DEVELOPMENT IMPACT OF AGRICULTURAL PROJECTS ON SMALLHOLDER FARMERS: A CASE STUDY FROM THE FADAMA III PROJECT IN EBONYI STATE, NIGERIA

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Declaration

I hereby declare that this mini-thesis, entitled *Development impact of agricultural projects on smallholder farmers: A case study of the Fadama III Project in Ebonyi State, Nigeria*, is my own work and that I have not previously submitted it at any university for a degree or examination. All sources that I have quoted have been indicated and duly acknowledged by means of referencing.

Stanley Egenti

Signature: Egenti Stanley

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Dedication

This thesis is dedicated to my parents, Mr and Mrs Allison Egenti, who both sacrificed immeasurably to give me the type of education I desire.

Abstract

Nigeria has over 100 million people living below the US$1.90 poverty line. Most of these poor people are rural smallholder farmers. Agricultural interventions are ongoing to alleviate poverty and food insecurity amongst smallholder farmers in Nigeria, but these interventions have been less successful when compared to similar interventions implemented by developed countries. One such intervention in Nigeria is the Fadama III project. It is against this background that this study evaluated the development impact of the Fadama III project on the agricultural yield, food security, and income of smallholder farmers. The aim was to draw lessons from the evaluated project that would guide the design of future agricultural projects that are more effective.

Using primary data from 300 farmers, descriptive statistics, inferential statistics, probit regression, propensity score matching, and a quasi-experimental research design, this study found that the Fadama III project increases agricultural yield (rice yield), three dimensions of food security (food availability, food access, food utility), and some type of income (income from cassava production) of smallholder farmers in Ebonyi State. However, Fadama III does not significantly cause an increase in the food stability dimension of food security and other types of income like income from rice production. It also found that youth and female farmers are under-represented in Fadama III project. Also, most farmers in the Fadama III project (90% of the beneficiary farmers) still depend majorly on their human power for farming.

It was recommended that the fifth component of the Fadama III project which involves Agricultural Equipment Hiring Enterprises (AEHE), should be revised to eliminate all bottlenecks that could prevent beneficiary farmers from easily accessing farm equipment, including machines. For future agricultural development projects to impact food stability, there is a need for Sustainable Agriculture Land Management (SALM) to be a necessary part of the extension service delivered. The SALM should have been part of Fadama III's third component, 'advisory services and input support', for the project to have more impact on livelihoods. Lastly, future agricultural projects should have a special component dedicated to ensuring youth and female farmer participation.

Contents

List of abbreviations and acronyms

ADPs	Agricultural Development Programs
AEHE	Agricultural Equipment Hiring Enterprises
ANOVA	Analysis of Variance
ATT	Average Treatment Effect on the Treated
FGT	Foster-Greer-Thorbecke
FTCs	Farmers’ Training Centers
HHS	Household Hunger Scale
LATE	Local Average Treatment Effect
NERICA	New Rice for Africa
NPRTD	National Program for Roots and Tubers Development
OLS	Ordinary Least Squares
PANTIL	Program for Agricultural and Natural Resource Transformation for Improved Livelihood
PCI	Presidential Cassava Initiative
PSM	Propensity Score Matching
SDGs	Sustainable Development Goals
SLF	Sustainable Livelihoods Framework

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Chapter 1: Introduction

1.1 Background to the study

It has been empirically established that low productivity in agriculture is the major cause of the high incidence of food insecurity and poverty in developing countries (World Bank, 1996). This is because agriculture is the mainstay of the economy of developing nations. This study maintains that any policy measure aimed at alleviating poverty and hunger in developing countries must take agriculture and rural development into consideration.

In Nigeria, the need to support agriculture has led to several agricultural development projects and programs. One such program is the First National Fadama Development Program (FNFDP), which was initiated for small-scale irrigation development to increase the productivity of the farming system during the dry and wet seasons (Nwalieji and Ajayi, 2009).

As a follow up to the FNFDP, the World Bank and the African Development Bank (AfDB) jointly supported the Federal Government of Nigeria (FGN) to invest in the Second National Fadama Development Project (NFDP-II) known as Fadama II project. The NFDP-II target was the development of small-scale irrigation, especially, in the low-lying alluvial floodplains. The NFDP-II attempted to increase the productivity, income, living standards and development capacity of the economically active rural communities, while increasing efficiency in delivering implementation services to an estimated four million rural beneficiary households (Kudi et al., 2008). The design of Fadama II incorporated a paradigm shift from the traditional public sector-dominated or supply-led development approaches of the past to a private sector-led, demand-driven strategy. Beneficiaries included all the rural dwellers who derived their livelihoods from the Fadama extension activities among whom are crop farmers (rice farmers), and pastoralists.

Fadama III was initiated in 2008 as a follow up to Fadama II. It was aimed at sustainably increasing the productivity and income for users of rural lands and water resources to reduce rural poverty, increase food security as well as contribute to the achievement of the Millenium Development Goals (MDGs). The project involves enhancement of farm infrastructure in many areas through the construction of wells, storage facilities, and procurement of farm equipment. Furthermore, the project provides veterinary clinics, feeder roads, improvement or construction of rural roads and small bridges linking farmers and their goods to local markets. The project also incorporates the use of Information and Communication Technology (ICT) to improve the operations of the farmers (World Bank, 2010b). It has additional financing which is focused on improving farm productivity, the performance of clusters of farmers engaged in priority food staples, namely rice, cassava, and sorghum, and improving horticulture in six selected states with high potential (World Bank, 2010a).

What have been the development impacts of these programs? The answer to this question requires empirical evidence that is produced by 'counterfactual' impact evaluations (IEs) or treatment group (TG) versus comparable group (CPG) analysis. In the absence of understanding what effects have occurred as a result of these programs, it is not possible to know if the programs are actually boosting productivity, and alleviating poverty and food insecurity. Hence, this study is aimed at evaluating the development impact of agricultural projects on smallholder farmers.

1.2. Problem statement

The population of people in the world experiencing hunger reduced from 947 million in 2005 to 785 million in 2015. However, since 2015, the world's hunger has been on the increase, rising to 821 million in 2018 (Food and Agricultural Organisation (FAO), 2019a). Similarly, the prevalence of undernourishment in the world decreased from 14.5% in 2005 to 10.6% in 2015, but has been increasing since 2015, reaching 10.8% in 2018 (FAO, 2019a).

In almost every region in Africa, hunger has been on the increase. Africa currently has a high rate of undernourishment at 20%, making it the continent with the highest food insecurity in the world (FAO, 2019a). In Nigeria alone, the recent projected report by the Food and Agriculture Organization (FAO) about the situation of malnutrition and food insecurity shows that throughout the lean season (June to August 2019), over 2.7 million people will suffer severe food insecurity (FAO, 2019b). Nigeria, as Africa's most populated country with about 200 million people, is one of the countries in Africa with the highest number of people who have food security challenges and are poor, as over 100 million people (53%) live below the US$1.90 poverty line (World Bank, 2017). Furthermore, the World Bank (1996) found that low productivity in the agricultural sector accounts for the high rate of food insecurity and poverty ravaging the country. More recently, Nwajiuba (2012) also found that low agricultural productivity has contributed to the large food insecurity and poverty Nigeria faces today. Smallholder farmers account for 80% of all locally produced food in Nigeria, yet the crop yield and livestock they produce are below potential (Nwajiuba, 2012).

Small-scale farmers and their households are still suffering from poverty. Anderson et al. (2017) carried out a national segmentation and survey of small-scale farmers and their households in all 36 states of Nigeria and collected data from 3026 households to analyze their poverty status. The results showed that only 27% of the households live above the poverty line, while the remaining 73% live below the poverty line. This suggests that 73% of farmers are among the 53% of Nigerians who are poor while only 27% of farmers are among the 47% of Nigerians who are not poor. Their financial status showed that 51% of the households could afford only food and clothes, 20% could not even afford to buy food, 22% could not afford expensive goods but could afford to buy food, clothes and save a little, while only 6% could afford to buy expensive goods. The remaining 1% gave a 'don't know' response (Anderson et al., 2017).

Among the states in Nigeria, Ebonyi is the poorest state in the entire South-East region with a 70.6% rate of poverty (National Bureau of Statistics (NBS), 2019). There is a high level of rural underdevelopment and food insecurity in the state (Ndukwe and Nwuzor, 2014). Rural dwellers make up about 75% of the total population, and over 90% of the workforce in rural areas engage indirectly or directly in small-scale farming activities (Ndukwe and Nwuzor, 2014). This high level of poverty and food insecurity in Ebonyi State is the reason why it was chosen as the case study for this research.

The low agricultural productivity and poor living conditions of smallholder farmers, despite the huge investments in agricultural projects, calls for a need to evaluate the development impact of these projects on smallholder farmers. Although the Fadama III project aims at increasing productivity and reducing poverty and food insecurity among smallholder farmers, there is little or no empirical evidence of the development impact of this project. This is the reason why this study focused on evaluating the development impact of the Fadama III project on smallholder farmers.

1.3. Overall objectives

The overall aim of this research is to ascertain the development impact of Fadama III project on the livelihoods of smallholder farmers in Nigeria and to provide evidence-based policy recommendations.

1.4. Specific objectives

The specific objectives of this study are:

i. To assess the impact of the Fadama III project on the increase in the agricultural yield of smallholder farmers in Ebonyi State.
ii. To examine the impact of the Fadama III project on the increase in the food security level of smallholder farmers in Ebonyi State.
iii. To analyze the impact of the Fadama III project on the increase in the farm income of smallholder farmers in Ebonyi state.
iv. To provide recommendations for policymakers on pathways for better agricultural development projects in the future.

1.5. Research questions

This study will answer the following research questions:

i. What is the impact of the Fadama III project on the increase in the agricultural yield of smallholder farmers in Ebonyi State?
ii. What is the impact of the Fadama III project on the increase in the food security level of smallholder farmers in Ebonyi State?
iii. What is the impact of the Fadama III project on the increase in the farm income of smallholder farmers in Ebonyi State?

It is important that big agricultural projects like Fadama III are successful in developing countries like Nigeria where most of the population depends on agriculture. This study focuses on agricultural yield, food security and income of farmers because low agricultural productivity, hunger and low income (poverty) are amongst the most pressing challenges of farmers in Nigeria.

1.6 Relevance of the study to development

Fadama III aims at alleviating food insecurity and poverty amongst smallholder farmers in Nigeria. This suggests that the success of the intervention is important for achieving SDG 1 (no poverty) and SDG 2 (zero hunger) in Nigeria. Hence, it is of developmental relevance to evaluate the impact of Fadama III on smallholder farmers.

1.7. Structure of the thesis

The rest of the thesis is structured into five chapters as follows:

Chapter two provides an empirical literature review. This section starts by firstly reviewing global studies. Studies in African countries are then reviewed, followed by studies done in Nigeria. The chapter ends by presenting a summary of the reviewed literature and their main weaknesses.

Chapter three presents the sustainable livelihoods framework (SLF) as the theoretical framework for the study. The key concepts of the SLF are explained and the assumptions discussed. The key concepts of the study such as Fadama III, agricultural yield, food security, farm income, impact evaluation, and agricultural development projects are explained. The chapter ends with a depiction of the expected linkages among the concepts.

Chapter four presents the research methodology used to analyze the development impact of Fadama III on smallholder farmers. A justification for the research methods is also presented. The chapter explains and justifies the sampling method and data collection instrument used for the study. The various quantitative data analysis tools (like econometrics, inferential, and descriptive statistics) used are presented and justified. The validity and reliability test of the data collection instrument is also discussed. The chapter ends with an ethics statement of the data collection.

Chapter five presents the empirical results that shows the impact of Fadama III on smallholder farmer agricultural yield, food security, and income in the study area. The empirical results include descriptive statistics of their demographic and socio-economic characteristics. Results from inferential statistics like t-test, Chi-square test, Fisher's exact test, and multivariate regression are also presented. The findings from econometrics analysis like probit regression and propensity score matching are discussed. The research questions are explicitly answered and the findings validated with the sustainable livelihoods framework.

Chapter six concludes the research and gives a summary of the thesis, which includes discussing the findings and the implications, making policy recommendations on pathways for future agricultural development projects.

Chapter 2: Literature review

2.1. Introduction

Several kinds of research have been carried out on topics relating to the development impact of agricultural projects. In this chapter, previous studies are reviewed and grouped into three sections, namely, Global studies, studies in Africa, and studies in Nigeria. The chapter ends with a summary of the reviewed literature.

2.2 Global studies

In Central America, Bravo-Ureta et al. (2006) analyzed the impact of a natural resource management project (soil conservation technologies) in El Salvador and Honduras on the farm income of hillside farmers. Data was collected from 678 farmers that benefitted from the project. The findings showed that the project had a significantly positive impact on the income of the farmers, especially aspects of the project that improved their soil conservation practices and forestry systems. The project had a more positive impact on farmers who owned land than on farmers who did not own land.

In Asia, Hussain et al. (2003) analyzed the impact of an irrigation infrastructure project on poverty alleviation in Sri Lanka and Pakistan. Primary data was collected from 858 randomly selected households from 2000 to 2002. Their results showed that irrigation projects reduced the depth and severity of poverty among farmers in Sri Lanka and Pakistan.

In another study, Hussain and Wijerathna (2004) conducted a comparative assessment of the impact of a multi-country (China, Bangladesh, Indonesia, India, Vietnam, Pakistan) irrigation project on poverty alleviation of farmers. The project provided medium and large-scale canal irrigation systems to the countries involved. A total of 26 irrigation systems were randomly selected and household data was collected from 2001 to 2002. The findings showed that there was a strong link between irrigation projects and poverty alleviation as poverty incidence was 20-30% lower in areas with the irrigation system compared to areas without the irrigation system.

Similarly, Jabbar et al. (2011) analyzed the development impact of agricultural projects that provided agricultural knowledge and technology to farmers in Bangladesh. They estimated how those projects affected the yield, income, and food security of the farmers. They adopted the quasi-experimental method to analyze the impact of the projects. They found that crop yield in the project areas increased by 8-21%. The net increase of income and food security of farmers in project areas was also more than those in non-project areas.

In another study, Jabbar et al. (2010) studied the impact of the Food Security for Sustainable Household Livelihoods (FoSHoL) project on the food access and affordability of the poor in Bangladesh. The FoSHoL was aimed at providing farmers with better skills, knowledge, inputs, technology, and finance to boost the yield, prices, marketability, and income. Their findings also showed that farmers in the project areas had more food access and affordability than their counterparts in non-project areas.

2.3 Studies in Africa

Without using a theoretical approach, Yabi (2008) evaluated the impact of 20 rural development projects on the agricultural productivity of rural farmers in the Nagot and Adja regions of the Republic of Benin using the with-without approach for ascertaining the impact of interventions. Data on agricultural productivity of 120 farmers was collected and analyzed using the Cobb-Douglas production function. The results showed that the projects positively affected the agricultural productivity of the farmers in both regions.

In a more recent study, Yabi et al. (2014) examined the impact of the adoption of semi-mechanized technologies of shea processing on the income of rural women in Northern Benin. Using questionnaires and semi-structured interviews, data was collected from the 200 female shea-butter producers who were selected using the multi-stage random sampling technique. The results from their analysis revealed that adopting shea processing technologies increased the income of female adopters compared to non-adopters.

In another study, Allogni et al. (2008) investigated the impact of new technologies of producing cowpea on the expenditure and income of cowpea farmers in the Republic of Benin. A total of 120 farmers were selected through the stratified random sampling technique. Data was analyzed using multivariate regression and the results showed that adopting new cowpea technologies increased cowpea production by 20% and farmers' income by 13%. The weakness of this study was that it lacked theoretical underpinning.

Another study, also without a theoretical approach, Adekambi et al. (2009) investigated the impact of improved rice technology (NERICA) adoption on poverty reduction in the Republic of Benin. Data for this study was collected from 268 families residing in rural Benin through a series of interviews and questionnaires. The Local Average Treatment Effect (LATE) approach was used to analyze the data and the results showed that the impact of NERICA adoption on the expenditure of households was significantly positive. Also, the impact was greater in households headed by females compared to households headed by males. Therefore, farmers who adopted NERICA varieties increased their probability of not falling below the poverty line, as suggested by the findings.

The findings of Allogni et al. (2008) are in line with the work of El Mamoun et al. (2013), which analyzed the impacts of four commodity development projects on smallholders' livelihoods and market access in four developing countries using logit regression analysis and descriptive statistics. In Ethiopia, the project was aimed at building the capacities of the farmers and equipping them with production and post-harvest skills. In Peru, the farmers acquired improved techniques for producing Jatropha curcas. In Tanzania, sisal cultivation was introduced while the dairy project was implemented in Zambia. This project included a diffusion of innovative technologies for feeding livestock. The four projects increased their livelihoods, total productivity, and access to the markets. However, their findings lacked a theoretical approach.

Adopting a propensity score matching technique and Tobit regression, Sikwela and Mushunje (2013), without using a theoretical approach, examined the impact of farmer support programs like cooperatives on household income in South Africa. The primary data used in the study was obtained from personal interviews and structured questionnaires from 99 farmers. The findings of this research showed that collective marketing activities had a positive and significant impact on the income of South African small-scale farmers who participated in the support program.

Using the same estimation technique and model as Adekambi et al. (2009), Kinkingninhoun-Medagbe et al. (2014) studied the impact of NERICA adoption on income and productivity in the Republic of Benin. They applied the SLF and argued that NERICA increased the farmers' human and physical assets, and this increased the farmers' productivity and income. They also applied the LATE technique and found that the adoption of NERICA had a significant and positive impact on the productivity of farmers and the per capita income of households. However, the positive impact was greater among female farmers when compared to male farmers. The research suggests that NERICA targeted at females is likely to significantly increase income, total production, and the productivity of rice compared to when it is targeted at males. These findings agree with the findings of Adekambi et al. (2009).

The findings of Sikwela and Mushunje (2013) agree with the work of Singh et al. (2015) which examined the impact of a micro-project (a project aimed at empowering grassroots communities) on rural household incomes in Swaziland. Households that engaged in the program and those that did not engage in the program were selected using random sampling and data was analyzed using the propensity score matching technique. Factors affecting program participation were identified using logit analysis. The results from the propensity score matching analysis revealed that households that participated in the project had an average income that was 120.3% higher than those that did not participate. The weakness of their investigation was that it lacked a theoretical underpinning.

Furthermore, the findings of El Mamoun et al. (2013) were similar to that of Warinda (2016) who investigated the impact of regional agricultural projects (projects implemented simultaneously in more than one country, in this case, Kenya, Burundi, Rwanda, Uganda, and Tanzania) on the productivity and growth of the small farm sector in East Africa. The author developed a conceptual framework called "Generalized Impact Pathway of Regional Projects" and used it to argue how regional agricultural projects affected the productivity of farmers. He further used primary and secondary data and employed various techniques such as regression analysis, Chi-square, descriptive statistics and propensity score matching techniques to analyze the data collected. Results from the analysis showed that regional agricultural projects implemented in East Africa had a more positive and significant impact on agricultural productivity, incomes, innovations, and access to financial services when compared to similar projects implemented in single countries.

Wordofa and Sassi (2017) assessed the impact of Farmers' Training Centers (FTCs) on household incomes in Eastern Ethiopia. Data was analyzed using propensity score matching techniques and the results of the analysis showed that FTCs had a significant and positive impact on the household income of farmers who participated in the training. The weakness of their investigation was that it also lacked a theoretical underpinning.

Bruce (2015) investigated the impact of improved rice variety adoption on rice output in Ghana using Chi-square to analyze data from 407 respondents randomly selected from 11 rice-producing communities. The study was based on the discretion choice model. The findings showed that the adoption of improved seed had a positive impact on rice output. The weakness of this study was that the method for evaluating the impact did not make use of a control and treatment group farmers to properly isolate the impact of the intervention.

Using the logic model, Michele (2017) investigated the impact of the National Program for Roots and Tubers Development (NPRTD) on production and income levels of rural farmers in Cameroon. Using a questionnaire, data was collected from farmers in eight communities that were beneficiaries of the project. The simple random sampling technique was adopted in selecting the sample and data was analyzed using descriptive statistics. The results showed that NPRTD had a positive impact on the production and income of the farmers under study. The weakness of this study was that the method for evaluating the impact did not make use of a control and treatment group of farmers to properly isolate the impact of the intervention.

Without using a theoretical framework, the impact of NERICA adoption on farmers' income in Namulonge, Central Uganda was analyzed by Haneishi et al. (2013). The multistage random sampling technique was used, and data was collected from the NERICA adopters using a structured questionnaire. The ordinary least square estimation technique was used for analysis, and empirical findings show that the adoption of NERICA increased the farm income of farmers. The methodological problem with this study was that ordinary least square may lead to biased findings as the treatment and control group farmers may not be comparable since assignment of treatment was not based on randomization.

Kosgei (2008) assessed the impact of various irrigation methods on tomato yields of farmers in Kenya. A stratified random sampling technique was adopted to select a sample of 180 respondents. Data was collected using questionnaires. Descriptive statistics and Analysis of Variance (ANOVA) were employed in data analysis. Findings showed that the tomato yield of farmers who adopted any of the various irrigation methods (i.e. gravity, pump, and motor pump irrigation method) was higher than the tomato yield of farmers who practiced only the rain-fed system. However, this study also lacked a theoretical framework.

Kijima et al. (2008) investigated the impact of NERICA adoption on poverty reduction and income levels of beneficiaries in Uganda. Data was collected using a questionnaire and was analyzed using the Local Average Treatment Effect (LATE). The results showed that adoption of NERICA increased income and reduced the level of poverty among adopters. This study also lacked a theoretical framework.

Similarly, Agboh-Noameshie et al. (2008), adopted LATE in estimating the impact of NERICA adoption on female and male farmer crop yields in Central Benin. The empirical findings from their study revealed that NERICA adoption increased the yields of farmers but the impact was higher on female farmers than male farmers. This finding is similar to the finding of Adekambi et al. (2009). However, this study also lacked a theoretical framework.

Using the propensity score matching technique, Asfaw et al. (2010) analyzed the impact of the adoption of improved pigeon pea and chickpea technology on farmers' standard of living (measured by their farm income and expenditure on consumption) in Tanzania and Ethiopia. The multi-stage random sampling technique was used in the selection of the study sample while structured questionnaires were used to collect data from 613 respondents in four pigeon pea producing regions in Tanzania and 700 respondents from three chickpea producing districts in Ethiopia. Findings from the study indicated a higher consumption expenditure and income for households who adopted improved chickpea and pigeon pea technology compared to non-adopters of this technology in both Tanzania and Ethiopia. This study also lacked a theoretical framework.

Kilima et al. (2013) investigated if the Program for Agricultural and Natural Resource Transformation for Improved Livelihood (PANTIL) had more benefits to farmers with the ability to maximize gains from the program than farmers without such abilities. Theil's T-statistics and Gini coefficients were used to assess the distribution of the gains of PANTIL. Results showed that the gains from PANTIL were equitably distributed amongst farmers regardless of their abilities. The study also lacked a theoretical framework.

In another study, Wiredu et al. (2014) investigated the impact of the adoption of NERICA on rice income, agricultural income, per capita income and total income of rice-producing farmers in Northern Ghana. A total of 150 households producing rice were selected systematically from Northern Ghana and cross-sectional data was collected from these households using semi-structural questionnaires and informal interviews. The LATE technique was used for data analysis and results showed that the adoption of NERICA in Northern Ghana increased rice income, per capita income, agricultural income and total income of the rice-producing households under study. This study also lacked a theoretical framework.

Using propensity score matching and descriptive statistics to analyze the data collected from 186 irrigation farmers and 70 non-irrigation farmers, Sinyolo et al. (2014), investigated the effect of the Tugela Ferry Irrigation Scheme on households' standard of living in Kwazulu-Natal, South-Africa. Their empirical findings showed that the standard of living of irrigators was found to be better than that of non-irrigators. This study also lacked a theoretical framework.

The effect of modern agricultural technology on the standard of living of farmers who adopted the technology was studied by Challa and Tilahun (2014), using primary data collected from 145 adopters and non-adopters of the technology. The respondents were selected purposively, the data collected was analyzed using the logit model and propensity score matching technique. The results showed that the average farm income of adopters was higher than the average income of non-adopters. This study also lacked a theoretical framework.

In a similar study, Acheampong and Owusu (2015) assessed the impact of the adoption of improved cassava varieties on farmers' income in rural Ghana. Propensity score matching was used to analyze the data collected from 450 cassava farmers through the administration of structured questionnaires. The results from the study showed that the adoption of improved cassava varieties had a positive impact on the income of the cassava farmers. The positive effect was more among female farmers compared to male farmers. This study also lacked a theoretical framework.

Using secondary data from Nepal's Central Bureau of Statistics, Budhathoki and Bhatta (2016) adopted the propensity score matching technique to investigate the impact of the adoption of improved rice varieties on living standards (proxied by annual farm income, and total consumption expenditure). Their findings showed that annual farm income and consumption expenditure was higher for farmers that adopted the improved rice variety than farmers that did not adopt. This study also lacked a theoretical explanation.

Data collected from 213 non-users and 155 users of organic fertilizers in Ethiopia was used by Gelgo et al. (2017) to examine the effect of organic fertilizer usage on the income of farmers. A multistage random sampling technique was employed in the selection of the sample. Data was collected using questionnaires and analyzed using propensity score matching. The results indicated that there was a significant difference between the farm incomes of those who had used organic fertilizer and those who had not. The study concluded that the adoption of organic fertilizer increased the farm income of farmers.

2.4 Studies in Nigeria

Ayanwale and Alimi (2004) analyzed the effect of lowland irrigation projects on the income of small-scale farmers and their productivity. The participants' level of technical efficiency was estimated using a stochastic frontier production function model. The findings of the analysis revealed that farm income realized from using the irrigation facilities was about three times higher than their previous farm income before the facility took off. Also, the analysis suggested that the irrigation facility brought about an efficient level of production compared to their previous production level before the irrigation facility. The weakness of their study was that it also lacked a theoretical underpinning.

The findings of Ayanwale and Alimi (2004) were supported by the findings of Oni and Olaniran, (2010) who in similar research evaluated the poverty situation of Fadama II and non-Fadama II beneficiaries in the rural areas of Oyo state. A total of 150 non-beneficiaries were randomly selected outside the Fadama II local governments. 300 beneficiaries were selected in the Fadma II local governments. The results show that the level of poverty was at its lowest among the Fadama II beneficiaries (38%) and at its highest (73%) among non-beneficiaries residing within Fadama II local government areas. The weakness of this investigation was that it lacked a theoretical underpinning.

In another study, Nguezet et al. (2011) examined the impact of improved rice technology (NERICA) on poverty reduction and income among rice farmers in Kano, Osun, and Niger states.

The theoretical framework for this study was the SLF and data was collected from 481 farmers in the irrigated rice environments, lowlands, and uplands. The study adopted the instrumental variables estimator for data analysis. Results showed that the implementation of NERICA helped in increasing the per capita income and expenditure of households by 44% and 49.1% on average respectively, thereby reducing poverty levels among the households who adopted NERICA. This finding contradicts John Maynard Keynes's consumption theory. The reason for this contradiction could be that the farmers are in absolute poverty with insufficient income to satisfy the basic needs of the households, hence their expenditure often increases more than the increase in their income. The limitation of their studies was that although the SLF was discussed as the theoretical framework, the framework was neither applied nor embedded in the research.

Sanusi et al. (2012) used a Foster-Greer-Thorbecke (FGT) poverty model to show that the poverty level in Oyo state increased after the implementation of the Fadama II program compared to the poverty level before the implementation of the intervention. Also, the Gini coefficient showed that after the implementation of the program, income inequality in the entire state became higher than before the commencement of the program. Nevertheless, the expenditure and incomes of households/farmers who participated in the intervention increased. This suggests that the increase in the poverty level after the intervention was not because the intervention had a negative impact, but rather because other factors increased the poverty levels in the state. The weakness of this investigation is that it lacked a theoretical underpinning.

The findings of Sanusi et al. (2012) were contradicted by Olaolu et al. (2013) who examined the impact of Fadama II on food security and poverty among rice farmers in Kogi state. They obtained data using a structured questionnaire and interviews from 112 rice farmers randomly selected from four local governments that participated in the project using the multistage random sampling technique. Data was analyzed using descriptive statistics. Foster-Greer-Thorbecke (FGT) food security and poverty models were also used to estimate the farmers' poverty levels and food security conditions. The findings showed that the project had a positive impact on poverty reduction as it reduced poverty depth by 96%, while poverty incidence reduced by 66.8% in Kogi state. These findings agree with the findings of Ayanwale and Alimi (2004) and with the findings of Oni and Olaniran (2010).

Furthermore, Ajah and Peace (2013), without using a theoretical approach, investigated the impact of Fadama II on decision-making power, output and income of male and female farmers in the Federal Capital Territory of Nigeria. Data for this study was collected using a structured questionnaire. A two-way factorial ANOVA estimation technique was adopted to analyze the data. The results showed that the intervention had a similar impact on decision-making power, output and incomes for male and female farmers.

Donkor et al. (2017) used the production theory (which explains the input-output relationship) to evaluate the impact of the Presidential Cassava Initiative (PCI) on cassava productivity in Nigeria using the World Bank time-series data from 1961 to 2013. The data included the food adequacy index, the food production index, fertilizer use, land area under cassava production and agricultural machinery. Data was analyzed using the three-stage multivariate linear regression model. The results indicated that PCI had a positive impact on cassava output, food supply and national food security.

Using Analysis of Variance (ANOVA) to analyze the data collected from 400 respondents who were selected using a stratified random sampling method, Meshack (2015) analyzed the effect of the National Fadama Development Project on agricultural productivity of farmers in Taraba state. The study was based on the theory of comparative advantage that states that beneficiaries of the project will engage in a specific agricultural activity capable of attracting profit and perceived to have added advantage over other activities and this will in turn increase productivity. Their empirical findings showed that the project had a positive impact on agricultural productivity. The weakness of this study was that the method for evaluating the impact did not make use of a control and treatment group farmers to properly isolate the impact of the intervention.

In another study, Jumoke (2012) evaluated the impact of Fadama II on the poverty level of farmers in Nigeria. Time series data spanning from 2006 to 2007 was obtained from the survey conducted by the International Food Policy Research Institute in 12 World Bank supported Fadama II states. The study employed Foster-Greer Thorbeke (FGT) weighted poverty indices, a double difference estimator, and descriptive statistics to analyze the data collected. The findings showed that there was a reduction in the poverty incidence of male beneficiaries by 7.8% compared to a reduction of 34% for female beneficiaries. Also, the study showed a 14.2% reduction in the poverty incidence of beneficiaries that were engaged in upstream farming activities compared to 7.1% reduction for non-beneficiaries.

Madu and Wakili (2012) investigated the development impact of agricultural interventions (Green Revolution, Operation Feed the Nation, and National Accelerated Food Production Program) in Adamawa state. Using personal interviews and structured questionnaires, data on annual crop output, access to credit among farmers, farm size, rural infrastructural development, farmers' training, and use of improved technology was collected from 100 rural farmers selected randomly. The comparability test for mean difference (t-test) and descriptive statistics was employed; results showed that the project improved agricultural productivity and income of the farmers. However, the project did not have an impact on rural infrastructure development. The weakness of this study was that the method for evaluating the impact did not make use of a control and treatment group farmers to properly isolate the impact of the intervention. The study also lacked a theoretical explanation.

Raufu and Masuku (2013) examined the impact of Fadama II on poverty alleviation in Oyo state. The study employed a multi-stage sampling technique in the selection of 120 farmers and data was collected using a structured questionnaire. Probit regression and descriptive statistics were used to analyze the data. The results showed that Fadama II had a positive impact on alleviating poverty of rural farmers under study. The weakness of this study was that the method for evaluating the impact did not make use of a control and treatment group farmers to properly isolate the impact of the intervention. The study also lacked a theoretical explanation.

The literature reviewed shows that agricultural projects in the form of new technologies improves the livelihoods of smallholder farmers (Allogni et al., 2008; Wanyama et al., 2010). Studies have found that the introduction of NERICA (New Rice for Africa) reduces the poverty and increases the income and productivity of smallholder farmers (Nguezet et al., 2011; Kinkingninhoun-Medagbe et al., 2014). There is empirical evidence that regional agricultural projects improve the productivity and growth of the small farm sector when compared to projects implemented in a single country (Warinda, 2016). In Nigeria, agricultural projects have reduced poverty and increased the income and productivity of smallholder farmers (Ayanwale and Alimi, 2004; Jumoke, 2012).

2.5 Chapter summary

In summary, the literature shows that agricultural projects have a development impact on smallholder farmers. Most of the studies made use of quantitative methods for data collection and analysis. However, most of the studies also lacked a theoretical explanation, with only a few studies (Kinkingninhoun-Medagbe et al., 2014; Warinda, 2016; Nguezet et al., 2011) using a theoretical or conceptual framework. However, these studies did not use the theoretical framework to explain how the interventions have development impact on farmers. Furthermore, there exists no case study in Ebonyi State. This study differs from previous studies as its region of study is Ebonyi State. Unlike previous studies that lack theoretical foundations, this study is based on the Sustainable Livelihoods Framework discussed in the next chapter. This theoretical framework was chosen because it can be used to explain the effect of interventions on the livelihoods outcomes of smallholder farmers like food security, sustainability, income, agricultural yield, etc. The next section provides a discussion of the theoretical framework (the Sustainable Livelihoods Framework).

Chapter 3: Conceptual linkages and theoretical framework

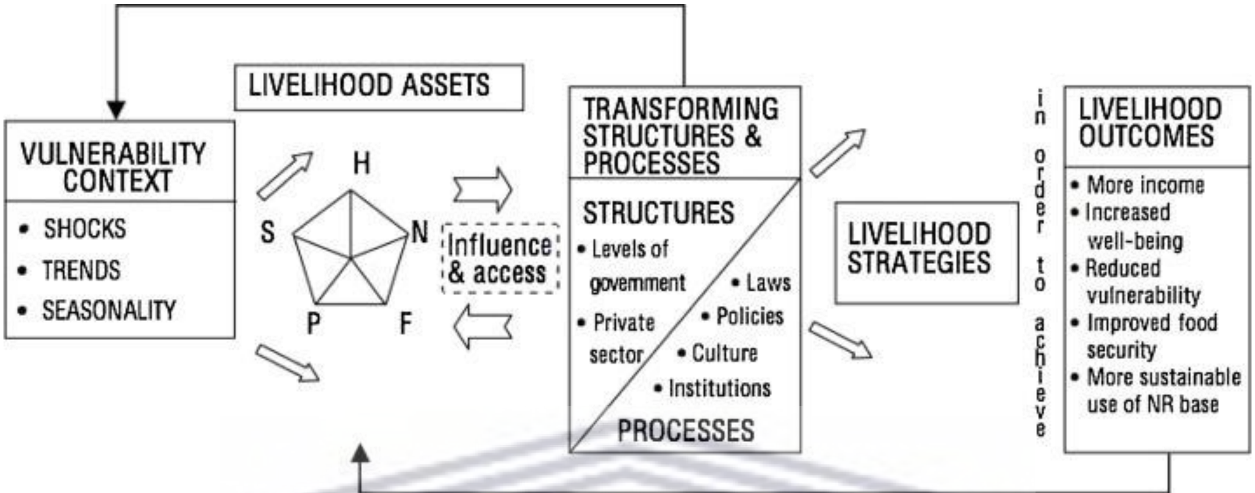
3.1 Introduction

This chapter presents and discusses the Sustainable Livelihoods Framework (SLF) as the theoretical framework for the study. The assumptions underlying the framework are also discussed. Key concepts of the study such as agricultural yield, food security, farm income, smallholder farmers, the Fadama III project, agricultural development projects, etc. are explained. The chapter ends with a depiction of the linkages between the concepts.

3.2 The Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework (SLF) is the theoretical framework of this study because it explains and analyzes poor people's livelihoods. This strategy adopts a unique viewpoint in understanding the livelihoods of the rural poor and how they achieve desired livelihood outcomes through interventions that increase their livelihood assets and reduce their vulnerability. The sustainable livelihoods thinking is inspired by the work of Robert Chambers in the 1980s. The SLF was then developed by Robert Chambers and Gordon Conway in the 1990s. It was further developed by the Department for International Development (DFID) in 2000 (Petersen and Pedersen, 2010). It was developed to describe and analyze the key factors that affect poor peoples' livelihoods. It was used to describe what development workers, who aim to reduce poverty, should focus on in order to improve poor peoples' livelihoods (Petersen and Pedersen, 2010). As mentioned earlier, the SLF is applied in this study because it can be used to explain how development interventions like Fadama III could affect farmers' livelihoods and livelihood outcomes. Since the framework is meant for analysis of poor peoples' livelihoods, it is appropriate for this study because most of the smallholder farmers under investigation are poor.

Figure 3.1: Sustainable Livelihoods Framework



Source: DfID (2000)

The SLF is discussed under the following headings that are relevant to this investigation: livelihood assets, transforming structures and processes, vulnerability context, livelihood strategies, and livelihood outcomes.

3.2.1 Livelihoods assets

Livelihood assets in this study refer to the resources at the disposal of farmers which they utilize in the pursuit of their desired livelihood outcomes (Amekawa, 2011). An increase in assets suggests that farmers are more equipped to achieve a better livelihood outcome such as improved food security status and more income. Amekawa (2011) classified these assets into physical, financial, natural, social, and human assets.

The physical assets represent all the man-made goods like farm infrastructures, farm equipment, storage facilities, tube-wells, feeder roads, veterinary clinics, rural roads and small bridges connecting local markets and farmers. Financial assets refer to the stock of money at the disposal of the farmer in the form of pensions, savings, remittances, and credit (Amekawa, 2011). Natural assets refer to all environmental resources such as water, land, and biological resources (Amekawa, 2011). Social assets refer to the stock of trust and reciprocity in the interaction between farmers and their friends, family, relatives, and networks. Human assets are said to be the quality of labor, health, and education of the farmers (Amekawa, 2011).

The Fadama III project is designed to increase these assets directly or indirectly. For example, the project is designed to increase the human assets of the farmers by engaging them in the design and implementation of the project. Involvement of the farmers leads to their empowerment, skills and capacity building (Amekawa, 2011). However, the farmers' levels of access to these assets are determined by transforming structures and processes, discussed below.

3.2.2 Transforming structures and processes

Transforming structures refer to all levels of government, civil society organizations and the private sector that make and implement policies and provide services that affect the livelihoods of farmers. Transforming processes, on the other hand, refer to the policies, rules, and legislation, which affect the farmers' access to livelihood assets (Twigg, 2001).

Transforming structures and processes are very important determinants of livelihood outcomes as they determine: the access to all the livelihoods assets; livelihood strategies and decisions; returns from livelihood strategies; and how one livelihood asset is exchanged for another (terms of exchange). They also determine the vulnerability of farmers to shocks, stress, trends, and seasonality (Twigg, 2001). These vulnerabilities are discussed below.

3.2.3 Vulnerability context

Vulnerability context refers to trends, seasonality, stress, and shocks that affect the livelihood outcomes of farmers. Farmers with sustainable livelihoods and more access to assets can quickly recover after a period of adverse shocks, stress, or trends. Trends refer to long-term socioeconomic settings which may result in a fortuitous or adverse livelihood outcome for farmers (Amekawa, 2011). Trends could be in the form of price irregularities or oversupply. Trends could make the market unfavorable for many small-scale producers as a sudden fall in price and oversupply can lead to a fall in income or even abandonment of their farms (Amekawa, 2011).

Stress is an environmental pressure that is normally predictable, cumulative and continuous (Amekawa, 2011). Seasonality is a major stress that affects the livelihood outcomes of farmers as periodic recurrence of lean seasons affects the productivity of farmers adversely. Furthermore, degradation of resources such as soil deterioration and deforestation is stress that adversely affects farmers' productivity and livelihood outcomes (Amekawa, 2011). Shocks are effects that are normally severe, sudden and unpredictable (Amekawa, 2011). They include floods and drought that are caused by climatic factors. In attempting to improve resistance against vulnerability, owning more assets is necessary as farmers with erosional assets will be more vulnerable, whereas those with more assets will be less vulnerable to the adverse effect of shocks, trends, and stress (Amekawa, 2011). Less vulnerability allows farmers to expand their livelihood strategies, discussed below.

3.2.4 Livelihood strategies

Livelihood strategies refer to the combination of a range of choices and activities undertaken by farmers to enable them to realize their livelihood goals (more income, food security, better wellbeing etc.) (Kollmier and Gamper, 2002). From the position held within the framework, strategies may be hindered or improved by a changing asset status. For example, with more physical assets (like irrigation and storage facilities) provided by the Fadama III project, farmers' livelihood strategies increase. This is because they are now able to intensify their agricultural productivity since irrigation allows them to produce all year round, even during the drought, while storage facilities encourage them to produce many quantities even when there is low demand. These lead to better livelihood outcomes like increased farm income and better food security statuses for the farmers, as discussed below.

3.2.5 Livelihood outcomes

The achievements of livelihood strategies are referred to as livelihood outcomes. These outcomes include increased productivity, better welfare, increased income, increased food security, reduced vulnerability and maximization of natural resources. Livelihood outcomes help to show what motivates farmers to behave the way they do. Livelihood outcomes of the farmers directly affect their assets and dynamically change the level of the assets (Kollmier and Gamper, 2002). In conclusion, livelihood outcomes are the desired goals of the farmers and they are affected by livelihood assets, vulnerability context, and livelihood strategies.

3.3 Assumptions of the SLF

The Sustainable Livelihoods Framework (SLF) assumes that there are favorable transforming structures and processes, such that increases in the livelihoods assets (this could be a result of agricultural development projects) of the poor (in this case smallholder farmers) will always lead to an increase in their access to assets. It is further assumed that more access to assets will help to reduce their vulnerability to shocks, seasonality, trends, and stress. Reducing their vulnerability and increasing their assets and access to assets is assumed to have a positive impact on their livelihood strategies (e.g. they can now intensify their agricultural production all year round). This leads to positive livelihood outcomes (higher agricultural yield, food security, and income).

3.4 Explanation of key concepts

The main concepts used in this study include agricultural development projects, impact evaluation, smallholder farmers, agricultural yield, food security, farm income and Fadama III. This section explains these concepts as they relate to this study and then presents expected linkages between them.

3.4.1 Agricultural development projects

Agricultural development projects are development interventions targeted at increasing agricultural productivity with the goal of reducing poverty in rural areas (World Bank, 2010a). The communities benefiting from the interventions usually take part in the design and implementation of the intervention. These interventions typically have six components. The first component is usually targeted at upgrading the infrastructure through various activities like rehabilitation of rural access trails, tracks and small-scale irrigation systems. It also supports better sanitation and water supply in the rural areas (World Bank, 2010a). The second component is usually a grant that is given to the rural communities to implement small scale projects which they have identified (World Bank, 2010a). The third component strengthens agricultural services at community and state levels for better extension services. This component also supports adaptive research and demonstrations (World Bank, 2010a). The fourth component supports the management of irrigation systems by the associations of rural water users (World Bank, 2010a). The fifth component supports activities that make the extension workers and farmers aware of environmental issues while the sixth component supports the implementation and coordination of the project. Financial management and monitoring and evaluation capacities are usually strengthened under the sixth component (World Bank, 2010a).

3.4.2 Impact evaluation

Impact evaluations (IEs) are empirical studies that quantify the causal effects of interventions on outcomes of interest (White and Raitzer, 2018). This is far different from traditional process evaluations that are concerned with characterizing how projects were implemented. IEs are based on analysis of what happened with an intervention, compared to an empirically estimated counterfactual scenario of what would have happened in the absence of the intervention. This difference between the observed outcomes and the counterfactual outcomes is the measure of impact, i.e. the difference that can be attributed to the intervention (White and Raitzer, 2018).

3.4.3 Smallholder farmers

These refers to those farmers who produce crops and livestock on a small piece of land without using advanced and expensive technologies. They practice agriculture on land that ranges from 0.1 to 4.99 hectares (World Bank, 2010b). They include all farmers farming on pieces of land owned by families, on traditional lands and smallholdings on the periphery of urban areas. The type of farming they do is usually characterized by intensive labor and in most cases, animal traction, limited use of agrochemicals and supply to the local or surrounding markets. Their farm products serve a dual role of being a source of household food security as well as income from sale of surplus (World Bank, 2010b).

3.4.4 Farm income

Farm income in this study refers to the money value (in local currency) of the total farm produce in the previous farming season (World Bank, 2010b). This suggests that the farm income will include the money value of the food that is sold and the produce that is consumed by the farmers. The farm income of the farmers will be measured by the total income that could be generated from the sale of all their farm produce, specifically rice and cassava, during the previous planting season. These crops were chosen because they are supported by Fadama III. They are also among the most cultivated crops in Ebonyi State. The income is calculated as the result of the multiplication of the quantity of each crop by the prevailing market price for the crop.

3.4.5 Agricultural yield

Agricultural yield in this study refers to the amount of a crop grown, or product such as wool, meat, or milk produced, per unit area of land (World Bank, 2010b). In this study, crop yield will be used to measure agricultural yield. This is given by:

$$Crop\ \ yield = \frac{crop\ produced}{harvested\ unit\ of\ land}$$

There are several methods that could be used to collect data needed to compute the farm yield. One of the methods is farmer recall (World Bank, 2010b). Here farmers are asked to recall the crops produced and the harvested unit of land. Another method is the farmer prediction method (World Bank, 2010b). Here the farmers are asked the expected number of crops to be produced and the unit of land to be harvested. Expert assessment could also be used. Here an expert assesses the condition and performance of the crops and then guesses the crop yield. Lastly, crop cards could also be used if the farmers kept records of crops produced and area of land harvested (World Bank, 2010b). This study made use of these four methods depending on which method was best for the farmer. However, score cards were mostly preferred in the case where the farmer kept a record of his production and area of land harvested as the method gave the actual value of the crop yield. Rice yield measured in tons per hectare was used to proxy farm yield as it is the most cultivated crop in Ebonyi State.

3.4.6 Food security

Food security in this study refers to circumstances that exist when at all times, smallholder farmers have access to nutritional, safe and sufficient food that satisfies their food preference and dietary needs for a healthy and active life (Barrett, 2010).

Food security has four important aspects namely: availability of food, access to food, utilization of food, and stability of food (Napoli, 2011). These four aspects are related in a way that availability of food is a prerequisite for access to food, and access to food is a prerequisite for the utilization of food, and food stability affects these three aspects (Napoli, 2011). However, the availability of food does not guarantee that the farmers will have access to food, and the access to food does not guarantee utilization of food. These three aspects can be disrupted when there is little or no stability of food usually caused by conflict, change in climate, disease, and unemployment (Napoli, 2011).

Food availability refers to the total amount of food that is present in a region or country through all possible ways such as import, local production, food aid, and food stocks (World Food Program, 2009).

Food access is the ability of farmers to regularly obtain enough quantities of food through possible forms such as barter, purchase, gifts or food assistance, and borrowings (World Food Program, 2009). In other words, access to food refers to when the farmers in the region or country have the economic, physical, and social means to obtain the food that is available (Napoli, 2011). The economic aspect of this definition suggests that the farmers have the money to buy enough quantities of food they need, and there is an available market system where the food could easily be bought and sold (Napoli, 2011). The physical aspect suggests that there is no lack of food supply in any area of the country and farmers can always find food to buy (Napoli, 2011). The social aspect of access to food means that no gender or members of a particular social group are denied the access to food. This implies that every farmer who has economic and physical access to food can always have food regardless of their gender, religion, or the social group they belong to (Napoli, 2011).

Food utilization refers to when the smallholder farmers always have nutritious and safe food such that the food provides them with the balanced diets that they need to lead a healthy and active life. Utilization requires that the farmers are aware of how to prepare and store their food in a hygienic way, consume healthy drinking water, and have adequate sanitary materials that prevent them from spreading diseases (Napoli, 2011).

Food stability means that at all times, food is available for the smallholder farmers, and they often have access to food, and always utilize the food properly to meet their dietary needs to live a healthy and active life (Napoli, 2011).

Thus, food security in this study encompasses the abovementioned four aspects and is measured using the Household Hunger Scale (HHS), which is discussed in the next sub-heading, 'food security methodology'. This is calculated by finding the average score based on some food security questions that require a 5 Likert scale response, where the closer the response is to 5, the more food secure the farmer and his or her household is, while the closer the response is to 1, the more food insecure they are.

Food security methodology

There are basically two types of food security measurements. One of the measurements is the dietary diversity and food frequency. This type of measurement relies on the different groups and classes of food consumed and the frequency of consumption. This measurement produces a score that shows the dietary diversity of the population. However, it does not show the quantity of food consumed (Vhurumuku, 2014)

The second measure is the consumption behaviors. This approach is an indirect measure of food security, it produces an index which shows the severity and frequency of behaviors that people are involved in when they do not have enough money to buy food or do not have adequate food available (Vhurumuku, 2014).

The dietary diversity and food frequency measures uses indicators like Food Consumption Score (FCS), undernourishment, spending on food, Household Dietary Diversity Scale (HDDS). On the other hand, consumption behaviors uses indicators like Coping Strategy Index (CSI), the Household Hunger Scale (HHS), Reduced Coping Strategy Index (rCSI), Household Food Insecurity and Access Scale (HFIAS), and Self Assessed measure of Food Security (SAFS). Global Hunger Index (GHI) belongs to dietary diversity and food frequency measure, and also the consumption behavior measure (Vhurumuku, 2014).

CSI and rCSI shows the sufficiency and quantity of food, HFIAS shows a combination of food sufficiency and psychological factors associated with food insufficiency, HHS shows the highest manifestation of food insufficiencies, FCS and HDDS shows the diversity and quality of food consumed (FCS also shows the quantity of food consumed as well), GHI calculate hunger using child underweight, undernourishment, and child mortality (Vhurumuku, 2014).

FCS is computed using data on how frequent a household consumes different classes and groups of food within the past 7 days. This score reflects a composition of food frequency, dietary diversity, and the nutritional value attached to different groups of food. When other household access indicators are added, it shows the food security status of the household. It is acceptable for measuring the quality of diet and the intake of calories at household level (Vhurumuku, 2014). FCS is used mostly by World Food Program (WFP)

The HDDS reflects the different variety of food classes and groups that is eaten by household within a specific period. It is quite like the FCS but the recall period in HDDS is 24 hours without information about the frequency on consumption. When the target group are individuals, it is called Individual Dietary Diversity Score (IDDS), but if the target group are women, it is called Women Dietary Diversity Score (WDDS). It usually examines about 7-16 food groups, and it is most widely used by USAID and FAO (Vhurumuku, 2014).

The undernourishment measure reflects compares the mean dietary energy (Kcal) of the food energy consumed, to the acceptable dietary energy that is required for optimal health. The proportion of the population whose consumption of dietary energy is below the minimum acceptable dietary energy required is categorized as been undernourished. This measure is also used mostly by FAO (Vhurumuku, 2014).

The spending on food measure reflects the proportion of household total income that is spent on food. When the proportion of household total income spent on food is high, the household is close to the edge of poverty. This measure also looks at the proportion of household total income that is spent of different classes of food (Vhurumuku, 2014).

The CSI reflects the behavior of people when they do not have access to adequate amount of food. It also accounts for the adjustments that the household make when they do not have adequate food, these adjustments/coping strategies include livelihoods expansion, expenditure reduction, and changes in consumption. The CSI is widely used by the Vulnerability Analysis Mapping (VAM) unit of World Food Program (WFP), FAO, and global Integrated Phase Classification (IPC) team (Vhurumuku, 2014).

The HFIAS reflects the behavior that the household put up which indicates lack of adequate quantity and quality of food. The HFIAS also reflects anxiety and uncertainty behavior due to lack of adequate availability and/or access to food (Vhurumuku, 2014).

The HHS reflects very severe behavior due to lack of access to food. It asks questions like: Did you or any member of the household go to bed at night without eating due to lack of access or availability of food? Did you or any member of your household eat no food in a whole day because the food was not available or there was no access to food? Did you or any member of your household borrow food from your neighbors, family and friends due to lack of access or availability of food? Do all household members eat roughly the same diet due to lack of access or availability of food? Reduce number of meals eaten in a day due to lack of access or availability of food? Restrict consumption by adults for children to eat due to lack of access or availability of food? Must eat a limited variety of foods due to lack of access or availability of food? (Vhurumuku, 2014).

The SAFS is a subjective measure that uses the how people rank their food security status over a recall period that is recent. It also uses how people rank the changes in their livelihood status over a recall period that is longer than that of the recall period for their food security status (Vhurumuku, 2014).

Since Ebonyi state is amongst the least developed states in South East Nigeria, this study made use of the Household Hunger Scale (HHS) as it is the best measure to use when assessing areas that are already known for high level of poverty and food insecurity. It is also appropriate for monitoring and evaluating the impact of projects, programs, and policies that are aimed at reducing or eradicating hunger and food insecurity. Furthermore, the HHS is very appropriate in tracking progress of international development interventions towards achieving a reduction in the prevalence of hunger over time (Ballard, Coates, Swindale, and Deitchler, 2011).

3.4.7 Fadama III

The Fadama III project is an agricultural development project that has six main components. The first component, ‘capacity building, communications and information’, directly improves the social assets of the farmers. It involves strengthening the relationship between farmers and other key agricultural players (like processing firms, agro-dealers, private sector) to have an agreement on the quality and quantity of outputs produced (National Fadama Coordination Office, 2019). This component has activities that also increase farmers' human assets such as training farmers in how to develop a business plan and providing support for implementing the activities contained in the business plan. Other activities that increase farmers' financial and social capital include linking farmers with financial institutions, community relations, and farmer group mobilization (National Fadama Coordination Office, 2019).

The second component, ‘small-scale community-owned infrastructure’, increases the physical assets of the farmers. It involves activities such as construction of new borehole structures, small-scale irrigation structures, groundwater irrigation structures and surface water rehabilitation (National Fadama Coordination Office, 2019).

The third component, ‘advisory services and input support’, increases the human and physical assets of the farmers. This component pays for advisory services that teach the farmers techniques that will help them to make optimal use of their factors of production (improved seeds, fertilizers, and machinery). Here, farmers are also provided with the vital inputs they need to increase their production (National Fadama Coordination Office, 2019).

The fourth component, ‘support to the ADPs, research and on-farm demonstrations’, indirectly increases the farmers’ human assets as it involves activities that build capacity for delivering extension services (National Fadama Coordination Office, 2019). This component incorporates nutritional information and advice to the delivery of extension service, incorporates and promotes quality control and assurance to the delivery of extension services, encourages the use of e-extension services especially in the production cluster, and promotes on-farm demonstrations and adaptive research (National Fadama Coordination Office, 2019). All these improve the farmers' human assets directly or indirectly (National Fadama Coordination Office, 2019).

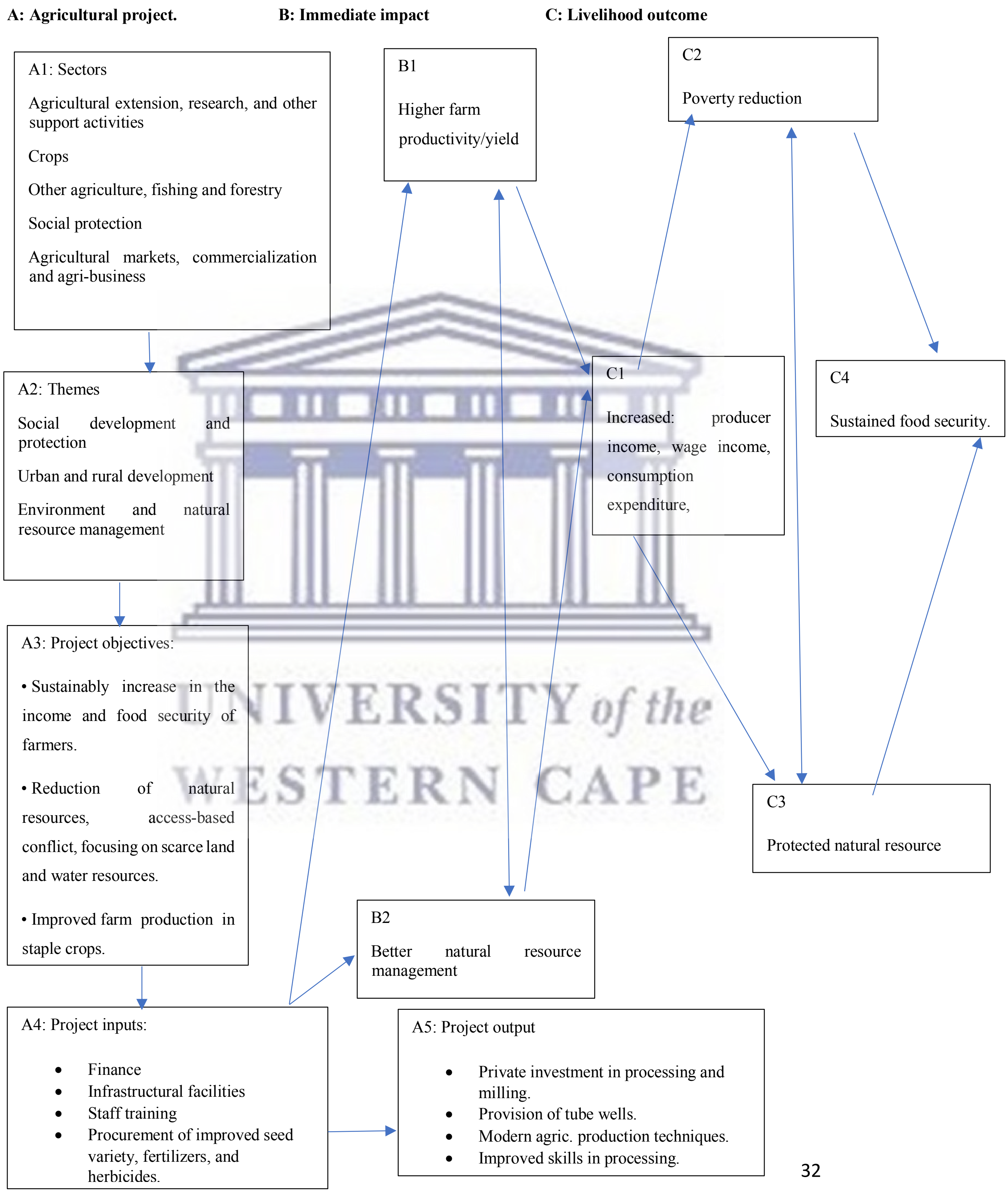
The fifth component, ‘asset acquisition for individual farmer groups’, has two categories. The first category, ‘gender equity and inclusive targeting’, increases the financial assets and human assets of the farmers as it involves activities that ensure that there is equal access to matching grants and equitable access to improved communication strategies and information (National Fadama Coordination Office, 2019). The second category, 'agricultural machinery', increases the financial assets and physical assets of farmers, especially the youth and female farmers by providing them with matching grants (National Fadama Coordination Office, 2019). It also provides apex farmers with matching grants to enable them to acquire and run agricultural equipment hiring enterprises (AEHEs).

Lastly, the sixth component, 'project administration, monitoring and evaluation', develops the human assets of the farmers as they are trained to take part in the implementation and monitoring of the project (National Fadama Coordination Office, 2019).

3.4.8 Conceptual linkages

The conceptual linkages present key concepts and how these are related. The map shows that the agricultural development project (ADP) is expected to be positively related with smallholder farmers' livelihood outcomes through an increase in farm productivity. Section A of the conceptual linkages provides an overview of the Agricultural Development Program (ADP). This section comprises of subsections A1, A2, A3, A4, and A5. A1 consists of the priority sectors that the project is interested in. A2 consists of the major themes of the project while A3 is about the project objectives. A4 consists of the project inputs while A5 contains the project output. Section B is about the short-term effect of the project. This section consists of B1 and B2. B1 shows that there will be an increase in farm productivity while B2 shows that there will be in improvement in the management of natural resources (water resources and scarce land). The long-term impact of the project is shown in section C. C1 shows that there is an increased income for both farmers and farm laborers, which leads to reduction in poverty as shown in C2. C3 shows that better management of natural resources leads to protected natural resources. Lastly, C4 shows sustained food security.

Figure 3.2: Conceptual linkages



Source: Author's conceptual linkage modified from Olaolu et al., 2013.

3.5 Chapter summary

The chapter has shown how the concept of the agricultural development project is expected to be positively related with the concept of Livelihood Outcomes. The chapter also presented the Sustainable Livelihoods Framework (SLF) as the theoretical framework on which this study is underpinned, tracing its history to the work of Robert Chambers in the 1980s. The SLF has proven to be useful in describing and analyzing the key factors that affect poor people's livelihoods. Drawing on these frameworks, the chapter also outlined the various methods that could be used to measure food security. The chapter argued that Household Hunger Scale (HHS) is the best measure of food security to use when assessing areas that have widespread poverty and food insecurity, like Ebonyi State. The next chapter provides a detailed explanation of the methodology adopted for data collection and data analysis.

Chapter 4: Methodological approach

4.1 Introduction

This chapter presents the methodology adopted for the study and explains the research processes employed throughout. The methodology of the research is important as it helps draw emphasis to the systematic ways of providing answers to research questions and solving the research problem. The chapter starts with a detailed elucidation of the research design. The sampling techniques, data collection methods, data analysis process as well as the statement of ethics that guided the conduct of the research are then discussed. The chapter thus intends to provide a strong footing for the subsequent chapters.

4.2. Research design

Research design, according to Babbie (2008), provides a blueprint for how a specific research project will be conducted. It is defined as a procedural plan implemented by the researcher to answer questions validly, objectively, accurately and economically and its main function is to explain how the researcher intends to find answers to his or her research questions (Kumar, 2010). For this study, the quasi-experimental research design was used. Quantitative data was collected using questionnaires completed by smallholder farmers who are beneficiaries of the Fadama III project in Ebonyi State. Quantitative tools such as descriptive statistics, probit regression, and propensity score matching were used to analyze the data collected.

4.3 Research methods

There are two methods that could be used to ascertain the development impact of interventions. One method is quantitative, and the other method is qualitative. These two methods have their merits and demerits, and the application of either of these methods depends on some conditions like the type of research questions to be answered. This study adopted the quantitative method because it is objective and helps to reduce or remove human bias that could affect the evaluation, thus making findings from quantitative evaluation more reliable. Unlike qualitative methods where the sampling technique and sample size hardly lead to a sample that is a good representation of the population, quantitative methods allow for a random sampling technique and larger sample size which often leads to a sample that better represents the population. Thus, findings from quantitative methods can be used for making reliable generalizations about the population (Sufian et al., 2011). The quantitative method is more appropriate in answering research questions that require numeric answers, like the research questions in this study which require numeric answers on the difference in the food security level and farm income of beneficiaries and non-beneficiaries of Fadama III.

4.3.1 Sampling and population

The population of the study includes all smallholder farmers in Ebonyi State but only a sample of these farmers was used for this study. The study applied the multi-stage random sampling technique to ensure a representative sample. In order to have a good representation of Ebonyi State, all three senatorial zones (Ebonyi North, Ebonyi Central, and Ebonyi South) were considered. In the first stage of the sampling, the researcher used Microsoft Excel to randomly select 2 local governments from the lists of local governments in each of the three senatorial zones, making a total of six local governments. The six local governments include Abakaliki and Izzi local governments from Ebonyi North senatorial zone, Afikpo North and Afikpo South local governments from Ebonyi South senatorial zone, and Ikwo and Ezza local governments from Ebonyi Central senatorial zone. In the second stage, the researcher used the list of Fadama III beneficiaries in these local governments to randomly select 25 beneficiaries from each local government.. The researcher applied the criteria of willingness to cooperate and availability to select 25 non-beneficiaries from each local government, making a total of 50 participants from each local government and 300 participants in total. Because of the bias that results from the non-random selection of the non-beneficiaries, the propensity score matching was used to control for this bias.

4.3.2 Data collection method

This study required quantitative data from primary sources (farmers). This study made use of self-designed questionnaires for the data collection because it was easier and faster to collect reliable and valid data from a large sample size than other data collection instruments like interviews (Gangrade, 1982). With a given amount of funds, it is usually possible to obtain data from more people and cover a wider area when using questionnaires than when using other data collection instruments like interviews. According to Gangrade (1982), questionnaires ensure some level of uniformity from one measurement situation to another as a result of their impersonal nature, standardized order of questions, wordings, and instructions for response recording. Furthermore, questionnaires were used in this study because they allowed respondents to express themselves freely with no fear because their anonymity was protected. Gangrade (1982) also argued that if respondents are given enough time while completing the questionnaires, they would consider each point carefully.

The questionnaire was self-designed and structured into five sections. Section A contained general questions about the respondents, like demographic and socio-economic characteristics. Section B contained questions about their asset ownership and farming practice. Section C tried to ascertain their other sources of income, while section D tried to ascertain their food security levels. Finally, section E ascertained their crop yield and farm income for the previous planting season. The questionnaire is attached in the appendix.

4.3.3 Data analysis

This study used descriptive statistics like bar charts to graphically analyze the demographics and observable characteristics of farmers that could affect their food security and farm income. The observable characteristics of the farmers were of interest to this study because the beneficiaries and non-beneficiaries of the Fadama III project were not assigned, based on randomization, and the non-beneficiaries were not randomly selected for the survey. Thus, it was possible that the beneficiaries and non-beneficiaries were not comparable because they had different observable characteristics. The study also used inferential statistics like linear regression models via ordinary least square, t-test for mean comparison of two groups, Chi-square test and Fishers' exact test for independence. The linear regression was used to estimate the development impact of the intervention without controlling for observable characteristics that could affect the outcome of interest. The t-test was used to ascertain if there was a mean difference in the observable characteristics between participant farmers and non-participant farmers. The Chi-square test and Fisher's exact test were used to ascertain if farmers' food security levels were dependent on their participation in Fadama III.

To estimate the impact of the intervention while controlling for observable characteristics, the study employed the with-without method. This method estimates the impact of interventions by comparing the development outcome of the group with the intervention versus the development outcome of the group without the intervention. This method involves matching the 'with group' and 'without group' so that both matched groups have similar observable characteristics. After matching with suitable methods, the Average Treatment Effect on the Treated (ATT) is estimated as the impact of the intervention. According to Sikwela and Mushunje (2013), the development impact of an intervention estimated using the ATT is robust and reliable. The study employed the Propensity Score Matching (PSM) to execute the with-without analysis. According to Rosenbaum and Rubin (1983, p. 6), "The propensity score is the conditional probability of assignment to a particular treatment given a vector of observed covariates." For a formal presentation of the PSM, let the covariates be X_i, the dummy variable D_i be equal to 1 if farmer is a treated farmer (farmer that is benefitting from the project) and be equal to 0 for those farmers who did not benefit from the project. Y_{i1} and Y_{i0} are the outcome variable (food security and farm income) of treatment group farmers and comparison group farmers respectively.

The propensity score is then given as:

$(X_i) = \Pr\{D_i = 1/X_i\}$……1

The $P(X_i)$ can be estimated using a logit or probit regression model. Hence, the average treatment effect on the treated (ATT) can be estimated using:

$\Delta Y_i = [Y_{i1}/D_i = 1, p(X_i)]$ - $E[Y_{i0}/D_i = 0, p(X_i)]$……2

As long as the balancing property of covariates is not violated, it is necessary to include many covariates during estimation to control for observable characteristics as much as possible (Nwosu et al., 2015). As with most methods, the PSM has a methodological limitation. The PSM produces more accurate estimates when there is a large sample of the treatment group and the comparison group farmers. Furthermore, propensity scores used for matching are estimated, based on observable characteristics and thus, do not control for unobservable characteristics (motivation to succeed, personal ability, preferences) that could affect farmers' farm yield, food security and farm income.

There are several methods that can be used for matching after the propensity scores have been estimated. These methods include: Nearest Neighbor matching, Radius matching, Stratification matching, and Kernel matching (Caliendo and Kopeinig, 2008). Nearest Neighbor matching is the simplest method and involves matching the non-participant farmers with participant farmers whose propensity scores are closest to the propensity score of the non-participant farmers. The problem with this method is that it could result in bad matches if there is a wide gap between the propensity scores of the closest farmers that are matched. The Radius matching tries to solve the problem of the Nearest Neighbor matching. It avoids bad matches by imposing a maximum allowed gap between the propensity scores of the closest farmers that are matched. By doing this, all the non-participating farmers whose propensity scores are within the allowed gap are matched with the nearest participating farmers. The challenge of the radius method is that it is difficult to determine the optimum maximum gap that should be allowed (Caliendo and Kopeinig, 2008).

The Stratification matching divides the common support of the propensity score to form a set of strata. Usually, five stratum are sufficient to eliminate 95% of the bias caused by one covariate. In each stratum, the impact of the intervention is calculated by taking the average difference of the participant and non-participant farmers' food security and farm income. The Stratification matching is also known as blocking and Subclassification matching, or Interval matching (Caliendo and Kopeinig, 2008).

The three matching methods discussed so far only make use of some of the non-participant farmers to construct the counterfactual outcome. Unlike these methods, the Kernel matching makes use of the weighted averages of all the non-participant farmers to construct the counterfactual outcome. The unique strength of this method is that it has low variance as more information is used to form the counterfactual outcome. The criticism of this method is that some of the non-participant farmers used could be bad matches (Caliendo and Kopeinig, 2008).

Having presented the various matching methods, it is important to know that no matching method is superior to the other, and all the methods should yield the same result as the sample size gets larger. However, a small sample size could make the results differ slightly. This study makes use of the four matching methods. In cases where the matching methods produce different results, the Kernel matching is considered because it has low variance when compared to other matching methods.

Stata 14 statistical software was used for the data analysis because it has comprehensive tools for descriptive statistics, inferential statistics, and econometric analysis. It is also simple to operate.

4.3.4 Validity and reliability of the survey instrument

The face validity technique was used to confirm whether the response from the questionnaire was able to measure what it aimed to measure. This was done by interviewing some of the respondents face-to-face to ascertain if their real opinions corresponded with the response given on the questionnaires after they had completed them (Williams, 2003). In addition, the Fadama staff further validated the questionnaires before they were administered. They recommended some modifications in the contents of the questionnaire to ensure it measured food security and farm income of farmers. They were also asked what they thought the purpose of the questionnaire was and what they thought it measured. This helped in validating the questionnaire to ensure it measured what it intended to measure.

Furthermore, the test-retest method was used to assess the reliability of the questionnaire by asking the same 10 farmers on two separate occasions within an interval of two weeks to complete the questionnaire, with the assumption that there would not be a change in their circumstances within the interim. The response from the two sets of questionnaires was then compared and found to be similar.

4.4 Ethics statement

This study was undertaken in accordance with the ethical research standards of the University of the Western Cape. As such, the study only commenced after approval was granted by the University of the Western Cape Senate, the Faculty of Economic and Management Sciences, and the Institute for Social Development. Permission was also sought from the project implementing agencies (the Federal Ministry of Agriculture and Rural Development; the Federal Ministry of Finance; and the National Fadama Coordination Office), the leadership of the project's beneficiaries from which respondents were drawn, as well as the respondents themselves. The study did not intend to cause any harm to any party involved, hence respondents' participation was voluntary. At all stages of data collection, the researcher made clear the purpose and objectives of the study to all who participated in the study. Finally, the researcher ensured the anonymity of all respondents and all the gathered information.

4.5 Chapter summary

The chapter provided a thorough elucidation of the research methodology used. The multistage random sampling method was used to sample 300 respondents for data collection while a combination of descriptive and inferential statistics and econometric tools was used in the analysis of the data. The chapter ends with a provision of an ethics statement which is an important requirement for conducting the research. Based upon the foregoing methodological approach and tools of analyses, Chapter 5 presents the empirical findings from the data analyzed.

Chapter 5: Empirical results

5.1 Introduction

This chapter presents an analysis of the data collected and discusses the analyzed data and findings. It responds to the research questions and seeks to fulfill the objectives of the research as laid out in the first chapter of the study. The main purpose of the research is to examine the impact of the Fadama III project on the livelihood outcomes of smallholder farmers in Ebonyi State. The chapter thus focuses on exploring the foregoing based on the theoretical and conceptual frameworks presented earlier. The following sections comprise of (a) a quantitative analysis and discussion of respondents' socio-economic and demographic characteristics presented; (b) an inferential analysis of the impact of Fadama III on the livelihoods of smallholder farmers; and (c) an econometric analysis of the impact of Fadama III on the livelihoods of smallholder farmers. Finally, the chapter provides a concluding remark.

5.2 Descriptive statistics

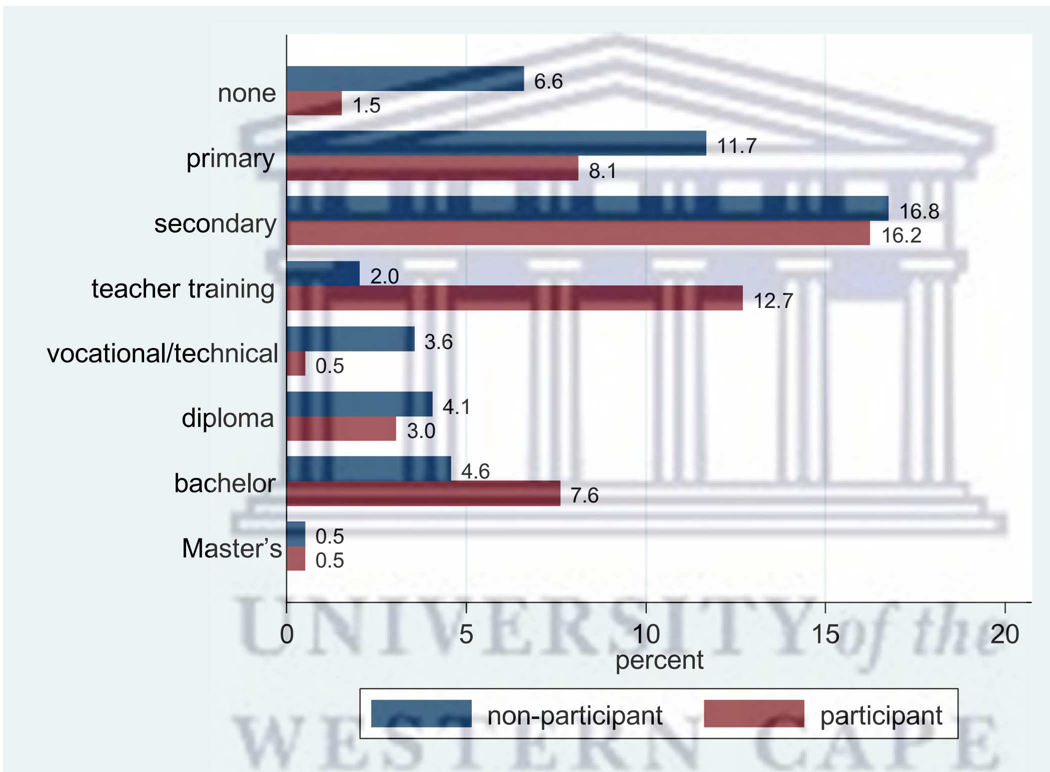
Socio-economic status has been identified as a key driver of agricultural outputs (Gebrekidan, 2012), which is important to measure the impact of interventions (Babatunde et al., 2007). The study therefore examines the socio-economic and demographic characteristics considered to have very strong contributions to the central theme of this study. These include the sex, age, marital and educational status, primary occupation, years of farming experience, main source of farm power, and area of land cultivated. Other descriptive statistics presented include income from rice and cassava production, different aspects of food security of farmers, and farm yield.

5.2.1 Education levels of farmers

Education goes a long way in influencing farmers' participation in an intervention (Vanslembrouck et al., 2002) and agricultural productivity (Gebrekidan, 2012), and also has the inherent ability to influence the livelihood outcomes of farmers (De Gregorio and Lee, 2002).
Figure 5.1 shows that most of the farmers who do not have any level of education or who have, at the most, a primary level of education, are the non-participant farmers. Most of the farmers with higher levels of education like Bachelor's degrees are the participant farmers. The participant and non-participant farmers are not similar in the distribution of their levels of education as can be

seen in the significant difference between them in educational levels like teacher training education, primary education, vocational or technical education, and no level of education. Only at the secondary and Master's degree levels of education, are there similar levels in education. Secondary school education is the highest level of education for most of the participants and non-participant farmers in Ebonyi State. On the other hand, very few participant and non-participant farmers in Ebonyi State have obtained a Master's degree.

Figure 5.1: Education of farmers

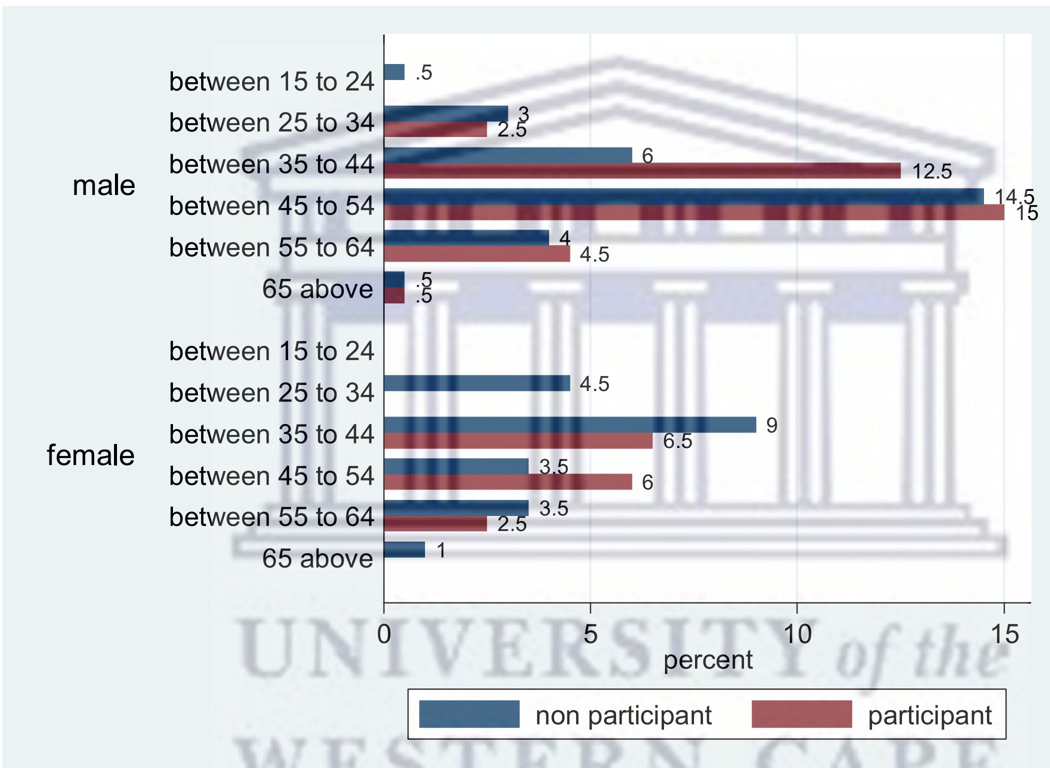


Source: Author's own compilation

5.2.2 Sex and age distribution

Figure 5.2 presents the sex and age distribution of farmers. The figure shows that the number of male beneficiaries is far higher than the number of female beneficiaries. This is not surprising as the number of male farmers is far higher than the number of female farmers in Ebonyi State. There is no youth beneficiary between the ages of 15 to 24 and only a few male farmers between the ages of 25 to 34 years are beneficiaries. Although there are female farmers between the ages of 25 to 34 years, none of them are beneficiaries. The number of beneficiaries between the ages of 35 to 54 years is far higher than the other age categories who are beneficiaries. Most of the female farmers are between 35 to 44 years old, thus most of the female beneficiaries fall within that age range. Although there are female farmers who are 65 years and above, none of the farmers in this age range are beneficiaries of the intervention.

Figure 5.2: Sex and age distribution

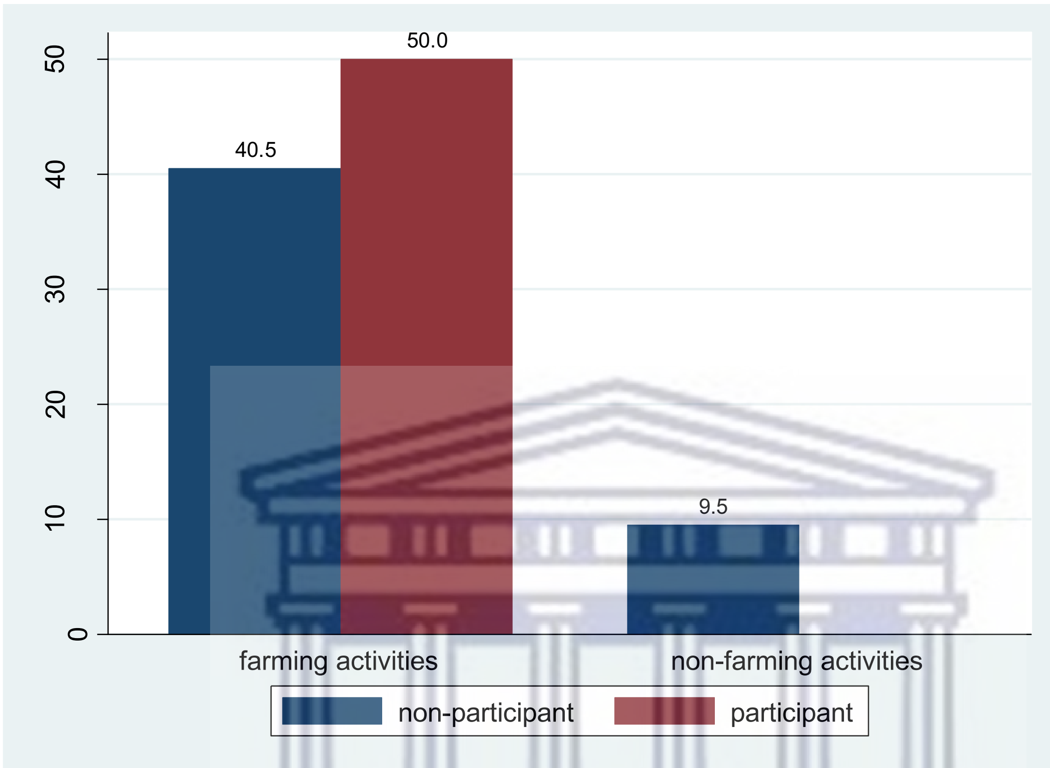


Source: Author's own compilation

5.2.3 Primary occupation of farmers

Figure 5.3 shows that the primary occupation of all the participants of Fadama III is farming. For the non-participants, most of them depend on farming as their main source of livelihood while only a few depend on non-farming activities as their main source of livelihood. Although farming is the major source of livelihood for both participants and non-participant farmers, the distribution of the primary occupation of the participant and non-participant farmers is not similar.

Figure 5.3: Primary occupation of farmers

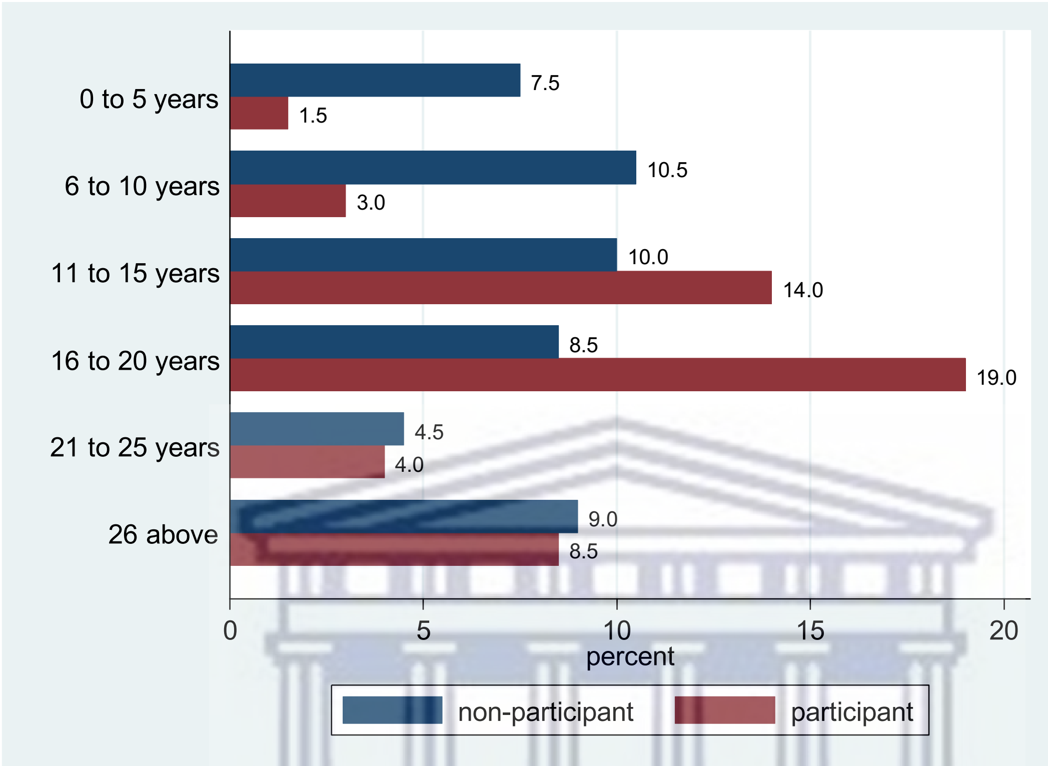


Source: Author's own compilation

5.2.4 Years of farming experience

Figure 5.4 shows that most of the farmers who have low years of farming experience (0 to 5 years, 6 to 10 years) are the non-participating farmers. On the other hand, most of the farmers who have higher years of farming experience (11 to 15 years, 16 to 20 years) are the participating farmers. There is not much difference between participating and non-participating farmers who have higher years of farming experience (21 to 25 years, and 26 years above). In summary, farmers who are participating in the Fadama III project have more years of farming experience when compared to the farmers who are not participating in the project.

Figure 5.4: Years of farming experience

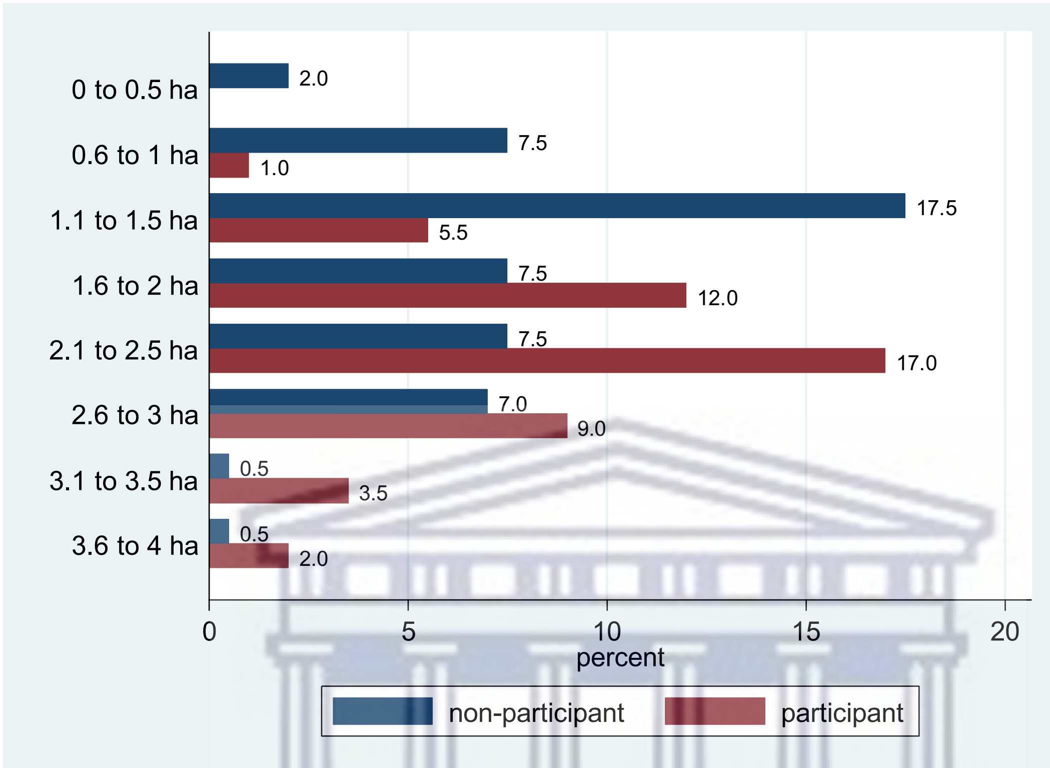


Source: Author's own compilation

5.2.5 Area of land cultivated

Figure 5.5 shows that most of the farmers who cultivate smaller areas of land (0.6 to 1 ha, 1.1 to 1.5 ha) are the non-participating farmers. On the other hand, most of the farmers who cultivate larger areas of land (1.6 to 2.0 ha, 2.1 to 2.5 ha, 2.6 to 3.0 ha, 3.1 to 3.5 ha, 3.6 to 4 ha) are the participating farmers. The least area of land cultivated by participant farmers ranges between 0.6 to 1 ha while non-participant farmers cultivate as low as 0 to 0.5 ha of land. Most participating farmers cultivate 2.1 to 2.5 ha of land while most non-participating farmers cultivate 1.1 to 1.5 ha of land. In summary, farmers who are participating in the Fadama III project cultivate a larger area of land when compared to the farmers who are not participating in the project.

Figure 5.5: Area of land cultivated

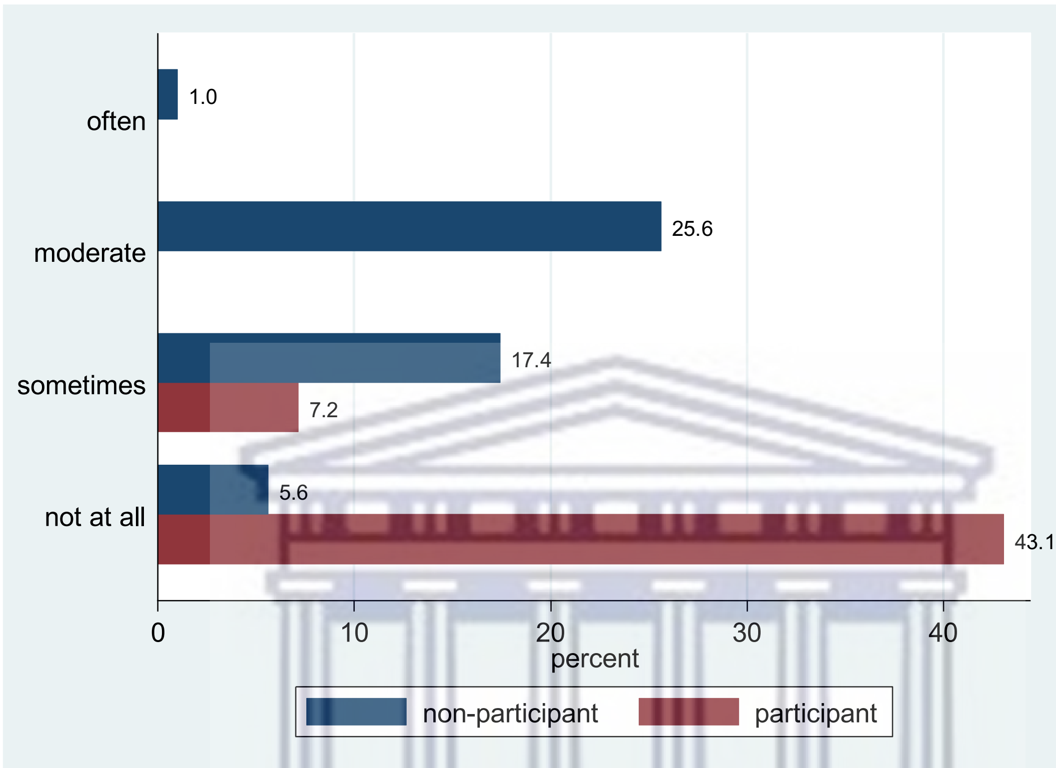


Source: Author's own compilation

5.2.6 Food availability and access

Figure 5.6 shows the food availability and access dimension of food security for participant and non-participant farmers. Farmers categorized under 'not at all' are said to be food secure; those categorized under 'sometimes' or 'moderate times' are said to have mild food insecurity, while those categorized under 'often' or 'very often' are said to have severe food insecurity. The graph shows that some of the non-participant farmers are severely food insecure as they fall under the 'often' category. On the other hand, none of the participant farmers are severely food insecure. Most of the non-participant farmers are mildly food insecure while some of the participating farmers are mildly food insecure as they fall under the 'moderate' or 'sometimes' category. Only few non-participating farmers are food secure while most of the participating farmers are food secure as they belong to the 'not at all' category. The food access and availability dimensions of food security show that participating farmers are more food secure than non-participating farmers.

Figure 5.6: Food availability and access

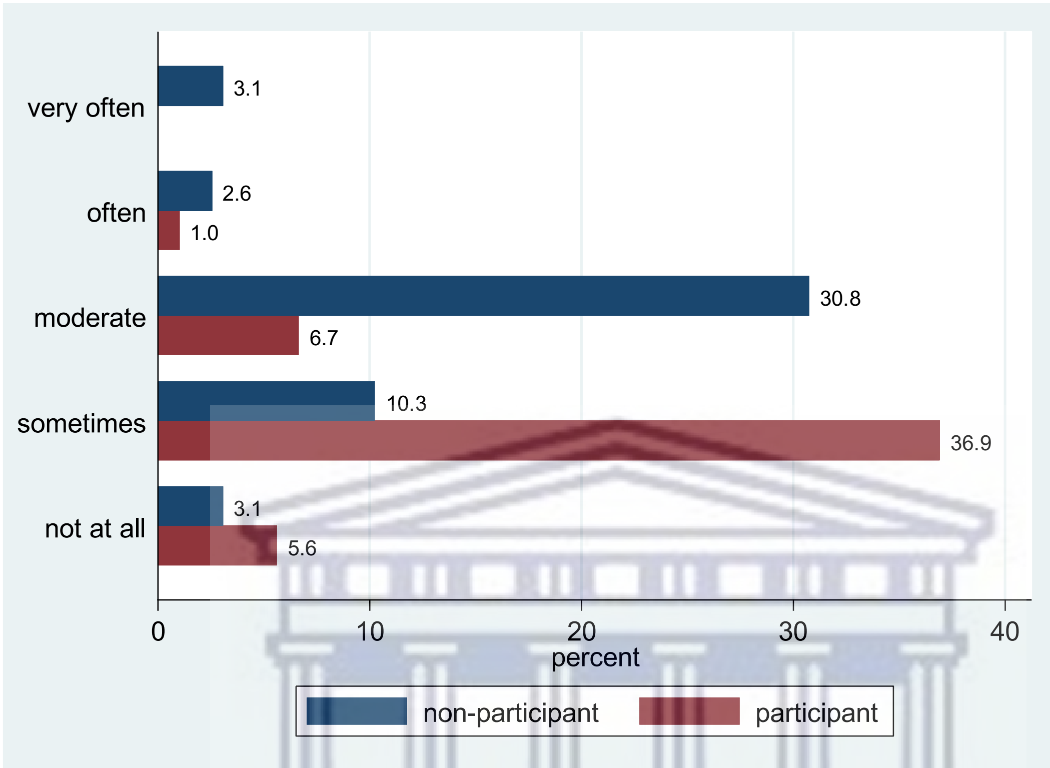


Source: Author's own compilation

5.2.7 Food utility

Figure 5.7 shows the food utility dimension of food security for participant and non-participant farmers. The figure shows that some of the non-participant farmers and participant farmers are severely food insecure. However, more non-participating farmers are severely food insecure compared to participating farmers. Most of the non-participant farmers and participating farmers are mildly food insecure but more non-participating farmers are mildly food insecure compared to participating farmers. Only a few participating and non-participating farmers are food secure but more participating farmers are food secure compared to non-participating farmers. It is not clear which group of farmers (participating vs non-participating) is more food secure with respect to the food utility dimension of food security.

Figure 5.7: Food utility

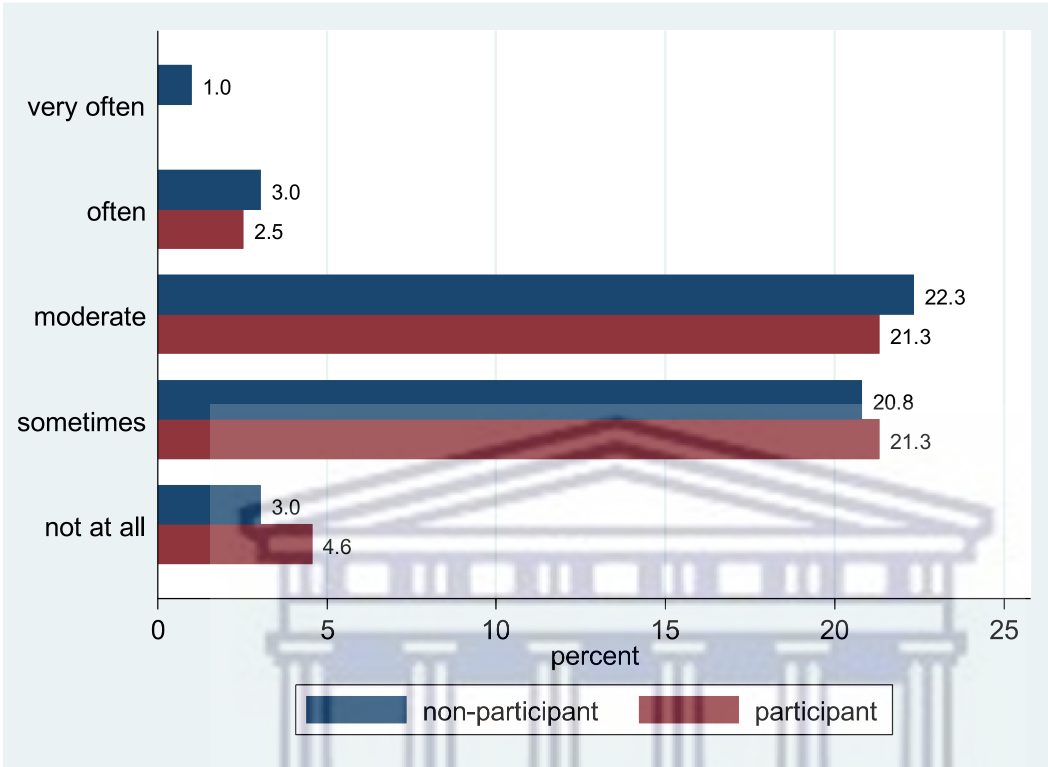


Source: Author's own compilation

5.2.8 Food stability

Figure 5.8 shows the food stability dimension of food security for participant and non-participant farmers. The figure shows that some of the participant and non-participant farmers are severely food insecure. However, more non-participating farmers are severely food insecure compared to participating farmers. Most of the non-participant farmers and participating farmers are mildly food insecure. Only few participating and non-participating farmers are food secure. The distribution of food secure and mildly food-insecure farmers is similar for both participating and non-participating farmers. It is not clear which group of farmers is more food secure with respect to the food stability dimension of food security.

Figure 5.8: Food stability

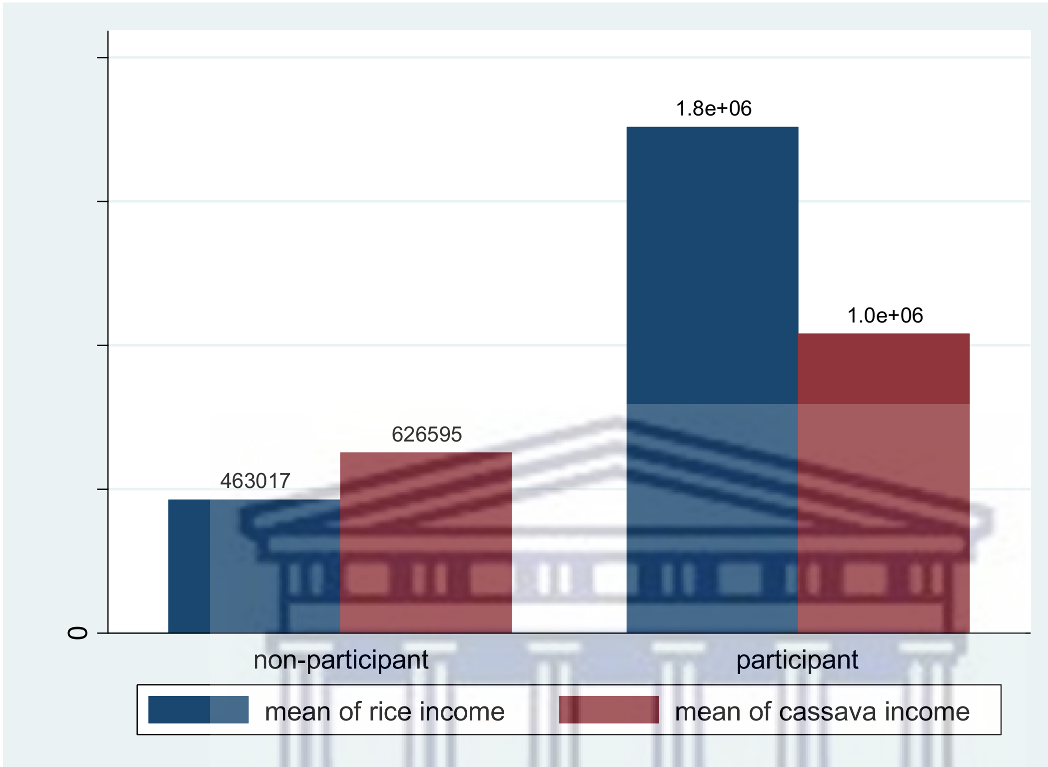


Source: Author's own compilation

5.2.9 Rice and cassava income

Figure 5.9 shows that the mean income participant farmers make from the production of rice is about four times larger than the mean income that non-participant farmers make from the production of rice. For income from cassava production, participant farmers make almost double the income made by non-participant farmers. The participant farmers have more farm income than non-participant farmers do.

Figure 5.9: Rice and cassava income



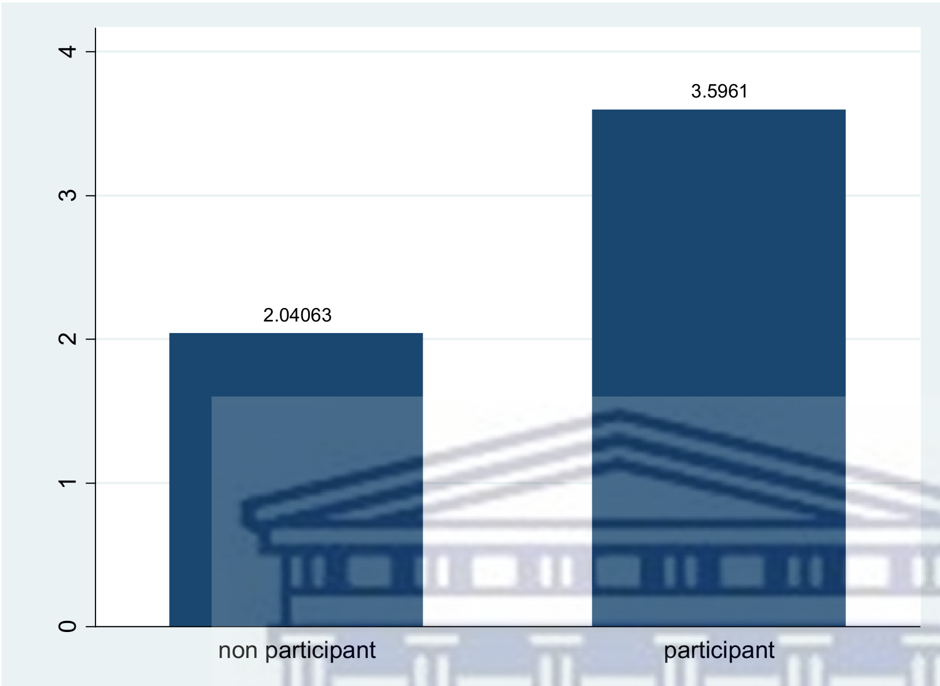
Source: Author's own compilation

5.2.10 Rice yield and main source of farm power

Figure 5.10 shows the average rice yield (in tons per hectare) for participants and non-participants of the Fadama III project. The average rice yield (3.59 tons per hectare) of participant farmers was found to be 1.75 times more than the average rice yield of non-participant farmers (2.04 tons per hectare). This suggests that participant farmers are more productive than non-participant farmers.

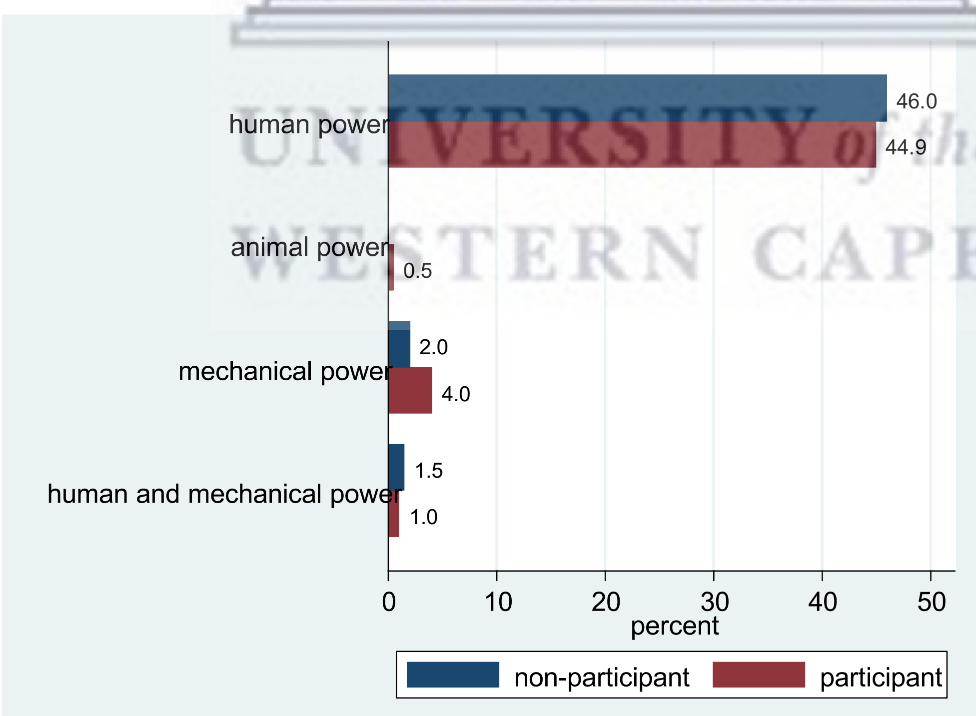
Figure 5.11 shows that human power is still the main source of farm power for most of the participant farmers. Only a few participant farmers use mechanical power for farming.

Figure 5.10: Rice yield



Source: Author's own compilation

Figure 5.11: Main source of farm power



Source: Author's own compilation

5.3 Inferential statistics

Here, important inferential statistics like the t-test for difference in group means, Chi-Square and Fisher's exact tests, and multivariate linear regressions were used to analyze the impact of Fadama III on the livelihood outcomes of the smallholder farmers.

5.3.1 t-test for differences in group mean

The t-test conducted is in line with the pioneering work of Rosenbaum and Rubin (1983) on PSM which showed that a t-test can be used to ensure that the participant farmers and non-participant farmers have no statistically significant difference in their observable characteristics in order to reduce attribution error.

Table 5.1 presents the t-test results for comparing the means of covariates between the participant farmers and non-participant farmers. The covariates are observable characteristics that could affect the desired outcome of the Fadama III project (food security, more farm income) or could determine farmers' decisions to participate in the intervention. Thus, it is important that the participant farmers and non-participant farmers have no statistically significant difference in these observable characteristics in order to be able to estimate only the impact of Fadama III on the farm yield, food security status, and farm income. The null hypothesis of the t-test is that the observable characteristic is not different for both groups of farmers while the alternative hypothesis is that the observable characteristic is different for both groups of farmers. Since the t-statistics are all less than 2 (in absolute terms) for observable characteristics like sex, age, and marital status, this study does not reject the null hypothesis and concludes that there is no statistically significant difference between both groups of farmers in those observable characteristics at 5% level of significance. On the other hand, since the t-statistics are greater than 2 (in absolute terms) for observable characteristics like education, primary occupation, years of farming experience, and area of land cultivated, this study rejects the null hypothesis and concludes that there is a statistically significant difference between both groups of farmers in those observable characteristics at 5% level of significance. In summary, both groups of farmers are similar in some observable characteristics but different in other observable characteristics. Thus, it is important to control for observable characteristics while estimating the impact of the Fadama III intervention.

Table 5.1: t-test for differences in group mean

	Difference	
Sex	0.130	(1.92)
Age	-0.100	(-0.75)
Marital status	0.430	(1.56)
Education	-0.542	(-2.11)
Primary occupation	0.470***	(5.72)
Years of farming experience	-0.550**	(-2.62)
Area cultivated	-1.190***	(-6.02)
N	200	

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Source: Author's own compilation

5.3.2 Chi-Square and Fisher's exact test

Table 5.2 presents the Chi-square and Fisher's exact test. The Chi-square test was conducted to further study the relationship between participation in Fadama III and food security. However, the Fisher's exact test was used to supplement the Chi-square because some of the expected frequencies of the Chi-square contingency tables were less than 5 (see appendix for detailed result). This suggests that using Chi-square alone could give biased findings. The Chi-square could not be applied to the relationship between participation in Fadama III and farm income or farm yield because farm income and farm yield are continuous variables and Chi-square only works for categorical variables. The null hypothesis of the Chi-square is that there is no relationship between participation in Fadama III and food security. In other words, the farmers' food security levels are independent of the farmers' participation in Fadama III. The alternative hypothesis is that there is a relationship between participation in Fadama III and food security. This means that the farmers' food security levels are dependent on the farmers' participation in Fadama III. Since both the Pearson chi2 Pr. (0.000) and Fisher's exact Pr. (0.000) are less than 0.05 for the relationship between participation in Fadama III and farmers' food access and availability, and also for the relationship between participation in Fadama III and food stability, this study rejects the null hypothesis. This study concludes that farmers' food access and availability, and food stability depend on the farmers' participation in Fadama III at 5% level of significance. For the relationship between participation in Fadama III and food stability, this study does not reject the null hypothesis, hence concluding that farmers' food stability is independent of their participation in Fadama III at 5% level of significance since the Pearson chi2 Pr (0.601) and Fisher's exact Pr (0.718) are greater than 0.05.

These findings agree with a similar study by Olaolu et al. (2013) who found that most dimensions of food security of smallholder farmers are dependent on Fadama II in Kogi State, Nigeria, using Chi-square and Fisher's exact tests.

Table 5.2: Chi-Square and Fisher's exact test

	Food access & availability	food utility	food stability
Pearson chi2(3)	116.4260	68.4046	2.7445
Pearson chi2 pr.	0.000*	0.000*	0.601
Fisher's exact pr.	0.000*	0.000*	0.718

* p<0.05

Source: Author's own compilation

5.3.3 Impact of project without other covariates: Linear regression 1 using OLS

Table 5.3 shows the impact of participating in the Fadama III project without other covariates. There are significant results related to food access and availability (coefficient 1.3), food utility (0.784), cassava income (412332.3), and rice yield (1.34) at 0.1% level of significance. These results show that the food access and availability, and food utility status of participant farmers are higher than that of non-participant farmers by 1.3 and 0.784 points on the 5-points Likert scale used to measure food security where 5-points show that the farmers are food secure, and 1-point shows that the farmers are severely food insecure. The rice yield shows that participant farmers are more productive than non-participant farmers by 1.34 tons per hectare. The cassava income shows that the income from cassava production of participant farmers is higher than non-participant farmers by 412332.3 Naira (local currency). There are insignificant results related to food stability (coefficient 0.127) and rice income (1294581.1) at 5%, 1%, and 0.1% levels of significance.

These findings agree with the existing literature, which applied similar methodology. Such existing literature includes, Bruce (2015), who found that improved rice variety projects increased rice yields in Ghana; Yabi (2008) who found that agricultural projects increased the agricultural productivity of the farmers in Benin Republic; Sikwela and Mushunje (2013), who found that farmer support programs increased the income of small-scale farmers in South Africa; and Agboh-Noameshie et al. (2008), who showed that agricultural projects increased the yields of farmers in Central Benin, especially female farmers.

Table 5.3: Impact of project without other covariates: Linear regression 1 using OLS

	(1) Food access & availability	(2) food utility	(3) food stability	(4) rice income	(5) cassava income	(6) Rice yield
Participation	1.3**	0.784**	0.127	1294581.1	412332.3**	1.34**
	(16.03)	(7.52)	(1.17)	(1.34)	(3.55)	(2.97)
Constant	3.557****	3.155***	3.434***	463016.9	626594.7***	4.71*
	(61.83)	(42.67)	(45.0)	(0.65)	(7.98)	(12.3)
N	195	195	197	180	138	186

t statistics in parentheses
* p<0.05, ** p<0.01, ***p<0.001

Source: Author's own compilation

5.3.4: Impact of project with other covariates: Linear regression 2 using Ordinary Least Squares (OLS)

In accordance with the groundbreaking work of Katchova (2010) on impact evaluation, the impact of project with other covariates was estimated.

Table 5.4 shows that when covariates were added, rice yield, rice income and cassava income, which were formerly 1.34 tons per hectare, 1294581.1 Naira (local currency) and 412332.3 Naira (local currency), reduced significantly to 1.21 tons per hectare, 453031.7 Naira (local currency) and 331599.8 Naira (local currency) respectively. Food stability and food utility, which were formerly 0.127 points and 0.784 points, both reduced to 0.0596 points and 0.715 points respectively. However, food access and availability, which was formerly 1.3 points, increased slightly to 1.321 points. In summary, the regression coefficients for the impact of Fadama III reduced as other covariates were added, except for the coefficient of food access and availability which slightly increased. However, the decision of whether the coefficients were statistically significant or not remained the same.

Table 5.4: Impact of project with other covariates: Linear regression 2 using OLS

	(1) Food access & availability	(2) food utility	(3) food stability	(4) rice income	(5) cassava income	(6) Rice yield
Participation	1.321***	0.715***	0.0596	453031.7	331599.8**	1.21*
	(14.82)	(6.12)	(0.46)	(0.39)	(2.71)	3.1
Sex	-0.0586	-0.181	-0.0824	-420781.6	-43795.4	-0.31
	(-0.71)	(-1.69)	(-0.69)	(-0.39)	(-0.38)	(-0.42)
Age	-0.114*	-0.0977	-0.187*	-743713.2	-10429.4	-0.74
	(-2.24)	(-1.41)	(-2.49)	(-1.05)	(-0.16)	(-0.54)
Marital Status	0.00835	0.0460	-0.00805	29835.7	44401.1	0.93
	(0.42)	(1.68)	(-0.27)	(0.10)	(1.56)	(1.21)
Education	0.0149	0.00585	0.00758	-469948.7	22268.8	0.82
	(0.67)	(0.20)	(0.23)	(-1.61)	(0.73)	(1.3)
Primary Occupation	0.342***	0.161	-0.145	63720.4	138125.5	0.43
	(5.13)	(1.76)	(-1.48)	(0.06)	(1.56)	(1.41)
Farming Experience	0.0132	0.0972*	0.127*	326232.0	223756.8*	0.21*
	(0.39)	(2.23)	(2.60)	(0.75)	(5.05)	(2.3)
Area Cultivated	0.116***	0.0560	-0.0548	857403.4*	62800.7	0.74
	(3.70)	(1.34)	(-1.20)	(1.99)	(1.35)	(1.09)
Constant	2.987***	2.894***	4.197***	747474.8	-709134.9	1.2*
	(10.63)	(7.76)	(10.18)	(0.20)	(-1.92)	(4.23)
N	193	192	194	177	138	187

t statistics in parentheses
* p<0.05, ** p<0.01, ***p<0.001

Source: Author's own compilation

5.4 Econometric analysis

The probit regression and propensity score matching are the main econometric analysis used to answer the research questions. The probit regression model was used to estimate the propensity scores while the propensity score matching was used to match the treatment and control group farmers using several matching methods like Nearest Neighbor matching, Radius matching, Stratification matching, and Kernel matching presented below.

5.4.1 Estimating propensity scores

A source of bias in estimating the impact of Fadama III intervention could be a result of spillover effects. It is possible that the extension services received by participating farmers could be benefited by non-participating farmers residing near participant farmers. This could lead to an underestimation of the impact of the Fadama III intervention. Another source of bias could arise from the fact that non-participating farmers are benefitting from other agricultural intervention(s) which could affect their food security levels and farm income. This could also lead to an underestimation of the impact of the Fadama III intervention. To address the possible spillover and crossover bias, 9 non-participating farmers, who were found to be living near the participating farmers, were dropped from the sample. Two non-participating farmers who were beneficiaries of other community-based agricultural interventions were also dropped from the sample. This procedure reduced the sample size slightly by 11 but eliminated any potential bias that could result from spillovers and crossovers.

The probit regression model was used to estimate the propensity scores. The probit regression showed that farmers' education, primary occupation, and area of land cultivated, statistically significantly determine farmers' participation in Fadama III intervention. Precisely, the more educated the farmer is, the more likely the farmer is to participate in the intervention. Farmers whose primary occupation is farming only are more likely to participate in the intervention than farmers whose primary occupation is non-farming activities. The higher the area of land the farmer cultivates, the more likely the farmer will participant in the intervention. Other observable characteristics like sex, age, marital status and years of farming experience do not statistically significantly determine farmers' participation in the intervention (see appendix for detailed result).

The region of common support of the estimated propensity scores is [0.19204929, 0.95715468]. The final number of blocks is 5. This number of blocks ensures that the mean propensity score is not different for treated and controls in each block. The balancing property is also satisfied (see appendix for detailed result). This agrees with the work of Sikwela and Mushunje (2013) which also used probit regression and propensity score matching with final number of blocks to be 5 and balancing property satisfied.

5.4.2 Matching of propensity scores and estimation of ATT

Tables 5.5 and 5.6 show the impact of Fadama III when the observable characteristics are controlled. The results for food access and availability (ATT 1.219), food utility (0.626), income from cassava production (332000), and rice yield (1.27) are statistically significant at 5% level of significance. These mean that participation in Fadama III increases farmers' food access and availability, and food utility by 1.219 and 0.626 points on the 5-points Likert scale of food security where 5 points signify food security and 1 point signifies severe food insecurity. Furthermore, participation in Fadama III increased income from cassava production by 332000 Naira (local currency) and rice yield by 1.27 tons per hectare.

It is important to note that the various matching methods produced slightly similar ATT except for Radius matching that produced a slightly different ATT. This could be because of the choice of the radius that was selected for matching. The ATT of all four matching methods is statistically significant at 5% level of significance, except for cassava income where only the ATT of Kernel matching is significant. As discussed earlier in the methodology, whenever there is a difference in the ATT of the matching methods, we consider the ATT of the Kernel matching because it uses all information available to compute the counterfactual outcome and produces the least variance ATT when compared to other matching methods. Thus, the ATT discussed are those produced by the Kernel matching.

For food stability and income from rice production, the ATT for all four matching methods are statistically insignificant at 5% level of significance. This means that participation in Fadama III does not increase food stability and income from rice production.

The finding of this study agrees with most existing literature, like Olaolu et al. (2013) who found that Fadama II increases food security of farmers in Kogi state; Nguezet et al. (2011) who showed that adoption of NERICA helped in increasing the per capita income of farmers in Kano, Osun, and Niger state; and Donkor et al. (2017) who found that the Presidential Cassava Initiative (PCI) increased cassava output and food security.

Table 5.5: Development impact of Fadama III: Controlling for covariates

Food access and availability					
Matching method	**Number of treatments**	**Number of controls**	**Average treatment effect on the treated**	**Standard error**	**t-statistic**
Nearest neighbor	97	37	1.176	0.148	7.932
Kernel	97	87	1.219	0.107	11.428
Stratification	97	87	1.212	0.103	11.725
Radius	12	85	1.408	0.079	17.746
Food utilization					
Matching method	**Number of treatments**	**Number of controls**	**Average treatment effect on the treated**	**Standard error**	**t-statistic**
Nearest neighbor	97	38	0.679	0.179	3.788
Kernel	97	87	0.626	0.140	4.468
Stratification	97	87	0.601	0.178	3.371
Radius	97	87	0.737	0.109	6.777
Food stability					

Matching method	Number of treatments	Number of controls	Average treatment effect on the treated	Standard error	t-statistic
Nearest neighbor	97	37	0.084	0.185	0.454
Kernel	97	87	0.092	0.150	0.611
Stratification	97	87	0.020	0.147	0.137
Radius	3	86	0.294	0.672	0.438

Source: Author's own compilation

Table 5.6: Development impact of Fadama III: Controlling for covariates

Income from rice production					
Matching method	**Number of treatments**	**Number of controls**	**Average treatment effect on the treated**	**Standard error**	**t-statistic**
Nearest neighbor	97	37	1220000	723000	1.689
Kernel	97	87	1290000	972000	1.327
Stratification	97	87	1260000	952000	1.324
Radius	43	53	263000	158000	1.659
Income from cassava production					
Matching method	**Number of treatments**	**Number of controls**	**Average treatment effect on the treated**	**Standard error**	**t-statistic**
Nearest neighbor	97	31	116000	153000	0.755
Kernel	97	87	332000	127000	2.613
Stratification	97	87	260000	155000	1.682
Radius	0	0	0	0	0
Rice yield					
Nearest neighbor	98	72	1.23	0.3093	3.97
Kernel	86	91	1.27	0.440	2.88
Stratification	94	85	1.26	0.367	3.43
Radius	57	73	1.29	0.425	3.03

Source: Author's own compilation

5.5 Answering research questions

As discussed earlier, this study focused on three research questions. The first research question asks if the Fadama III project increases the smallholder farmers' farm yield in Ebonyi State. The second question asks if it increases their food security level. The third question asks if it increases their farm income. Based on the results, this study concludes that the Fadama III project increased farm yield, farm income (income from cassava production), and most aspects of food security (food availability, food access, and food utility) of smallholder farmers in Ebonyi State. However, Fadama III does not significantly cause an increase in food stability and the rice income of the farmers.

5.6 Validating empirical findings with theoretical framework

These findings are in line with the expectations of the Sustainable Livelihoods Framework (SLF) which explains how Fadama III intervention causes an increase in farmers' productivity or farm yield, food security and income. The explanation is that the Fadama III project comes in as a pro-poor intervention which increases livelihood assets (human assets, physical assets, financial assets, natural assets, and social assets) which farmers could access. Government policies towards Fadama III are favorable and encourage farmers to access the livelihood assets made available by the intervention. With access to more livelihood assets, farmers became less vulnerable to shocks, trends, and stress that could have affected their productivity, food security, and income adversely. All these enabled the farmers to expand their livelihood strategies by intensifying their agricultural production all year round. This led to desirable livelihood outcomes like higher farm yield, better food security and higher income for the smallholder farmers in Ebonyi State.

5.7 Chapter summary

This chapter has extensively explored the development impact of Fadama III on smallholder farmers' agricultural yield, food security, and income using descriptive statistics, inferential statistics, probit regression, and propensity score matching. The analysis shows that the Fadama III project increases agricultural yield (rice yield), three dimensions of food security (food availability, food access, food utility), and some type of income (income from cassava production) of smallholder farmers in Ebonyi State. However, Fadama III does not significantly cause an increase in the food stability dimension of food security and other types of income like income from rice production. It also found that youth and female farmers are under-represented in Fadama III project. Also, most farmers in the Fadama III project (90% of the beneficiary farmers) still depend majorly on their human power for farming.

The next chapter presents the summary of research findings and recommendations for pathways of future agricultural projects.

Chapter 6: Conclusion

6.1 Summary

In almost every region in Africa, hunger has been on the increase although there has been a reduction in global hunger from 947 million in 2005 to 821 million as of 2018 (FAO, 2019a). Africa currently has a high rate of undernourishment at 20%, making it the continent with the highest food insecurity in the world (FAO, 2019a). In Nigeria alone, the recent projected report by the FAO about the situation of malnutrition and food insecurity shows that throughout the lean season (June to August 2019), over 2.7 million people will suffer severe food insecurity (FAO, 2019b).

Nigeria has over 100 million people living below the US$1.90 poverty line (World Bank, 2017). Most of these poor and food-insecure people are rural smallholder farmers. Agricultural interventions have been ongoing to alleviate poverty and food insecurity amongst smallholder farmers in Nigeria, but these interventions have been less successful when compared to similar interventions implemented by developed countries.

One such intervention is the Fadama III project implemented since 2008. The project aims to contribute to the achievement of SDG 1 (no poverty) and SDG 2 (zero hunger) by helping farmers increase their productivity or farm yield, income, and food security. It is against this background that this study focused on evaluating the impact of the Fadama III project on the livelihood of smallholder farmers, with the aim of providing evidence-based policy recommendations on pathways for the future agricultural development projects in Nigeria. To achieve this objective, this study answered research questions about the impact of Fadama III in increasing farm yield, food security, and farm income of smallholder farmers in Ebonyi State. This study focused on food security and the income of farmers because hunger and low income (poverty) are amongst the most pressing challenges in Nigeria.

Using primary data, descriptive statistics, inferential statistics, and propensity score matching, this study found that the Fadama III project increases rice yield, food availability, food access, and cassava income of smallholder farmers in Ebonyi State. However, Fadama III does not significantly cause an increase in food stability and the rice income of the farmers.

It is important to note that a potential bias towards the findings could come from the fact that farmers who participated in the intervention were not assigned, based on randomization but self-selected themselves to be participants of the intervention. Hence, it is possible that the participant farmers are different from the non-participant farmers in unobservable characteristics (motivation to succeed, personal ability, preferences) that could affect their farm yield, food security, and farm income. The greater these unobservable characteristics, the greater the bias of the findings.

6.2 Policy recommendations

For future agricultural development projects to impact on food stability, there is a need for Sustainable Agriculture Land Management (SALM) to be a necessary part of the extension service delivered. The SALM should have been part of the Fadama III project's third component, "advisory services and input support" and its fourth component, "support to the ADPs, research and on-farm demonstrations." The SALM demonstrates various methods farmers can use to make their agricultural environment resilient to the changing climate. The SALM involves nine practices, namely: nutrient management, soil and water conservation, agronomic practices, agroforestry, tillage and residue management, restoration and rehabilitation, integrated livestock management, sustainable energy, and integrated pest management. These practices ensure uninterrupted agricultural productivity in both the short term and the long term. This could go a long way in ensuring food stability.

Almost 90% of the participant farmers still depend majorly on human power for farming, just like the non-participant farmers, while only 8% of the participant farmers depend majorly on mechanical power for farming. The fifth component of the Fadama III project, which involves Agricultural Equipment Hiring Enterprises (AEHE), has to be revised to eliminate all challenges that could prevent farmers from easily accessing farm equipment and machines.

Finally, future agricultural projects should have a special component dedicated to youth and women participation in the project. Only 30% of the beneficiaries are female farmers while no beneficiary is within the age range of 15 to 24 years, and only 5% of the beneficiaries are between the ages of 25 to 34. Some pre-implementation activities of the component governing the participation of women and youth, could include extensive advertisement of the project on youth platforms and social media prior to selection of beneficiaries. It could also involve giving female and youth farmers special quotas and incentives to participate in the agricultural intervention.

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ANNEXURES

Annexure A: Questionnaire

IMPACT OF AGRICULTURAL DEVELOPMENT PROJECTS ON THE LIVELIHOOD OF SMALLHOLDER FARMERS

A case study from the

Fadama III project in Ebonyi state, Nigeria.

Introduction
We are conducting research on the impact of the Fadama III project on the livelihood of smallholder farmers in Ebonyi State. We would appreciate you taking the time to complete the following survey. The survey should only take 10-15 minutes, and your responses are completely anonymous. Your responses are voluntary and will be confidential. Responses will not be identified as individuals. All responses will be compiled together and analyzed as a group.
If you have any questions about the survey, please email us: stanley.egenti@ruhr-uni-bochum.de
We really appreciate your input!

Instruction: Please fill in the answer or tick the option that most applies to you.

Date of interview………..
Place of interview………..
Initials of interviewer…….
Questionnaire serial number………

SECTION A: DEMOGRAPHICS

1. What is your sex?
   a. Male ☐ b. Female ☐
2. How old are you (years)?
   a. 15-24 ☐ b. 25-34 ☐ c. 35-44 ☐ d. 45-54 ☐ e. 55-64 ☐ f. 65 and above ☐
3. What is your marital status?
   a. Married (monogamous) ☐ b. Married (polygamous) ☐ c. Informal union ☐ d. Divorced ☐ e. Separated ☐ f. Widowed ☐ g. Never married ☐
4. What is the highest level of education you have completed?
   a. None ☐ b. Primary ☐ c. Secondary ☐ d. Teacher training ☐ e. Vocational/technical ☐ f. Diploma ☐ g. Bachelor ☐ h. Masters or PhD ☐
5. What is your primary occupation?
   a. Farming ☐ b. Processing ☐ c. Construction ☐ d. Retail trade ☐ e. Wholesale trade ☐ f. Mechanic ☐ g. Mining & quarrying ☐ h. Hotels & restaurants ☐ i. Community, social and personal services ☐ j. Manufacturing k. Others ☐
6. How many years have you been farming for?
   a. 0-5 ☐ b. 6-10 ☐ c. 11-15 ☐ d. 16-20 ☐ e. 21-25 ☐ f. 26 and above ☐
7. How many members are there in your household? ....
8. How many members of your household are male?...........,.
9. How many members of your household are female?...........
10. How many member(s) of your household are within the following age range (in years)
    a. 0-14.......
    b. 15- 29…….

c. 30-44………
d. 45-59………
e. 60 and above ……….

SECTION B: ASSET OWNERSHIP AND FARMING PRACTICE

1. What is your ownership status of the land you are using for farming?
    a. Communally owned ☐ b. individually owned ☐ c. leasehold ☐ d. jointly owned ☐ e. Others ☐
2. What is the size of the land (in hectares) you use for farming?
    a. 0 - 0.5 ☐ b. 0.6 – 1 ☐ c. 1.1 – 1.5 ☐ d. 1.6 - 2 ☐ e. 2.1 – 2.5 ☐ f. 2.6 – 3.0 ☐ g. 3.1 – 3.5 ☐ h. 3.6 - 4.0 ☐ i. 4.1 and above ☐
3. What area of the land (in hectares) is cultivated?
    b. 0 - 0.5 ☐ b. 0.6 – 1 ☐ c. 1.1 – 1.5 ☐ d. 1.6 - 2 ☐ e. 2.1 – 2.5 ☐ f. 2.6 – 3.0 ☐ g. 3.1 – 3.5 ☐ h. 3.6 - 4.0 ☐ i. 4.1 and above ☐
4. What farm implements do you own? Select all options that apply to you.
    a. Hoe ☐ b. Cutlass ☐ c. Wheelbarrow ☐ d. Sickle ☐ e. Water pump ☐ f. Plough ☐ g. Ridger ☐ h. Planter ☐ i. Pickup ☐ j. Sprayer ☐ k. Harvester ☐ l. Sprinkler ☐
5. What durable consumer goods do you own? Select all options that apply to you
    a. TV ☐ b. Radio ☐ c. Mobile phone ☐ d. Washing machine ☐ e. Gas stove ☐ f. Computer ☐ g. Refrigerators ☐ h. Others. ☐
6. What livestock do you own? Select all options that apply to you
    a. Ox ☐ b. Cattle ☐ c. Donkey ☐ d. Goat ☐ e. Pig ☐ f. Horse ☐ g. Sheep ☐ h. Camels ☐ i. Others ☐
7. What kind of power is predominantly used for farming?
    a. Human ☐ b. Animal ☐ c. Mechanical (e.g. tractor, and other oil engines) ☐ d. Electrical ☐ e. Wind ☐
8. Which of the following agricultural inputs are used and how often?
    a. Irrigation/water

1	2	3	4	5

Very often Not at all

b. Fertilizer

1	2	3	4	5

Very often Not at all

c. Compost

1	2	3	4	5

Very often Not at all

d. High-quality seeds

1	2	3	4	5

Very often Not at all

e. Pesticide

1	2	3	4	5

Very often Not at all

f. Insecticide

1	2	3	4	5

Very often Not at all

g. Insect traps

1	2	3	4	5

Very often Not at all

h. Soil

1	2	3	4	5

Very often Not at all

i. Straw

1	2	3	4	5

Very often Not at all

j. Hay

1	2	3	4	5

Very often Not at all

9. What crop(s) are you farming? Select all that applies to you
   a. Rice ☐ b. Cassava ☐ c. Tomatoes ☐ d. Sorghum ☐ e. Yam ☐ f. Maize ☐ g. Others ☐
10. What vegetable(s) and fruit(s) are you farming? Select all that applies to you
    a. Okra ☐ b. Cabbage ☐ c. Cucumber ☐ d. Watermelon ☐ e. Mango ☐ f. Guava ☐ h. ☐ Apple ☐ i. Pineapple ☐ j. Others ☐

SECTION C: OTHER SOURCES OF INCOME

1. How often are you engaged in the following activities for income generation:

a. Processing

1	2	3	4	5

Very often Not at all

b. Construction

1	2	3	4	5

Very often Not at all

c. Retail trade

1	2	3	4	5

Very often Not at all

d. Wholesale trade

1	2	3	4	5

Very often Not at all

e. Mechanic

1	2	3	4	5

Very often Not at all

f. Mining & quarrying

1	2	3	4	5

Very often Not at all

g. Hotels & restaurants

1	2	3	4	5

Very often Not at all

h. Community, social and personal services

1	2	3	4	5

Very often Not at all

i. Manufacturing

1	2	3	4	5

Very often Not at all

2. What is the average monthly income (in Naira) generated from these activities:
   a. Processing...........
   b. Construction.........
   c. Retail trade..........
   d. Wholesale trade..........
   e. Mechanic ....
   f. Mining & quarrying.........
   g. Hotels & restaurants............
   h. Community, social and personal services...........
   i. Manufacturing..................
3. Do you receive any transfers (free money from government or relatives abroad)?
   a. Yes ☐ b. No ☐
4. If yes, what is the average monthly transfers you receive in Naira?...........
5. Do you receive any credit?
   a. Yes ☐ b. No ☐
6. If yes, what is the average monthly credit you receive in Naira?...........
7. Are any assets sold this farming season?
   a. Yes ☐ b. No ☐
8. If yes, how much did you realize in Naira?................
9. Are savings used to buy food?
   a. Yes ☐ b. No ☐
10. If yes, how much savings (in Naira) on the average is used to buy food on a monthly basis?.........

SECTION D: FOOD SECURITY

FOOD AVAILABILITY & FOOD ACCESS

1. Do all household members eat roughly the same diet?

1	2	3	4	5

Very often Not at all

   a. Was this due to lack of food produced? Yes ☐ No ☐
   b. Was this due to lack of resources? Yes ☐ No ☐

In the past four weeks, how often or rarely do you or someone in your household

2. worry that they would not have enough food?

1	2	3	4	5

Very often Not at all

   a. Was this due to lack of food produced? Yes ☐ No ☐
   b. Was this due to lack of resources? Yes ☐ No ☐

3. Go to sleep at night hungry?

1	2	3	4	5

Very often Not at all

   a. Was this due to lack of food produced? Yes ☐ No ☐
   b. Was this due to lack of resources? Yes ☐ No ☐

4. Borrow food, or rely on help from a friend or relative?

1	2	3	4	5

Very often Not at all

   a. Was this due to lack of food produced? Yes ☐ No ☐
   b. Was this due to lack of resources? Yes ☐ No ☐

5. Reduce number of meals eaten in a day?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

6. Restrict consumption by adults for children to eat?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

7. Not able to eat the kinds of foods preferred?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

8. Have to eat a limited variety of foods?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

9. No food to eat of any kind?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

10. Have to eat a smaller meal than needed?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

11. Been faced with a situation where there was inadequate food to feed the household?

1	2	3	4	5

Very often Not at all

a. Was this due to lack of food produced? Yes ☐ No ☐
b. Was this due to lack of resources? Yes ☐ No ☐

FOOD UTILIZATION

In the past 12 months, how often or rarely do you or someone in your household

12. Not have access to improved water sources?

1	2	3	4	5

Very often Not at all

13. Not have access to improved sanitation facilities?

1	2	3	4	5

Very often Not at all

In the past 7 years, how often or rare do members of your household who were under 5 years

14. Suffer from stunting (low height for age)?

1	2	3	4	5

Very often Not at all

15. Suffer from wasting (low weight for height)?

1	2	3	4	5

Very often Not at all

16. Suffer from being underweight (low weight for age)?

1	2	3	4	5

Very often Not at all

FOOD STABILITY

17. In the past 12 months, how equipped is your land with irrigation?

1	2	3	4	5

Very often Not at all

18. In the past 7 years, how often or rarely do you experience food shortage due to political instability?

1	2	3	4	5

Very often Not at all

19. In the past 12 months, how often or rarely do you experience seasonal shortages of food?

1	2	3	4	5

Very often Not at all

20. In the past 5 years, how often or rarely do you experience shortages of food due to changes in weather or climate?

1	2	3	4	5

Very often Not at all

SECTION E: CROP YIELD & FARM INCOME FOR 2018 PLANTING SEASON

	1	2	3	4	5
	B Area harvested in hectare (ha)	**C** Quantity harvested in kilograms (kg)	**D** Yield: **C/B** (kg/ha)	**E** Price per kg (Naira)	**F** Farm income: **C*E** (Naira)
Rice					
Cassava					
Yam					
Maize					
Sorghum					
Tomatoes					
Okra					
Peanut					
Garlic					

Annex A2: Ethical clearance

UNIVERSITY of the WESTERN CAPE

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20 June 2019

Mr S Egenti
Institute for Social Development
Faculty of Economics and Management Sciences

Ethics Reference Number: HS19/4/9

Project Title: Impact evaluation of agricultural development project on livelihoods outcome of smallholder farmers: A case study of Fadama III project in Nigeria.

Approval Period: 13 June 2019 – 13 June 2020

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Annexure B:

t-Test for comparison of mean of covariates

```
. ttest AQ1_sex, by(participation)


Two-sample t test with equal variances

------------------------------------------------------------------------------

 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]

---------+--------------------------------------------------------------------

non part | 100 1.43 .049757 .4975699 1.331271 1.528729

particip | 100 1.3 .0460566 .4605662 1.208614 1.391386

---------+--------------------------------------------------------------------

combined | 200 1.365 .0341277 .4826383 1.297702 1.432298

---------+--------------------------------------------------------------------

 diff | .13 .067801 -.0037047 .2637047

------------------------------------------------------------------------------

 diff = mean(non part) - mean(particip) t = 1.9174

Ho: diff = 0  degrees of freedom = 198


 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

 Pr(T < t) = 0.9717 Pr(|T| > |t|) = 0.0566 Pr(T > t) = 0.0283


. ttest AQ2_age, by(participation)


Two-sample t test with equal variances

------------------------------------------------------------------------------

 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]

---------+--------------------------------------------------------------------

non part | 100 3.58 .1046205 1.046205 3.37241 3.78759

particip | 100 3.68 .0815011 .8150107 3.518284 3.841716

---------+--------------------------------------------------------------------

combined | 200 3.63 .0662377 .936743 3.499382 3.760618

---------+--------------------------------------------------------------------

 diff | -.1 .1326193 -.3615276 .1615276

------------------------------------------------------------------------------

 diff = mean(non part) - mean(particip) t = -0.7540

Ho: diff = 0  degrees of freedom = 198
```

```
 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

 Pr(T < t) = 0.2259 Pr(|T| > |t|) = 0.4517 Pr(T > t) = 0.7741


. ttest AQ3_mstatus, by(participation)


Two-sample t test with equal variances

------------------------------------------------------------------------------

 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]

---------+--------------------------------------------------------------------

non part | 100 2.34 .2128308 2.128308 1.917697 2.762303

particip | 100 1.91 .1764378 1.764378 1.559909 2.260091

---------+--------------------------------------------------------------------

combined | 200 2.125 .1387195 1.96179 1.851451 2.398549

---------+--------------------------------------------------------------------

 diff | .43 .2764548 -.1151738 .9751738

------------------------------------------------------------------------------

 diff = mean(non part) - mean(particip) t = 1.5554

Ho: diff = 0  degrees of freedom = 198


 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

 Pr(T < t) = 0.9393 Pr(|T| > |t|) = 0.1214 Pr(T > t) = 0.0607


. ttest AQ4_education, by(participation)


Two-sample t test with equal variances

------------------------------------------------------------------------------

 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]

---------+--------------------------------------------------------------------

non part | 98 3.346939 .1880627 1.861725 2.973686 3.720191

particip | 99 3.888889 .1751925 1.743143 3.541225 4.236553

---------+--------------------------------------------------------------------

combined | 197 3.619289 .1295913 1.818901 3.363717 3.874862

---------+--------------------------------------------------------------------

 diff | -.5419501 .2569352 -1.048679 -.0352215

------------------------------------------------------------------------------

 diff = mean(non part) - mean(particip) t = -2.1093

Ho: diff = 0  degrees of freedom = 195
```

```
 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

 Pr(T < t) = 0.0181 Pr(|T| > |t|) = 0.0362 Pr(T > t) = 0.9819


. ttest AQ5_poccupation, by(participation)


Two-sample t test with equal variances

------------------------------------------------------------------------------

 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]

---------+--------------------------------------------------------------------

non part | 100 1.49 .0797661 .7976607 1.331727 1.648273

particip | 100 1 0 0 1 1

---------+--------------------------------------------------------------------

combined | 200 1.245 .0434085 .6138887 1.1594 1.3306

---------+--------------------------------------------------------------------

 diff | .49 .0797661 .3326999 .6473001

------------------------------------------------------------------------------

 diff = mean(non part) - mean(particip) t = 6.1430

Ho: diff = 0  degrees of freedom = 198


 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0

 Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000


. ttest AQ6_farmingyears, by(participation)


Two-sample t test with equal variances

------------------------------------------------------------------------------

 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]

---------+--------------------------------------------------------------------

non part | 100 3.38 .1686428 1.686428 3.045376 3.714624

particip | 100 3.93 .1249283 1.249283 3.682115 4.177885

---------+--------------------------------------------------------------------

combined | 200 3.655 .1064733 1.505759 3.445039 3.864961

---------+--------------------------------------------------------------------

 diff | -.55 .2098749 -.963877 -.136123

------------------------------------------------------------------------------

 diff = mean(non part) - mean(particip) t = -2.6206

Ho: diff = 0  degrees of freedom = 198


 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
```

```
 Pr(T < t) = 0.0047 Pr(|T| > |t|) = 0.0095 Pr(T > t) = 0.9953

. ttest BQ3_areacultivated, by(participation)

Two-sample t test with equal variances
------------------------------------------------------------------------------
 Group | Obs Mean Std. Err. Std. Dev. [95% Conf. Interval]
---------+--------------------------------------------------------------------
non part | 100 3.73 .1489729 1.489729 3.434405 4.025595
particip | 100 4.92 .1300194 1.300194 4.662013 5.177987
---------+--------------------------------------------------------------------
combined | 200 4.325 .1072586 1.516865 4.113491 4.536509
---------+--------------------------------------------------------------------
 diff | -1.19 .1977321 -1.579931 -.8000689
------------------------------------------------------------------------------
 diff = mean(non part) - mean(particip) t = -6.0182
Ho: diff = 0  degrees of freedom = 198

 Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

.
```

Annexure C:

OLS Regression 1

```
. eststo: reg food_access_and_availability participation

 Source | SS df MS Number of obs = 195
-------------+---------------------------------- F(1, 193) = 256.89
 Model | 82.4413428 1 82.4413428 Prob > F = 0.0000
 Residual | 61.9381443 193 .320923028 R-squared = 0.5710
-------------+---------------------------------- Adj R-squared = 0.5688
 Total | 144.379487 194 .744224161 Root MSE = .5665

------------------------------------------------------------------------------
food_access~y | Coef. Std. Err. t P>|t| [95% Conf. Interval]
--------------+---------------------------------------------------------------
participation | 1.300442 .081137 16.03 0.000 1.140413 1.460471
 _cons | 3.556701 .0575194 61.83 0.000 3.443254 3.670148
------------------------------------------------------------------------------
(est1 stored)

. eststo: reg food_utility participation

 Source | SS df MS Number of obs = 195
-------------+---------------------------------- F(1, 193) = 56.54
 Model | 29.9741141 1 29.9741141 Prob > F = 0.0000
 Residual | 102.313065 193 .53011951 R-squared = 0.2266
-------------+---------------------------------- Adj R-squared = 0.2226
 Total | 132.287179 194 .681892678 Root MSE = .72809

------------------------------------------------------------------------------
 food_utility | Coef. Std. Err. t P>|t| [95% Conf. Interval]
--------------+---------------------------------------------------------------
participation | .7841363 .104281 7.52 0.000 .5784596 .9898131
 _cons | 3.154639 .0739267 42.67 0.000 3.008831 3.300447
------------------------------------------------------------------------------
(est2 stored)

. eststo: reg food_stability participation

 Source | SS df MS Number of obs = 197
-------------+---------------------------------- F(1, 195) = 1.37
```

```
 Model | .79284558 1 .79284558 Prob > F = 0.2424
 Residual | 112.455885 195 .576696848 R-squared = 0.0070
-------------+---------------------------------- Adj R-squared = 0.0019
 Total | 113.248731 196 .577799648 Root MSE = .75941

------------------------------------------------------------------------------
food_stabil~y | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------+----------------------------------------------------------------
participation | .1268811 .1082122 1.17 0.242 -.0865355 .3402976
 _cons | 3.434343 .0763231 45.00 0.000 3.283819 3.584868
------------------------------------------------------------------------------
(est3 stored)

. eststo: reg rice_income participation

 Source | SS df MS Number of obs = 180
-------------+---------------------------------- F(1, 178) = 1.81
 Model | 7.4961e+13 1 7.4961e+13 Prob > F = 0.1805
 Residual | 7.3828e+15 178 4.1477e+13 R-squared = 0.0101
-------------+---------------------------------- Adj R-squared = 0.0045
 Total | 7.4578e+15 179 4.1664e+13 Root MSE = 6.4e+06

------------------------------------------------------------------------------
 rice_income | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------+----------------------------------------------------------------
participation | 1294581 962969.9 1.34 0.181 -605725.3 3194887
 _cons | 463016.9 706907 0.65 0.513 -931980 1858014
------------------------------------------------------------------------------
(est4 stored)

. eststo: reg cassava_income participation

 Source | SS df MS Number of obs = 138
-------------+---------------------------------- F(1, 136) = 12.60
 Model | 5.8213e+12 1 5.8213e+12 Prob > F = 0.0005
 Residual | 6.2815e+13 136 4.6188e+11 R-squared = 0.0848
-------------+---------------------------------- Adj R-squared = 0.0781
 Total | 6.8636e+13 137 5.0100e+11 Root MSE = 6.8e+05

------------------------------------------------------------------------------
cassava_inc~e | Coef. Std. Err. t P>|t| [95% Conf. Interval]
```

```
--------------+----------------------------------------------------------------
participation | 412332.3 116145.2 3.55 0.001 182648.1 642016.5
 _cons | 626594.7 78475.12 7.98 0.000 471405.3 781784
-------------------------------------------------------------------------------
(est5 stored)
```

Annexure D:

OLS Regression 2

```
.   eststo:   reg   food_access_and_availability   participation   AQ1_sex   AQ2_age   AQ3_mstatus   AQ4_education
AQ5_poccupation AQ6_farmingyear

> s BQ3_areacultivated


 Source | SS df MS Number of obs = 193

-------------+---------------------------------- F(8, 184) = 45.87

 Model | 94.7732861 8 11.8466608 Prob > F = 0.0000

 Residual | 47.5168694 184 .258243855 R-squared = 0.6661

-------------+---------------------------------- Adj R-squared = 0.6515

 Total | 142.290155 192 .74109456 Root MSE = .50818


------------------------------------------------------------------------------------

food_access_and_~y | Coef. Std. Err. t P>|t| [95% Conf. Interval]

-------------------+----------------------------------------------------------------

 participation | 1.321494 .0891489 14.82 0.000 1.145609 1.49738

 AQ1_sex | -.058584 .0820029 -0.71 0.476 -.2203708 .1032027

 AQ2_age | -.1144223 .0511274 -2.24 0.026 -.2152937 -.0135509

 AQ3_mstatus | .0083471 .0199856 0.42 0.677 -.0310832 .0477775

 AQ4_education | .0149004 .0220948 0.67 0.501 -.0286913 .0584921

 AQ5_poccupation | .34231 .0666776 5.13 0.000 .210759 .473861

 AQ6_farmingyears | .0131649 .0334244 0.39 0.694 -.0527794 .0791093

BQ3_areacultivated | .1161896 .0314441 3.70 0.000 .0541522 .178227

 _cons | 2.98718 .2810226 10.63 0.000 2.432739 3.541621

------------------------------------------------------------------------------------

(est1 stored)


.   eststo:   reg   food_utility   participation   AQ1_sex   AQ2_age   AQ3_mstatus   AQ4_education   AQ5_poccupation
AQ6_farmingyears BQ3_areacultiv

> ated


 Source | SS df MS Number of obs = 192

-------------+---------------------------------- F(8, 183) = 9.93

 Model | 36.0230023 8 4.50287529 Prob > F = 0.0000

 Residual | 82.9561643 183 .453312373 R-squared = 0.3028

-------------+---------------------------------- Adj R-squared = 0.2723

 Total | 118.979167 191 .622927574 Root MSE = .67328
```

```
------------------------------------------------------------------------------------
 food_utility | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------------+----------------------------------------------------------------
 participation | .7145164 .1168234 6.12 0.000 .4840226 .9450103
 AQ1_sex | -.1814645 .1074606 -1.69 0.093 -.3934856 .0305565
 AQ2_age | -.0977023 .0694385 -1.41 0.161 -.2347052 .0393007
 AQ3_mstatus | .0460214 .0274546 1.68 0.095 -.0081469 .1001897
 AQ4_education | .0058535 .0293634 0.20 0.842 -.0520808 .0637878
 AQ5_poccupation | .1608889 .0913825 1.76 0.080 -.0194099 .3411876
 AQ6_farmingyears | .0971559 .0435915 2.23 0.027 .0111493 .1831625
BQ3_areacultivated | .0560183 .0419089 1.34 0.183 -.0266684 .138705
 _cons | 2.894148 .3730091 7.76 0.000 2.158196 3.630099
------------------------------------------------------------------------------------
(est2 stored)

. eststo: reg food_stability participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears BQ3_areacult
> ivated

 Source | SS df MS Number of obs = 194
-------------+---------------------------------- F(8, 185) = 1.88
 Model | 8.43959335 8 1.05494917 Prob > F = 0.0661
 Residual | 104.039788 185 .562377233 R-squared = 0.0750
-------------+---------------------------------- Adj R-squared = 0.0350
 Total | 112.479381 193 .582794723 Root MSE = .74992

------------------------------------------------------------------------------------
 food_stability | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------------+----------------------------------------------------------------
 participation | .0596306 .1298743 0.46 0.647 -.1965944 .3158556
 AQ1_sex | -.0823676 .1191764 -0.69 0.490 -.3174871 .1527518
 AQ2_age | -.1872938 .0751085 -2.49 0.014 -.3354731 -.0391146
 AQ3_mstatus | -.008049 .0294389 -0.27 0.785 -.0661282 .0500302
 AQ4_education | .0075844 .0327974 0.23 0.817 -.0571206 .0722894
 AQ5_poccupation | -.1451871 .0980751 -1.48 0.140 -.3386764 .0483022
 AQ6_farmingyears | .1265718 .0487408 2.60 0.010 .0304126 .222731
BQ3_areacultivated | -.0547571 .0456868 -1.20 0.232 -.1448913 .0353771
 _cons | 4.197358 .4124685 10.18 0.000 3.383612 5.011105
------------------------------------------------------------------------------------
```

```
(est3 stored)

. eststo: reg rice_income participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears BQ3_areacultiva

> ted

 Source | SS df MS Number of obs = 177

-------------+---------------------------------- F(8, 168) = 1.52

 Model | 5.0383e+14 8 6.2979e+13 Prob > F = 0.1529

 Residual | 6.9519e+15 168 4.1380e+13 R-squared = 0.0676

-------------+---------------------------------- Adj R-squared = 0.0232

 Total | 7.4557e+15 176 4.2362e+13 Root MSE = 6.4e+06

------------------------------------------------------------------------------

 rice_income | Coef. Std. Err. t P>|t| [95% Conf. Interval]

-------------------+----------------------------------------------------------

 participation | 453031.7 1174352 0.39 0.700 -1865357 2771421

 AQ1_sex | -420781.6 1079205 -0.39 0.697 -2551331 1709768

 AQ2_age | -743713.2 709751.9 -1.05 0.296 -2144895 657468.5

 AQ3_mstatus | 29835.72 288129.9 0.10 0.918 -538986 598657.4

 AQ4_education | -469948.7 292610.2 -1.61 0.110 -1047615 107717.9

 AQ5_poccupation | 63720.4 991425.3 0.06 0.949 -1893537 2020978

 AQ6_farmingyears | 326232 433868.7 0.75 0.453 -530305.2 1182769

BQ3_areacultivated | 857403.4 430219.6 1.99 0.048 8070.118 1706737

 _cons | 747474.8 3726398 0.20 0.841 -6609125 8104075

------------------------------------------------------------------------------

(est4 stored)

. eststo: reg cassava_income participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears BQ3_areacult

> ivated

 Source | SS df MS Number of obs = 138

-------------+---------------------------------- F(8, 129) = 10.17

 Model | 2.6548e+13 8 3.3184e+12 Prob > F = 0.0000

 Residual | 4.2089e+13 129 3.2627e+11 R-squared = 0.3868

-------------+---------------------------------- Adj R-squared = 0.3488

 Total | 6.8636e+13 137 5.0100e+11 Root MSE = 5.7e+05

------------------------------------------------------------------------------
```

```
 cassava_income | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------------+----------------------------------------------------------------
 participation | 331599.8 122315.1 2.71 0.008 89596.34 573603.2
 AQ1_sex | -43795.39 115197.5 -0.38 0.704 -271716.4 184125.6
 AQ2_age | -10429.44 64338.31 -0.16 0.871 -137724.4 116865.5
 AQ3_mstatus | 44401.07 28391.92 1.56 0.120 -11773.03 100575.2
 AQ4_education | 22268.8 30375.27 0.73 0.465 -37829.41 82367
 AQ5_poccupation | 138125.5 88705.69 1.56 0.122 -37380.86 313631.9
 AQ6_farmingyears | 223756.8 44337.11 5.05 0.000 136034.8 311478.9
BQ3_areacultivated | 62800.68 46373.26 1.35 0.178 -28949.94 154551.3
 _cons | -709134.9 369811.4 -1.92 0.057 -1440816 22546.03
------------------------------------------------------------------------------------
(est5 stored)
```

Annexure E:

Chi- Square and Fisher's exact test

```
. tabulate participation food_access_and_availability, chi2 exact expected

+--------------------+
| Key |
|--------------------|
| frequency |
| expected frequency |
+--------------------+

Enumerating sample-space combinations:
stage 4: enumerations = 1
stage 3: enumerations = 3
stage 2: enumerations = 81
stage 1: enumerations = 0

 if farmers are |
 participating | food_access_and_availability
 in fadama III | often moderate sometimes not at al | Total
----------------+--------------------------------------------+----------
non participant | 2 50 34 11 | 97
 | 1.0 24.9 23.9 47.3 | 97.0
----------------+--------------------------------------------+----------
 participant | 0 0 14 84 | 98
 | 1.0 25.1 24.1 47.7 | 98.0
----------------+--------------------------------------------+----------
 Total | 2 50 48 95 | 195
 | 2.0 50.0 48.0 95.0 | 195.0

 Pearson chi2(3) = 116.4260 Pr = 0.000
 Fisher's exact = 0.000

. tabulate participation food_utility, chi2 exact expected

+--------------------+
| Key |
```

```
|--------------------|
| frequency |
| expected frequency |
+--------------------+

Enumerating sample-space combinations:
stage 5: enumerations = 1
stage 4: enumerations = 7
stage 3: enumerations = 53
stage 2: enumerations = 768
stage 1: enumerations = 0

 if farmers are |
 participating | food_utility
 in fadama III | very ofte often moderate sometimes not at al | Total
----------------+-------------------------------------------------------+----------
non participant | 6 5 60 20 6 | 97
 | 3.0 3.5 36.3 45.8 8.5 | 97.0
----------------+-------------------------------------------------------+----------
 participant | 0 2 13 72 11 | 98
 | 3.0 3.5 36.7 46.2 8.5 | 98.0
----------------+-------------------------------------------------------+----------
 Total | 6 7 73 92 17 | 195
 | 6.0 7.0 73.0 92.0 17.0 | 195.0

 Pearson chi2(4) = 68.4046 Pr = 0.000
 Fisher's exact = 0.000

. tabulate participation food_stability, chi2 exact expected

+--------------------+
| Key |
|--------------------|
| frequency |
| expected frequency |
+--------------------+

Enumerating sample-space combinations:
stage 5: enumerations = 1
```

```
stage 4: enumerations = 3

stage 3: enumerations = 7

stage 2: enumerations = 18

stage 1: enumerations = 0


 if farmers are |

 participating | food_stability

 in fadama III | very ofte often moderate sometimes not at al | Total

----------------+--------------------------------------------------------+----------

non participant | 2 6 44 41 6 | 99

 | 1.0 5.5 43.2 41.7 7.5 | 99.0

----------------+--------------------------------------------------------+----------

 participant | 0 5 42 42 9 | 98

 | 1.0 5.5 42.8 41.3 7.5 | 98.0

----------------+--------------------------------------------------------+----------

 Total | 2 11 86 83 15 | 197

 | 2.0 11.0 86.0 83.0 15.0 | 197.0


 Pearson chi2(4) = 2.7445 Pr = 0.601

 Fisher's exact = 0.718


.
```

Annexure G:

Propensity Score Matching

```
. pscore participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscore (mysc

> ore) blockid (myblock) comsup


****************************************************

Algorithm to estimate the propensity score

****************************************************


The treatment is participation


 if farmers are |

 participating |

 in fadama III | Freq. Percent Cum.

----------------+-----------------------------------

non participant | 100 50.00 50.00

 participant | 100 50.00 100.00

----------------+-----------------------------------

 Total | 200 100.00



Estimation of the propensity score


Probit regression  Number of obs = 195

  LR chi2(7) = 57.19

  Prob > chi2 = 0.0000

Log likelihood = -106.56457 Pseudo R2 = 0.2116


------------------------------------------------------------------------------

participat~n | Coef. Std. Err. z P>|z| [95% Conf. Interval]

-------------+----------------------------------------------------------------

 AQ1_sex | .23449 .1976619 1.19 0.235 -.1529203 .6219003

 AQ2_age | -.1583282 .1418617 -1.12 0.264 -.4363721 .1197157

 AQ3_mstatus | -.03324 .0537926 -0.62 0.537 -.1386716 .0721916

AQ4_educat~n | .1874231 .0612847 3.06 0.002 .0673074 .3075388

AQ5_poccup~n | -.5554223 .1606876 -3.46 0.001 -.8703643 -.2404804

AQ6_farmin~s | .0168462 .0886867 0.19 0.849 -.1569765 .1906689
```

```
BQ3_areacu~d | .423368 .0855337 4.95 0.000 .255725 .591011
 _cons | -1.526817 .6906189 -2.21 0.027 -2.880405 -.173229
------------------------------------------------------------------------------

Note: the common support option has been selected
The region of common support is [.0762511, .96872045]

Description of the estimated propensity score
in region of common support

 Estimated propensity score
-------------------------------------------------------------
 Percentiles Smallest
 1% .0846999 .0762511
 5% .1207146 .0846999
10% .2264696 .0908954 Obs 184
25% .3290143 .0913665 Sum of Wgt. 184

50% .5331899 Mean .5260782
 Largest Std. Dev. .2346637
75% .7315551 .9181906
90% .8473193 .9335479 Variance .055067
95% .872901 .9390363 Skewness -.0841814
99% .9390363 .9687205 Kurtosis 1.97897

******************************************************
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
******************************************************

The final number of blocks is 5

This number of blocks ensures that the mean propensity score
is not different for treated and controls in each blocks

**********************************************************
Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
**********************************************************
```

The balancing property is satisfied

This table shows the inferior bound, the number of treated

and the number of controls for each block

```
 | if farmers are
 Inferior | participating in
 of block | fadama III
of pscore | non parti participa | Total
-----------+---------------------+----------
 .0762511 | 12 3 | 15
 .2 | 32 13 | 45
 .4 | 32 21 | 53
 .6 | 6 36 | 42
 .8 | 5 24 | 29
-----------+---------------------+----------
 Total | 87 97 | 184
```

Note: the common support option has been selected

****

End of the algorithm to estimate the pscore

****

Annexure H:

ATT MATCHING FOR FOOD ACCEBILITY AND AVAILABILITY

```
attnd food_acc_ava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated,

> pscore(myscore) comsup boot reps($breps)



 The program is searching the nearest neighbor of each treated unit.

 This operation may take a while.

(1 missing value generated)


ATT estimation with Nearest Neighbor Matching method

(random draw version)

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 37 1.176 0.155 7.606


---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

nearest neighbour matches



Bootstrapping of standard errors


command: attnd food_acc_ava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_area

> cultivated , pscore(myscore) comsup

statistic: attnd = r(attnd)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------
```

```
Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
 attnd | 50 1.175548 .0518175 .1482008 .8777276 1.473369 (N)
 |  .9572549 1.482453 (P)
 |  .910202 1.42398 (BC)
------------------------------------------------------------------------------
Note: N = normal
 P = percentile
 BC = bias-corrected

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Bootstrapped standard errors

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 37 1.176 0.148 7.932

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

. attk food_acc_ava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, p
> score(myscore) comsup boot reps($breps)

 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 87 1.219 . .
```

```
---------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.
Bootstrapping of standard errors

command: attk food_acc_ava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areac
> ultivated , pscore(myscore) comsup bwidth(.06)
statistic: attk = r(attk)
note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200
  Replications = 50

------------------------------------------------------------------------------
Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
 attk | 50 1.219447 .0345388 .1067093 1.005007 1.433887 (N)
 |  1.035484 1.422517 (P)
 |  .9676908 1.337217 (BC)
------------------------------------------------------------------------------
Note: N = normal
 P = percentile
 BC = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 87 1.219 0.107 11.428

---------------------------------------------------------

. atts food_acc_ava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, p
> score(myscore) blockid(myblock)comsup boot reps($breps)
```

```
ATT estimation with the Stratification method

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 87 1.212 0.123 9.850


---------------------------------------------------------


Bootstrapping of standard errors


command: atts food_acc_ava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areac

> ultivated , pscore(myscore) blockid(myblock) comsup

statistic: atts = r(atts)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 atts | 50 1.212102 .0114904 .1033781 1.004356 1.419848 (N)

 |  1.029932 1.429912 (P)

 |  1.024755 1.429912 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected


ATT estimation with the Stratification method

Bootstrapped standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------
```

```
 97 87 1.212 0.103 11.725

---------------------------------------------------------

.attr food_access_and_availability participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacultivated, pscore(myscore) comsup radius (0.4)

 The program is searching for matches of treated units within radius.

 This operation may take a while.

ATT estimation with the Radius Matching method

Analytical standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 12 85 1.408 0.079 17.746

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual

matches within radius
```

Annexure I:

ATT FOR FOOD UTILITY

```
. attnd food_util participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, psc

> ore(myscore) comsup boot reps($breps)



 The program is searching the nearest neighbor of each treated unit.

 This operation may take a while.


ATT estimation with Nearest Neighbor Matching method

(random draw version)

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 38 0.679 0.210 3.232


---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

nearest neighbour matches


Bootstrapping of standard errors


command: attnd food_util participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacul

> tivated , pscore(myscore) comsup

statistic: attnd = r(attnd)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 attnd | 50 .6791102 -.0108127 .1792634 .3188669 1.039353 (N)
```

```
 |  .2774807 .9573477 (P)

 |  .1317757 .9287149 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected


ATT estimation with Nearest Neighbor Matching method

(random draw version)

Bootstrapped standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 38 0.679 0.179 3.788


---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

nearest neighbour matches


. attk food_util participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, psco

> re(myscore) comsup boot reps($breps)


 The program is searching for matches of each treated unit.

 This operation may take a while.


ATT estimation with the Kernel Matching method


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 87 0.626 . .


---------------------------------------------------------

Note: Analytical standard errors cannot be computed. Use

the bootstrap option to get bootstrapped standard errors.
```

Bootstrapping of standard errors

command: attk food_uti1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears BQ3_areacult

> ivated , pscore(myscore) comsup bwidth(.06)

statistic: attk = r(attk)

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200

Replications = 50

```
------------------------------------------------------------------------------
Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
 attk | 50 .6255154 -.0052979 .1399974 .3441801 .9068507 (N)
 |  .3270183 .8203453 (P)
 |  .317651 .8203453 (BC)
------------------------------------------------------------------------------
```

Note: N = normal

P = percentile

BC = bias-corrected

ATT estimation with the Kernel Matching method

Bootstrapped standard errors

```
---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 87 0.626 0.140 4.468

---------------------------------------------------------
```

. atts food_uti1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears BQ3_areacultivated, psco

> re(myscore) blockid(myblock)comsup boot reps($breps)

```
ATT estimation with the Stratification method

Analytical standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------

 97 87 0.601 0.157 3.817

---------------------------------------------------------

Bootstrapping of standard errors

command: atts food_util participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacult

> ivated , pscore(myscore) blockid(myblock) comsup

statistic: atts = r(atts)

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200

  Replications = 50

------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 atts | 50 .6008111 -.0348983 .1782236 .2426573 .9589649 (N)

 |  .221978 .8927961 (P)

 |  .221978 .9422188 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected

ATT estimation with the Stratification method

Bootstrapped standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------
```

```
 97 87 0.601 0.178 3.371

---------------------------------------------------------

. attr food_utility participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscore(myscore) comsup radius (0.4)

 The program is searching for matches of treated units within radius.

 This operation may take a while.

ATT estimation with the Radius Matching method

Analytical standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------

 97 87 0.737 0.109 6.777

---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

matches within radius
```

Annexure J:

ATT FOOD STABILITY

```
. attnd food_sta1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, psc

> ore(myscore) comsup boot reps($breps)



 The program is searching the nearest neighbor of each treated unit.

 This operation may take a while.

(1 missing value generated)



ATT estimation with Nearest Neighbor Matching method

(random draw version)

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 37 0.084 0.182 0.462


---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

nearest neighbour matches



Bootstrapping of standard errors


command: attnd food_sta1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacul

> tivated , pscore(myscore) comsup

statistic: attnd = r(attnd)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50
```

```
------------------------------------------------------------------------------
Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
 attnd | 50 .0838268 -.0980321 .1847519 -.287446 .4550996 (N)
 |  -.263299 .3002041 (P)
 |  -.1378367 .5050505 (BC)
------------------------------------------------------------------------------
Note: N = normal
 P = percentile
 BC = bias-corrected


ATT estimation with Nearest Neighbor Matching method
(random draw version)
Bootstrapped standard errors

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 37 0.084 0.185 0.454

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

. attk food_sta1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, psco
> re(myscore) comsup boot reps($breps)

 The program is searching for matches of each treated unit.
 This operation may take a while.


ATT estimation with the Kernel Matching method

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------
```

```
 97 87 0.092 . .

---------------------------------------------------------

Note: Analytical standard errors cannot be computed. Use

the bootstrap option to get bootstrapped standard errors.


Bootstrapping of standard errors


command: attk food_sta1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacult

> ivated , pscore(myscore) comsup bwidth(.06)

statistic: attk = r(attk)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 attk | 50 .0919281 .0043974 .1503728 -.2102573 .3941135 (N)

 |  -.1564402 .3577794 (P)

 |  -.2091149 .3577794 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected


ATT estimation with the Kernel Matching method

Bootstrapped standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 87 0.092 0.150 0.611


---------------------------------------------------------
```

```
. atts food_sta1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, psco

> re(myscore) blockid(myblock)comsup boot reps($breps)


ATT estimation with the Stratification method

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 87 0.020 0.150 0.135


---------------------------------------------------------


Bootstrapping of standard errors


command: atts food_sta1 participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacult

> ivated , pscore(myscore) blockid(myblock) comsup

statistic: atts = r(atts)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 atts | 50 .0202172 .0038821 .1471434 -.2754785 .3159129 (N)

 |  -.248827 .2757827 (P)

 |  -.1684392 .3768181 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected


ATT estimation with the Stratification method

Bootstrapped standard errors
```

```
--------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

--------------------------------------------------------


 97 87 0.020 0.147 0.137


--------------------------------------------------------


. attr food_stability participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated,pscore(myscore) comsup radius (0.6)


 The program is searching for matches of treated units within radius.

 This operation may take a while.


ATT estimation with the Radius Matching method

Analytical standard errors


--------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

--------------------------------------------------------


 3 86 0.294 0.672 0.438


--------------------------------------------------------

Note: the numbers of treated and controls refer to actual

matches within radius
```

Annexure K:

ATT RICE INCOME

```
. attnd F5_rice participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscor

> e(myscore) comsup boot reps($breps)



 The program is searching the nearest neighbor of each treated unit.

 This operation may take a while.

(5 missing values generated)

(3 missing values generated)


ATT estimation with Nearest Neighbor Matching method

(random draw version)

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 31 1.22e+06 9.65e+05 1.266


---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

nearest neighbour matches



Bootstrapping of standard errors


command: attnd F5_rice participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areaculti

> vated , pscore(myscore) comsup

statistic: attnd = r(attnd)


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------
```

```
Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
 attnd | 50 1221305 -219542.7 723025.1 -231668 2674279 (N)
 |  141909.8 2192297 (P)
 |  230017 3901263 (BC)
------------------------------------------------------------------------------
Note: N = normal
 P = percentile
 BC = bias-corrected

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Bootstrapped standard errors

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 31 1.22e+06 7.23e+05 1.689

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

. attk F5_rice participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscore
> (myscore) comsup boot reps($breps)

 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 87 1.29e+06 . .

---------------------------------------------------------
```

```
Note: Analytical standard errors cannot be computed. Use

the bootstrap option to get bootstrapped standard errors.


Bootstrapping of standard errors


command: attk F5_rice participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultiv

> ated , pscore(myscore) comsup bwidth(.06)

statistic: attk = r(attk)


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 attk | 50 1289522 82621.4 971769.5 -663321.9 3242366 (N)

 |  218622.3 3328802 (P)

 |  183650.9 3099455 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected


ATT estimation with the Kernel Matching method

Bootstrapped standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 87 1.29e+06 9.72e+05 1.327


---------------------------------------------------------


. atts F5_rice participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscore

> (myscore) blockid(myblock)comsup boot reps($breps)
```

```
ATT estimation with the Stratification method

Analytical standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------

 97 87 1.26e+06 8.87e+05 1.421

---------------------------------------------------------

Bootstrapping of standard errors

command: atts F5_rice participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultiv

> ated , pscore(myscore) blockid(myblock) comsup

statistic: atts = r(atts)

Bootstrap statistics Number of obs = 200

  Replications = 50

------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 atts | 46 1260217 -107026.8 951708.5 -656622 3177057 (N)

 |  238052.1 3075879 (P)

 |  266828.8 3946093 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected

ATT estimation with the Stratification method

Bootstrapped standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------
```

```
 97 87 1.26e+06 9.52e+05 1.324

---------------------------------------------------------

. attr rice_income participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscore(myscore) comsup radius (0.01)

 The program is searching for matches of treated units within radius.

 This operation may take a while.

ATT estimation with the Radius Matching method

Analytical standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 43 53 2.63e+05 1.58e+05 1.659

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual

matches within radius
```

Annexure L:

ATT CASSAVA INCOME

```
. attnd F5_cassava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, ps

> core(myscore) comsup boot reps($breps)


 The program is searching the nearest neighbor of each treated unit.

 This operation may take a while.

(3 missing values generated)

(4 missing values generated)


ATT estimation with Nearest Neighbor Matching method

(random draw version)

Analytical standard errors


---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------


 97 31 1.16e+05 2.12e+05 0.547


---------------------------------------------------------

Note: the numbers of treated and controls refer to actual

nearest neighbour matches


Bootstrapping of standard errors


command: attnd F5_cassava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacu

> ltivated , pscore(myscore) comsup

statistic: attnd = r(attnd)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]
```

```
-------------+----------------------------------------------------------------
 attnd | 50 115729.7 78081.75 153195.2 -192127.6 423587 (N)
 |  -106547.6 465773.2 (P)
 |  -286497 348409.1 (BC)
------------------------------------------------------------------------------
Note: N = normal
 P = percentile
 BC = bias-corrected

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Bootstrapped standard errors

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 31 1.16e+05 1.53e+05 0.755

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

. attk F5_cassava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, psc
> ore(myscore) comsup boot reps($breps)

 The program is searching for matches of each treated unit.
 This operation may take a while.

ATT estimation with the Kernel Matching method

---------------------------------------------------------
n. treat. n. contr. ATT Std. Err. t
---------------------------------------------------------

 97 87 3.32e+05 . .

---------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
```

```
the bootstrap option to get bootstrapped standard errors.

Bootstrapping of standard errors

command: attk F5_cassava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacultivated , pscore(myscore) comsup bwidth(.06)

statistic: attk = r(attk)

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200

  Replications = 50

------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 attk | 50 332316.4 23715.77 127192.9 76712.77 587920.1 (N)

 |  136380.5 580214.3 (P)

 |  84766.56 560874.1 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected

ATT estimation with the Kernel Matching method

Bootstrapped standard errors

---------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

---------------------------------------------------------

 97 87 3.32e+05 1.27e+05 2.613

---------------------------------------------------------

. atts F5_cassava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation AQ6_farmingyears
BQ3_areacultivated, pscore(myscore) blockid(myblock)comsup boot reps($breps)

ATT estimation with the Stratification method

Analytical standard errors
```

```
--------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

--------------------------------------------------------


 97 87 2.60e+05 . .


--------------------------------------------------------


Bootstrapping of standard errors


command: atts F5_cassava participation AQ1_sex AQ2_age AQ3_mstatus AQ4_education AQ5_poccupation
AQ6_farmingyears BQ3_areacul

> tivated , pscore(myscore) blockid(myblock) comsup

statistic: atts = r(atts)

note: label truncated to 80 characters


Bootstrap statistics Number of obs = 200

  Replications = 50


------------------------------------------------------------------------------

Variable | Reps Observed Bias Std. Err. [95% Conf. Interval]

-------------+----------------------------------------------------------------

 atts | 33 260476.8 57050.45 154842.9 -54927.97 575881.5 (N)

 |  -142407.2 580234 (P)

 |  -142407.2 466516.1 (BC)

------------------------------------------------------------------------------

Note: N = normal

 P = percentile

 BC = bias-corrected


ATT estimation with the Stratification method

Bootstrapped standard errors


--------------------------------------------------------

n. treat. n. contr. ATT Std. Err. t

--------------------------------------------------------


 97 87 2.60e+05 1.55e+05 1.682


--------------------------------------------------------
```