Assessment of the Adoption Rate of Technologies among Fadama III Farmers in Adamawa State, Nigeria

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The study was conducted in Adamawa State, Nigeria. The major thrust of this study is to assess the adoption rate of technology in Fadama III project, Adamawa State, Nigeria. Fadama III is being implemented in 20 Local Government Areas (LGA) of Adamawa State. In its four years of operation, Fadama III project has realized significant impact on household access to new and proven technologies. The results showed adoption rate of technologies among beneficiaries has increased from 43.75% before the inception of the project to 96.255% after the project intervention. This indicates 50% increase against only 20% increase among the non-beneficiaries. This increase is far above the set target of 20% by Fadama III. Plant spacing (43.75%), improved breeds (40.63%) and improved seeds (38.13%) were the most widely adopted technology for both the beneficiaries and non-beneficiaries. Adoption rate of off-farm technologies (agricultural marketing and financial management) was also large. The adoption rate for the all the technologies was significant at p = 0.05, except for fish feed formulation, Cold storage, marketing and fish smoking. Yields among respondents have increased significantly due to adoption of proven technologies. The increase was higher among crop farmers (59.38%) followed by livestock farmers (48.75%). The increase in yields across all the enterprises has exceeded the set target of 20% increase except for fish production (11.25%) and agro-forestry (6.88%). The increase was more among the beneficiaries compared to non-beneficiaries. It can be concluded that project did not only influence the beneficiaries to adopt technologies for the purpose of improving their socio-economic status but it has also influenced the non-beneficiaries living in Fadama III communities to adopt technologies. The adoption rate for fisheries and agro-forestry technologies were low. This raises the need for sensitization on the importance of these technologies that are germane to their activities. It is also important for Fadama III to strengthen its support for ADP because the latter has limited funding to effectively provide its primary role of transfer of technology. Fadama III needs to harmonize existing approaches and need to use complementary systems rather than conflicting ones.
[Umar, Adamu Madu. Assessment of the Adoption Rate of Technologies among Fadama III Farmers in Adamawa State, Nigeria. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems, 2012; 2(4):195-201].
Keywords: Fadama III, Adoption, Improved, Technology

Received: 3 September2013,
Reviewed: 6 September 2013,
Revised: 7 September 2013,
Accepted: 8 September2013

1. Introduction

1.1. Background Information

Improved agricultural production is the major weapon in the fight against world hunger. It aims at improving rural livelihood and increasing economic growth. The World Development Report of the World Bank (2008) argued that growth in agricultural sector contributes more to poverty reduction than any other economic sector. Within the last decades, serious efforts have been made to make the ordinary Nigerian self-sufficient in food production. One of such efforts was the establishment of Fadama II. The successful implementation and achievement recorded in Fadama II has led to the establishment of the Third National Fadama Development Project (Fadama III). Fadama III has been considered as a major approach in the realization of Agricultural Transformation Agenda (Bakari, 2012). Transforming agriculture is dependent on the adoption of improved technologies. The transfer of technology and the subsequent adoption of same by the predominantly traditional farming communities is one of the challenges facing agricultural scientists and extensionists (Okoro, 1991). Fadama III over its period of implementation has introduced improved technologies, through advisory services and on-farm adaptive research. The assessment of the performance and rate of adoption of technologies among beneficiaries of Fadama III and its spillover effect in the adjoining communities forms the major focus of this study.

1.2. Overview of Fadama III Project

The establishment of Fadama III is based on the success and benefits of the implementation of Fadama II, which was also a follow-up to the First National Fadama Development Project (NFDP-I). The project which was conceived by the Federal Ministry of Agriculture and Water Resources

(Nigeria) is designed to run for five years (Bakari, 2012). Like Fadama II, the project has employed demand- driven approach to: (1) address productive infrastructure (2) improve livelihood opportunities (3) empower rural poor (4) promote socially inclusive and community-based approaches, and (5) accord adequate attention to technical quality assurance.

Fadama III is instrumental in driving the current effort of the government to transform the Nigerian Agriculture. The major thrust of the project is to increase the income of users of rural land and water on a sustainable basis. This is to reduce rural poverty, increase food security and contribute to the realization of key Millennium Development Goals (MDGs).

According to Bakari (2012), these laudable objectives of Fadama III are to be achieved through the successful implementation of the activities of well designed and comprehensive activities of the following components:

1. Capacity building, communication and information support.
2. Small scale infrastructural development for participating communities.
3. Delivery of advisory services and input support.
4. Support to ADPs and promotion of adaptive research.
5. Asset acquisition for FUGs and EIGs.
6. Project management, monitoring and evaluation.

The project has set target to achieve the following outcomes at the end of its five year period:

1. 75% of participants will increase their incomes by 40% at the end of the project life.
2. At least 10% of net earnings from income generating activities of the participants to be saved annually.
3. 75% of the beneficiaries will be satisfied with operation, maintenance and utilization of community owned infrastructures and capital assets acquired through the project at mid-term and close of the intervention.
4. Yield of primary agricultural products should increase by at least 20% among the beneficiaries.
5. By mid-term and close of the project, there should be a physical verification of

operation, maintenance and utilization of assets acquired through the project.

2. Materials and methods

2.1. Study Area

This study was conducted in Adamawa State. The state is located in the moist agro-ecological zone of Nigeria and lies between latitude 7° 28″N and 10° 55″ N of the equator and longitude 11° 30″ E and 13° 45" E of the Greenwich Meridian. The State has a land mass of 39, 743.12 sq km with a population of 3,194,781 (National Population Commission, 2006). Subsistence agriculture forms the major source of livelihood for a majority of the population. The project was implemented in 20 out of 21 local government areas that form the state.

This study was conducted in 10 participating Local Government Areas and one non-participating LGA. The participating LGAs includes: Ganye, Song, Jada, Yola-North, Fufore, and Lamurde. Others include Madagali, Hong, Mayo-belwa and Maiha. While Numan is the only non-participating LGA.

2.2. Sample Selection

To analyze the adoption rate of new technologies among Fadama III beneficiaries, its impact on the participants and the spill-over benefit on the non-participants living in Fadama III communities, the respondents were classified into three categories. These categories are: (1) Direct Fadama III participants (2) Non-Fadama III participants, living in Fadama III LGAs (3) Non-Fadama III participants, living outside Fadama III LGAs. The non-participants have comparable socio-economic characteristics to the Fadama III communities. This categorization is to allow for determination of the direct and indirect benefits of Fadama III in relation to technology transfer. It is expected that non-participants living in the same communities with project participants will benefit from spill-over effects of some of the technologies introduced.

The sampling procedure involved purposive selection of 10 out of 11 LGAs that received new technologies from the project. In each of the 10 sampled LGAs, 160 households were randomly selected from across all the FCAs that received technologies. In other words a total of 160 households made up each respondent type. A total sample size of 480 respondents was therefore used for this study. The sampling frame was designed to cover all FCAs that received technology; this method was to ensure that all the FUGs that had received technologies were included in the list. The sampling frame of household was also stratified by gender and vulnerable groups. This choice is to ensure that not less than 25% of respondents from each FCA are female.

2.3. Survey Instruments and Data Collection

To collect a reliable data, a structured survey instrument was used to collect the required information from households. Structured questions were used to determine the adoption rate of technologies among the project participants and non-participants. The survey instrument was administered by trained enumerators under the supervision of the researchers.

2.4. Baseline Data Collection

Double difference analysis (explained later in the text) employed in this study requires baseline data. The baseline data was collected using recall information, one year before the inception of Fadama III – that is for the cropping year 2008. The recall information includes data on technologies adopted, and yield of crops per annum.

2.5. Data Analysis

An experimental approach was used to construct an estimate of the counterfactual situation by randomly assigning households to treatment and control groups. Random assignment ensures that both groups are statistically similar in observable and unobservable characteristics, thus avoiding project placement and self-selection biases.

Propensity Score Matching (PSM) and Double-difference (DD) were used in this study to address the challenges faced by impact studies of this kind as outlined above. The PSM method matches project beneficiaries and comparable non-beneficiaries using propensity score; which is the estimated probability of being included in the project. In this study, only beneficiaries and non-beneficiaries with comparable propensity scores are used to determine the effect of the project. Double–difference on the other hand, compares changes in outcome from before and after the project between beneficiaries and non-beneficiaries, instead of just comparing outcome levels at one point in time.

To determine the adoption rate of technologies (among the beneficiaries and corresponding non-beneficiaries), percentages and standard deviation were used. Statistical test for difference between the project participants and non-project participants was also used to determine statistical significance.

3. Results and discussion

Agricultural extension has been a major instrument of emphasis in agricultural development processes. It has been noted that every aspect of agriculture requires adequate extension services for it to succeed and be sustained (Ani, 2007). The importance of agricultural extension lies in teaching of farmers methods of raising their own standard of living by adopting improved technologies in their farming practices. This focus on farming will largely increase the income of the beneficiaries which will consequently improve their well-being.

Agricultural extension covers all areas of agriculture and beyond including techniques of production, farm decision-making, marketing, processing, storage, and other socio-economic as well as cooperative matters (Van den Ban and Hawkins, 1999). The source of technologies available to farmers before the advent of Fadama Development Project was largely ADP sponsored extension system. In its effort to contribute to the government's Agricultural Transformation Agenda, Fadama III has provided support to ADP and promotion of adaptive research as well as pluralistic advisory services that are demand-driven, based on the felt needs of the farmers. The spread of farm information and subsequent adoption of same by farmers is the primary responsibility of advisory and extension services.

3.1. Adoption Rate of Technologies in Fadama III

Transfer of improved technologies is one of the responsibilities of Fadama III project. In an attempt to fulfil this responsibility, the project has demonstrated commitment to encourage the participating farmers through on-farm adaptive research and advisory services to adopt one or more improved technologies. According to Olayide (1980) as reported by Ajayi and Ajala (2008), agricultural technology is the application of technology for the promotion and the development of agriculture. Improved technologies employed in agriculture generally increase productivity and income of the farmers (Bennett, 1990).

As noted by Ajayi and Ajala (2008), adoption is a mental process whereby an individual decides to use a new technology (innovation). The rate of adoption of technology among farmers in a project is the most important measure of success of the project and effectiveness of the service (Okoro, 1991). There are serious debates in literature about difference in rate of adoption among farmers within a social system (Ajayi and Ajala, 2008).

Greater proportion of the beneficiaries of Fadama III project has adopted new technologies from inception of the project to date. As the result shows, the adoption rate is over 50% among the project participants compared to only 20% among the non-participants. This has surpassed the set target of 20% by Fadama III (Table 1). This huge achievement is what is expected since some of the beneficiaries have adopted some of these technologies from Fadama II project, considering the adoption rate of almost 44% before the inception of Fadama III.

It is also interesting to note that spillover effect has manifested among non-beneficiaries living in the same community with the project participants. The level of adoption among this category of respondents is almost 30% as against 20% for non-beneficiaries outside Fadama III LGAs (Table 1). The reason for this is not far-fetched. It may be attributed to the fact that this group of non-beneficiaries might

have benefited from some of the technologies introduced to the beneficiaries. Moreover, a good number of this group has also benefited from advisory services from the concluded Fadama II project.

3.2. Technology Adoption Disaggregated by Types of Technology

As earlier noted, Fadama III has in its efforts to transform agriculture in the rural communities in Adamawa State, introduced technologies in four areas of agriculture. This includes crop, livestock, fisheries and agro-forestry. However, the beneficiaries have benefited from agro-processing and off-farm technologies from Fadama III and probably during Fadama II project. Technologies adopted by majority of farmers were plant spacing, improved breeds and improved seeds, at 43.75%, 40.63% and 38.13% respectively (Table 2). Similarly, agricultural marketing and financial management were also adopted by a greater number of both the beneficiaries and non-beneficiaries.

The use of packaging, fish smoking, cold storage and grafting technologies were very low for both the project participants and non-participants. However, the level of adoption is disproportionately higher for the beneficiaries than for the corresponding non-beneficiaries of all the technologies (Table 2).

Table 1. Percentage of farmers adopting technology before and after Fadama III intervention

Type of respondents	Before	After	% change
FIII Beneficiaries	43.75(3.449)	96.25(7.512)	50.50
Non Beneficiaries Within	45.63(3.594)	74.38(5.819)	28.75
Non Beneficiaries Outside	33.75(2.675)	53.75(4.223)	20.00

Note: Number in Parentheses are Standard Deviations, FII = Fadanma III, Within = Fadama III LGAs, Outside = Non- Fadama III LGAs

Table 2. Percentage of farmers adopting new technologies disaggregated by types of technology

Technology	Beneficiaries	Non Beneficiaries Within	Non Beneficiaries Outside
	n = 160	n=160	n=160
Improved seeds	38.13(0.48723)	34.37(0.47645)	11.87(0.32451)
Plant Spacing	43.75(0.49767)	32.5(0.46985)	13.13(0.33874)
Fertilizer Application	31.87(0.46745)	28.13(0.45102)	7.50(0.26422)
Improved breeds	40.63(0.4926)	17.50(0.38116)	3.13(0.17454)
Artificial Insemination	11.88(0.32451)	5.00(0.21863)	3.75(0.19058)
Livestock feed formulation	22.50(0.41889)	4.37(0.20518)	2.50(0.156615)
Improved fingerlings	12.50(0.33175)	7.50(0.26423)	6.25(0.24282)
Hatchery	8.13(0.27407)	4.37(0.20518)	3.75(0.19058)
Fish feed formulation	7.50(0.26423)	1.87(0.13607)	3.13(0.17454)
Improved Seedling	10.00(0.30094)	3.75(0.19058)	0.23(0.11145)
Budding	11.87(0.32451)	8.75(0.28345)	5.63(1.25000)
Grafting	6.87(0.25383)	7.50(0.26423)	1.05(0.00125)
Grinding/Hulling	21.87(0.41469)	11.25(0.31697)	9.37(0.29239)
Cold storage	6.25(0.24282)	11.88(0.32451)	4.37(0.20518)
Fish Smoking	5.00(0.21863)	3.13(0.17454)	2.50(0.15662)
Packaging	3.75(0.19058)	1.25(0.11145)	9.37(0.29239)
Sorting/Grading	7.50(0.26423)	10.63(0.30913)	1.25(0.11145)
Agricultural Marketing	36.13(0.40122)	34.37(0.49838)	35.25(0.40015)
Record Keeping	22.50(0.42078)	19.37(0.39647)	11.25(0.31697)
Financial Management	30.63(0.49365)	20.63(0.40588)	10.00(0.30094)

Note: Numbers in parentheses are standard deviation

Table 3. T-test analysis of rate of adoption of technologies among beneficiaries

Technology	Beneficiaries	Non Beneficiaries	T-test (P value)
	n=160	n=160	
Improved Seeds	0.3812(0.03852)	0.1188(0.02565)	0.00**
Plant Spacing	0.4375(0.03934)	0.1312(0.02678)	0.00**
Fertilizer Application	0.3188(0.03696)	0.0750(0.02089)	0.00**
Improved Breeds	0.4062(0.03895)	0.0312(0.01380)	0.00**
Artificial Insemination	0.1188(0.02565)	0.0375(0.01507)	0.007**
Livestock feed formulation	0.2250(0.03312)	0.0250(0.01238)	0.00**
Improved Fingerling	0.1250(0.02623)	0.0625(0.01920)	0.055
Fish Hatchery	0.0812(0.02167)	0.0375(0.01507)	0.098
Fish feed formulation	0.0750(0.02089)	0.0312(0.01380)	0.081
Improved Seedling	0.1000(0.02379)	0.0125(0.00881)	0.001**
Grafting	0.1188(0.02565)	0.0562(0.01827)	0.048**
Budding	0.0688(0.02007)	0.0188(0.01076)	0.029**
Grinding/Hulling	0.2188(0.03278)	0.0938(0.02312)	0.002**
Cold Storage	0.0625(0.01920)	0.0438(0.01622)	0.456
Smoking	0.0500(0.01728)	0.0250(0.01238)	0.241
Package	0.0375(0.01507)	0.0938(0.02312)	0.032**
Sorting/Grading	0.0750(0.02089)	0.0125(0.00881)	0.006**
Agricultural Marketing	0.4812(0.03962)	0.4625(0.03954)	0.738
Record Keeping	0.2278(0.03348)	0.1125(0.02506)	0.006**
Financial Management	0.4114(0.03927)	0.1000(0.02379)	0.00**

Note: Number in parentheses are standard error, **= significant at 5% level

Table 4. Percentage of farmers whose yield increase as a result of adopting new technologies

	Beneficiary (n=160)	Non Beneficiary Within (n=160)	Non Beneficiary Outside (n=160)
Crop farmers	59.38(0.49267)	34.38(0.47645)	1.88(0.13607)
Livestock farmers	48.75(0.50141)	16.25(0.37007)	7.50(0.26422)
Fish farmers	11.25(0.31697)	6.25(0.24282)	2.50(0.15662)
Agro Forestry farmers	6.88(0.25382)	5.63(0.23113)	3.75(0.19058)
Agro Processors	30.00(0.45970)	21.88(0.41470)	1.88(0.13607)

Note: Number in parentheses are standard deviation

It is interesting to note here that marketing and financial management were used more than most of the technologies. This is a clear manifestation that all enterprises require knowledge of marketing and financial management. As stated earlier, adoption of improved crop practices recorded the highest among the technologies introduced. This may be attributed to the importance placed on crop production basically to ensure self-sufficiency in line with Transformation Agenda (TA) of the present administration. Low rate of adoption for processing and agro-forestry technologies has been noted. However, the project may have a much bigger impact on those technologies among beneficiaries in the future because of lagged effects of technology adopted. Considering the fact these are new technologies, it has been noted that farmer's decision about whether or not to adopt a technology is recognized to occur over a period of time rather than being instantaneous (Ani, 2007). The reason for lower rate may also mean that those areas are not widely practiced in the study area.

Spillover effects have also cropped up among the non-Fadama III beneficiaries within Fadama III LGAs as the adoption rate for all the technologies was higher compared to non-beneficiaries outside Fadama III LGAs. This may not be unconnected with the fact that this category of the respondents may have taken advantage of living in Fadama III communities. There is also likelihood that this group of respondents have benefited those technologies from Fadama II.

Further analysis was conducted to determine the level of significance of the adoption rate of new technologies among the beneficiaries of Fadama III project. Comparability test for difference between the beneficiaries and non-beneficiaries was conducted using T-test analysis. As table 3 depicts, the adoption

rate for all the technologies was significant at P = 0.05. However, the results were not significant for marketing, fish hatchery; fish feed formulation, cold storage and fish smoking technologies.

From the foregoing, it can be concluded that the project has performed creditably in introducing new technologies to benefiting communities of Adamawa State. Fadama III has implemented its component IV(on-farm adaptive research) and advisory services. The ultimate aim of this is to increase productivity and income, and consequently improve well-being of the beneficiaries.

3.3. Impact of Technology Adoption on the Yield of Participating Farmers

Agricultural technology is the use of technology for the promotion and development of agriculture (Olayide, 1980). According to Bennett (1990) improved technologies are employed in agriculture to increase productivity and subsequently farmers' income. Due to the importance given to increase in agricultural productivity, Fadama III project has set target of 20% increase in productivity of the participating farmers by the close of the project. This is in line with the Transformation Agenda of increasing agricultural productivity by the present administration through promotion of efficient agricultural production (FGN, 2012)..

Yields among beneficiaries have increased significantly due to adoption of proven technologies introduced to them. This is particularly higher among crop farmers (59.38%) followed by livestock farmers (48.75%) as indicated in table 4. The increase in yields across all the enterprises has exceeded the set target of 20% increase except for fish production (11.25%) and Agro-forestry (6.88%). The increase was however, more among beneficiaries compared to non-beneficiaries. This result suggests that Fadama project may have given the beneficiaries incentives to use new technologies and may have contributed to higher yields anticipated by beneficiaries.

Another interesting phenomenon also manifested. The increase among non-beneficiaries within Fadama III LGAs was higher than for non-beneficiaries living outside Fadama III LGAs (see table 4). This suggests spill-over effect among this category of respondents. This category of non-beneficiaries may have taken the advantages of using technologies introduced to beneficiaries and translated it into higher productivity. In summary, Fadama III has caused the beneficiaries to realize significant increases in yield. These results can be attributed to participation in the project by the beneficiaries.

4. Conclusion and Recommendation

Fadama III project has realized significant impact on household's access to new and proven technologies. The adoption rate of technologies among its beneficiaries has from 43.75% before the inception of the project to 96.255% after the project intervention. This indicates a 50% increase against only 20% increase among the non-beneficiaries outside Fadama III LGAs. This increase is far above the set target of 20% by Fadama III.

Plant spacing, improved breeds and improved seeds were the most widely adopted technologies for both the beneficiaries and non-beneficiaries. Interestingly, the adoption rate of off-farm technologies (agricultural marketing and financial management) was also large. The rate of adoption for all the technologies adopted was higher for the beneficiaries than for the two control groups (non-beneficiaries within and outside Fadama III LGAs). The adoption rate for all the technologies was significant at p = 0.05, except for fisheries and agro-processing.

Level of adoption was higher among the youth. About 50% of the respondents who are beneficiaries and below the age of 40 have adopted new technologies for the beneficiaries. Similarly farmers with small farm sizes adopted technologies more for both beneficiaries and non-beneficiaries. 65.69% and 67.44% of the respondents who are beneficiaries and non-beneficiaries respectively have farm sizes of less than 5 hectares. However, the rate is higher among the beneficiaries than the non-beneficiaries; i.e for respondents having farm sizes from 5 - 8 hectares.

Fadama III has supported the vulnerable groups to adopt new technologies. Rate of adoption was higher among the unemployed youth (22.20%), followed by the widows 20.00%. Although, level of adoption was low, the project has demonstrated commitment in reaching out to the poor and vulnerable groups. Greater number (67.80%) of male beneficiaries adopted new technologies as against 32.20% for female beneficiaries. However, the level of adoption for female beneficiaries (32.20%) was more than for female non-beneficiaries (22.12%).

Yields among respondents have increased significantly due to adoption of proven technologies introduced to them. This is particularly higher among crop farmers (59.38%) followed by livestock farmers (48.75%). The increase in yields across all the enterprises has exceeded the set target of 20% increase except for fish production (11.25%) and Agro-forestry (6.88%). The increase was more among the beneficiaries compared to non-beneficiaries.

From the foregoing, the project did not only influence the beneficiaries to adopt technologies for the purpose of improving their socio-economic status but it has also influenced the non-beneficiaries living in Fadama III communities to adopt technologies.

The adoption rate for fisheries and agro-forestry technologies was low. This raises the need for sensitization on the importance of these technologies that are necessary to their activities. Most farmers were oblivious of the existence of these innovations, let alone their importance to their activities.

It is important for Fadama III to strengthen support for ADP because the latter has limited funding to effectively provide its primary role, which is transfer of technology. As it strives to reform its extension systems toward more pluralistic systems, there is the need to harmonize existing approaches and to seek the use of complementary systems rather than conflicting ones.

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