarly, an increase in the age of children was associated with about a 0.67 and 0.65 increase in their average years of schooling for the VCDP non-participant and VCDP participant rice farmers, respectively. Increases in the farmer household's food expenditure were also associated with increases in their children's average years of schooling for both the VCDP participant and non-participant rice farmers. On the other hand, married rice farmers were associated with a 2.28 and 1.25 decrease in the children's average years of schooling compared to their single compatriots, for the VCDP nonparticipant and participant rice farmer households, respectively. With additions to persons living in the farmer household, the children's average years of schooling decreased by 0.14 years for the VCDP non-participant rice farmer. Similarly, the revenue from rice farming had an inverse relationship with the years of schooling, such that extra Naira earnings were associated with about

0.44-year decrease in the children's average years of schooling for the VCDP non-participant farmer. Farming as a primary occupation, as opposed to other occupations, reduced the children's average years of schooling by about 0.87 years for VCDP non-participant rice farmers. In the same way, farmer membership in an agricultural association, as opposed to non-membership, reduced the children's years of schooling by approximately 1.0 year for the VCDP non-participant rice

farmers. For agricultural interventions like the VCDP, the wellbeing of children is usually influenced through the pathway of farmer household economic welfare and household

consumption expenditure (Rutherford et al., 2016; Shah et al., 2018).

The inverse relationship of the children's average years of schooling vs the household size could be related to the increased dependency ratio due to more members; and this was more likely with married persons, exerting more pressure on farmer resources needed to fund their children's education to higher levels. In the same vein, individuals who have farming as their primary means of earning a living may rather subscribe to training their children in agriculture than enrolling them in formal education. Hence, this factor could be connected to the inverse relationship observed with their revenue/earnings from rice farming, which increased their conviction to have their children acquire skills in agriculture to take over in the farming business rather than pursue formal education. (Shah et al., 2018) shares in this opinion, citing reasons of increased opportunity cost of enrolling children in school as opposed to training them in the 'booming' farm enterprise. These core farmers were most likely to be the ones who enrolled in agricultural associations, hence the inverse relationship to average years of schooling observed. Household food expenditure is an indication of farmer economic status, such that higher figures were indicative of the availability of resources to advance their children's education. A priori, the children's years of schooling were expected to increase as they age, for different levels of school.

In Table 4.9 (column 6), the result of the factor determinants of farmer household health expenditure showed that the household size, the rice revenue and visit to healthcare were all positively related to it. Thus, a unit increase in the number of persons living in the household increased the health expenditure by 6.6% for the rice VCDP non-participant farmer. Similarly, a

Naira increase in the rice revenue of the farmer was associated with a 26.8% and 38.9% increase in the healthcare expenditure for the VCDP non-participant and participant rice farmer household, respectively. Expectedly, households that actually visit the healthcare center compared to those that do not, tended to spend about 0.5% and 0.6% more in healthcare expenditure for VCDP participant and non-participant rice farmers, respectively. Again, these factors are connected through the productivity pathway of the farmer household, considering the importance of labour provided by household members, and earnings generated from the farm enterprise necessary to keep the human resources/capital healthy (Berha *et al.*, 2021; Chavez, Sonneveld, Yaghmaei, Francesconi and Alba, 2022).

This result is not unusual, because as income of persons increase so also does their consumption especially when it involves fulfilling the basic necessities of life (like healthcare). It also recounts that, when people give more value to their health by going to the healthcare centers (and not cutting-corners), they incur more expenses to get proper care, and this is because they are able to allocate more resources for this purpose. The larger the household, the more likely to incur higher household expenditure (including healthcare). Thus, these key covariates are duly accounted for in elucidating the actual effect of the treatment (rice VCDP) on the unit of analysis (farmers).

Table 4.9 also reported the treatment model part of the regression (TME1), showing the factors used to determine selection into treatment (i.e. the determinants of participation in the rice VCDP). All the variables were significant and positively related to the treatment (VCDP participation). This means that farmer membership in an agricultural association (Daudu, Abdoulaye, Bamba, Shuaib and Awotide, 2023; Ndlovu *et al.*, 2021; Yang, Zhang, Liu and Zeng, 2021), attending agricultural trainings (Yang et al., 2021), belonging to agricultural associations where farm inputs

are benefited, and having access to extension services (Daudu et al., 2023; Ndlovu et al., 2021) improved the likelihood of selection to participate/benefit from the rice VCDP intervention. This finding is plausible because originally, one of the major criteria of rice farmers benefiting from the VCDP intervention was that they must belong to a formal farmer cooperative, organization or group. The Agricultural Development Programme of the State (EBADEP) was involved in the VCDP implementation proceedings, hence extension service providers as controlled by EBADEP, could have influenced farmer participation through their activities - whereby farmers leverage on their beneficial information (Ayanwale, Ojo and Adekunle, 2023). It is also reasonable to assume that another valid means through which farmers got information about the VCDP is by attending these agricultural trainings; this medium expands their social network integration and creates awareness of new opportunities in the agriculture sector.

4.1.8 Impact of the Rice VCDP on the Welfare Outcomes of Rice Farmers

This sub-section investigated the causal relationships between participation in the rice VCDP and the various welfare outcomes (net farm income, productivity, food & nutrition security, education and healthcare) for the rice farmers. Here the effects of the VCDP intervention on each of the outcomes for the population of rice VCDP participant farmers was further estimated (also known as treatment on the treated sample).

4.1.8.1 Treatment Effects of the Rice VCDP on Net Farm Income

Table 4.10 shows the result of the estimated average treatment effect on the treated for the NFI.

Table 4.10: Average Treatment Effect on the Treated Net Farm Income

	Net Farm Income
ATET	1.794***
(VCDP participation (1 vs 0)	(0.464)

POmean	12.992***
(Rice VCDP)	(0.469)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

The IPWRA was also used to elucidate the true impact of the rice VCDP intervention on the rice farmer net farm income (NFI), and to do this it estimated the average treatment effect on the treated (ATET). The result in Table 4.10 showed that the rice VCDP had a positive and significant effect on net farm income, such that the net farm income of the rice VCDP participants was 1.79% points greater than it would be had the farmers not participated. The positive and significant impact of the rice VCDP intervention was confirmed by the positive potential outcome mean magnitude. This corroborates the findings of several research works on the effects of similar agricultural interventions. (Ayanwale et al., 2023) found that participation in innovation platforms (similar to VCDP idea) improved income mostly for the poorer farmers. The strategies of the VCDP which involved developing farmer groups/associations/cooperatives and granting them better access to agricultural technologies, was found to also impact positively on the farm incomes of lowerincome farmers (Yang et al., 2021). Meanwhile, (Addison et al., 2023) found that the adoption of such package of agricultural innovation has differential gender income effects, but positively improved the income of participant rice farmers.

4.1.8.2 Treatment Effects of Rice VCDP on the Total Factor Productivity

Table 4.11 presents the result of the average treatment effect on the treated farmer group for the total factor productivity (TFP) of the rice farmers in the study area.

Table 4.11: Average Treatment Effect on the Treated Total Factor Productivity

	Total Factor Productivity

ATET	1.014***
(VCDP participation (1 vs 0)	(0.237)
POmean	1.942***
(Rice VCDP)	(0.193)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

The result of the IPWRA estimates on table 4.11 showed that the rice VCDP intervention had a positive effect on the total factor productivity of rice farmers. Specifically, rice VCDP participants who received the treatment had 1.014 productivity factor greater than if they had not participated in the programme. In other words, the total factor productivity of the rice VCDP participant farmer is about 2.956, for participating in the programme. It means that because these rice farmers participated in the VCDP, they gain an extra margin of 1.014 ratio of outputs for factor-inputs employed than they would ordinarily get without the programme (i.e. in comparison to the potential outcome mean of 1.942).

The positive impact of such agricultural enhancement programmes on farmer productivity are well documented in research (Baiyegunhi, Akinbosoye, & Bello, 2022; Daudu et al., 2023). Just as was employed in the VCDP, (Abdul-Rahaman and Abdulai, 2018) found that participation in a farmer group program strategy significantly impacted on the yield and technical efficiency of rice farmers; whereas participation in farmer comprehensive agricultural training program increased productivity by as much as 15% (Martey et al., 2021).

4.1.8.3 Treatment Effects of Rice VCDP on Food and Nutrition Security

Table 4.12 shows the result of the estimated average treatment effect on the treated based on the food consumption score of the rice farmers.

Table 4.12: Average Treatment Effect on the Treated Food Consumption Score

	Food Consumption Score
ATET	8.690***
(VCDP participation (1 vs 0)	(4.093)
POmean	46.102***
(Rice VCDP)	(3.919)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

Table 4.12 presented the result of the causal effect of the rice VCDP on the participant farmers in the study area. It showed that participating in the rice VCDP increased the participant rice farmer household food consumption score by 8.69 compared to when they do not participate. This means that the potential outcome mean FCS when they do participate is 54.79, compared to 46.10 food consumption score had they not participated in the rice VCDP. The food and nutrition security of the rice farmers improved significantly with the VCDP, such that they moved further away from the threshold (42 score) to be categorized in the acceptable food and nutrition secure space.

Literature has shown that in recent times, the objectives of the agricultural value chains programmes have food security concerns as one of its priorities, and the IFAD-VCDP was not left out. The findings of this study corroborate the success stories for food and nutrition security impacts made by similar value chain strategies using various metrics; household food calorie intake (Mossie, Gerezgiher, Ayalew and Elias, 2021); household food insecurity access scale (Ndlovu et al., 2022; Rutherford et al., 2016); food consumption score and coping strategy index (Kissoly et al., 2017).

4.1.8.4 Treatment Effects of Rice VCDP on Educational Outcome

Table 4.13 presents the result of the average treatment effect on the treated rice farmer group for their children's average years of schooling in the study area.

Table 4.13: Average Treatment Effect on the Treated Children's Average Years of Schooling

	Children Average Years of Schooling
ATET	0.539***
(VCDP participation (1 vs 0)	(0.153)
POmean	5.663***
(Rice VCDP)	(0.313)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

Estimates of the treatment effects regression in table 4.13 showed that the rice VCDP intervention increased the average years of schooling of the farmers' children by approximately 0.54 years for the participant rice farmer households. This means that participating in the rice VCDP increases the period of the farmer children's enrolment in school more than a situation where the rice farmers did not participate in the programme. The observed increase for the rice VCDP participant farmer household may seem marginal, but this could be because the education outcomes were more of secondary welfare effects for the farmers. Contrary to the findings of this study, (Shah et al., 2018) found that the value chain development programme failed to increase the enrolment or attendance of the farmer school children, even after increasing farmer incomes. Whereas, (Rutherford et al., 2016) found positive trends in farmer's children school enrolment, attendance and expenditure, although the increase was not statistically significant to validate it as an impact of the agricultural value chain project.

4.1.8.5 Treatment Effects of Rice VCDP on Health Outcome

Table 4.14 shows the result of the estimated average treatment effect on the treated based on the healthcare expenditure of the rice farmers in the study area.

Table 4.14: Average Treatment Effect on the Treated Healthcare Expenditure

	Healthcare Expenditure

ATET	-0.667***
(VCDP participation (1 vs 0)	(0.165)
POmean	10.042***
(Rice VCDP)	(0.123)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey Data 2024

In Table 4.14, the result of the treatment effect model revealed that participating in the rice VCDP reduced the household healthcare expenditure of the participating farmers by 66.7% less than if they had not participated. This means that the rice VCDP substantially reduced the healthcare burden or the level of healthcare spending of the rice farmer. The result may be related to a situation whereby the VCDP intervention's influence improved the farmer household's state of health, hence reducing expenses in healthcare matters. Also, it may be likened to a situation whereby the impact of the rice VCDP generally raised the farmer earnings, such that operating at higher income levels, the proportion of spending on healthcare has become smaller (reducing over time) relative to income. Similarly, (Haby et al., 2016) argue that most agriculture, food and nutrition interventions they reviewed had impact on different measures of health outcomes. However, (Rutherford et al., 2016) found no difference in the health outcomes for treatment and comparison groups for agricultural value chain project participation.

4.2 DISCUSSION

The socioeconomic characteristics of rice farmers in the study area were identified as it has a bearing on the decision-making processes of the rice farmers. Thus, they were profiled based on their demographics, education, farm characteristics, income sources, and social capital. The farmer respondents presented in the study include a pool of rice VCDP participants and non-participants

in Ebonyi State. Based on the characteristics observed from the profiling, it was deduced that rice farming in the study area was dominated by literate males in their active mid-stage of life, with many years of farming experience and an average household size of 7 persons. These rice farmers were smallholders who had access to social networks and extension services, they diversified their income sources and were willing to take formal and informal loans to facilitate their farming activities in terms of input resources. The rice farmers also had reasonable access to information assets and other valuable assets like motorcycles to aid transportation.

The net farm income (NFI) of the pooled rice farmers in the study area was approximately ₦1,770,828 Naira on average, indicating the profiting nature of the enterprise (although few farmers were observed to have faced some losses). The NFI of the rice VCDP participant farmers (₦2,140,000 Naira) was higher than that of the non-participants farmers (₦1,180,000 Naira), showing the possibility of increased profits among participants. The total factor productivity for rice farmers in the study area was about 2.67. This meant that for every 1 Naira spent on factor inputs, the farmers were able to produce about 2.67 Naira worth of rice. The descriptive statistics showed that VCDP participants had slightly higher total factor productivity of 2.96 compared to non-participants at 2.17, suggesting better productivity outcomes among the VCDP participants.

The food consumption score (FCS) of the rice farmer households in the study area was about 54.28, indicating acceptable levels of food and nutrition security, this meant that on average most rice farmers in the study area were able to access an adequate amount of food to meet their nourishment needs. Based on the classifications from the FCS, 76.17% of the sampled rice farmers were classified as food secure, while 23.83% were classified as food insecure. However, from the

descriptive analysis, the rice VCDP participant household had slightly higher percentage of food insecure households compared to the non-participant household.

For education, the study found that on average, children in farmer households enrolled in school for about 6 years, although some of the school-age children attained 14 years of schooling. More years of school enrolment implies more expenditure on education. The rice VCDP participant farmer households spent more on education, suggesting that they may have had more resources to invest in their children's education. On healthcare, rice farmer households spent on average about 19,479.91 Naira per month on healthcare, whereby majority reported actual visit to healthcare centres whenever a household member is ill. However, only a small proportion of these farmers had healthcare insurances. Generally, the rice farmer households prioritized education and healthcare, with the differences in spending based on factors like education level and perhaps participation in the rice VCDP.

The inverse probability weighted regression adjustment (IPWRA) was used to estimate the impact of the rice VCDP on the various welfare outcomes for the farmers. The study established that the determinants of rice farmer participation in VCDP were; membership of an agricultural association, participation in agricultural trainings, access to extension services and access to inputs from agricultural associations. Several covariates, indicative of observable farmer characteristics which influenced the various analysed outcomes from rice farming were captured. Some of the key covariates identified were farm size, household size, farm experience and frequency of extension service providers visits.

The impact estimates, using the average treatment effect on the treated, revealed that IFAD-VCDP intervention had positive significant effects on the income, total factor productivity, food and

nutrition security, and children's years of schooling for the participating rice farmers. Also, the rice VCDP had a negative and significant effect on the household healthcare expenditure of the participating rice farmers.

CHAPTER FIVE

CONCLUSION, RECOMMENDATIONS AND CONTRIBUTION TO KNOWLEDGE

5.1 Conclusion

The value chain development programme as conceived by the International Fund for Agricultural Development (IFAD), and implemented in partnership with the Federal and State Governments of Nigeria was a well-thought-out project, planned to enhance agricultural marketing development and smallholder productivity. It actually involved many activities with the goal of improving farmer organisations' value integration, alleviating poverty and improving earnings from agriculture. An assessment of the realisations of the expected deliverables and impact (long term outcomes) serves to verify the sustainability of the programme effects in the society.

This study contributes to knowledge by providing feedback on the rice VCDP plausible impact beyond the project activities and the possible pathways to creating the desired change. The study also contributes to literature by analysing the effect for all welfare dimensions connected to the

basic needs of man. The focus on farmers is crucial as a notable entry point in the value chain and as a creator of primary produce from raw inputs. The rice VCDP improved the outcomes for farmers based on the five welfare dimensions assessed. The impact on education and health outcomes seems secondary, occurring through indirect pathways. Hence, there may be need to review the strategies peculiar to these outcomes in order to enhance its results for the farmers. The study framework of analysis put into consideration the possibility of endogeneity or confoundedness in order to ascertain the impact estimation pathway and avoid misleading inferences.

5.2 Recommendations

Based on the findings of the rice VCDP in Ebonyi State, the following recommendations were preferred:

1. The development and formalization of agricultural associations, farmer organisations and cooperatives should be facilitated through the local governments Department of Agriculture and Registrar of Cooperatives to ease rice farmers' membership enrolment. This channel is known to enhance farmer access to information, resources, and networking opportunities. It also helps improve farmer knowledge and skills in rice farming, as well as enable them to access support services and inputs at a lower cost. Access to inputs from agricultural associations create more beneficial channels for rice farmers to improve access and availability of high-quality seeds, fertilizers, and other inputs at competitive prices, by pooling their resources. This can help farmers improve the quality of their crops and increase their overall profitability.

2. Participation in agricultural training benefits rice farmers and agriculturists generally by increasing their technical know-how and improving and updating their farming practices especially in a continuously evolving climate and business environment. It is known to lead to higher yields, better quality crops, and ultimately, higher profits. Hence, farmers should be incentivized to always participate, by localizing these training opportunities regularly. The local government authorities should work-out modalities with research institutes, higher institutions of learning in their domain and the State government to institutionalize regular training/workshop for farmers to facilitate domestication of research outputs and innovations.
3. Access to extension services is vital for rice farmers as it allows them to receive personalized advice, guidance, and support from professionals in the field. This can help them address specific challenges they may face on their farms and make informed decisions to enhance their productivity and profitability. The State Agricultural Development Programme must work with the Ministry of Agriculture to regularly recruit, train and equip extension services providers with the means to frequently visit and engage farmers at the grassroots. Also, the local government Department of Agriculture should work-out modalities with the State government to prioritize the establishment of extension outposts in all communities in the State. It is known that regular visits from extension service providers can ensure that farmers receive ongoing support and guidance to address their needs and challenges effectively.
4. Land tenure systems must be optimized by local authorities creating exclusive farming zones with requisite farm infrastructure, and which is restricted from non-agricultural activities or non-farm uses. These low-cost land banks will provide the incentives and encouragement for farmers to scale their rice farming enterprise to competitive commercial levels. Farm size is a huge economic productive asset. It could easily become the distinguishing factor in farmer

income and earnings from farm business. Access to larger farm sizes enhances the opportunities for farmers to try out innovations and new agricultural technologies, which increases their chances of higher yield and productivity growth. Larger farms may have economies of scale that allow for higher production levels. Hence, the similar importance of household size as it influences family labour availability, contributing to smallholders cost savings even with land expansion.

5.3 Contribution to knowledge

This study has remarkable bearing on the agricultural technologies, farmer organization and group dynamics in the value chain and market linkages.

1. It serves the purpose an independently-assessed and objective feedback on the sustainable contributions of agricultural value chain interventions for the agricultural development and economic advancement of the developing world.
2. The study put forward more evidence to appraise the widely proposed adoption of agrifoods value chain development strategies as solutions for agricultural development and transformation.
3. It highlighted the probable pathways through which farmer and farming households' welfare in terms of the basic needs of life can be influenced through agricultural innovations.
4. The study contributes to empirical literature on impact evaluation of agricultural interventions in developing countries and rural settings, specifically for Ebonyi State, using a retrospective survey data, and surmounting the challenges of absence of baseline data.

5. Specifically, the study contributes to knowledge by providing research evidence on measurable relationships between farming and education outcomes. It revealed that such intervention can increase farmer capacity to finance the education of their wards beyond basic education level, and also improve enrolment in school by approximately 1year.
6. Finally, this study proved that integrated agricultural interventions can actually be used to improve health outcomes for farming households, by reducing the challenges with healthcare spending by up to 66.7%.

REFERENCES

Aatish K. S., Zhopnu C. and Sanjoy D. (2017) Measuring Household Food Security Index for High Hill Tribal Community of Nagaland, India. *Journal of Food Security*, 5(5):155-161. doi: 10.12691/jfs-5-5-1.

Abdul-Rahaman, A. and Abdulai, A. (2018). Do farmer groups impact on farm yield and efficiency of smallholder farmers? Evidence from rice farmers in northern Ghana. *Food Policy*, *81*, 95–105. https://doi.org/10.1016/j.foodpol.2018.10.007

Abdul-Rahaman, A., Issahaku, G., & Zereyesus, Y. A. (2021). Improved rice variety adoption and farm production efficiency: Accounting for unobservable selection bias and technology gaps among smallholder farmers in Ghana. *Technology in Society*, *64*. https://doi.org/10.1016/j.techsoc.2020.101471

Addison, M., Ohene-Yankyera, K., Osei-Wusu Adjei, P., Mujawamariya, G., & Asante, B. (2023). Uptake and income distribution effects of targeted farm technologies on rice farmers in forest and Guinea Savannah Zones of Ghana: Does gender matter? *Journal of Agriculture and Food Research*, *11*. https://doi.org/10.1016/j.jafr.2023.100516

Adediran, O., Osabuohien, E., Silberberger, M., Osabohien, R. and Adebayo, W. G. (2024) Agricultural value chain and households' livelihood in Africa: The case of Nigeria. *Heliyon,* 10. https://doi.org/10.1016/j.heliyon.2024.e28655.

AfricaRice (2011) Boosting Africa's Rice Sector: A research for development strategy 2011–2020. Africa Rice Center, Cotonou, Benin.

Ahearn, M., Yee, J., Ball, E. and Nehring, R. (1998) Agricultural productivity in the United States. Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agriculture Information Bulletin no. 740.

Akande, Y. B., Tijani, A. A., Kehinde, A. D., & Oyenpemi, L. O. (2023). Impact of compliance with European Union (EU) regulations on the income of actors along the cocoa supply chain in Osun state, Nigeria. *Sustainable Futures*, *6*. https://doi.org/10.1016/j.sftr.2023.100120

Akbar, M., Niaz, R., & Amjad, M. (2020). Determinants of households' food insecurity with severity dimensions in Pakistan: Varying estimates using partial proportional odds model. Health & Social Care in the Community, 28(5), 1698-1709.

Al Daccache, M., Abi Zeid, B., Hojeij, L., Baliki, G., Brück, T., & Ghattas, H. (2024). Systematic review on the impacts of agricultural interventions on food security and nutrition in complex humanitarian emergency settings. In *BMC Nutrition* (Vol. 10, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s40795-024-00864-8

Alexander, K.S., Greenhalgh, G., Moglia, M., Thephavanh, M., Sinavong, P., Larson, S., Jovanovic, T., & Case, P. (2020). What Is technology adoption? Exploring the agricultural research value chain for smallholder farmers in Lao PDR. Agric. Hum. Values, 37, 17-32.

Awio, T., Senthilkumar, K., Ibrahim, A., Corbeels, M. and Saito, K. (2025). Yield stability of four staple crops of sub-Saharan Africa: analysis of long-term trials. *Nutrient Cycling in Agroecosystems*. https://doi.org/10.1007/s10705-025-10397-6

Awotide, B.A., Abdoulaye, T., Alene, A. and Manyong, V.M. (2015) Impact of access to credit on agricultural productivity: Evidence from smallholder cassava farmers in Nigeria. International Conference of Agricultural Economists. August 9–14, Milan, Italy.

Ayanwale, A. B., Ojo, T. O., & Adekunle, A. A. (2023). Estimating the distributional impact of innovation platforms on income of smallholder maize farmers in Nigeria. *Heliyon*, *9*(5). https://doi.org/10.1016/j.heliyon.2023.e16026

Babych M. and Kovalenko A. (2018). Food security indicators in Ukraine: Current state and trends of development. *Baltic Journal of Economic Studies,* 4(1):8-15. https://doi.org/10.30525/2256-0742/2018-4-1-8-15.

Baiyegunhi, L.J.S., Akinbosoye, F. and Bello, L.O. (2022) Welfare impact of improved maize varieties adoption and crop diversification practices among smallholder maize farmers in Ogun State, Nigeria. *Heliyon*, 8. https://doi.org/10.1016/j.heliyon.2022.e09338.

Bakare, A. Y., Ogunleye, A. S. and Kehinde, A. D. (2023). Impacts of microcredit access on climate change adaptation strategies adoption and rice yield in Kwara State, Nigeria. *World Development Sustainability*, *2*. https://doi.org/10.1016/j.wds.2023.100047

Balié, J., Prete, D.D., Magrini, E., Montalbano, P. and Nenci, S. (2019). Does Trade Policy Impact Food and Agriculture Global Value Chain Participation of Sub-Saharan African Countries? *American Journal of Agricultural Economics*, 101 (3):773-789. https://doi.org/10.1093/ajae/aay091.

Banerjee, S., & Basu, A. (2021). Estimating Endogenous Treatment Effects Using Latent Factor Models with and without Instrumental Variables. Econometrics, 9(1), 14. https://doi.org/10.3390/econometrics9010014

Barrett C. B. 2010. Measuring Food Insecurity. *Science* 327, 825-828

Barrett, C. B. (2013). *Food security & sociopolitical stability*. Oxford: Oxford University Press.

Barrett, C. B., Reardon, T., Swinnen, J., & Zilberman, D. (2022). Agri-food Value Chain Revolutions in Low- and Middle-Income Countries. *Journal of Economic Literature*, *60*(4), 1316–1377. https://doi.org/10.1257/jel.20201539

Basu A. and Chan K.C.G. (2014). Can we make smart choices between OLS and contaminated IV methods? *Health Economics,* 23: 462–72.

Becker, G.S. (1965) A theory of allocation of time. *The Economic Journal*, 75 (299): 493– 517, https://doi.org/10.2307/2228949

Bellemare, M. F. (2012). As you sow, so shall you reap: The welfare impacts of contract farming. *World Development*, 40(7):1418-1434.

Bello L.O., Baiyegunhi L.J.S. and Danso-Abbeam G. (2020): Productivity impact of improved rice varieties' adoption: case of smallholder rice farmers in Nigeria, *Economics of Innovation and New Technology*, DOI: 10.1080/10438599.2020.1776488

Berha, A., Mogess, Y. and Wassie, M. (2021). Revisiting nutrition-labour productivity link: New empirical evidence from farm households in Ethiopia. Agriculture & Food Security, 10.

Bertrand M., Duflo E. and Mullainathan S. (2004) How much should we trust differences-indifferences estimates. *Quarterly Journal of Economics,* 119: 249-275.

Bhaskar A.V.V., Nithya D.J., Raju S. and Bhavani R.V. (2017). Establishing integrated agriculture-nutrition programmes to diversify household food and diets in rural India. *Food Security*. DOI 10.1007/s12571-017-0721-z.

Biggeri, M., Carraro, A., Ciani, F. and Romano, D. (2022). Disentangling the impact of a multiplecomponent project on SDG dimensions: The case of durum wheat value chain development in Oromia (Ethiopia). *World Development*. https://doi.org/10.1016/j.worlddev.2021.105810

Bizikova, L., Nkonya, E., Minah, M., Hanisch, M., Turaga, R. M. R., Speranza, C. I., Karthikeyan, M., Tang, L., Ghezzi-Kopel, K., Kelly, J., et al. (2020). A scoping review of the contributions of farmers' organizations to smallholder agriculture. Nature Food, 1, 620-630.

Bresciani, F. and Valdes A. (2007) Beyond food production: The role of agriculture in poverty reduction. FAO, Rome.

CABI (2024). Challenges and strategies in Nigerian agribusiness entrepreneurship. CABI Agriculture and Bioscience.

Caldera, S. (2019, March 12). *Techniques for robustness & threats to inference: Inverse probability weighted regression adjustment.* Unpublished manuscript.

Cameron, A. C., Trivedi P.K., Milne F. and Piggott J. (1988), A microeconometric model of the demand for health care and health insurance in Australia, *Review of Economic Studies, 55,* 85-106.

Chavez, H., Sonneveld, A., Yaghmaei, N., Francesconi, N. and Alba, S. (2022). *Agriculture & Health are Inseparably Linked in Work Towards Sustainable & Economic Development*.

Chiaka, J., Zhen, L., Hu, Y., Xiao, Y., Muhirwa, F. and Lang, T. (2022). Smallholder Farmers Contribution to Food Production in Nigeria. *Frontiers in Nutrition*, 9. https://doi.org/10.3389/fnut.2022.916678

Chidiebere-Mark, N.M. (2017) Analysis of value chain in rice production systems in Ebonyi State, Nigeria. (Unpublished doctoral dissertation), Federal University of Technology, Owerri, Imo State.

Chima, O., Gberevbie, D., Duruji, M., Osimen, G., & Abasilim, U. (2024). Modern farming techniques in enhancing rice production: Insights from the anchor borrowers' programme in Ebonyi state, Nigeria. *Journal of Infrastructure, Policy and Development*. https://doi.org/10.24294/jipd.v8i11.5987

City Population (2017). https://www.citypopulation.de/Nigeria-Cities.html.

Cordelia, N.O and Edwin, O. (2020). Analysis of the factors influencing productivity of rice farms in Ebonyi State, Nigeria. *SVU-International Journal of Agricultural Science* 2(2):316-325. Doi: 10.21608/svuijas.2020.42033.1036.

Danbaba, M. (2023). Nigeria Can Be Self-Sufficient in Rice in 8 Years. National Accord. Retrieved from https://www.nationalaccordnewspaper.com/nigeria-can-be-self-sufficientin-rice-in-8-years-if-research/.

Dasgupta, S. and Robinson, E. (2022). Attributing changes in food insecurity to a changing climate. *Scientific Reports*, 12. https://doi.org/10.1038/s41598-022-08696-x

Daudu, A. K., Abdoulaye, T., Bamba, Z., Shuaib, S. B., & Awotide, B. A. (2023). Does youth participation in the farming program impact farm productivity and household welfare? Evidence from Nigeria. *Heliyon*, *9*(4). https://doi.org/10.1016/j.heliyon.2023.e15313

Deaton, A. (1980) *The measurement of welfare: Theory and practical guidelines*. Living Standard Measurement Study (LSMS) Working paper No. 7, The World Bank, Washington D.C. USA.

Diewert, W. E. (1974). Intertemporal Consumer Theory and the Demand for Durables. *Econometrica*, (42): 497-516.

Directorate for International Development (DFID) (2004). Agriculture, growth and poverty reduction. http://www.dfid.gov.uk/Documents/publications/agri-poverty-reduction.pdf

Dorosh, P., and Thurlow, J. (2018). Beyond Agriculture versus Non-agriculture: Decomposing Sectoral Growth-Poverty Linkages in Five African Countries. *World Development* 109: 440–51.

Ebonyi State Environmental and Social Impact Assessment (2024). Final Report for The Proposed Ebonyi State Special Agro-Industrial Processing Zone (SAPZ) Hub.

Eissler, S., & Heckert, J. (2024). *Evaluation of the Value Chain Development Program in Nigeria: Qualitative Findings* (02234; IFPRI Discussion Paper).

Evbuomwan, G. O. and Okoye L. U. (2017) Agricultural value chain financing and small scale farmers in Nigeria: The pre-requisites. *NG-Journal of Social Development*, 6(1):47-57.

Fanifosi, G., Asiru, A. and Rauf, M. (2025). Implication of cereal production and intra-food trade to agricultural growth in Sub-Saharan Africa. *Agricultura Tropica et Subtropica*, 58, 1 - 7. https://doi.org/10.2478/ats-2025-0001

FAO. (2023). FAOSTAT: Crops and livestock products.

Foster, A. D., & Rosenzweig, M. R. (2010). Microeconomics of technology adoption. *Annual Review of Economics*, 2, 395-424.

Fotakis, E., Kontele, I., Tzoutzou, M., Grammatikopoulou, M., Arvanitaki, E., Sergentanis, T., Kotrokois, K., Kornarou, E. and Vassilakou, T. (2024). Food Insecurity in Greece and across the Globe: A Narrative Literature Review. *Foods*, 13. https://doi.org/10.3390/foods13101579

Garrity, K., Guerra, K., Hart, H., Al-Muhanna, K., Kunkler, E., Braun, A., Poppe, K., Johnson, K., Lazor, E., Liu, Y. and Garner, J. (2024). Local Food System Approaches to Address Food and Nutrition Security among Low-Income Populations: A Systematic Review. *Advances in Nutrition*, 15. https://doi.org/10.1016/j.advnut.2023.100156

Gelli, A., Donovan, J., Margolies, A., Aberman, N., Santacroce, M., Chirwa, E., Henson, S. and Hawkes, C. L. (2020). Value chains to improve diets: diagnostics to support intervention design in Malawi. *Global Food Security*, 25, 100321.

Gertler P.J., Martinez S., Premand P., Rawlings L.B. and Vermeersch C.V.M. (2016) *Impact evaluation in practice*. World bank, Washington D.C. USA.

Guerra, K., Hanks, A., Plakias, Z., Huser, S., Redfern, T and Garner, J. (2021). Local Value Chain Models of Healthy Food Access: A Qualitative Study of Two Approaches. *Nutrients*, 13. https://doi.org/10.3390/nu13114145

Gurmessa, N., Agwanda, C., Oduor, G., Musebe, R., Akiri, M., & Romney, D. (2022). Sustainability and Gender Dynamics of Coffee Value-Chain Development Intervention: Lessons from Ethiopia. *Sustainability*. https://doi.org/10.3390/su141911928

Haby, M. M., Chapman, E., Clark, R., & Galvão, L. A. C. (2016). Agriculture, food, and nutrition interventions that facilitate sustainable food production and impact health: an overview of systematic reviews. In *Rev Panam Salud Publica* (Vol. 40).

Hardwick, T. & Keyser, J. (2010). Quantitative value chain analysis; An application to Malawi. Policy Research Working Paper 5242, World Bank.

Hermiatin, F., Handayati, Y., Perdana, T. and Wardhana, D. (2022). Creating Food Value Chain Transformations through Regional Food Hubs: A Review Article. *Sustainability*. https://doi.org/10.3390/su14138196

Hicks, J.R. (1956) *A Revision of Demand Theory*. Oxford University Press, Oxford.

Hussein F.M., Ahmed A.Y. and Muhammed O.S. (2018). Household food insecurity access scale and dietary diversity score as a proxy indicator of nutritional status among people living with HIV/AIDS, Bahir Dar, Ethiopia. *PLoS ONE* 13(6):e0199511. https://doi.org/10.1371/journal.pone.0199511.

Iannotti, L., Kleban, E., Fracassi, P., Oenema, S. and Lutter, C. (2024). Evidence for Policies and Practices to Address Global Food Insecurity.. *Annual review of immunology*. https://doi.org/10.1146/annurev-publhealth-060922-041451

IFAD-Universities Win-Win Partnerships Project July, 2018. Doi:10.13140/RG.2.2.27240.11522.

International Fund for Agricultural Development [IFAD]. (2012, April). *Federal Republic of Nigeria: Value Chain Development Programme (VCDP) programme design report (Report No. 2597).* Programme Management Department, West and Central Africa Division.

Iordekighir, A. A., Biam, C. K., Abu, G. A. and Ezihe, J. A. C. (2025). Economic Impact of IFADValue Chain Development Programme on Rice Farmers in North Central Zone, Nigeria. *Journal of Applied Sciences and Environmental Management*, *29*(1), 71–77. https://doi.org/10.4314/jasem.v29i1.10

Islam, A.H.M.S. (2021). Dynamics and determinants of participation in integrated aquacultureagriculture value chain: Evidence from a panel data analysis of indigenous smallholders in Bangladesh. J. Dev. Stud, 1-22.

Kamanyire, M.C., Matovu, F. and Wabiga, P. (2024). Electricity accessibility and household business start-ups in rural Uganda: Evidence from quasi-experimental analysis. *African Journal of Economic Review,* 12 (3): 74-97.

Kaplinsky and Morris (2002). A Handbook for Value Chain Research. Brighton: Institute of development studies, University of Sussex. p. 46–47.

Kassie, M., Tekalegne, T. and Tjabeha, M. (2020). Integrated health interventions for improved livelihoods: A case study in Ethiopia. Sustainability, 12(6), 2284.

Keyser, J. (2006) Definition of methodology and presentation of templates for value chain analysis. Background paper for the Competitive Commercial Agriculture in SSA (CCA) study, 35pp.

Khandker S., Koolwal B., and Samad H. (2009) *Handbook on Impact Evaluation*. Washington DC: WorldBank. (Retrieved from *http://wp.udesa.edu.ar/virtual/campusvirtual.udesa.edu.ar/moodledata/repository/Cursos*

Kissoly L., Faße A. and Grote U. (2017). The integration of smallholders in agricultural value chain activities and food security: evidence from rural Tanzania. *Food Security*, 9(6):1219– 1235. https://doi.org/10.1007/s12571-016-0642-2.

Kwizerimana, S., Mugwe, J, and Nigat, B. (2023). Impact of collective marketing participation on farmers' income: Evidence from smallholder avocado farmers of Murang'a County, Kenya. *Social Sciences and Humanities Open* 8 (100614), https://doi.org/10.1016/j.ssaho.2023.100614.

Laroche-Dupraz, C., and Huchet-Bourdon, M. (2016). Agricultural Support and Vulnerability of Food Security to Trade in Developing Countries. *Food Security* 8:1191–1206. DOI 10.1007/s12571-016-0623-5.

Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labour. *Manchester School* 22 (2): 139–91.

Liu, Y., Barrett, C. B., Pham, T. and Violette, W. (2020). The intertemporal evolution of agriculture and labor over a rapid structural transformation: lessons from Vietnam. *Food Policy*, 94, Article 101913.

Maertens M. and Velde K. V. (2017). Contract-farming in staple food chains: The case of rice in Benin. *World Development* (95):73–87, http://dx.doi.org/10.1016/j.worlddev.2017.02.011.

Malec, K., Rojík, S., Maitah, M., Abdu, M. and Abdullahi, K. (2024). Impact of investments in agricultural innovation on food security in sub-Saharan Africa. *Heliyon*, 10. https://doi.org/10.1016/j.heliyon.2024.e35913

Malhotra, S., Mantri, S., Gupta, N., Bhandari, R., Armah, R., Alhassan, H., Young, S., White, H., Puskur, R., Waddington, H., & Masset, E. (2024). Value chain interventions for improving women's economic empowerment: A mixed-methods systematic review and metaanalysis: A systematic review. *Campbell Systematic Reviews*, 20. https://doi.org/10.1002/cl2.1428

Malhotra, S., Saran, A., Singh, S., Mantri, S., Gupta, N., Bhandari, R., White, H., Puskur, R., Young, S., Waddington, H., & Masset, E. (2023). PROTOCOL: Value chain interventions for improving women's economic empowerment: A mixed-method systematic review. *Campbell Systematic Reviews*, 19. https://doi.org/10.1002/cl2.1331

Martey, E., Etwire, P. M. and Mockshell, J. (2021). Climate-smart cowpea adoption and welfare effects of comprehensive agricultural training programs. *Technology in Society*, *64*. https://doi.org/10.1016/j.techsoc.2020.101468

Mba, L., Ajaero, C. and Obetta, A. (2021). Patterns of rice production and yields in south eastern Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*. https://doi.org/10.18697/ajfand.102.20105

Miller, C. and Jones L. (2010) Agricultural value chain finance – Tools and lessons. Food and Agriculture Organization. Warwichshire: Practical Action Publishing Ltd. Pp176.

Mincer, J. (1976). Unemployment Effects of Minimum Wages. *Journal of Political Economy*, 84(4): 87-104.

Montalbano P., Nenci S. and Pietrobelli C. (2018a). Opening and linking up: firms, GVCs, and productivity in Latin America. *Small Business Economics*, 50 (4):917-935

Montalbano P., Pietrelli R. and Salvatici L. (2018b). Participation in the market chain and food security: The case of the Ugandan maize farmers. *Food Policy* (76):81-98. DOI: 10.1016/j.foodpol.2018.03.008.

Mossie, M., Gerezgiher, A., Ayalew, Z. and Elias, A. (2021). Food security effects of smallholders' participation in apple and mango value chains in north-western Ethiopia. *Agriculture and Food Security*, *10*(1). https://doi.org/10.1186/s40066-021-00310-z

NAERLS & FMARD (2020). 2020 Wet Season Agricultural Performance in Nigeria. National Agricultural Extension and Research Liaison Services (NAERLS) and Federal Ministry of Agriculture and Rural Development (FMARD). https://fscluster.org/sites/default/files/documents/aps_national_report_2020.pdf

Nakano Y, Tanaka Y, Otsuka K. (2018). Impact of training on the intensification of rice farming:

Evidence from rainfed areas in Tanzania. Agricultural Economics, 49, 193-202.

National Bureau of Statistics (NBS) (2023). Nigerian GDP Report Q4 2023.

Ndlovu, P. N., Thamaga-Chitja, J. M. and Ojo, T. O. (2022). Impact of value chain participation on household food insecurity among smallholder vegetable farmers in Swayimane KwaZulu-Natal. *Scientific African*, *16*. https://doi.org/10.1016/j.sciaf.2022.e01168

Ndlovu, P. N., Thamaga-Chitja, J. M., & Ojo, T. O. (2021). Factors influencing the level of vegetable value chain participation and implications on smallholder farmers in Swayimane KwaZulu-Natal. *Land Use Policy*, *109*. https://doi.org/10.1016/j.landusepol.2021.105611

Nicholson, C. F., Monterrosa, E., & Garrett, J. L. (2021). Food value chain interventions and nutritional outcomes: a review of evidence and recommendations for future assessments. In *Current Opinion in Biotechnology* (Vol. 70, pp. 61–67). Elsevier Ltd. https://doi.org/10.1016/j.copbio.2020.11.015

Nigeria Agribusiness Group (NABG) (2024). Agribusiness Policy Study Inception Report.

Nithya D.J. and Bhavani R.V. (2017). Dietary diversity and its relationship with nutritional status among adolescents and adults in rural India. *Journal of Biosoc. Sci.*, doi:10.1017/S0021932017000463.

Nwankwo, C., Ikehi, M., Ejiofor, T., & Ifeanyieze, F. (2024). Successive national agricultural policies/programmes, growth of gross domestic product (GDP) and expansion of agribusinesses in Nigeria. *PLOS ONE*, 19. https://doi.org/10.1371/journal.pone.0291999

Odewole, M., Sanusi, M., Sunmonu, M., Yerima, S., Mobolaji, D. and Olaoye, J. (2024). Digitalization of rice value chain in Nigeria with circular economy inclusion for improved productivity – A review. *Heliyon*, 10. https://doi.org/10.1016/j.heliyon.2024.e31611

Offer A. (2000). Economic welfare measurements and human wellbeing. Economic and Social History discussion paper No. 34, University of Oxford, USA.

Ogundipe, A. A., Oduntan E. A., Ogunniyi A. I. and Olagunju K. O. (2017) Agricultural productivity, poverty reduction and inclusive growth in Africa: Linkages and pathways. *Asian Journal of Agricultural Extension, Economics and Sociology,* 18(1):1-15.

Ogunniyi A., Omonona B., Abioye O. and Olagunju K. (2018) Impact of irrigation technology use on crop yield, crop income and household food security in Nigeria: A treatment effect approach. *AIMS Agriculture and Food,* 3(2): 154–171.

Ojo, T. and Baiyegunhi, L. (2023). Gender differentials on productivity of rice farmers in south western Nigeria: An Oaxaca-Blinder decomposition approach. *Heliyon*, 9. https://doi.org/10.1016/j.heliyon.2023.e22724

Ojo, T. O., & Baiyegunhi, L. J. S. (2021). Climate change perception and its impact on net farm income of smallholder rice farmers in South-West, Nigeria. *Journal of Cleaner Production*, *310*. https://doi.org/10.1016/j.jclepro.2021.127373

Okereke C.O., Ndukwe O., Oroke E. and Onwe, P. (2017) Promoting rice productivity in Ebonyi State: Linking data and policy. State Policy Note 4. Feed the Future Nigeria Agricultural Policy Project, pp 1-6.

Okonkwo, U.U., Ukaogo, V., Kenechukwu, D., Nwanshindu, V. and Okeagu, G. (2021) The politics of rice production in Nigeria: The Abakaliki example, 1942-2020, *Cogent Arts & Humanities*, 8:1, 1880680, DOI: 10.1080/23311983.2021.1880680.

Ola, O., & Menapace, L. (2020). Smallholders' perceptions and preferences for market attributes promoting sustained participation in modern agricultural value chains. Food Policy, 97, 101962.

Onyeneke, R. U. (2020). Does climate change adaptation lead to increased productivity of rice production? Lessons from Ebonyi State, Nigeria. *Renewable Agriculture and Food Systems, 115*. https://doi.org/10.1017/S1742170519000486.

Organization for Economic Co-operation of Development (OECD) (2001). Measuring Productivity – OECD Manual: Measurement of Aggregate and Industry-level Productivity Growth. OECD, Paris.

Ouya, F., Murage, A., Pittchar, J., Chidawanyika, F., Pickett, J. and Khan, Z. (2023). Impacts of climate-resilient push–pull technology on farmers' income in selected counties in Kenya and Tanzania: propensity score matching approach. *Agriculture & Food Security*, 12, 1-

14. https://doi.org/10.1186/s40066-023-00418-4

Pavithra, A.S., Singh K. M., Ahmad N., Sinha D.K. and Mishra R.R. (2018) Economic analysis of rice value chain in Bihar and Karnataka States of India. *International Journal of Current Microbiology and Applied Science,* 7(3):2738-2747.

Pigou, A. C. (1920). *The Economics of Welfare*. Macmillan and Company, London.

Pohlmeier, W. and Ulrich V. (1995), An econometric model of the two-part decision making process in the demand for health care, *Journal of Human Resources,* 30, 339-61.

Porter, M. E. (1985) Competitive advantage: Creating and sustaining superior performance. New York, Free Press. pp557.

Raheem, D., Dayoub, M., Birech, R., and Nakiyemba, A. (2021). The Contribution of Cereal Grains to Food Security and Sustainability in Africa: Potential Application of UAV in Ghana, Nigeria, Uganda, and Namibia. *Urban Sci*, 5, 8.

Rajendran S., Afari-Sefa V., Shee A., Bocher T., Bekunda M., Dominick I. and Lukumay P.J. (2017). Does crop diversity contribute to dietary diversity? Evidence from integration of vegetables into maize-based farming systems. *Agriculture & Food Security,* 6:50 DOI 10.1186/s40066-017-0127-3.

Rajkhowa, P. and Qaim, M. (2021). Personalized digital extension services and agricultural performance: Evidence from smallholder farmers in India. *PLoS ONE*, 16. https://doi.org/10.1371/journal.pone.0259319

Rosenbaum, P. R., and Rubin, D.B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika* 70: 41–55. https://doi.org/10.2307/2335942.

Roy A.D. (1951) Some thoughts on the distribution of earnings. *Oxford Econ Pap, New Ser* 3: 135–146.

Rubin, D.B. (1974). Estimating causal effects of treatments in randomized and nonrandomized studies. *Journal of Educational Psychology* 66: 688–701. https://doi.org/10.1037/h0037350.

Ruel, M. T., Quisimbing, A. R., & Balagamwala, M. (2018). Nutrition-sensitive agriculture: what have we learned so far? *Global Food Security*, 17, 128-153.

Rugema S. H., Sseguya H. and Kibwika P. (2018). Determinants of Smallholder Farmers' Participation in Rice Value Chains in Uganda. *Journal of Agricultural Extension*, 22(2):63-71. https://dx.doi.org/10.4314/jae.v22i2.6.

Russel, D. and Hanoomanjee S. (2012) Manual on value chain analysis and promotion. Regional training on value chain analysis. Pescares Italia SRL, pp37.

Rutherford, D. D., Burke, H. M., Cheung, K. K., & Field, S. H. (2016). Impact of an Agricultural Value Chain Project on Smallholder Farmers, Households, and Children in Liberia. *World Development*, *83*, 70–83. https://doi.org/10.1016/j.worlddev.2016.03.004

Sassi, M. (2023). Economic Connectiveness and Pro-Poor Growth in Sub-Saharan Africa: The Role of Agriculture. *Sustainability*. https://doi.org/10.3390/su15032026

Schneider K. and Gugerty M.K. (2010). Agricultural productivity and poverty reduction: Linkages and pathways. *The Evans School Review*, 1(1). DOI: http://dx.doi.org/10.7152/12259.

Sen, A. (1970). *Collective Choice and Social Welfare*. Elsevier Science Publishing Company, North Holland.

Shah G. M., Nepal A. K., Rasul G. and Ahmad F. (2018). Value chain development of bay leaf in Nepal: an impact assessment. *Journal of Development Effectiveness*. DOI: 10.1080/19439342.2018.1438494.

Shah G., Khadka M. S., Ahmad F., Budhathoki N. and Shrestha A. J. (2017). Assessment of Himalayan Nettle (*Girardinia diversifolia*) Value Chain Development Interventions: Evidences from rural households in the Far Western Nepal. *Journal of Agricultural Science*, 9(5): 19-32. doi:10.5539/jas.v9n5p19.

Sibhatu K. T., Qaim M. (2017) Rural food security, subsistence agriculture, and seasonality. *PLoS ONE* 12(10): e0186406. https://doi.org/10.1371/journal.pone.0186406.

Smith J., and Todd P. (2005). Does matching overcome Lalonde's critique of non-experimental estimators? *Journal of Economics* 125(2):305-353.

Sseguya, H., Robinson, D.S., Mwango, H.R., Flock, J.A., Manda, J., Abed, R. and Mruma, S.O. (2021). The impact of demonstration plots on improved agricultural input purchase in Tanzania: Implications for policy and practice. PLoS ONE 16(1): e0243896. https://doi.org/10.1371/journal.pone.0243896.

Stigler, G.J. and Becker, G.S. (1977) De gustibus non est disputandum. *American Economics Review*, 67, 76-90.

Takahashi and Barrett (2014) The system ofrice intensification and its impacts on household income and child schooling: Evidence from rural Indonesia. *American Journal of Agricultural Economics,* 96 (1): 269–289; doi: 10.1093/ajae/aat086.

Tenabe F.O., Olayide O.E. and Nwadihi M. (undated) Effects of IFAD value chain development on economic welfare of smallholder rice and cassava producers in Anambra State Nigeria.

Terdoo F. and Feola G. (2016). The vulnerability of rice value chains in Sub-Saharan Africa: A review. *Climate*, 4 (47) doi:10.3390/cli4030047.

Thirtle, C., Lin L. and Piesse J. (2003) The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. *World Development*, 31(12):19591975.

Thorbecke, E. and Ouyang, Y. (2022). Towards A Virtuous Spiral Between Poverty Reduction and Growth: Comparing Sub Saharan Africa With The Developing World. *World Development*. https://doi.org/10.1016/j.worlddev.2021.105776

Tinsley, R. (2012). Rice value chain analysis – Sokoto State Nigeria (NIG 244): Volunteer report. Winrock International, Nigeria Farmer-to-Farmer Program.

Ullah, S., Zaefarian, G. and Ullah, F. (2021). How to use instrumental variables in addressing endogeneity? A step-by-step procedure for non-specialists. *Industrial Marketing Management*. https://doi.org/10.1016/j.indmarman.2020.03.006

United Nation Industrial Development Organisation (UNIDO) (2009) Agro-value chain analysis and development. UNIDO, Vienna. pp74.

Vos, R. and Cattaneo, A. (2021). Poverty reduction through the development of inclusive food value chains. *Journal of Integrative Agriculture*, 20, 964-978. https://doi.org/10.1016/S2095-3119(20)63398-6

Wabi, M. A., Vanhove, W., Idohou, R., Hounkpèvi, A., Kakaï, R. L. G. and Van Damme, P. (2022). Identification of socio-economic characteristics and farmers' practices affecting rice (Oryza spp.) yields in Benin (West Africa). *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, *123*(2), 257–271. https://doi.org/10.17170/kobra202212057195

Wang, H., Wang, X., Sarkar, A. and Qian, L. (2021). Evaluating the Impacts of Smallholder Farmer's Participation in Modern Agricultural Value Chain Tactics for Facilitating Poverty Alleviation—A Case Study of Kiwifruit Industry in Shaanxi, China. *Agriculture*, 11 (5). https://doi.org/10.3390/AGRICULTURE11050462

Wang, T. (2025). Econometric Modeling Combining MCMC Algorithm and Random Coefficient Quantile AR Model. *IEEE Access*, 13, 42129-42142. https://doi.org/10.1109/ACCESS.2025.3547348

Wanzala, R. W., Marwa, N., & Lwanga, E. N. (2024). Impact of agricultural credit on coffee productivity in Kenya. *World Development Sustainability*, *5*. https://doi.org/10.1016/j.wds.2024.100166

Webb, P., Coates, J., Frongillo, E. A., Rogers, B. L., Swindale, A., & Bilinsky, P. (2006). Measuring household food insecurity: Why it's so important and yet so difficult to do. The Journal of Nutrition, 136(Supplement), 1404S–1408S. (doi.org in Bing)

Wiesmann D., Bassett L., Benson T. and Hoddinott J. (2009). Validation of the World Food Programme's food consumption score and alternative indicators of household food security. IFPRI discussion paper 00870. Ifpri-copyright@cgair.org.

Windmeijer F. and Santos Silva J. (1997), Endogeneity in count data models: an application to demand for health care. *Journal of Applied Econometrics* 12(3): 281–294.

Wooldridge, J. M. (2010).*Econometric Analysis of Cross Section and Panel Data*. 2nd ed. Cambridge, MA: MIT Press.

World Bank. (2020). World Development Report 2020: Trading for Development in the Age of Global Value Chains. Washington, DC: World Bank.

World Food Program (WFP) (2008) Food consumption analysis calculation and use of the Food Consumption Score in food security analysis, Rome.

World Food Programme (WFP) (2009). Comprehensive food security & vulnerability analysis guidelines. World Food Programme, Rome.

Wu, H., Ding, S., Pandey, S., & Tao, D. (2010). Assessing the impact of agricultural technology adoption on farmers' well-being using propensity-score matching analysis in rural China. *Asian Economic Journal, 24*(2), 141-160. https://doi.org/10.1111/j.14678381.2010.02033.x.

Yang, D., Zhang, H., Liu, Z. M. and Zeng, Q. (2021). Do cooperatives participation and technology adoption improve farmers' welfare in China? A joint analysis accounting for selection bias. *Journal of Integrative Agriculture*, *20*(6), 1716–1726. https://doi.org/10.1016/S20953119(20)63325-1

Yang, S. and Chen, J. (2019). Organic connection between small farmers and modern agriculture in China: Obstacles and solutions. High. Educ. Soc. Sci, 16, 1-4.

Yi, J., Meemken, E., Mazariegos-Anastassio, V., Liu, J., Kim, E., Gómez, M.I., Canning, P. and Barrett, C.B. (2021). Post-farmgate food value chains make up most of consumer food expenditures globally. *Nature Food*, 2, 417-425.

Zakari, S., Moussa, B., Ibro, G. and Abdoulaye, T. (2021). Factors influencing farmers' participation in groups and the impact of collective marketing on household food security and income in Sahel, Niger. World's Largest Open Access Agriculture and Applied Economics Digital Library.

APPENDICES

Appendix 1

Questionnaire A. Socio-economic Characteristics

1. Name of Local Government Area:_____
2. Name of community:_____
3. Phone number of respondent (farmer):_____
4. Age (years) _____
5. Gender: Male [ ]; Female [ ]
6. Marital status: Married [ ]; Single [ ]; Divorced [ ]; Widowed [ ]

7. Education status (household head): No formal education [ ]; Primary [ ]; Secondary [ ]; Tertiary []
8. Education status (spouse): No formal education [ ]; Primary [ ]; Secondary [ ]; Tertiary [ ]
9. Number of persons living in your household _____
10. How many school-aged children (6 – 20yrs) do you have? _____
11. Fill the table below according to your children's age and level of enrollment in school

S/N	Age of child (yrs)	Education level of enrollment (Primary/Secondary/Tertiary)	Total amount of school fees paid (naira) per semester
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

12. Main occupation: _____
13. How many years have you been farming rice? _____
14. What is the area of your rice farm land (farm size)? _____ hectare(s)
15. Did you benefit from the IFAD rice Value Chain Development Program (VCDP)? Yes [ ] No [ ]
16. If yes, what type of assistance (benefit) did you receive during the VCDP? Inputs [ ]; training [ ]; funds [ ]; equipment/machinery [ ]; others _____
17. What year(s) did you benefit from the VCDP? _____
18. Do you have another occupation/source of earning a living? Yes [ ]; No [ ]
19. If yes, what is the other occupation (job) you are engaged in? _____
20. How much do you spend monthly on your household food consumption? _____Naira
21. How much do you spend monthly on living house rent? _____ naira
22. What is your average monthly income from the following activities (if applicable)?

Activity	Estimated Monthly income (Naira)
Farming	
Trading	
Working in other people's farm	
Remittance (money sent from other people)	
Formal employment/civil service and others	

Artisanal jobs (carpentry, bricklayer, welding, etc.)	
Others specify	

23. Do extension agents visit you? Yes [ ]; No [ ]
24. How many times did extension agent(s) visit you in the last one year:……
25. Did you borrow money for your rice farming activity last year? Yes [ ] No [ ]
26. If yes, mention the sources of the loan you borrowed: family [ ]; friend [ ]; bank [ ]; microfinance bank [ ]; cooperative [ ]; esusu (contribution) [ ]; others (specify) _____
27. If yes to question 25, how much in total did you borrow for last year farming? _____ Naira

B. Possession of household assets and durable goods

28. Do you have television? Yes [ ] No [ ]
29. Do you have mobile phone? Yes [ ] No [ ]
30. Do you have radio? Yes [ ] No [ ]
31. Do you have car? Yes [ ] No [ ]
32. Do you have a motorcycle? Yes [ ] No [ ]
33. Do you have a tricycle (keke)? Yes [ ] No [ ]
34. Do you have a bicycle? Yes [ ] No [ ]

C. Access to Markets and Social Networks

35. Your access to the market (for input and output sale? Please indicate in the table below

	Do you have access to these markets? (indicate **Yes/No** below)	Average distance to the market (in kilometres)	Average time taken to walk to the market (in minutes	Cost of transport to market (naira)
Access to farming input market				
Access to output market where you sell your products				

36. Are you a member of any farmer group (farmer organization/cooperative)? Yes [ ] No [ ]
37. If yes, what is your position in this group/cooperative? _____
38. How long have you been a member of this group/cooperative? _____
39. What benefits do you derive from belonging to this group/cooperative? _____
40. Have you participated in any agric. workshops/trainings on farming? Yes [ ] No [ ]
41. If yes, how many of such workshops and trainings did you attended? _____

D. Healthcare

42. Are you/your household registered in any healthcare insurance scheme? Yes [ ]; No [ ]
43. Has any member of your family fallen sick in the last 6 months? Yes [ ] No [ ]
44. How many times did you or household member fall sick in the last 6months _____ times
45. Have you/your household member visited a healthcare facility in the last 6 months? Yes [ ] No [ ]
46. Has a health worker visited you in the last 6 months? Yes [ ] No [ ]
47. Do you go to a healthcare facility when a family member is sick? Yes [ ] No [ ]
48. How much do your household spend on health/medical care issues monthly? _____naira
49. What is the walking distance from your house to the nearest healthcare facility? _____ minutes
50. How much does it cost from your house to the nearest healthcare facility? _____ naira
51. Total amount spent on health/medical care issues (hospital bills, hospital admission, checkups and medication) for your household in the last 12months _____ naira.

E. Rice Input and Output

52. Did you cultivate rice last season? Yes [ ] No [ ]
53. If No, when last did you farm rice? _____
54. What is the total land area (in hectares) you cultivated rice last season? ……
55. What are the rice varieties you cultivated last season? ----------
56. What is the qty of paddy harvested (in 100kg bag/50kg bag) from your farm land? _____
57. What are the costs of the inputs you used in cultivating rice last season? Please indicate the costs in the table below.

Input	**Unit of measurement**	**Quantity**	**Unit cost (Naira/unit)**	**Total cost (Naira)**
1. Input				
Rice seed/seedling				
Fertilizer				
Herbicides/Pesticides/agrochemicals				

58. Please indicate your labour costs in the table below

Labour	**Mandays (no. of days)**	**No. of persons**	**cost/manday (naira)**	**Total cost (naira)**

Land clearing				
Land preparation				
Nursery preparation				
Planting/transplanting				
First weeding				
Second weeding				
Third weeding				
Fertilizer application				
Application of herbicides/pesticides				
Harvesting				
Threshing/Winnowing				

59. Please indicate your other logistic costs you spent in handling the paddy

Other costs	**No. of trips**	**Cost/trip (naira)**	**Total cost (naira)**
Cost of transporting the paddy to point of sale			
Cost of loading and off-loading the paddy			

60. Cost of storing the rice/paddy until sale _____Naira
61. Cost of bagging the rice/paddy until sale _____ Naira
62. Amount of money borrowed for rice farming _____Naira; for _____ yrs/months
63. Interest rate (on borrowed money) per annum (year) _____ percent
64. Please indicate in the table below the fixed input/equipment you used in rice cultivation last season.

Fixed input/equipment	**Quantity**	**Life span/period of usefulness**	**Unit cost (Naira)**	**Total cost (Naira)**
Hoe				
Cutlass/matchet				
Sickle				
Shovel				
Wheel barrow				
Rake				
Other equipment				

Landed property (used for rice farming)	Qty (ha or plots)	years of holding land	Cost/ha or plot	Total cost
Purchased land				
Rented land				
Inherited land				

65. Please fill the table below according to your output from rice farming

Output	Unit of measurement (kg or bags)	Quantity	Unit price (naira)	Total revenue (naira)
Unprocessed rice (paddy)				
Processed rice				

F. Constraints/Challenges to Rice farming/production in your area

66. To what extent do you agree that the following factors affect rice production in your area

Challenges	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Lack of farm labour					
High cost of farm labour					
Poor access road to farm					
Poor access to capital/funds					
High cost of capital/loans					
High cost of farm inputs (seedlings, fertilizer and agrochemicals)					
Unavailability of farm inputs (seedlings, fertilizer and agrochemicals)					
Poor access to farm machinery (tractor, e.t.c.)					
High cost of farm machinery					
Unfavorable weather conditions for rice farming					
Limited access to land for rice farming					
High cost of land for rice farming					
Incidence of pest and diseases					
Poor extension services					

Unfavorable Government policies for rice farming					
Farmers/Herdsmen conflicts					

G. Food consumed within the last 7 days by your family

Food consumed within the last 7 days by your household members	**Tick the ones eaten in the spaces below**
Cassava (garri, fufu)	
Rice	
Potato/Potato chips	
Yam	
Cocoyam (Ede)	
Maize/Akamu	
Beans/Akara/Moi Moi	
Groundnut	
Walnut	
Tigernut (Aki hausa)	
Soyabean	
Coconut	
Bambara nut (okpa)	
Oil bean (ugba/ukpaka)	
Breadfruit (ukwa)	
Unripe plantain/plantain chips	
Ripe plantain	
Egg	
Milk	
Bread	
Meat	
Fish	
Avocado pear (ube bekee)	
African pear (ube)	
Banana	
Paw paw	
Mango	
Water melon	
Apple	
Carrot	
Garden egg (anara)	

Fresh tomato	
African star apple (udara)	
Ube mgba	
Pineapple	
Orange	
Grape	
Cucumber	
Cabbage	
Salad	
Lettuce	
Ugu	
Amaranthus (green)	
Spinach	
Water leaf	
Bitter leaf	
Gnetum africana (Okazi)	
Oha	
Edible insects and termites	
Noodles and spaghetti	
Yoghurt	
Oats/Quaker oats	
List others not captured above:	