The World Bank

Agriculture and Rural Development Discussion Paper 40

From the Ground up:

Impacts of a Pro-Poor Community-Driven Development Project in Nigeria

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AGRICULTURE AND RURAL DEVELOPMENT

Agriculture & Rural Development Department
World Bank
1818 H Street, NW
Washington, DC 20433
http://www.worldbank.org/rural

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1818 H Street, NW
Washington, DC 20433
Telephone: (202) 473-1000
Internet www.worldbank.org/rural
E-mail ard@worldbank.org

Authors

Ephraim Nkonya is a research fellow at the International Agricultural Research Institute. His research focus is on sustainable land management and poverty reduction; Dayo Phillip is a professor of agricultural economics at the University of Agriculture Abeokuta, Nigeria. His research interest is in the agricultural technology adoption, impact modeling, Price determination, and agricultural Insurance and risk modeling; Tewodaj Mogues is a research fellow at the International Food Policy Research Institute. Her research interest is in public investment for poverty reduction, long-term effects of shocks on household assets and welfare and social capital; John Pender is a senior research fellow at the International Research Institute. His research focus is on land resource management for poverty reduction; Muhammed Kuta Yahaya is the secretary to the state of Niger. Before joining the Niger state, Muhammed was a professor at University Ibadan with research interest in communication and extension services; Gbenga Adebowale works with ENPLAN as a senior consultant. He was one of the consultants who offered technical support to the Fadama II project on issues related to irrigation and farm machinery; Tunji Arokoyo is a professor of extension at Ahmadu Bello University in Nigeria. His research interest is in extension methods, human resources development in agricultural and rural development and gender issues; Edward Kato is a senior research assistant at the International Food Policy Research Institute. His research interest is in sustainable land management and poverty reduction and impact assessment.

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This report is a result of the excellent collaboration and support we received from the participants in our survey and focus group discussions. We thank the 3,750 household survey respondents and the participants in the 200 focus group discussions for their time and valuable information. We are also indebted to the leaders of the many local governments and economic interest groups that supported our fieldwork.

For their hard work in implementing the fieldwork and data entry and cleaning, we thank the following state-level consultants Dr. A.C. Iheanacho (Adamawa), Dr. J.E. Ochi (Bauchi), Professor J.O. Olukosi (Gombe), Professor J.E. Njoku (Imo), Dr. D.O. Chickwendu (Kaduna), Dr. Bello Faruk Umar (Kebbi), Dr. O.A. Oladunni (Federal Capital Territory), Dr. Mure Agbonlahor (Lagos), Dr. Adeyemi Kayode (Niger), Dr. S. Momoh (Ogun), Dr. Wale Oni (Oyo), and Dr. Park Idisi (Taraba).

We are also grateful to Professor James Akinwumi for his support and assistance in planning and professional guidance in conducting this study. Additionally, we appreciate the support of the state-level Fadama II project coordinators and staff during data collection and cleaning and report writing.

This study could not have been possible without the crucial support and efficient coordination of Dr. Adetunji Oredipe and Mr. Frank Idefoh. Their administrative and resource support was crucial in carrying out the study in a very short time. We also thank all the staff members of the Fadama II national office for their cordial and efficient support.

We appreciate the financial support we received from the federal government of Nigeria and the World Bank. We also thank Dr. Simeon Ehui, the Fadama II task team leader, for his professional and collegial support during the preparation and implementation of the study. Further, we extend our appreciation to Mr. Thomas Muenzel for his valuable comments on our questionnaire and the draft report, and to Professor Daramola and Dr. Omonona for their reviews and their valuable comments on the draft report. We also thank participants in the medium-term review meeting in Abuja and the Brown Bag seminars conducted by the International Food Policy Research Institute and the World Bank. In addition to making these acknowledgments, however, we recognize that any errors in or omissions from this report remain the sole responsibility of the authors.

Abstract

The community-driven development (CDD) approach has become increasingly popular because of its potential to develop projects that are sustainable, are responsive to local priorities, empower local communities, and more effectively target poor and vulnerable groups. The purpose of this study is to assess the impacts of Fadama II, which is a CDD project and the largest agricultural project in Nigeria. This study used propensity score matching (PSM) to select 1,728 comparable project beneficiaries and nonbeneficiaries. The study also used double difference methods to compare the impact indicators.

Our results show that the Fadama II project succeeded in targeting the poor and women farmers in its productive asset acquisition component. Participation in the project also increased the income of beneficiaries by about 60 percent, which is well above the targeted increase of only 20 percent in the 6-year period of the project.

Regarding rural infrastructure investments, we found that the Fadama II project had positive near-term impacts on beneficiaries' access to markets and transportation costs, although the study revealed surprising effects on beneficiaries' commercial behavior and statistically insignificant impacts on nonfarm activities.

We also observed that Fadama II increased the demand for postharvest handling technologies but did not have a significant impact on the demand for financial management and market information. Fadama II reduced the demand for soil fertility management technologies. The decline likely reflects the project's focus on providing postproduction advisory services and suggests the need for the project to increase its support for soil fertility management and thus limit the potential for land degradation resulting from increased agricultural productivity. Overall, the Fadama II project has achieved its goal of increasing the incomes of the beneficiaries in the first year of its operation. The project has also succeeded in targeting the poor and vulnerable in its productive-asset component, even though that did not appear to increase significantly short-term household incomes among the poorest asset tercile. The unique feature that could have contributed to the significant impact of the project in a short time is its broad-based approach, which addresses the major constraints limiting the success of CDD projects that address only one or two constraints. This has implications on planning poverty reduction efforts in low-income countries. Given that the poor face numerous constraints, a CDD project that simultaneously addresses many constraints will likely build synergies that will lead to larger impacts than will a project that addresses only one or two constraints. This suggests the need for the government and donors to pool resources and initiate multipronged CDD projects rather than many isolated projects.

1. Introduction

The community-driven development (CDD) approach has become a key strategy used by both government and development assistance programs (Gillespie, 2004; Mansuri and Rao, 2004; Platteau, 2004). The popularity of the CDD approach has been propelled by its potential to develop projects and programs that are sustainable and responsive to local priorities, empower local communities to manage and govern their own development programs, and more effectively target poor and vulnerable groups (Dongier et al., 2001; Gillespie, 2004). Empirical evidence of the effectiveness of CDD in achieving these objectives is mixed (Mansuri and Rao, 2004). Among the interesting questions capturing the attention of scholars are the sustainability of donor-supported CDD and its effectiveness in targeting the poor and vulnerable. Khwaja (2001) observed that projects managed by communities were more sustainable than those managed by local governments because of better maintenance. However, Cleaver (1999), Kleimeer (2000), and Mosse (1997) found that CDD projects that lacked external institutional, financial, and technical support were not sustainable.

Targeting the poor has been one of the challenges of development and emergency response programs (Farrington and Slater, 2006). One argument in favor of CDD asserts that it can improve targeting because CDD projects make better use of local knowledge to define and identify the targeted groups (Mansuri and Rao, 2004). However, empirical evidence is mixed concerning the effectiveness of targeting using the CDD approach. One review concluded that in heterogeneous communities with high social inequality, the performance of CDD projects in targeting has been worse than that of externally managed programs (Conning and Kevane, 2002). However, the review also revealed that in egalitarian communities with open and transparent systems of decision making, targeting was better with CDD than with development approaches using external project management.

This study was conducted to assess the impact of a CDD project called Fadama II, which is the largest agricultural project in Nigeria. The Fadama II project aims to reduce poverty by supporting communities to acquire infrastructure and productive assets, providing demand-driven advisory services, increasing the capacity of communities to manage economic activities, and reducing conflicts among resource users. This report evaluates the impact of the project on income poverty,[1] access to infrastructure and productive assets, and provision of demand-driven advisory services. It does not evaluate how the project affected the capacity to resolve conflicts among users of *fadama* resources and the capacity of beneficiaries to manage CDD projects.[2] In this report, we also examine whether the project succeeded in targeting the poor and the vulnerable through its poverty reduction efforts and productive asset acquisitions.

Section 2 of the report discusses the CDD approach and how the Fadama II project applied it in its design and implementation. Section 3 provides a brief review of the initial accomplishments of the project identified by the medium-term review (MTR) and discusses what our study contributes beyond the MTR. The fourth section discusses the methods of data collection and analysis used in the study. Section 5 reports the initial impacts of Fadama II on productive asset acquisition, rural infrastructure development, and household income; and Section 6 assesses the project's effects on demand for and use of advisory services. The last section draws conclusions and discusses the policy implications of the study findings, with an emphasis on strategies that can be used to ensure sustainability of similar projects and improve targeting to the poor and vulnerable.

Notes

1. Income poverty is the most common measure of poverty. It uses income as the indicator of poverty. For example, people with income of less than US$1 a day per capita are regarded as poor by many studies and reports (e.g., see World Bank, 2007).
2. *Fadama* is a Hausa word for low-lying flood plains, usually with easily accessible shallow groundwater. Fadama are typically waterlogged during the rainy season but retain moisture during the dry season. These areas are considered to have high potential for economic development through appropriate investments in infrastructure, household assets, and technical assistance.

2. Background and Approach of the Fadama II Project

2.1. Background

Fadama II is a follow-up to Fadama I (phase I of the National Fadama Development Project), which was implemented during the period 1993–1999.[1] Fadama I focused mainly on crop production and largely neglected support of postproduction activities such as commodity processing, storage, and marketing. The emphasis of Fadama I was on providing boreholes and pumps to crop farmers through simple credit arrangements aimed at boosting aggregate crop output. Fadama I worked with Fadama User Associations, which the states used mainly to recover loans and to decide on water infrastructure locations.

The design of Fadama I did not support rural infrastructure development and did not consider other resource users such as livestock producers, fisherfolk, pastoralists, and hunters, among others. The focus on crop producers contributed to increased conflicts among the users of *fadama* resources. Increased crop production increased the surplus, but the project did not support postharvest technology, contributing to reduced crop prices and increased storage losses.

Fadama II was first implemented in 2005 and operates in 12 states, 9 of which were Fadama I states (Bauchi, Kebbi, Niger, Benue, Taraba, the Federal Capital Territory [FCT], Ogun, Oyo, and Lagos).[2] Fadama II seeks to address the shortcomings of Fadama I by shifting from a top-down and supply-driven public sector development program to the community-driven development approach. Fadama II also includes other *fadama* resource users that the first project had ignored. As discussed in the following section, Fadama II also supports activities and services other than production.

2.2. Community-Driven Development Approach of Fadama II

CDD is a development approach that empowers local people and local governments to participate in the decision making, control, and management of development programs (Dasgupta and Beard, 2007; Dongier et al., 2001). The approach differs from programs and projects that treat beneficiaries as passive aid recipients (Labonne et al., 2007). Most CDD projects focusing on poverty reduction have five main features (Dongier et al., 2001; Dasgupta and Beard, 2007; Labonne et al., 2007):

1. *Empowerment of the local communities and local governments:* CDD projects are designed to empower local communities and local governments to participate in decision making and management of development

programs, to negotiate with institutions and service providers on the planning and implementation of development programs, and to hold services providers accountable.

2. *Demand-driven design:* CDD projects reflect the needs of local communities and governments, allowing them to determine what types of development activities and resource allocations the project should include to make it effective for them.

3. *Social inclusion:* Not all CDD projects involve the poor, women, youth, and other vulnerable groups. For example, CDD projects that target commercially oriented farmers do not include poor subsistence farmers. However, CDD projects that focus on poverty reduction make deliberate efforts to include the poor and vulnerable because they are most prone to poverty.

4. *Collective action:* Because they are community-based, CDD projects are designed to be implemented collectively through communities or local governments rather than individuals (Binswanger and Aiyar, 2003; Dasgupta and Beard, 2007). CDD beneficiaries collectively plan and implement project activities, budget, and other resource allocation decisions. CDD projects are also supported by public funding from central governments or donors that support the communities or local governments. However, CDD projects are not likely to succeed if they include several communities or involve beneficiaries with significant inequalities in income and other measures of poverty (Dongier et al., 2001; Labonne et al., 2007).

5. *Support from external institutions and organizations:* As already mentioned, CDD projects receive support from governments and donors. This is one of the main characteristics that differentiate the CDD approach from the methods used by community-based organizations (CBOs), which may not receive external support.[3] The support that CDD projects receive include strengthening the ability of beneficiaries to plan, implement, and manage development programs; to facilitate access to services that support the relevant development programs; and to strengthen the link with formal institutions and organizations (e.g., CBOs, nongovernmental organizations, traders; Dongier et al., 2001).

The design of the Fadama II project meets all the key features of a CDD project. Consistent with the CDD approach, project activities are centered on Fadama User Groups (FUGs) and Fadama Community Associations (FCAs). An FUG comprises *fadama* users with a common economic interest and is therefore a type of economic interest group. FCAs are the associations of FUGs operating in a given area. Each FCA designs and oversees the implementation of a local development plan, which is the blueprint of the Fadama II and the development project in that FCA. The major productive sectors that Fadama II supports include crops, livestock, agroforestry, fishing, and fish farming (fisherfolk). Addressing one of the weaknesses of Fadama I, Fadama II also supports postproduction activities that are closely linked to the project's

productive activities. These include agroprocessing enterprises and rural marketing service providers. As part of its targeting strategies, Fadama II provides special preferences to groups of youth, women (especially widows), physically challenged persons, the elderly, and people with HIV/AIDS. Targeted groups can belong to any of the productive or service sectors supported by the project. Because the Fadama II uses the CDD approach, beneficiaries are given the chance to choose the kind of activities they want to pursue. However, there are some activities that the project does not support, such as activities that could lead to degradation of natural resources or large-scale changes in land use (NFDO, 2005). Under the CDD approach of Fadama II, all users of *fadama* resources are encouraged to develop participatory and socially inclusive local development plans.

The 12 states benefiting under the World Bank–assisted aspects of Fadama II are Adamawa, Bauchi, Gombe, FCT, Imo, Kaduna, Kebbi, Lagos, Niger, Ogun, Oyo, and Taraba.[4] Fadama II was designed to operate for 6 years (2004–2010) with a goal of contributing to poverty reduction in Nigeria. Actual implementation did not begin until September 2005, however. The project set a target of 50 percent of male and female *fadama* resource users who benefit from the project-supported activities achieving an increase in average real income by at least 20 percent compared with the baseline.

The project designed the following five components to achieve its targets:

1. *Rural infrastructure investment* to support creation of economic infrastructure and local public goods that would improve the productivity of households using *fadama* resources. Under this component, beneficiaries are required to pay 10 percent of the costs of constructing rural infrastructure, including rural roads, culverts, market stalls, cold storage, boreholes, and irrigation infrastructure, among others.
2. *Pilot productive asset acquisition support* to enhance the improvements in the productivity and income *fadama* resource users by facilitating the acquisition of productive assets by individuals or FUGs. Under this component, *fadama* resource users are required to pay 30 percent of the cost of the productive assets acquired.
3. *Demand-responsive advisory services* to support advisory services that will enable *fadama* resource users to adopt output-enhancing techniques and more profitable marketing practices in their enterprises.
4. *Capacity building* to increase the ability of its beneficiaries to assess their needs, participate in planning, and implement and manage economic activities, and to increase the capacity of the project coordinators to conduct monitoring and evaluation. Fadama II provides capacity building through trained facilitators. In addition, FUG members are trained to negotiate and manage contracts and to conduct basic financial analysis.
5. *Conflict resolution* to address the shortcoming of Fadama I by increasing the capacity of FUGs to manage conflicts, which were particularly serious and more frequent between pastoralists and crop farmers. More than 98 percent

of conflicts among *fadama* resource users involved pastoralists and farmers (Schoen et al., 2002). The project set an objective of reducing the number of conflicts by 50 percent by 2010.

Because we evaluated the progress of the project and its income impacts after only 1 full year of implementation, this study should not be considered a final impact assessment of Fadama II. Rather, it is a quantitative assessment of initial progress and impacts after 1 year of implementation, and a potentially useful baseline against which to measure future progress and impacts.

Notes

1. Fadama I operated in 25 states, of which 9 are also covered by Fadama II. The Fadama I states were Bauchi, Jigawa, Kano, Kebbi, and Sokoto in the North; Kogi, Niger, Plateau, Benue, Taraba, and the Federal Capital Territory in the Middle Belt; and Ogun, Oyo, Osun, Ondo, Lagos, Edo, Delta, Anambra, Enugu, Imo, Abia, Rivers, Cross Rivers, and Akwa Ibom in the South.
2. We discuss the implications of Fadama I and Fadama II sharing the same states in the methods section.
3. A CBO is a locally organized and managed formal or informal group that requires membership and whose members have a common interest (Dongier et al., 2001). Nongovernmental organizations do not require membership but are required to be formally registered and may not have beneficiaries (Dongier et al., 2001; Jagger and Pender, 2006). CDD projects usually work with existing relevant CBOs. For example, Fadama II required its beneficiaries to be members of FUGs. If relevant CBOs do not exist, CDD projects help to build the capacity to form CBOs (Dongier et al., 2001).
4. An additional six states are benefiting under a version of the project supported by the African Development Bank.

3. Past Studies on the Effects of Fadama II

This section describes the progress of Fadama II implementation based mainly on the medium-term review (MTR) completed in May 2007 (Anonymous, 2007a). Although the MTR assessed many aspects of the implementation of the Fadama II project, here we focus on the outcomes we analyzed in our study.

3.1. Advisory Services

The Fadama II project has implemented a pluralistic advisory service in which both private and public entities provide services and funds. Advisory service providers are largely private, with only 5 percent of the services offered by public providers. However, funding of the advisory services is mainly public, with project beneficiaries paying 10 percent of the cost and the project paying 90 percent. Thus, the Fadama II project has formed a foundation for developing demand-driven advisory services using a pluralistic approach, which is an important step in establishing sustainable demand-driven advisory services.

The MTR report states that the advisory service component achieved most of its objectives, although it is not clear how the achievements were measured. For example, the report states that 1,700 advisory services were provided to 1,026 FUGs. However, that achievement affected only 12 percent of the 8,577 FUGs. It is not clear why about 88 percent of the FUGs did not receive advisory services. The MTR also observed collusion between advisory service providers and FCA/FUG officials. This has compromised the independent recruitment of providers and serves as one example of elite capture in CCD projects in developing countries (Mansuri and Rao, 2004).

3.2. Pilot Productive Asset Acquisition Support

According to the MTR, the pilot asset acquisition (PAA) component was readily accepted by beneficiaries because they obtained tangible near-term benefits from the project, whereas with other components, like infrastructure development, capacity building, or advisory services, the impacts are not as readily felt or seen. A total of 7,511 subprojects were undertaken in the PAA component, representing 67 percent of the subprojects undertaken in all components of Fadama II. At the time of the MTR, at least 67 percent of all PAA subprojects under the local development plans had been completed and 27 percent were ongoing. Thus, 94 percent of PAA subprojects have been funded and almost completed, indicating a high demand for this component by *fadama* resource users and rapid achievement of the outputs of this component. In Section 5.2, we quantify the value of productive assets acquired and measure the impact of Fadama II on productive asset acquisition across several comparison groups.

3.3. Rural Infrastructure

At the time of the MTR, 2,817 rural infrastructure projects had been initiated, 63 percent of which were completed. This significant achievement is likely a result of the large amount of matching funds paid by the project (90 percent), a level that certainly contributed to the fast acceptance and implementation of the rural-infrastructure component. An important issue is the sustainability of the component after the project ends. The commitment of beneficiary communities to adequately maintaining the infrastructure using their own resources is not yet clear but might have been undermined by such a large matching contribution from the project. Also, the 90 percent matching contribution provided by the project will be costly to replicate in other areas.

3.4. Contribution of This Study

In general, the MTR report indicates that the accomplishments of the Fadama II project have been positive in all components except monitoring and evaluation, which was rated as marginally satisfactory. However, the MTR did not quantify the impacts of the project on community or household wealth and income, or other expected outcomes of the project. Also, the approach used in the MTR did not control for factors outside the project that could affect outcomes. The major contribution of this study is its approach of investigating counterfactual nonproject communities and households as well as project beneficiaries, allowing better attribution of the outcomes to the project. This contribution is important to evaluating not only the Fadama II project but also the many other impact studies of projects conducted without using comparison groups (Mansuri and Rao, 2004).

This study uses quasi-experimental and econometric methods to control for other factors that could affect project outcomes. The main focus of the study is on quantifying the impacts of the project on poverty reduction, which is the major objective of Fadama II. We do this by examining the impact of Fadama II on acquisition of productive assets, income, rural infrastructure, and advisory services. The analysis in this report is based on the household survey only.[1]

Note

1. Other reports analyze particular impacts or components of Fadama II, including impacts on conflict reduction, capacity building, communication and advisory services, and rural infrastructure (Arokoyo, 2007; Gbenga, 2007; Yahaya, 2007). The reports on advisory services and rural infrastructure do not use the survey data used in this study but rather use secondary data and primary data collected by different methods.

4. Methodological Framework

4.1. Study Area

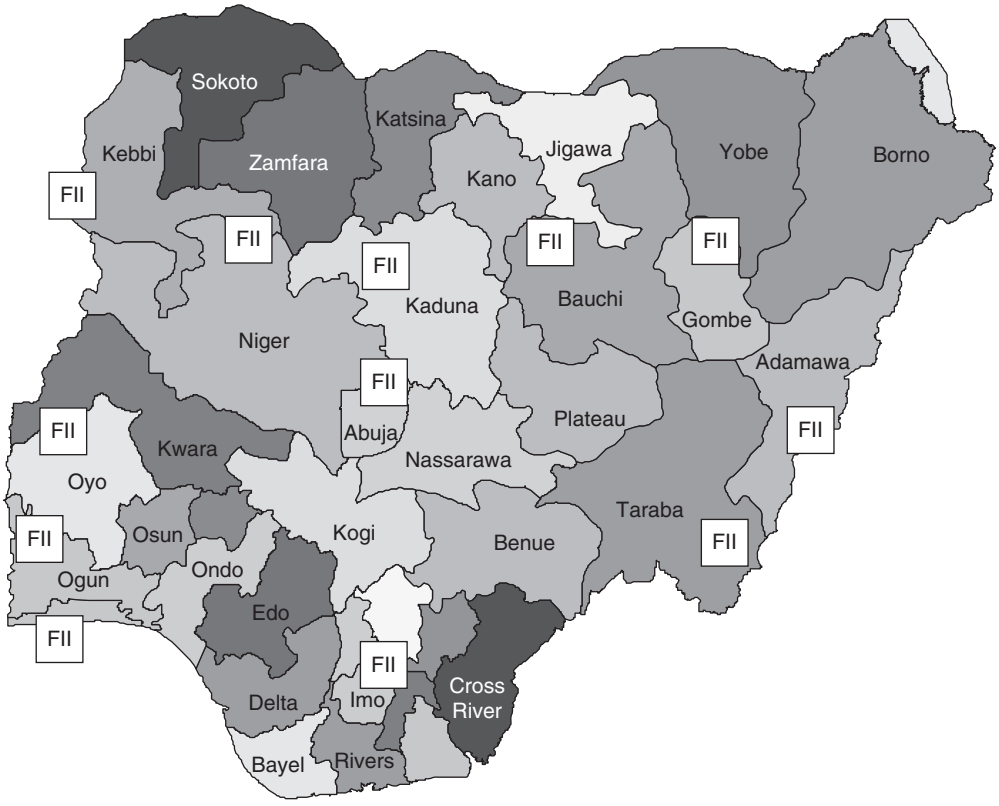
This study was conducted in all 12 states benefiting from the Fadama II project. As shown in Figure 4.1, the 12 states lie in three major agro-ecological zones (Maziya-Dixon et al., 2004): the humid forest (Lagos, Ogun, and Imo); moist savannah (Adamawa, FCT, Oyo, and Taraba); and dry savannah (Bauchi, Gombe, Kaduna, Kebbi, and Niger). In each benefiting state, the project was implemented in 10 selected local government areas (LGAs).

4.2. Sample Selection

4.2.1. Household Survey

To analyze the impact of the Fadama II project on beneficiaries and the spillover of benefits to nonparticipants living in Fadama II communities, we divided the sampling frame into three strata: (1) direct project participants, (2) respondents living in Fadama II communities but not directly participating

Figure 4.1 Map of Nigeria Showing Fadama II States (FII)



Source: Survey data.

in the project (although they might benefit indirectly), and (3) respondents living in communities in *fadama* resource areas outside the Fadama II LGAs but with socioeconomic and biophysical characteristics comparable to the Fadama II communities and in the same state. We expected nonbeneficiaries living in communities with a Fadama II project to be affected by spillover from some project benefits, such as construction of rural infrastructure and provision of advisory services. For example, project participants living in a Fadama II community that built a culvert could use the same road to transport their produce, and information about new technologies provided by the Fadama II advisory services might be shared with nonparticipants.

This stratification was designed to allow for estimation of the direct and indirect effects of Fadama II. By comparing project outcomes for direct beneficiaries with outcomes for similar (in terms of initial productive asset endowments, education, etc.) nonparticipating households in the same communities, we obtained an estimate of the direct impacts of Fadama II participation. Because nonparticipating households in the Fadama II communities may have benefited from spillover effects, this comparison does not provide an estimate of the full impact of the project. Comparing Fadama II beneficiaries to similar households in similar communities not included in the project provides a better estimate of the total impact of the project on beneficiaries (assuming that spillovers are not affecting households in the communities outside the project), while comparing nonparticipants in Fadama II communities with similar households in communities outside the project provides an estimate of the impact of spillover effects on nonparticipants in project communities.

As with Fadama I, selection of states to participate in Fadama II was not random. The 12 Fadama II states and the local *fadama* resource areas where the project operated were purposely selected by the government of Nigeria in collaboration with the World Bank.[1] Purposive sampling is common with many government-funded programs in developing countries (Duflo et al., 2006). This introduces a selection bias and weakens the external validity of our results. Most of the states selected were in the humid and dry savannah zones. As previously stated, 9 of the 12 states also participated in the Fadama I project. Fadama II did not give special preference to or bias against Fadama I beneficiaries. However, former Fadama I beneficiaries might have derived an advantage because of their membership in Fadama User Associations (FUAs). Each Fadama II beneficiary is required to be a member of an FUG, which can be based on an FUA formed under Fadama I. This could have introduced some selection bias in sampling Fadama II beneficiaries in the sense that FUA members in the 9 Fadama I states were more likely to be Fadama II beneficiaries and thus more likely to be sampled than were non-FUA members.[2]

At the LGA level, the sampling procedure involved randomly picking 4 LGAs from among the 10 in each state participating in Fadama II. One FCA was randomly selected from each of the 4 LGAs, and then 25 households were randomly selected from each FCA. This approach was designed to result in a sample size of 100 households for each household type (direct project beneficiaries, nonbeneficiaries living within Fadama II LGAs, and households

Table 4.1 Planned and Realized Household Sampling

Household type	Sample size (number of households)	
	Planned	Actual
FII beneficiaries	1,200	1,281
Nonbeneficiaries within FII LGAs	1,200	1,240
Nonbeneficiaries outside FII LGAs	1,200	1,229
Total	3,600	3,750

Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

outside Fadama II LGAs) in each state, for a total sample of 3,600 households. However, as shown in Table 4.1, some field teams randomly sampled more than 25 households per FCA but used the same approach used for the planned sample, resulting in a total sample size of 3,750 households. The sampling frame for the Fadama II FCA was stratified to ensure that all 14 FUGs supported by the project (where they existed in the sample FCA) were included in the list.[3] The sampling frame of the household survey was also stratified by the gender of the respondent, ensuring that a quarter of the respondents from each FCA were female.

Selection of nonbeneficiaries living within and outside Fadama II LGAs followed the same procedure as just described. However, the FUG listed depended on the availability of economic interest groups comparable to those in the Fadama II. Similarly, 25 percent of the sample consisted of female respondents.

4.2.2. Community Survey

The main aim of the community-level survey was to discuss community organizations, rural infrastructure, and conflicts over resource use. The sampling procedure of communities followed closely the household-level approach. However, only two strata were used: Fadama II and non–Fadama II communities. It was not feasible to establish the spillover effects by selecting communities in the neighborhood of Fadama II communities (as in the household survey sample) because some FCAs covered more than one village. Respondent groups among the Fadama II beneficiaries were chosen from a randomly selected group of 10 to 25 individuals who did not participate in the household survey. The individuals were selected from the four FCAs sampled in the household survey. The selected individuals were then separated into two focus groups for the first three LGAs and in four focus groups in the fourth LGA. This formed a total of 10 discussion groups. The same procedure was used to select groups from the non–Fadama II communities; that is, the same LGAs selected for the household survey were used to select 10 groups of *fadama* resource users who do not benefit from the Fadama II project. The economic interest groups selected were closely related to those supported by Fadama II project. However, finding those groups was difficult because the economic interest groups in non–Fadama II communities are generally not well organized.

4.3. Survey Instruments and Data Collection

A structured survey instrument was used for the household survey. The community survey was semistructured because it included both structured questions and discussion guidelines. Structured questions were used to determine the extent of conflict resolution among *fadama* resource users and changes in rural infrastructure. Guidelines were used to direct qualitative discussions about what factors led to conflict resolution and infrastructure changes, how they have affected livelihoods in the community, and what needs to be done in future. Each of these instruments was developed through a series of meetings, discussions, and pretesting. In each state, the state team leader was responsible for the administration of each type of survey instrument. However, the interviews were carried out by trained enumerators under the supervision of group team leaders. In each state, group team leaders reported to the state team leader at the end of each survey day.

4.4. Collecting Baseline Data

The double-difference analysis used in this study (explained further in the next section) requires baseline data of good quality. Because the baseline survey for Fadama II had some deficiencies (Faye and Sutherland, 2006), we collected baseline data for Fadama II using recall information. The project was implemented in September 2005, only slightly more than a year before the survey was conducted; therefore, we expected respondents to be able to remember the baseline data required for 2 years before the survey—that is, for the crop years October 2004 to September 2005 (2004–2005) and October 2005 to September 2006 (2005–2006). This recall information included data on household composition and size, major productive assets, and major components of household income. Household respondents had no difficulty recalling changes in household composition, size, or major productive assets since October 2004, while recall of income components posed some difficulties. However, because income was not used as an explanatory variable in the analysis (unlike prior household composition and assets) but only as a dependent variable, the potential for measurement error in that variable was of less concern, although it increased uncertainty and reduced the statistical power of the estimates.[4]

4.5. Data Analysis

Impact assessment studies face three interrelated challenges: establishing a viable counterfactual (the predicted outcome in the absence of the intervention—that is, what would have happened to the beneficiaries had they not participated in the project); attributing the impact to an intervention; and coping with long and unpredictable lag times (Alston and Pardey, 2001; Salter and Martin, 2001). If a project's outcome indicator is household income, the average impact of the project on its beneficiaries (referred to in the impact assessment literature as the average effect of the treatment on the treated [ATT]) is defined as the difference between the expected income earned by project beneficiaries while participating in the project and the expected income they would have received if they had not participated in the project:

$$\text{ATT} = \text{E}(Y_1 \mid p = 1) - \text{E}(Y_0 \mid p = 1) \quad (1)$$

where ATT = average impact of treatment on the treated; p = participation in the project ($p = 1$ if participated in the project, and $p = 0$ if did not participate in the project); Y_1 = outcome (household income, in this example) of the project beneficiary after participation in project; Y_0 = outcome (income) of the same beneficiary if he or she had not participated in the project.

Unfortunately, we cannot observe the counterfactual income of the beneficiaries had they not participated in the project—$E(Y_0 | p = 1)$. Simply comparing incomes of households participating in the project with those not participating could result in serious biases, because the two groups may be quite different and thus likely to have different incomes regardless of their participation in the project. For example, adding and subtracting $E(Y_0 | p = 0)$ on the right side of equation (1) results in the following:

$$\text{ATT} = [E(Y_1 | p = 1) - (E(Y_0 | p = 0)] - [E(Y_0 | p = 1) - (E(Y_0 | p = 0)] \quad (2)$$

The first expression (within the first set of square brackets) is observable because it is the difference between the incomes of the beneficiaries and nonbeneficiaries. The second expression is unobservable because $E(Y_0 | p = 1)$ is unobservable and thus represents the bias resulting from estimating ATT as the first expression. This bias results because the incomes that nonbeneficiaries receive without the project may not be equal to the incomes that beneficiaries would have received without the project; that is, $E(Y_0 | p = 1)$ may not equal $E(Y_0 | p = 0)$.

Two common sources of bias are (1) project placement or targeting bias, in which the location or target population of the project is not random (e.g., some subprojects of Fadama II are targeted to the poor and vulnerable so that wealthier groups do not have an equal chance of participating), and (2) self-selection bias, in which households choose whether or not to participate and thus may be different in their experiences, endowments, and abilities.[5] The most accepted method to address these biases is to use an experimental approach to construct an estimate of the counterfactual situation by randomly assigning households to treatment (beneficiary) and control (nonbeneficiary) groups. Random assignment ensures that both groups are statistically similar (i.e., drawn from the same distribution) in both observable and unobservable characteristics, thus avoiding project placement and self-selection biases. Such an approach is not feasible in the present study because project placement and participation decisions were already made before the design of the study and probably were not random. The notion of random assignment also conflicts with the nature of this CDD project, in which communities and households make their own decisions about whether to participate and what activities they will pursue, thus limiting the ability to use this approach even from the outset.

Various quasi-experimental and nonexperimental methods have been used to address the bias problem (for details, see Heckman, Ichimura, Smith, and Todd, 1998; Heckman, Ichimura, and Todd, 1998; Rosenbaum and Rubin, 1983; and Smith and Todd, 2001). One of the most commonly used quasi-experimental methods is propensity score matching (PSM), which selects

project beneficiaries and nonbeneficiaries who are as similar as possible in terms of observable characteristics expected to affect project participation as well as outcomes.[6] The difference in outcomes between the two matched groups can be interpreted as the impact of the project on the beneficiaries (Smith and Todd, 2001). We used this method to estimate the ATT for impacts of the Fadama II project on household productive assets, incomes, and indicators of access to rural infrastructure and impacts of this.

The PSM method matches project beneficiaries with comparable non-beneficiaries using a propensity score, which is the estimated probability of being included in the project. Only beneficiaries and nonbeneficiaries with comparable propensity scores are used to estimate the ATT. Those who do not have comparable propensity scores are dropped from the comparison groups. In our study, 1,728 of 3,758 observations matched. Therefore, we used only the matched observations to analyze the impact of Fadama II.

Among the advantages of PSM over econometric regression methods is that it compares only comparable observations and does not rely on parametric assumptions to identify the impacts of projects. However, PSM is subject to the problem of "selection on unobservables," meaning that the beneficiary and comparison groups may differ in unobservable characteristics, even though they are matched in terms of observable characteristics (Heckman, Ichimura, Smith, and Todd, 1998). Econometric regression methods devised to address this problem suffer from the problems previously noted. The bias resulting from comparing noncomparable observations can be much larger than the bias resulting from selection on unobservables, although they could not say whether that conclusion holds in general (Heckman, Ichimura, Smith, and Todd, 1998).

In this study, we address the problem of selection on unobservables by combining PSM with the use of the double-difference (DD) estimator.[7] The double-difference estimator compares changes in outcome measures (i.e., change from before to after the project) between project participants and nonparticipants, rather than simply comparing outcome levels at one point in time.

$$\text{DD} = (Y_{p1} - Y_{p0}) - (Y_{np1} - Y_{np0}) \tag{3}$$

where Y_{p1} = outcome (e.g., income) of beneficiaries after the project started; Y_{p0} = outcome of beneficiaries before the project started; Y_{np1} = outcome of nonbeneficiaries after the project started; and Y_{np0} = outcome of nonbeneficiaries before the project started.

The advantage of the double-difference estimator is that it nets out the effects of any additive factors (whether observable or unobservable) that have fixed (time-invariant) impacts on the outcome indicator (such as the abilities of farmers or the inherent quality of natural resources), or that reflect common trends affecting project participants and nonparticipants equally (such as changes in prices or weather; Ravallion, 2005). Thus, for example, if project participants and nonparticipants are different in their asset endowments

(mostly observable) or in their abilities (mostly unobservable), and if those differences have an additive and fixed effect on outcomes during the period studied, such differences will have no confounding effect on the estimated ATT.

In principle, the double-difference approach can be used to assess project impacts without using PSM and will produce unbiased estimates of impact as long as these assumptions hold. However, if the project has differential impacts on people with different levels of wealth or other observable characteristics, the simple double-difference estimator will produce biased estimates if participant and nonparticipant households differ in those characteristics (Ravallion, 2005). By combining PSM with the double-difference estimator, controls for differences in preproject observable characteristics can be established. A bias could still result from the heterogeneous or time-variant impacts of the unobservable differences between participants and nonparticipants. For example, communities and households that participated in Fadama I may have different responses to Fadama II than those that did not because of the cumulative effects of social capital developed under Fadama I, favorable or adverse experiences under Fadama I, or other factors.[8] Such shortcomings are unfortunately inherent in all nonexperimental methods of impact assessment (Duflo et al., 2006). Although no solution to these potential problems is perfect, we believe the method we have used addresses these issues as well as possible in this case.

The standard errors estimated by the double-difference method may be inconsistent because of serial correlation or other causes of a lack of independence among the errors. In ordinary regression models, serial correlation can result from unobserved fixed effects, but by taking first differences, the double-difference method eliminates that source of serial correlation. However, serial correlation still may be a problem if more than 2 years of panel data are used (Duflo et al., 2004). In our study, because we used only two periods, before and after the project, we do not have a concern about serial correlation among multiple periods. Another reason for the possible nonindependence of the errors is clustering of the sample.

The propensity scores were computed using binary probit regression models. We estimated three probit models for three comparisons: (1) Fadama II beneficiaries compared with all nonbeneficiaries, (2) Fadama II beneficiaries compared with nonbeneficiaries within Fadama II communities, and (3) Fadama II beneficiaries compared with nonbeneficiaries outside Fadama II communities. The dependent variable in each model is a binary variable indicating whether the household was a beneficiary of the Fadama II project.

The explanatory variables used in computing the propensity scores are those expected to jointly determine the probability to participate in the project and the outcome. We focused on the determinants of income and productive assets when selecting the independent variables for computing the principle score matching. We assumed that rural infrastructure should be included in productive assets. These variables are summarized in Table 4.2.

Table 4.2 Variables Used to Compute Propensity Scores and Their Expected Signs

Variable	Expected impact on participation in Fadama II	Why?	Expected sign on income and wealth	Why?
Gender of respondent (female = 1, male = 0)	+	Fadama II had special subprojects targeted to women groups	–	Women are usually poorer than men
Household size	+	Larger families could be associated with poverty or other vulnerability that qualifies for Fadama II support	–	The larger the family, the poorer
Age of respondent	+/–	Project supported both the elderly and youth	+	Older respondents likely to be better off than young ones because of accumulation of wealth and experience over the life cycle
Level of education of respondent (years of formal education)	+	Some project requirements need certain level of education[1]	+	Education increases income opportunities, such as on-farm activities
Area of rainfed land (ha)	+/–	Wealthier households more likely to join Fadama project because of their ability to pay the beneficiary contribution; however, the project also supported the poor	+	More land enables households to invest more and get higher income and more productive assets
Agro-ecological zone (compared with humid forest) Moist savannah	??	Unknown	–	Humid forest zone closer to major cities and has higher agro-ecological potential

Table 4.2 (*continued*)

Variable	Expected impact on participation in Fadama II	Why?	Expected sign on income and wealth	Why?
Dry savannah	??	Unknown	–	Same as above
Distance to nearest town (km) before project started	+	Requirement for bank account gives advantage to people living closer to roads and towns where banks always operate	+	Access to market increases income opportunities and reduces transaction costs
Distance to nearest all-weather road (km) before project	+	Same as above	+	Same as above
Value of productive assets (Naira) before project	+	Same as for land area	+	Same as for land area
Value of livestock before project	+	Same as for land area	+	Same as for land area

Source: Survey data.
[1]For example, FUGs qualifying for Fadama II support were required to have a bank account, a requirement that calls for a certain degree of education.

The results of the probit models are reported in the appendix. We found that Fadama II beneficiaries are more likely to be female and to have larger households than nonbeneficiaries (both within and outside Fadama II LGAs). Compared with nonparticipants within Fadama II communities, Fadama II participants also tend to be older. By contrast, participants tend to be younger and have more land but reside further from an all-weather road compared with nonparticipants outside Fadama II communities. These results suggest that the Fadama II project is targeted to vulnerable groups such as women, larger households, and people in more remote locations, although apparently the project also targets communities with larger-sized farms and is not targeted in terms of other factors, such as education, ownership of productive assets or livestock, or agro-ecological zone.

These probit model results were used to compute the propensity scores that were used in the PSM estimation of ATT. Several methods are possible for selecting matching observations (Smith and Todd, 2001). We used the kernel matching method (using the normal density kernel), which uses a weighted

average of "neighbors" (within a given range in terms of the propensity score) of a particular observation to compute matching observations. Unlike the nearest-neighbor method, using a weighted average improves the efficiency of the estimator (Smith and Todd, 2001). Observations outside the common range of propensity scores for both groups (i.e., lacking "common support") were dropped from the analysis. This requirement of common support eliminated about half of the total number of observations, indicating that many of the observations from the various strata were not comparable.

Further testing of the comparability of the selected groups was done using a "balancing test" (Dehejia and Wahba, 2002), which tests for statistically significant differences in the means of the explanatory variables used in the probit models between the matched groups of Fadama II participants and nonparticipants. In all cases, that test showed statistically insignificant differences in observable characteristics between the matched groups (but not between the unmatched samples), supporting the contention that the PSM ensures the comparability of the comparison groups (at least in terms of observable characteristics).

We used bootstrapping to compute the standard errors of the estimated ATT, generating robust standard errors because the matching procedure matched control households to treatment households "with replacement" (see Abadie and Imbens, 2002 and 2006, on the use of bootstrapping for inference in matching estimators).

Using the matched samples, we also analyzed the impact of Fadama II on demand for advisory services. In that analysis, we compared the type and rate of adoption of production and postproduction technologies of Fadama II beneficiaries and nonbeneficiaries. We also asked the respondents using each technology whether they asked for that technology. We then compared the type of technologies demanded by Fadama II beneficiaries and nonbeneficiaries.

Notes

1. The project planners did not take randomization into account when designing the project. This is common in many projects in developing countries (Duflo et al., 2006). This study was initiated about a year after the project started, so had no ability to influence the design of the project.
2. The double-difference estimator that we used in the impact evaluation helps to address the impacts of such differences in initial conditions by differencing out any additive fixed effects of such differences but does not completely solve the potential problem of selection bias because the impacts of Fadama II may interact with participation in Fadama I. These issues are discussed further in Section 4.5.
3. The 14 FUGs were crop farmers, fisherfolk, pastoralists, livestock farmers, hunters, gatherers, agroforesters, agroprocessors, service providers, elderly persons, widows, people living with HIV/AIDS, unemployed youths, and physically challenged persons.

4. In econometric analysis, measurement error in a dependent variable increases the uncertainty of the estimates but causes no bias as long as the error is not correlated with the explanatory variables, whereas measurement error in an explanatory variable does cause a bias (Greene, 2003). We believe that similar principles apply to the results of propensity score matching, the quasi-experimental approach used in this study, although we have not seen specific articles on this issue in the relatively recent literature on propensity score matching.
5. For example, a pastoralist in the state of Niger reported that he did not want to participate in Fadama II because similar projects in the past had failed.
6. This method is referred to as "quasi-experimental" because it seeks to mimic the approach of experiments in identifying similar "treatment" and "control" groups. However, because the comparison groups identified in PSM are not selected by random assignment, they may differ in unobserved characteristics, even though they are matched in terms of observable characteristics.
7. The double-difference method is also known as the difference-in-difference method (Duflo et al., 2004).
8. Unfortunately, we did not collect information on respondents' participation in Fadama I and thus could not try to test or control directly for such effects.

5. Empirical Results

5.1. Major Sources of Income

Table 5.1 shows that crop production was a major source of income for all types of respondents before and after the Fadama II project started. The enterprise contributed more than 46 percent to the incomes of both beneficiaries and nonbeneficiaries before and after the Fadama II project. The contribution of crop production to household income had increased 1 year after the project for all types of respondents, but the change was especially large (more than 10 percent) for the Fadama II beneficiaries and nonbeneficiaries outside Fadama II communities. For the Fadama II beneficiaries, the increase in the contribution of crops to household income could have resulted from the acquisition of productive assets that helped to add value (e.g., agroprocessing equipment) or increase productivity (e.g. irrigation). This is a reflection of the Fadama II focus on agriculture-based subprojects. Because Fadama II is a CDD project, the change also reflects the beneficiaries' demand for agricultural equipment and advisory services that led to increases in crop production. The factors contributing to the change in the contribution of crops to the household incomes of respondents outside Fadama II communities remain unclear.

Nonfarm activities contributed the second-largest share of household income before and after the project. The contribution of nonfarm activities to household income decreased for both the Fadama II beneficiaries and

Table 5.1 Sources of Income for Fadama II Beneficiaries and Nonbeneficiaries

Source	% contribution to total income before project (Oct. 2004 to Sept. 2005)			% contribution to total income after project started (Oct. 2005 to Sept. 2006)		
		Nonbeneficiaries			Nonbeneficiaries	
	FII beneficiaries	Within FII LGAs	Outside FII LGAs	FII beneficiaries	Within FII LGAs	Outside FII LGAs
Crop production	46.60	53.80	46.90	56.80	56.50	60.20
Nonfarm activities	48.50	38.70	43.30	41.10	39.90	39.30
Livestock production	4.90	7.43	9.70	2.10	3.50	0.05
Other activities	0.00	0.13	0.19	0.00	0.14	0.54

Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

nonbeneficiaries living in communities not participating in the Fadama II project. This reflects the increase in contribution of the crops for those types of respondents. The Fadama II project supported both agricultural and nonfarm activities. The decrease in the contribution of nonfarm activities for Fadama II beneficiaries suggests that most chose to develop crop production and/or value addition for crops rather than participate in nonfarm activities. What is interesting is the low contribution of some activities that Fadama II supports. Beekeeping, hunting, gathering wild products, fish farming, and pastoral livelihoods are among the activities the project encourages but did not contribute significantly to household income. Because the project is a CDD, the limited contribution of those activities suggests that few beneficiaries demanded them.

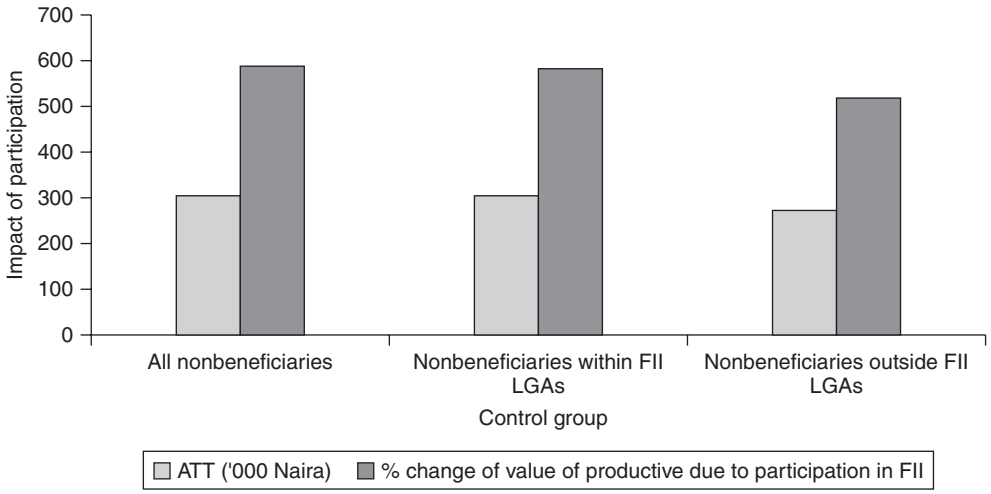
5.2. Impact of Fadama II on Pilot Asset Acquisition

Pilot asset acquisition is the second largest investment in the Fadama II project, after rural infrastructure investments (World Bank, 2003). Because Fadama II supported productive asset acquisition by FUGs rather than individual households, we divided the productive assets into those owned by individual farmers and those owned jointly by economic interest groups. It was not easy to determine the share of value that each member of a group held in jointly owned productive assets. The intensity of use of the productive assets also differed across households within groups. For example, members of an economic interest group owning a borehole for watering animals used the equipment not according to how much they contributed but according to their needs as determined by the number of animals they owned. Our data collection focused on the household-level assets and did not capture the group-level management of productive assets.

Figures 5.1 and 5.2 show that the Fadama II project had a large and statistically significant impact on the value of productive assets owned by groups and individuals benefiting from the project compared with nonbeneficiaries. In all comparisons reported in Table 5.2, Fadama II beneficiaries saw the value of group-owned productive assets increase significantly (at a statistical significance level of $p = .01$) across all agroecological zones (except the dry savannah, where the increase was significant only at $p = .10$), asset terciles, and genders. The poorest tercile of beneficiaries (in terms of value of assets owned before the project) experienced the largest increase of group-owned productive assets (both in absolute and percentage terms): an average increase of 91,780 percent (from only Naira 482 to 470,865).[1] The reason for this massive increase is that ownership of group productive assets was relatively small for those beneficiaries before the project.[2] The large increase in the value of jointly owned productive assets includes the value of the cash transfer (70 percent of the total productive asset value) from the project to the beneficiaries.

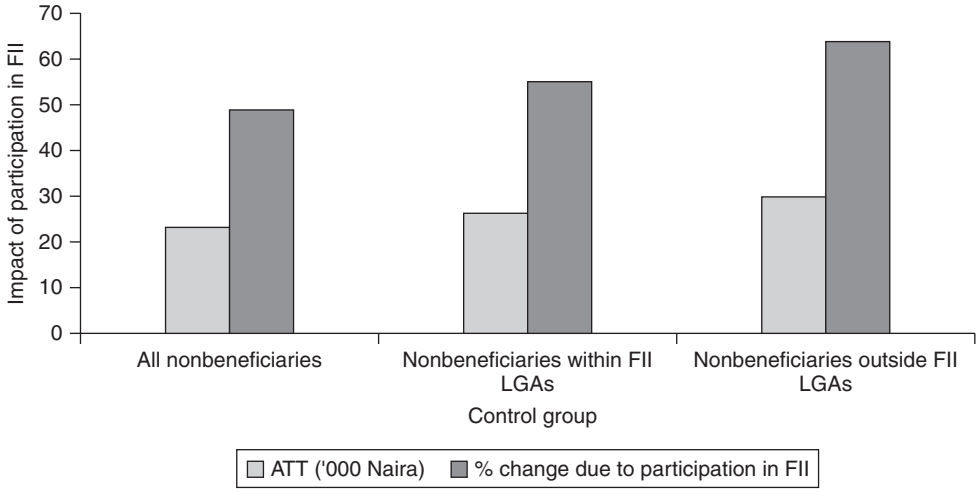
The most common FUG productive assets acquired were water and irrigation equipment, which 118 (24 percent) of 489 Fadama II households acquired (Table 5.3). The value of FUG water and irrigation equipment increased by 2,771 percent, from Naira 47,475 before the project to Naira 1,362,937 by

Figure 5.1 Change in the Value of Group-Owned Productive Assets Resulting from Participation in Fadama II



Source: Survey data.
Notes: FII = Fadama II. The ATT and the corresponding percentage refer to the change in productive assets resulting from participation in Fadama II compared with the corresponding group of nonbeneficiaries. Thus, they should not be interpreted as referring to the change in productive assets of the corresponding control group of nonbeneficiaries.
LGA = local government area.

Figure 5.2 Change in the Value of Individually Owned Assets Resulting from Participation in Fadama II



Source: Survey data.
Notes: FII = Fadama II. The ATT and the corresponding percentage refer to the change in productive assets resulting from participation in Fadama II compared with the corresponding group of nonbeneficiaries. Thus, it should not be interpreted as the change in productive assets of the corresponding control group of nonbeneficiaries.
LGA = local government area.

Table 5.2 Value of Productive Assets Before and After Fadama II Across Agro-Ecological Zones, Genders, and Asset Terciles

Treatment type	Value of individually owned assets (Naira)				Value of group-owned assets (Naira)			
	Before project[1]	After project[1]	ATT[2]	%[2]	Before project[1]	After project[1]	ATT[2]	%[2]
Agro-ecological zones								
Humid forest zone								
Fadama II beneficiaries	72,634 (160,061)	86,552 (206,851)	7,628 (14,340)	10.5	83,467 (408,783)	619,889 (1,287,487)	577,722*** (1,55,678.2)	692
All nonbeneficiaries	75986 (148462)	74963 (130112)			7,724 (60698)	3,087 (61750)		
Moist savannah zone								
Fadama II beneficiaries	74,640 (133,834)	103,899 (193,368)	61,342* (36,419)	82.2	9,810 (34,924)	397,858 (631,549)	446,230*** (103,044.1)	4,549
All nonbeneficiaries	47,909 (96,834)	43,831 (122,102)			5,957 (86,649)	11,943 (82,400)		
Dry savannah zone								
Fadama II beneficiaries	37,060 (41,595)	43,579 (51,842)	19,965*** (5,644)	53.9	4,6074 (168,351)	68,383 (353,121)	44,307* (25,334)	96
All nonbeneficiaries	40,372 (46,050)	36,716 (69,737)			4,248 (40,717)	963 (17,359)		

(*continued*)

Table 5.2 Value of Productive Assets Before and After Fadama II Across Agro-Ecological Zones, Genders, and Asset Terciles (*continued*)

Treatment type	Value of individually owned assets (Naira)				Value of group-owned assets (Naira)			
	Before project[1]	After project[1]	ATT[2]	%[2]	Before project[1]	After project[1]	ATT[2]	%[2]
Genders								
Women only								
Fadama II beneficiaries	51,572 (125,764)	74,202 (160,235)	16,701 (22,733)	32.4	28,651 (229,778)	505,381 (1,125,385)	448,254*** (124700.7)	1,565
Nonbeneficiaries	63,531 (151,330)	55,318 (158,418)			6,826 (65,012)	6,526 (82,256)		
Men only								
Fadama II beneficiaries	55,064 (75,064)	62,256 (137,669)	41,504** (19,286)	75.4	6,5774 (296,916)	260,596 (738,377)	217,442.8*** (49,500.26)	331
Nonbeneficiaries	49,812 (67,000)	53,054 (97,857)			5,715 (62,375)	4,181 (48,739)		
Asset terciles								
Tercile 1 (the poorest)								
Fadama II beneficiaries	5,228 (4,711)	52,936 (121,364)	6,682 (6,922)	127.8	482 (2,370)	470,865 (1,072,014)	442,471*** (76,891)	91,780
Nonbeneficiaries	7,642 (18,753)	47,468 (111,176)			123 (1,225)	3,687 (46,906)		

Tercile 2								
Fadama II beneficiaries	44,546 (23,112)	44,699 (45,656)	27,844*** (6,383)	62.5	3,573 (13619)	213,483 (629,129)	104,922*** (39,111.7)	2,937
Nonbeneficiaries	51,048 (24,780)	42,397 (61,513)			1,460 (8,460)	1,924 (18,802)		
Tercile 3								
Fadama II beneficiaries	99577 (52,972)	124,724 (237,442)	80,174*** (21,579)	80.5	236,793 (554,079)	130,155 (436,402)	149799*** (60,733)	63
Nonbeneficiaries	114,505 (49,934)	95,846 (148,597)			31447 (146,968)	11755 (104,818)		

Source: Survey data.
Note: Numbers in parentheses are standard deviations of the corresponding mean.
[1] "Before project" is 1 year before Fadama II started, October 2004 to September 2005, and "After project" is 1 year after the project started, October 2005 to September 2006.
[2] "ATT" and the corresponding "%" refer to the change in productive assets resulting from participation in Fadama II compared with the corresponding group of nonbeneficiaries. Thus, they should not be interpreted as referring to the change in the productive assets of the corresponding control group of nonbeneficiaries.
*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Table 5.3 Value of Productive Assets for Fadama II Beneficiaries on Matched Sample

Type of asset	Value of group-owned productive assets (Naira)		Value of individually owned productive assets (Naira)	
	Before project[1]	After project[1]	Before project[1]	After project[1]
Production equipment	71,944 (148,483) (n = 18)	158,888 (156,116) (n = 18)	38,335 (74,809) (n = 65)	52,856 (70,038) (n = 65)
Transport equipment	176,882 (122,897) (n = 17)	194,529 (117,323) (n = 17)	66,513 (95,992) (n = 127)	86,485 (115,898) (n = 127)
Processing equipment	165,149 (740,261) (n = 69)	527,011 (793,466) (n = 69)	49,440 (87,664) (n = 69)	59,512 (84,749) (n = 69)
Fishing equipment	43,422 (53,878) (n = 27)	147,674 (167,484) (n = 27)	111,187 (326,758) (n = 41)	91,589 (174,255) (n = 41)
Water and irrigation equipment	47,475 (205,301) (n = 118)	1,362,937 (1,440,951) (n = 118)	17,000 (28,967) (n = 74)	63,331 (124,446) (n = 74)
Livestock equipment	38,482 (113,752) (n = 31)	447,900 (492,751) (n = 31)	16,964 (34,555) (n = 49)	41,385 (97,515) (n = 49)
Building structures	139,903 (624,995) (n = 31)	512,419 (1,018,658) (n = 31)	92,504 (203,157) (n = 50)	119,024 (232,709) (n = 50)

Source: Survey data.

Notes: Number in brackets is standard deviation of the corresponding mean.

Production equipment = ox plow, oxen, tractor

Transport equipment = bicycle, wheelbarrow, pickup truck, motorcycle, other means of transport

Processing equipment = honey equipment, milling machine, refrigerator, other processing equipment

Fishing equipment = fishing gear, canoe, fishing engine

Water and irrigation equipment = water pump, borehole, tube well

Livestock equipment = cattle pen, cattle trough

Building equipment = storage, fishpond

[1] "Before project" is 1 year before Fadama II started, October 2004 to September 2005, and "After project" is 1 year after the project started, October 2005 to September 2006.

September 2006, highlighting the large impact that the Fadama II project had on the value of productive assets. Further, privately owned water and irrigation assets more than doubled in value over the same period. Likewise, total values of processing equipment, livestock, and building structures owned by FUGs more than doubled. The large increases for individual productive asset types add up to a large increase in the total value of productive assets, especially for beneficiaries in the poorest asset tercile, who had few productive assets before the project.

The increase in value of productive assets among the upper asset tercile was only 63 percent. The value of productive assets owned by women's economic interest groups participating in the project also increased significantly compared with the value of productive assets belonging to women's groups not participating in the project. These results demonstrate that the pilot asset acquisition component succeeded in its efforts to target poor and vulnerable groups.

Compared with all nonbeneficiaries and with nonbeneficiaries within and outside Fadama II communities, project beneficiaries experienced greater increases in the value of privately owned productive assets as a result of participating in the project. Comparisons between the dry savannah and the moist savannah and between male beneficiaries and male nonbeneficiaries also showed significantly greater increases in the value of private productive assets for beneficiaries. However, the increase in the value of productive assets was generally less for privately owned productive assets than for those owned by economic interest groups. That is because Fadama II supports asset acquisition through economic interest groups rather than individual Fadama users (NFDO, 2005). Even though Fadama II did not support individuals in purchasing productive assets, FUG members were able to acquire such productive assets through their groups. The individual acquiring the private productive asset would pay the entire beneficiary contribution in the name of the FUG. Fadama II did not interfere with the private ownership of productive assets, which could explain the significant increase in the value of privately owned productive assets for beneficiaries. Another possible explanation is that FUG members were required to buy complementary inputs to support the jointly owned productive assets. For example, FUG members owning irrigation equipment may have needed to buy pesticide sprayers to grow irrigated vegetables. The statistically insignificant impact of participation in the project on privately owned productive assets for beneficiaries in the poorest asset tercile and for female beneficiaries suggests that the poor and vulnerable were not able to finance both the privately owned productive assets and the beneficiary contribution of group productive assets. However, the estimated magnitude of the mean impacts for these groups was positive and large (128 percent increase for the poorest asset tercile and 32 percent for women), even though these estimates were not statistically significant. Therefore, the statistical insignificance of the estimates does not prove that the impacts were nonexistent; rather, it indicates that the variances of the subsample impacts were too large to measure with the sample size we had.

An interesting question to explore is how these productive assets are managed and how their benefits are shared among group members. This raises the need to study further the efficiency of collective ownership of productive assets and how the poor among FUG members benefit from such productive assets. Issues to investigate include the economic viability, maintenance, management, and operational efficiency of the productive assets. Among the benefits of studying jointly owned productive assets are a greater understanding of the returns to productive assets and how they affect productivity of labor and other resources, and increased knowledge of methods for targeting poor and vulnerable groups and how they benefit from productive assets. Our study

was conducted at the household level and did not capture these aspects for jointly owned productive assets. However, we did investigate the impacts of participation in Fadama II on household incomes, which reflects the impacts of acquisition and use of both group and individual productive assets, as well other components of the project such as the effects of rural infrastructure investments and agricultural advisory services.

Another interesting question to explore is the sustainability of the Fadama II success story beyond the project period and how it can be replicated to other communities that did not benefit from the project. The major constraint faced by poor households is their ability to finance acquisition of high-value assets without some form of support from projects or credit services. Fadama II did not involve credit service providers because of the high interest they charge and their limited availability. Thus, alternative sources of credit were used by the 14 percent of beneficiaries who had access to credit services (Table 5.4). Relatives, social clubs, and friends were reported to be the major sources of credit for Fadama beneficiaries as well as nonbeneficiaries within and outside Fadama II communities. This finding underscores the limited options that poor beneficiaries faced to pay for their 30 percent contribution to productive assets.

It is not clear how the poor were able to pay their contributions and if they were able to manage assets efficiently.[3] Those who could not secure the necessary funds may have used other forms of financing through wealthier friends or relatives (see Table 5.4). For example, an eligible but poor beneficiary could have entered into a rental agreement whereby an ineligible rich person paid the beneficiary's contribution and then asked the beneficiary to pay a premium for a specified period, or to share use of the productive asset or part of the returns. In some cases, an ineligible person could own the productive asset after paying the contribution of all beneficiaries and then rent the productive asset back to the beneficiaries. For example, a woman in one FUG reported that she entered into a rental agreement with a wealthy man who paid her beneficiary contribution for a milling machine. Such arrangements could affect the targeting of the poorest.

The World Bank supervision mission of February 2007 noted that most of the subprojects for women and vulnerable groups had not been implemented because women and vulnerable groups could not pay their contributions (Anonymous, 2007a, 2007b). The mission also noted that most of the processing equipment acquired by women was operated by hired hands who benefited more than the project beneficiaries and thus recommended the beneficiary contribution for women and vulnerable groups be reduced to 10 percent. Initially, the project set the contribution of beneficiaries of the pilot asset acquisition project at 40 percent of the value of the productive asset (NFDO, 2005) but reduced it to 30 percent because of overwhelming evidence of the failure of the poor to pay their share. Even the 30 percent contribution might be high for expensive productive assets and force FUG members who are unable to pay their contribution to turn to more wealthy individuals for credit support or to enter into rental arrangements like that previously discussed. Planning for

Table 5.4 Access to Credit in 2005–2006

Type of access	FII beneficiaries (n = 621)	Nonbeneficiaries		Total	Test
		Within FII LGAs (n = 568)	Outside FII LGAs (n = 539)		
Had access to credit (proportion of households)	0.176 (0.381)	0.089 (0.286)	0.141 (0.348)	0.137 (0.343)	a, c
Sources of credit (proportion of households with access)					
Bank	0.073 (0.262)	0.118 (0.325)	0.118 (0.325)	0.097 (0.297)	
Relatives, social clubs and friends	0.220 (0.416)	0.250 (0.437)	0.289 (0.457)	0.249 (0.433)	
Cooperative	0.186 (0.391)	0.308 (0.466)	0.179 (0.386)	0.210 (0.408)	
Farmers association	0.046 (0.210)	0.020 (0.140)	0.013 (0.115)	0.030 (0.170)	
NACRDB[d]	0.130 (0.338)	0.115 (0.323)	0.113 (0.318)	0.121 (0.327)	
Local government	0.018 (0.135)	0.059 (0.238)	0.013 (0.115)	0.025 (0.158)	
Nongovernmental organization	0.037 (0.189)	0.000 (0.000)	0.013 (0.115)	0.021 (0.144)	
State government	0.037 (0.189)	0.039 (0.196)	0.039 (0.196)	0.038 (0.192)	
Fadama	0.109 (0.313)	0.020 (0.140)	0.000 (0.000)	0.055 (0.228)	a, b
Other	0.046 (0.210)	0.000 (0.000)	0.039 (0.196)	0.034 (0.181)	

Source: Survey data.
Notes: FII = Fadama II; LGA = local government area. Figures in brackets are standard deviations.
[a]Difference between Fadama II beneficiaries and nonbeneficiaries living in the same community is significant at the 5% level.
[b]Difference between Fadama II beneficiaries and nonbeneficiaries living outside Fadama II community is significant at the 5% level.
[c]Difference between nonbeneficiaries living in and those living outside a Fadama II community is significant at the 5% level.
[d]NACRDB = Nigerian Agricultural Cooperative and Rural Development Bank.

the next phase of the project (Fadama III) needs to consider the use of sustainable financing for targeted groups—for example, through microfinancing institutions. Existing local rotating savings and credit schemes such as *esusu, dashi,* and *adashi* could help to increase credit access (Bascom, 1952; Bouman, 1995; Okonjo, 1979).

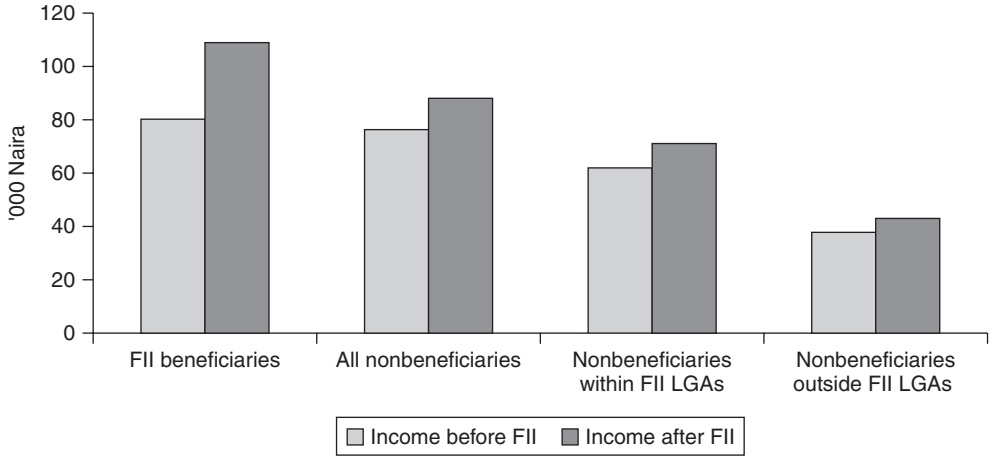
5.3. Impact of Fadama II on Household Income

Figure 5.3 shows that the average annual household income after Fadama II started (2005–2006) for all types of respondents ranged from Naira 43,298 to 108,625 (in year 2003 real value).[4] This is above the average rural household income of Naira 42,644 reported by the 2003–2004 living standard survey (FOS, 2004) but within the same order of magnitude. On average, the real incomes of Fadama II beneficiaries increased 58.5 percent as a result of participation in the project, based on the PSM and double-difference estimation (ATT); that is well above the target of a 20 percent increase that Fadama II set to achieve for 50 percent of beneficiaries after 6 years of operation. By contrast, average real incomes of all nonbeneficiaries increased only 15.5 percent and even less (12.7 percent) among nonbeneficiaries outside Fadama II communities (12.7%).[5] The mean increase in income for beneficiaries was significantly different from that for nonbeneficiaries at $p = .05$. Considering the income of beneficiaries before and after the project (without controlling for other reasons for income to change), about 42 percent of beneficiaries increased their incomes by at least 20 percent in the first year of Fadama II operation (Table 5.5). By contrast, the share of nonbeneficiaries who increased their incomes by at least 20 percent was only 34 percent. Although that percentage includes the effects of other factors that influence income changes over time, it is clear that Fadama II achieved considerable success in its first year of operation.

We also examined the spillover effects of the Fadama II project by comparing the changes in income of Fadama II beneficiaries with those of nonbeneficiaries living within and outside communities with Fadama II projects (Figures 5.3 and 5.4). The results show no significant difference between the income changes of Fadama II beneficiaries and nonbeneficiaries living in the same community. These results suggest that nonbeneficiaries in Fadama II communities may have benefited from spillover of the project. For example, nonbeneficiaries used roads, culverts, and other public facilities funded by Fadama II. Nonbeneficiaries could also benefit from services offered by beneficiaries. For example, beneficiaries who acquired milling machines could offer milling services and employment to nonbeneficiaries.[6]

It is likely that the impact of the project on incomes will be larger in the future because of lagged effects of investments in productive assets, infrastructure, and other project investments. Even without longer-term lags, the impacts on incomes in 2005–2006 could be expected to be less than proportionate to the increase in productive assets from September 2005 (at the beginning of project implementation) to September 2006 (the date for measuring changes in productive assets after implementation of the project), because many of the investments in productive assets occurring between September 2005 and September 2006 may not have come soon enough to affect agricultural production and income during the 2005–2006 production year. We would expect the full effects of productive assets acquired by September 2006 only to begin to be felt during the 2006–2007 production year. Future research on the impacts of Fadama II is needed to more fully assess income changes resulting from the project.

Figure 5.3 Household Income 1 Year before and 1 Year after Fadama II Started



Source: Survey data.
Notes: FII = Fadama II; LGA = local government area. "Income before FII" is income one year before Fadama II started, October 2004 to September 2005, and "Income after FII" is income 1 year after the project started, October 2005 to September 2006. The ATT and the corresponding percentage refer to the change in income resulting from participation in Fadama II compared with the corresponding group of nonbeneficiaries. Thus, it should not be interpreted as the change in income of the corresponding control group of nonbeneficiaries.

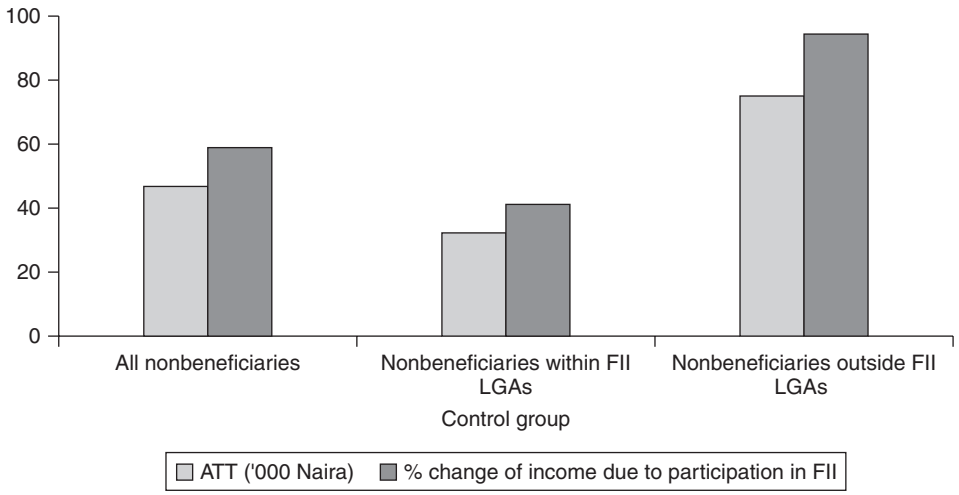
Table 5.5 Achievement of Target Increase in Income Among Fadama II Beneficiaries

Treatment type	% change in real income before and after the project started[1]		
	20% and below	20–50%	>50%
Fadama II beneficiaries	57.9	11.9	30.1
All nonbeneficiaries	66.2	12.6	21.1
Nonbeneficiaries within FII LGAs	65.1	15.5	19.4
Nonbeneficiaries outside FII LGAs	67.5	9.2	23.2

Source: Survey data.
[1]"Before project" is 1 year before Fadama II started, October 2004 to September 2005, and "After project" is 1 year after the project started, October 2005 to September 2006.

The effect of Fadama II varied across the three major agro-ecological zones of Nigeria (Table 5.6). The project had a significant impact (at $p = .10$) in the dry savannah zone, where participation in the project led to an average increase in income of 79 percent. In the humid forest and moist savannah zones, the changes in net income resulting from participation in the project were positive but smaller than in the dry savannah and not statistically significant. The large net increase in income in the dry savannah zone, where limited rainfall is a major problem, could be explained by the acquisition of irrigation facilities

Figure 5.4 Impact of Participation in Fadama II on Household Income of Beneficiaries Compared with Control Groups



Source: Survey data.
Notes: FII = Fadama II; LGA = local government area. The ATT and the corresponding percentage refer to the change in income resulting from participation in Fadama II compared with the corresponding group of nonbeneficiaries. Thus, it should not be interpreted as the change in income of the corresponding control group of nonbeneficiaries.

and water equipment, which address a major production constraint in that zone.

A comparison of men versus women beneficiaries showed no significant difference in income before or after the project. This could be due to the special preference that Fadama II gives to women whose incomes are usually lower than those of men. By targeting women, Fadama II may have enabled women to catch up with men in terms of income. As was the case with value of productive assets, the income change for female beneficiaries was significantly greater than the income change for female nonbeneficiaries. That was expected given the significant change in the value of productive assets for female nonbeneficiaries (see Table 5.2). We also found that the project significantly increased income for male beneficiaries relative to male nonbeneficiaries, with a higher estimated percentage ATT for men than women.

Concerning the effects of Fadama II on the three asset terciles, only the Fadama II beneficiaries in the second tercile increased their incomes significantly more (at $p = .05$) than the nonbeneficiaries in that tercile. That finding indicates that the project had a less immediate impact on poverty reduction among the poorest households. However, the magnitude of the estimated impact on incomes of the poorest asset tercile is large (45 percent, although it is statistically insignificant, reflecting a high variance of this estimate.[7] Still, the incomes of the poorest asset tercile appear to have been affected less than those of the second tercile, possibly because of the initial

Table 5.6 Impact of Fadama II on Household Income Across Agro-Ecological Zones, Genders, and Asset Terciles

Treatment type	Net real annual income (Naira/household)		ATT[1,2]	% net changed due to participation in project[3]
	Before project[1]	After project[1]		
Agro-ecological zones				
Humid forest zone				
FII beneficiaries (n = 176)	87,431 (292,102)	112,626 (299,102)	14,963	17.1
All nonbeneficiaries (n = 282)	12,307 (257,170)	31,343 (276,530)		
Moist savannah zone				
FII beneficiaries (n = 118)	70,578 (203,342)	74,295 (280,596)	33,522	47.5
All nonbeneficiaries (n = 251)	96,498 (258,137)	77,384 (271,796)		
Dry savannah zone				
FII beneficiaries (n = 205)	79,113 (255,967)	124,458 (225,341)	62,664*	79.2
All nonbeneficiaries (n = 335)	106,066 (255,201)	142,708 (254,173)		
Genders (only Fadama II beneficiaries)				
Male (n = 311)	83,691 (280,998)	107,454 (282,103)	−749	−0.9
Female (n = 198)	74,284 (217,805)	110,454 (239,427)		
Gender (women only)				
FII beneficiaries (n = 198)	74,326 (217,819)	110,383 (239,400)	51,303**	69.1
Nonbeneficiaries (n = 178)	35,414 (210,009)	48346 (219,474)		
Gender (men only)				
FII beneficiaries (n = 674)	83,701 (281,080)	107,495 (282,132)	84,825***	101.3
Nonbeneficiaries (n = 267)	86,261 (269,010)	98,249 (281,306)		

(*continued*)

Table 5.6 Impact of Fadama II on Household Income Across Agro-Ecological Zones, Genders, and Asset Terciles

Treatment type	Net real annual income (Naira/household)		ATT[1,2]	% net changed due to participation in project[3]
	Before project[1]	After project[1]		
Agro-ecolo				
Asset terciles				
Tercile 1 (the poorest)				
FII beneficiaries (n = 293)	70,851 (154,438)	82,745 (153,922)	31,776	*44.9*
Nonbeneficiaries (n = 505)	76,831 (153,000)	77,511 (153,998)		
Tercile 2:				
FII beneficiaries (n = 93)	93,847 (161,254)	119,013 (175,283)	94,750**	101.0
Nonbeneficiaries (n = 191)	74,705 (163,651)	104,994 (180,714)		
Tercile 3				
FII beneficiaries (n = 96)	122,074 (239,037)	154,892 (267,235)	1,177	1.0
Nonbeneficiaries (n = 139)	126,474 (207,494)	128,269 (223,225)		

Source: Survey data.
Notes: FII = Fadama II. Numbers in brackets are standard deviations of the corresponding mean.
[1]ATT = $(Y_{p1} - Y_{p0}) - (Y_{np1} - Y_{np0})$. "Before project" is 1 year before Fadama II started, October 2004 to September 2005, and "After project" is 1 year after the project started, October 2005 to September 2006.
[2]"ATT" and the corresponding "%" refer to the change in productive assets resulting from participation in Fadama II compared with the corresponding group of nonbeneficiaries. Thus, they should not be interpreted as referring to the change in the productive assets of the corresponding control group of nonbeneficiaries.
[3]% net change due to participation in project = $(ATT/Y_{p0})*100$
*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

investments that the poor had to make to participate in the project. Such investments could have crowded out short-term investments for the poorest, most liquidity-constrained households that could have otherwise increased income in the first year of participation. It is likely that beneficiaries in the poorest tercile will see their incomes increase significantly after starting to benefit from their investments in productive assets, which, as discussed in the previous section, increased significantly.

In summary, the Fadama II project has caused beneficiaries to realize significant increases in income. Using the PSM and double-difference methods, our results allowed us, with considerable confidence, to attribute the income increases among beneficiaries to participation in the project. However, the impact of Fadama II was different across agro-ecological zones and asset groups. The impact of Fadama II on income was not statistically significant in the humid forests and moist savannah zones and across gender, although increases in mean incomes of Fadama II beneficiaries were estimated in all cases. Beneficiaries in the lowest and highest asset terciles also did not realize statistically significant different income growth because of participation in the project (although the estimated mean impact was large and positive for the poorest asset tercile). The impacts of the project are not fully captured by this study because the project had operated for only 1 full year when the survey was done; thus, our results do not capture the lagged impacts of productive assets, rural infrastructure, and other project interventions. However, the study has collected a good baseline that could be used to conduct follow-up studies to capture the longer-term impacts of the project.

Fadama II targeted the poor and vulnerable groups like women, youth, the elderly, people with HIV/IADS, and the physically challenged. Holding other factors constant, this targeting is likely to reduce income inequality. In addition to comparing the value of productive assets and income across gender and asset terciles, we further analyzed the achievement of this targeting by examining the change in consumption inequality over the first year of the project. We computed the Gini coefficient using consumption expenditure instead of income, because the coefficient could be greater than 1 if income were negative (Berrebi and Silber, 1985; Chen et al., 1982; Stich, 1996). The results show that the Gini coefficient of Fadama II beneficiaries decreased by 9 percent, suggesting that the project contributed to reduction of consumption inequality (Table 5.7). This is consistent with the results of our productive asset analysis, which showed that the value of productive assets increased more significantly among the poorest asset tercile than among the middle and upper terciles.

5.4. Impact of Fadama II on Rural Infrastructure Development

5.4.1. Overview

This section discusses project activities in creating access to road infrastructure; the effect of those activities on access to transportation services; the uses, benefits, and problems associated with Fadama II roads as well as other rural

Table 5.7 Impact of Fadama II on Consumption Distribution

Treatment type	Gini coefficient before project started	Gini coefficient after project started	% Gini coefficient change
FII beneficiaries	0.408	0.370	−9.3
All nonbeneficiaries	0.319	0.325	1.9
Nonbeneficiaries within FII LGAs	0.323	0.317	−1.9
Nonbeneficiaries outside FII LGAs	0.316	0.331	4.8

Source: Survey data.
Note: FII = Fadama II; LGA = local government area.
[1]"Before project" is 1 year before Fadama II started, October 2004 to September 2005, and "After project" is 1 year after the project started, October 2005 to September 2006.

roads in the study area; and the role of the project in commercialization and nonfarm activities. The discussion includes methodological issues and challenges, especially when they are a relevant qualifier of the empirical results. Moreover, this section suggests feasible ways to overcome methodological and data challenges and offer a deeper analysis.

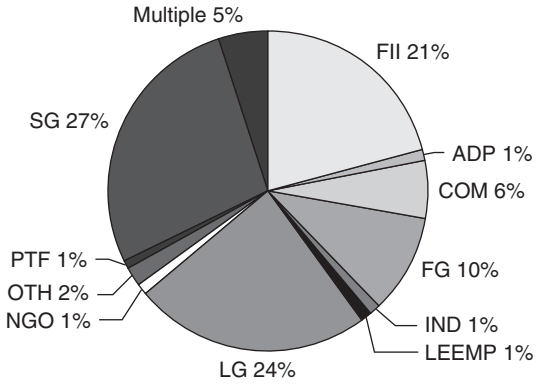
This study focuses on rural roads, rather than on all rural infrastructure supported by the project, for two primary reasons. First, rural roads are the most common type of rural infrastructure investment financed by the project. As discussed later, the available data did not enable us to differentiate individuals who were members of an FUG/FCA and received each type of rural infrastructure investment from individuals who participated in Fadama II in general. To minimize the inaccuracy of defining the treatment group, we focused on the type of infrastructure that is relatively prevalent across participating households. Second, the alternative of considering an index of rural infrastructure investments—for example, combining market stalls and roads with boreholes—would make it more difficult to trace and explore the different pathways through which different types of infrastructure may have an impact.

5.4.2. Sources of Funding for Roads and the Spillover Effect of Fadama II

We begin by detailing some basic characteristics and descriptive statistics of the Fadama II–financed rural roads. Figure 5.5 shows the composition of sources of funding for roads reported by the households as being important for pursuing their productive activities. Most of these roads are supported by resources from state government funds, local governments, the Fadama II project, and the federal government. The largest percentage of road investments is financed by state governments. Fadama II funds 21 percent of the road investments reported by respondents.

An examination of the three treatment types of respondents citing a Fadama II road as useful for their productive activities reveals tentative but interesting

Figure 5.5 Funding Sources for Roads



Acronyms

FII	Fadama II
ADP	Agricultural development programs
COM	Community
FG	Federal government
IND	Individual
LEEMP	Local Empowerment and Environmental Management Program
LG	Local government
NGO	Nongovernmental organizations
OTH	Other
PTF	Petroleum Trust Fund
SG	State governments
Multiple	Multiple sources

Source: Survey data.

Table 5.8 Respondents Stating a Fadama II Road Is Important for Their Productive Activities

Treatment type	% stating FII road important
FII beneficiaries	42.0
Nonbeneficiaries within FII LGAs	15.1
Nonbeneficiaries outside FII LGAs	7.8
Total	22.0

Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

evidence of strong and immediate spillover from the infrastructure provision aspect of the project. Table 5.8 shows that a substantial share of nonbeneficiaries use Fadama II roads in carrying out income-earning activities, especially nonbeneficiaries in Fadama II LGAs.

Given that the particular intervention of interest here is the provision of a local public good (rather than a private productive asset or service), our finding is to some extent what we expected, unless the project had an effectively enforced policy limiting the use of a public good to project beneficiaries. However, while some spillover was expected, the magnitude is notable: 15 percent of nonbeneficiaries in Fadama II LGAs and 8 percent of nonbeneficiaries outside Fadama II LGAs reported using Fadama II roads for their productive activities.

Although spillover is a project strength, it poses analytical challenges in identifying the impact of public infrastructure investments. Unlike the situation for private goods, productive assets, and services, for infrastructure investments it becomes difficult to differentiate between a "treated" and an "untreated" person. The direct spillover effect suggests that the impact of the project may be underestimated when people formally identified as nonbeneficiaries are considered members of the control group. This point is discussed further in a later discussion about estimating the impact of the road investments.

The stronger "public good" nature of the infrastructure component of Fadama II, compared with the small-scale components of assets and advisory services, also has important implications for the appropriate provision, financing, and maintenance of the infrastructure, especially in terms of project sustainability. Important factors in determining the financing and maintenance options that should be considered for the roads already built under the project are the number and coverage of the direct users. Here the term *direct user* refers to individuals, traders, and others who are actually traveling on a Fadama II road, as opposed to those benefiting from its existence in more indirect ways. User fees and the introduction of tolls are usually practicable only on major roads traversing larger geographic areas, which would not apply well in the context of the communities in the project area. If the majority of direct users are within a limited geographical area—for example, a community that is a subset of an LGA—then contributions could be sought from the community in kind, in labor, and in cash to complement public financing of maintenance costs (e.g., through the local government). Existing community-level institutions could facilitate the coordination and collection of contributions. The justification for local government involvement emerges from benefits that extend beyond the community—for example, sellers in a market profiting when potential buyers living close to the road gain better access to the market.

5.4.3. Time Dimension of Fadama II Roads

Table 5.9 highlights another caveat to keep in mind when discussing the estimated impact of the rural infrastructure component of Fadama II. The table shows the reported year in which Fadama II roads were built or rehabilitated, as captured through the household survey. It should be mentioned at this stage that improved data cleaning—that is, reexamination of the questionnaires and the data entries—are necessary to address what appears to be a significant degree of error in the data, because more than 12 percent of the Fadama II roads are stated to have been constructed before the project began.

Further, the table is a reminder that Fadama II roads had been accessible to the surveyed households only a year or less before the survey was conducted, with most roads available in 2006, mere months before the time for which the potential outcomes were measured. Perhaps even more than the spillover effect, this very short time span between provision of infrastructure and measurement of outcome limits the possibility of determining the extent to which households may materially benefit from this project component. It

Table 5.9 Reported Year in Which Fadama II Roads Were Constructed or Rehabilitated

Year reported by respondents	Roads	
	Number	Percent
Between 1960 and 2004	65	12.3
2005	106	20.0
2006	234	44.2
N/A	125	23.6
Total	530	100

Source: Survey data.
N/A = Not applicable (i.e., farmers did not report having road).

would therefore be critical to improve on this analysis in the future by obtaining additional data from the same households after sufficient time had elapsed for the development of mechanisms through which road infrastructure might improve well-being.

To strengthen confidence in the descriptive picture of the source of funds for various roads, it would be valuable to analyze Fadama II project data showing which FCAs have demanded and received roads and which FCAs have not, including information that would enable the researcher to match the surveyed beneficiaries with the FCAs from the project data. This would also allow for more in-depth and relevant analysis of other features concerning access to and benefits from rural infrastructure projects.

5.4.4. Access to Roads

Table 5.10 presents one type of evidence on the extent to which there have been changes in access to road infrastructure in the study areas. Individuals were asked to report the distance in kilometers between their residence and the nearest all-weather road for two periods: just before September 2005 (when Fadama II was implemented) and 1 year later, in September 2006.[8] We see that very few households in both the project and nonproject communities reported some change. In only 5 percent to 6 percent of cases did the distance to the nearest all-weather road change.

However, for 23 percent of individuals, distance changes could not be determined because of nonreporting at one or both points in time. Also, in interpreting these figures, it is useful to keep in mind that the time between the reported periods was very short. That fact is particularly relevant for larger investments such as roads (as opposed to productive assets or other services) for which procurement, planning, and construction procedures are time consuming.

Another notable finding in the empirical results is the nearly even split between respondents reporting that roads are now closer to their homes and those reporting increased distances. Although the survey included a question to ascertain the reasons for any changes in distance, unfortunately collection of these data was poor,[9] making further analysis of particularly the increased

Table 5.10 Respondents Reporting Changes in Distances to All-Weather Roads

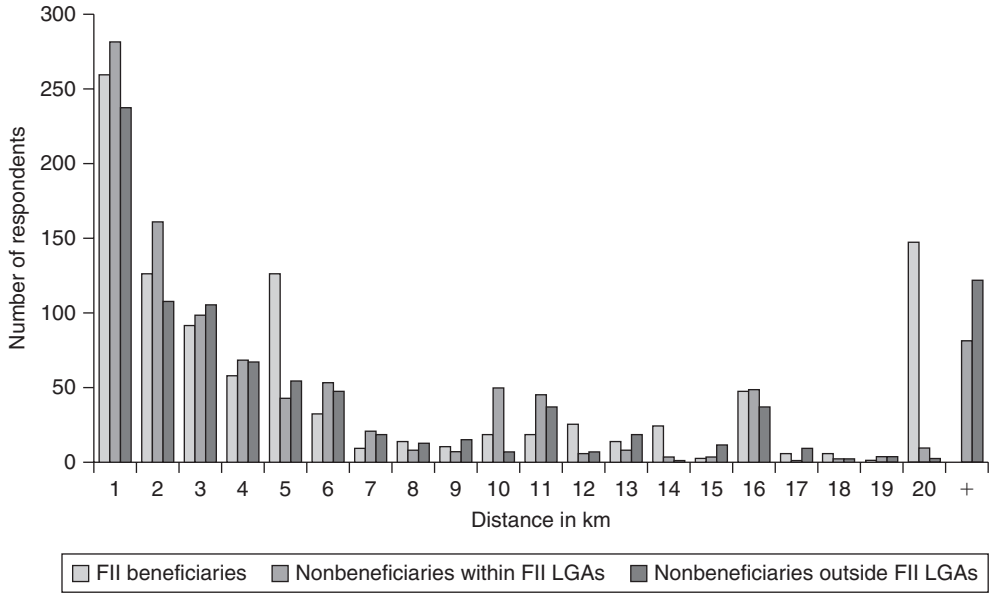
Change in distance	Total respondents		FII beneficiaries		Nonbeneficiaries within FII LGAs		Nonbeneficiaries outside FII LGAs	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Decreased	102	2.69	43	3.35	35	2.83	24	1.92
Increased	109	2.87	34	2.65	23	1.86	52	4.16
No change	2,717	71.65	937	73.09	938	75.95	835	66.85
N/A	864	22.78	268	20.9	239	19.35	338	27.06
Total	3,792	100.00	1,282	100.00	1,235	100.00	1,249	100.00

Source: Survey data.
Note: FII = Fadama II; LGA = local government area; N/A = Not applicable (i.e., farmers did not report having road).

distances impossible. Data on the reasons for distance changes would shed light on the causes of worsened access.

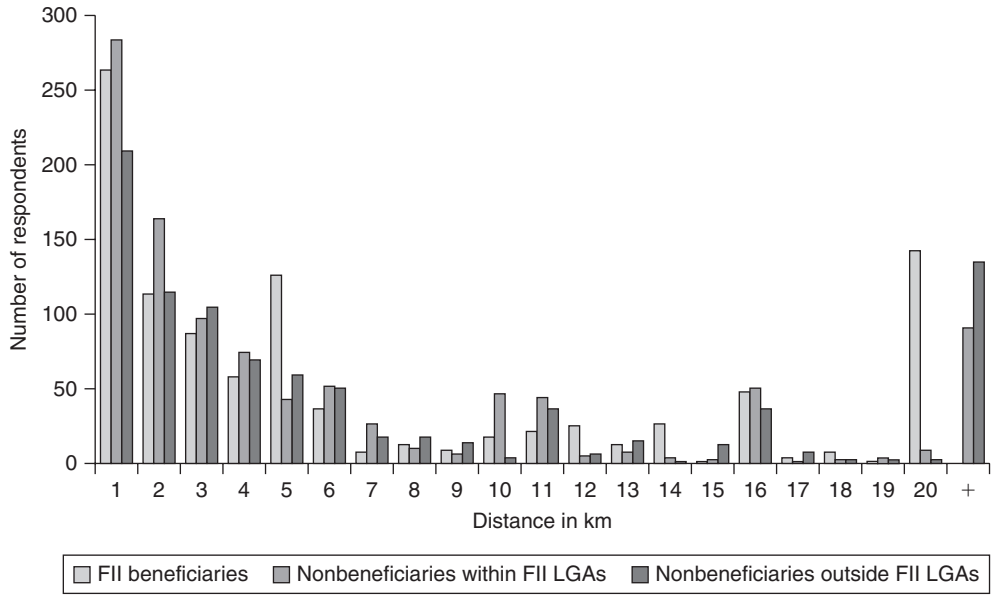
Figures 5.6a and 5.6b show the frequency distribution of the distance to all-weather roads for the three treatment types and the two periods. The figures show, not surprisingly in light of the overall limited changes in distances to

Figure 5.6a Distance to an All-Weather Road in 2005



Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

Figure 5.6b Distance to an All-Weather Road in 2006



Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

roads over time, that the distribution of respondents in the various distance categories did not change much from 2005 to 2006. Most households were within 1 km of an all-weather road, with the numbers declining with greater distance until about 9 km. Beyond that, the distribution is relatively scattered. Figure 5.6a shows that all three treatment types have similar distributions of distances to roads.

The average distances to town for the treatment groups in each period are shown in Figures 5.7a and 5.7b. As expected, the distribution suggests greater distances to town than to the nearest all-weather road. However, we found that the number of households in each distance category declined as distances increased until about 9 km, with the distribution beyond 9 km from town following less of a pattern.

In assessing the impact of public infrastructure provision through the project, we used the PSM approach combined with double-difference estimation, as already discussed in Section 4.5. Commonly in program evaluation, there are trade-offs in determining which households will be used for the comparison (control) group. The trade-offs are particularly prevalent in cases with more differentiated, treatment type stratification—for example, when data are available in three strata: (1) treated individuals, (2) untreated individuals in communities selected for intervention, and (2) untreated households in untreated communities—as in the context of our survey.

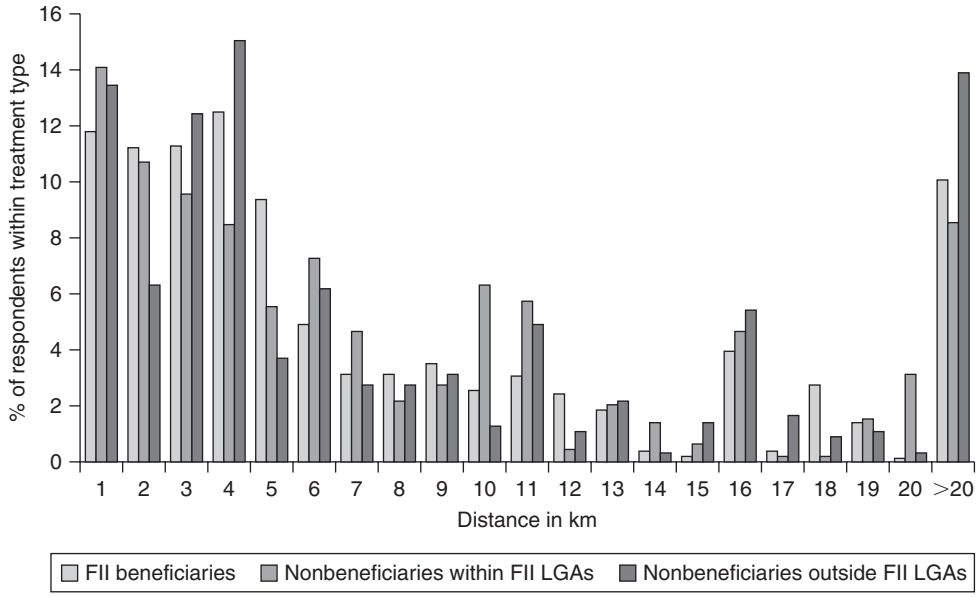
On the one hand, using category 2 as the control group avoids the project placement bias inherent in some nonrandomized interventions, because the same communities are involved in both groups. Although community placement is mitigated in choosing control households from within category 2, the potential for self-selection bias is greater because individuals' choosing to participate rests heavily on their own initiative and ability to be willing to organize into small groups, submit a proposal to the project, come up with matching funds, and so forth—factors that may also influence outcomes. On the other hand, identifying category 3 as the control group mitigates self-selection bias but accentuates project placement bias. As discussed in Section 4.5, we addressed the latter concern by using the double-difference estimator, which nets out the effects of fixed differences between project and nonproject locations.

Given that our approach addresses project placement bias and the potential for greater selection bias in CDD projects as opposed to other types of interventions, the case for using category 3 as the control group is relatively strong. In the evaluation of public infrastructure, a further element comes into play when determining which households to include in the control group. As shown in Table 5.8, the potential for spillover effects is particularly pronounced. That is, nonproject households near or within the same community as the project households are much more likely to benefit from infrastructure provision, because infrastructure assets are not privately held or used. Therefore, category 2 is much less likely to be an unaffected control group for the assessment of the impact of public infrastructure than it is for interventions providing private goods and services.

Because of the nature of the CDD mechanism underlying participation, the nature of the estimator used, and the likelihood of spillover effects from

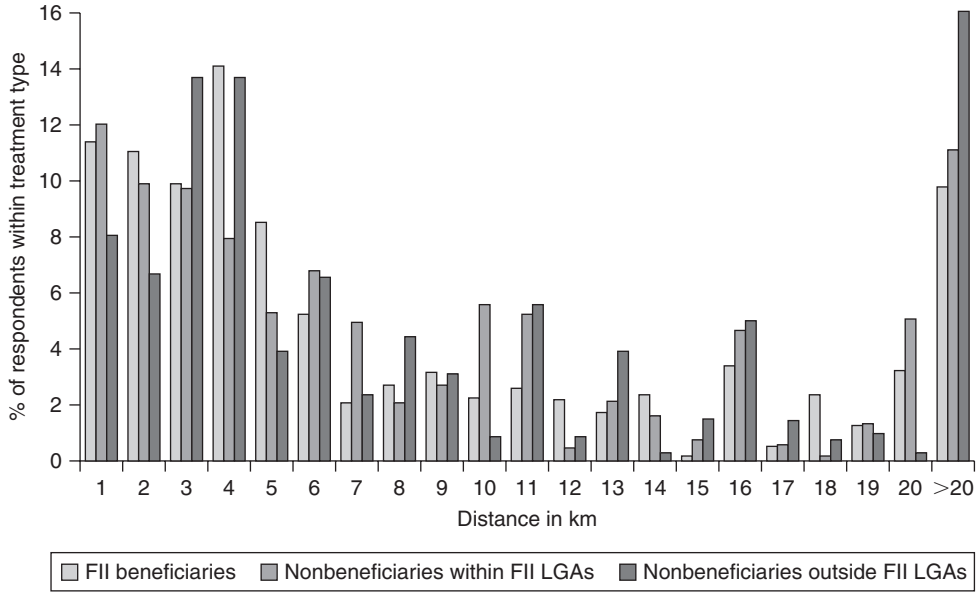
provision of public infrastructure as just discussed, for this analysis we consider only category 3 as the control group. It is important to note, however, that the contamination effect is thereby only reduced, not eliminated, as suggested from the share of households in nonproject LGAs that reported making use of Fadama II roads.

Figure 5.7a Distance to Nearest Town in 2005



Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

Figure 5.7b Distance to Nearest Town in 2006



Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

Just as important as a reasoned definition of the control group is the definition of the treatment group. The literature on project evaluation primarily analyzes interventions that either focus on only one activity or analyze projects that are multifaceted interventions and are evaluated in terms of all components' comprehensive effects on social and economic outcomes of interest. Of greater challenge are cases, as in this evaluation, in which the impact of a subcomponent (here, provision of rural infrastructure) is of interest. A precise definition of the treatment group in such a context would categorize individuals as "treated" only if they were part of an FUG or FCA that requested and received infrastructure investments through the project. This information could be obtained by linking Fadama II administrative and project management data to the household survey data, as well as by linking the user group and individual survey data. Such information would likely contribute to a more precise pinpointing of effects that arise specifically from infrastructure investments. With just the household survey data, however, we are limited to considering as the treatment group all households participating in Fadama II, whether or not they are part of a user group that received resources for investing in roads. Especially for outcomes (to be discussed later) that are more directly linked to road investments (as opposed to the other Fadama II interventions such as private productive asset provision or advisory services), the broader-than-ideal definition of who is in the treatment group may bias some of the results downward.

Finally, the original intent of the evaluation of rural infrastructure under Fadama II was to incorporate information on the costs of these investments alongside the potential benefits, enabling us to determine under which circumstances the returns to rural infrastructure investments are highest. Project evaluation that considers both costs and outcomes (as opposed to only outcomes) offers even more policy- and project-relevant recommendations for improving the efficiency of project investments. It is hoped that, through inclusion of project data, this assessment can be incorporated and thus be made useful as guidance in the course of implementation of Fadama II.

With these caveats expressed, we proceed to the results of the PSM and double-difference estimation of the effect of Fadama II treatment on various measures of access to infrastructure. In Table 5.11, the double-difference

Table 5.11 Project Impact on Access to Road Infrastructure

Outcome variable	Treated	Control	ATT	Std. Err[1]	*p* value
Change in mean distance to road (km)	3.501	4.087	–0.585	4.687	0.901
Change in mean distance to town (km)	–0.202	1.026	–1.227**	0.569	0.031
Change in mean travel time by motor vehicle (minutes)	–2.211	0.208	–2.418***	0.913	0.008

Source: Survey data.
[1]Bootstrapped standard errors.
*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

estimates show the change over time of the outcome variable among the treated respondents, after netting out the same change in the control respondents.

The impact of the project on access to roads is assessed using three measures. As shown in Table 5.11, in all three cases, the sign of the estimate suggests that access to road infrastructure improved as a result of the Fadama II project: the distance to the nearest all-weather road, the distance to town, and the time it takes to travel to the nearest road by motor vehicle was reduced. These results are statistically significant (at the 5 percent level) for two of the three measures.

5.4.5. Transportation Services

In addition to access to infrastructure, which is a more immediate outcome of constructing and rehabilitating roads, these interventions could also usher in public and private transportation—for example, by making it more profitable as well as feasible to supply transportation services on roads that were previously either nonexistent or not easily traversed by vehicles. Therefore, it is also useful to explore how the provision of transportation services may have changed over time in the study area.

We explored two dimensions of transportation. First, Table 5.12 reports the average length of time individuals waited for motor vehicles. We found that as a result of Fadama II, the waiting time for vehicle transportation fell by 11 percent on average, with the improvement in transportation availability more than twice as large in the LGAs in which the Fadama II project was operating. Further, we found the percentage change in wait time was similar for Fadama II beneficiaries as for nonbeneficiaries in Fadama II LGAs, suggesting spillover effects of infrastructure investment on access to transportation services.

The second aspect of transportation services considered is the cost of such services. This is particularly relevant when, before project intervention, both all-weather roads were within some reach of a given individual and transportation services existed. With either additional roads or improved road quality, one would expect that the reduced cost of operating motor vehicles would translate into reduced costs faced by the users of transportation services (for transporting either people or goods). This issue is investigated in

Table 5.12 Average Time Waiting for Motor Vehicle Transportation

	Average wait time (minutes)		
Treatment type	**2005**	**2006**	**% change**
FII beneficiaries	17.12	14.90	−13.0%
Nonbeneficiaries within FII LGAs	20.54	17.65	−14.1%
Nonbeneficiaries outside FII LGAs	15.89	14.93	−6.0%
Total	17.86	15.82	−11.4%

Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

Table 5.13, with average transportation costs disaggregated by treatment type and period. As the table shows, costs increased for beneficiaries and nonbeneficiaries alike. However, the increase is lower, in the case of transportation costs for both people and products, for the beneficiary households. Nonbeneficiaries in project LGAs faced lower cost increases than nonbeneficiaries outside project LGAs but higher than households directly participating in the project.

These findings provide tentative evidence that by providing infrastructure, Fadama II may have contributed to reducing transportation costs (or more accurately, to mitigating their increase). Table 5.14 presents the matching estimation results for the impact of the project on transportation services. We found that the provision of roads resulted in improved access to transportation services, in terms of both quantity and costs. These findings are statistically significant for two of the three indicators of transportation services.

It is worth noting that the cost data, as well as all other price and monetary value data in this discussion, are nominal. Therefore, some component of the cost increases observed in Table 5.13 emanated from general inflation. However, we corrected for that in the double-difference estimation, because all general time trends, including inflation, were removed from influencing the ATT (i.e., to the extent that general inflation affected treatment and control groups equally, its effects were netted out).

Table 5.13 Transportation Costs (in Naira)

	Cost of transporting one load on pickup truck			Fare to nearest urban area by motor vehicle		
Treatment type	**2005**	**2006**	**% change**	**2005**	**2006**	**% change**
FII beneficiaries	2,012	2,192	9%	103	106	3%
Nonbeneficiaries within FII LGAs	2,066	2,276	10%	106	123	16%
Nonbeneficiaries outside FII LGAs	2,147	2,589	21%	103	132	27%
Total	2,073	2,345	13%	104	120	15%

Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

Table 5.14 Project Effect on Transportation Services

Outcome variable	Treated	Control	ATT	Std. Err.[1]	*p* value
Change in mean time waiting for transportation (minutes)	–1.728	0.471	–2.200**	0.758	0.004
Change in mean cost of transporting load on truck	162.621	190.071	–27.450	58.032	0.636
Change in mean fare to nearest urban area	5.198	11.160	–5.962*	3.455	0.084

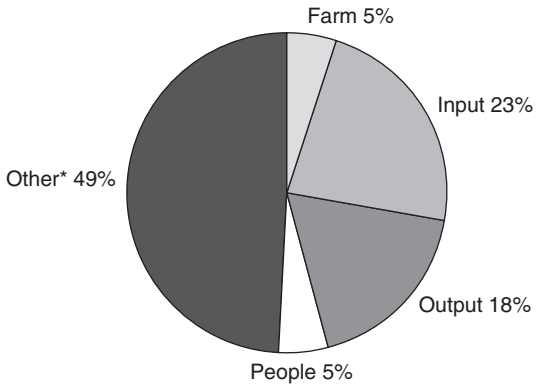
Source: Survey data.
[1]Bootstrapped standard errors.
*Significant at the 10% level; **significant at the 1% level.

5.4.6. Uses, Benefits, and Problems of Road Infrastructure

Improved access to roads and greater availability and affordability of transportation services are the direct and immediate ways in which the expansion of the rural infrastructure networks can benefit households. It is of interest, however, to assess how roads are actually being used and both the benefits and the drawbacks reported by the individuals using them.

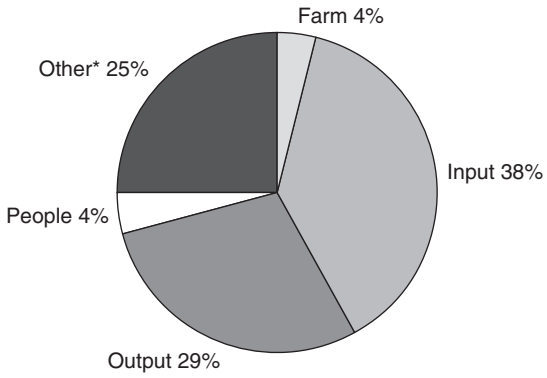
Figures 5.8a and 5.8b show the self-reported primary uses of roads that respondents accessed. Considering both project-supported and other roads, Figure 5.8a shows that, among the uses associated with productive activities, the transport of agricultural inputs is the single largest use, followed by the transport of agricultural outputs. A smaller share of individuals consider being able to transport "people" (e.g., to get themselves to places of employment) the main use of the roads, and a similarly small share mention the improved ability to access their farmland (presumably, these are farmers who reside in urban areas or other rural areas but who farm in *fadama* areas). Nearly half of the cases either did not report uses or reported uses not directly associated with productive activities. Because the survey only inquired about "productive" activities, no information is available on those cases. It is

Figure 5.8a Use of All Weather



Source: Survey data.

Figure 5.8b Use of Fadama II Roads



Source: Survey data.
*"Other" uses include uses considered not productive and cases with no reported uses.

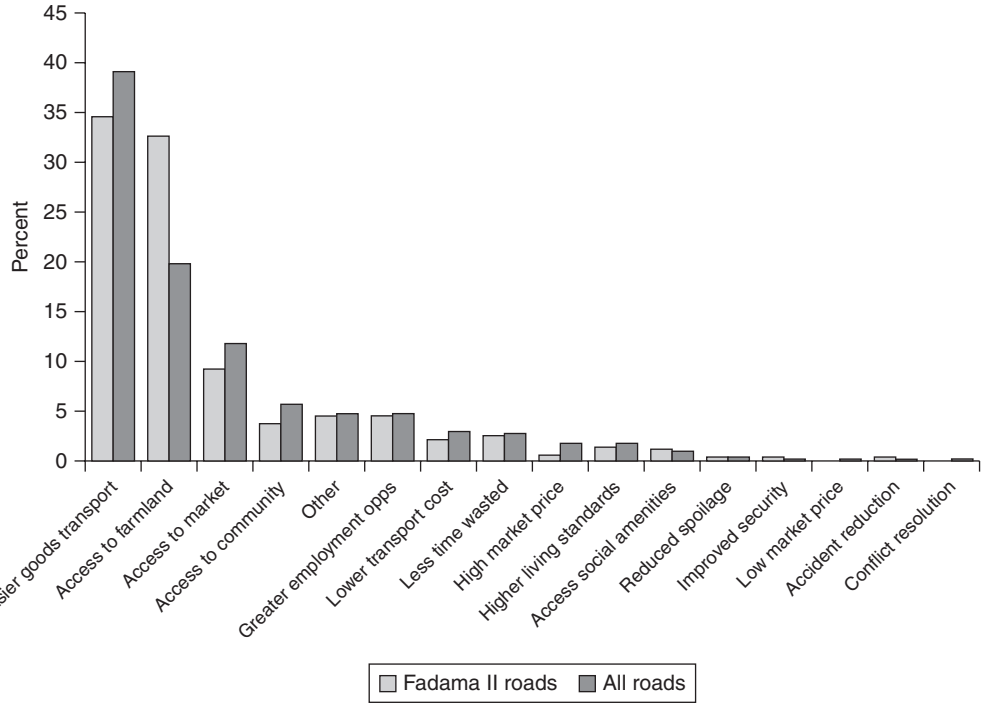
possible that those individuals travel to access health and education services, which were not directly referred to as productive but may still impact productivity in the medium to long term.

The same analysis limited to Fadama II roads is offered in Figure 5.8b. The figure shows that the extent of use to access farmland and to transport people is similar to the overall average. What is striking, however, is that the percentage of individuals using Fadama II roads for agricultural input and output transportation was much larger than was the case for all roads. Overall, the use of roads for productive purposes was larger by about 26 percentage points. This is consistent with the project's goal of improving access to public infrastructure and thereby improve production and marketing activities.

Interestingly, there is partial contrast between the reported uses of roads and the reported benefits from roads. For example, Figure 5.9 shows that the share of households reporting easier transportation of products as the main benefit was greater among users of all roads than among users of Fadama II roads. The reverse is seen with respect to access to farmland, although a slightly smaller percentage of individuals used Fadama II roads for accessing farms than used roads in general for that purpose (see also Figures 5.8a and 5.8b).

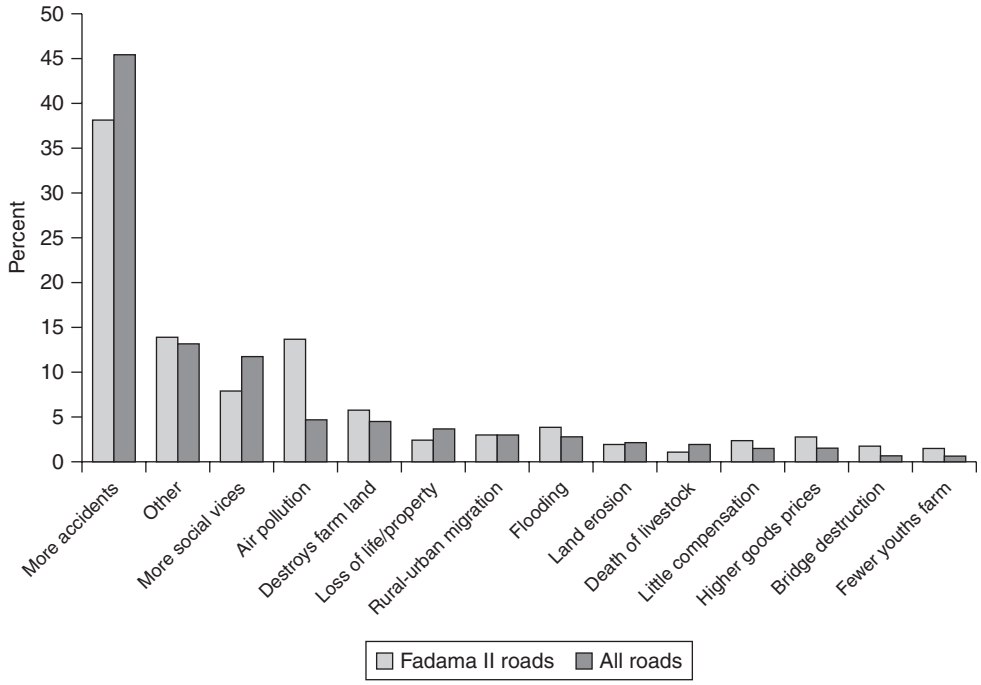
Considering the reported problems with roads, Figure 5.10 shows that the problem of accidents seems to have been relatively more prevalent on all roads than on Fadama II roads. Overall, this is by far the most frequently noted concern. Notable is the relatively higher rate of reporting of air pollution as a problem resulting from construction of Fadama II roads, although in absolute terms this is not a frequently reported problem. An interesting finding is that

Figure 5.9 Reported Benefits of Roads



Source: Survey data.

Figure 5.10 Reported Problems with Roads



Source: Survey data.

most of the stated problems are noneconomic in nature (i.e., accidents, social vices, air pollution). Only a few individuals cited as an economically relevant consequence as the main concern, such as destruction of farmland, land erosion, and loss of property.

5.4.7. Infrastructure and Marketing

A substantial body of literature on the impact of road infrastructure investments in developing countries suggests that one of the main contributions of infrastructure development to economic growth operates through its ability to facilitate market access and marketing of agricultural products, thus fostering a structural move from subsistence-based agriculture to increased commercialization.

In light of this hypothesis, we examined the extent to which commercialization of agriculture may have changed over time for households and LGAs receiving Fadama II support compared with those not directly supported by the project. Figures 5.11a through 5.11d offer a summary of our findings for four commodity groups. The bar charts, the scale for which is located on the left of each graph, show the share of agricultural production sold on the market in 2004–2005 and 2005–2006. The line chart summarizes this information by representing the percentage change over time in the share marketed, with the scale indicated on the right side of each graph.

For example, the share of grain sold on the market increased from 37.8 percent to 39.4 percent for Fadama II households, which represents a 4 percent change in this share We observed that the marketed share increased in the 1-year

Figure 5.11a Share of Grain Marketed

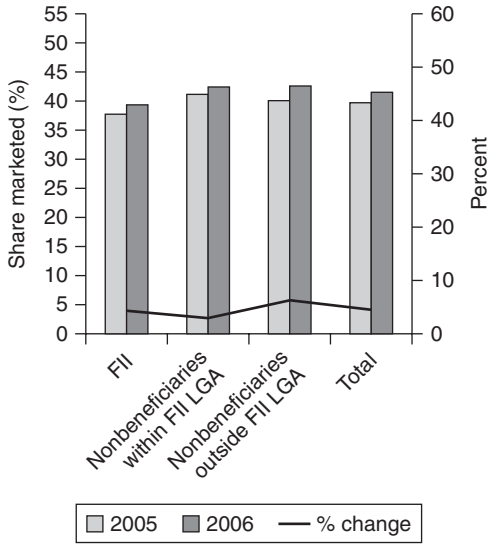


Figure 5.11b Share of Root Crops Marketed

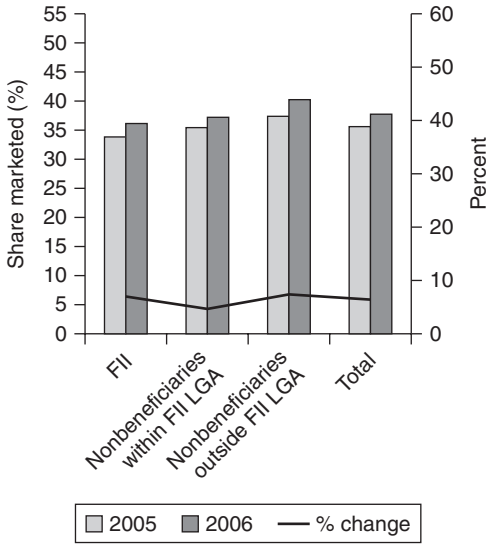


Figure 5.11c Share of Vegetables Marketed

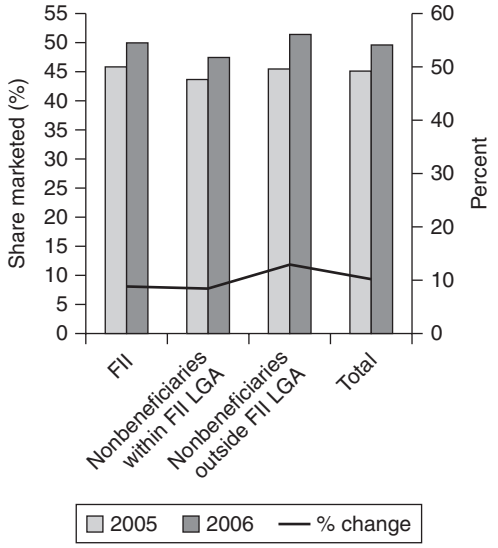
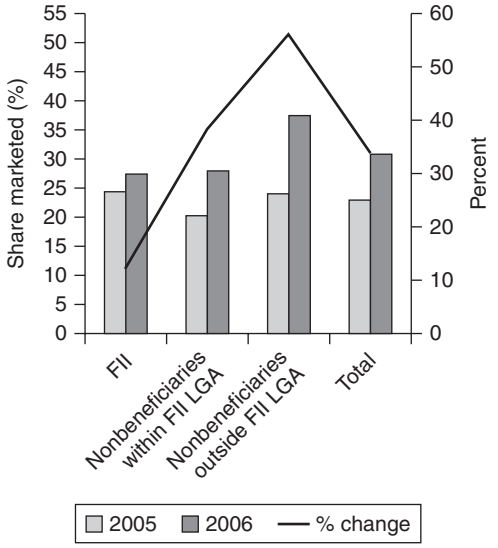


Figure 5.11d Share of Fish Marketed



Source: Survey data.
Note: FII = Fadama II; LGA = local government area.

period for all four commodity groups and for all treatment types, with increases of between 5 percent and 10 percent seen for grains, roots, and vegetables. For fish products, the increase was much more dramatic, averaging about 34 percent. Interestingly, the rise in the marketed share is highest for the nonparticipating LGAs and is again most pronounced in fish marketing. These findings raise the question, Are the process by which LGAs were selected for participation inversely correlated with community characteristics that also drive the potential for increased commercialization? It appears that the FII project targeted areas that were less prone to commercialization (probably unintentionally).

Table 5.15 Project Effect on Agricultural Marketed Share

Outcome variable	Treated	Control	ATT	Std. Err.[1]	*p* value
Change in mean share of grain marketed	1.142	3.379	−2.237*	1.210	0.065
Change in mean share of root crops marketed	0.833	2.904	−2.072	2.091	0.322
Change in mean share of vegetables marketed	2.438	9.342	−6.904***	2.100	0.001
Change in mean share of fish marketed	2.007	11.742	−9.734***	3.312	0.003

Source: Survey data.
[1]Bootstrapped standard errors.
*Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Further exploration of this question would necessitate more careful analysis of LGA (as opposed to only household) characteristics. However, this report is based solely on analysis of the household survey; the survey of economic interest groups that the evaluation team received could not be analyzed by LGA given missing identifier variables. It is hoped that this information can be supplemented, permitting a further examination of LGA-level factors that could be conditioning the empirical findings on marketing represented in Figures 5.11a through 5.11d.

Table 5.15 presents the corresponding ATT, controlling for household-level characteristics. Here we see, not inconsistent with the descriptive graphs, a negative effect across all commodity groups, with significant results for three of the four commodity types. To rule out the possibility that these results were the consequence of a failure to control for LGA-level characteristics, it is critical to be able to incorporate such data, and therefore these results should be considered preliminary until the community data can be made available and incorporated into the analysis.

5.4.8. Nonfarm Economic Activities

Finally, we consider the effect that road provision through the project had on nonfarm activities. Expanding the road network could affect both agricultural productivity and agricultural income, as well as open up avenues to other activities—for example, by facilitating access to employment opportunities outside the farm as well as establishing rural microenterprises. However, as Table 5.16 shows, there is no evidence of statistically significant effects of the Fadama II project on nonfarm activities, as measured by changes in the level of nonfarm income or in participation in nonfarm activities (proxied by a dummy variable on whether nonfarm income was earned). In contrast to all other outcome variables previously considered, expansion of nonfarm economic activities and diversification are changes that occur particularly slowly, even after improved access to roads and transportation has been established. Change occurs slowly because it often requires a structural shift in a household's activity choices, entails costs related to a potentially long search for employment, and

Table 5.16 Nonfarm Economic Activities					
Outcome variable	**Treated**	**Control**	**ATT**	**Std. Err.**	***p* value**
Change in mean nonfarm income (Naira)	53,654	126,531	–72,877	109,721	0.507
Change in mean of whether nonfarm income earned (dummy)	–0.026	–0.052	0.026	0.022	0.231
Source: Survey data.					

involves (in the case of establishing microenterprises outside the farm) new investments by households to launch the business. Given the short time span of this study, the lack of effects found should be viewed in light of this caution.

Notes

1. This increment is not a simple difference between the before and after values. Rather, it is an increase that takes into account the changes of the control group, such as ATT/value of assets of beneficiary before the project. These values are all in real (deflated to 2003) values.
2. However, the preproject level of group assets was significantly larger for Fadama II beneficiaries than for nonbeneficiaries. This might reflect actual differences resulting from a greater tendency of Fadama II beneficiaries to have participated in group activities before the Fadama II project, or it might reflect a reporting error concerning when group assets were acquired by Fadama II beneficiaries (i.e., some Fadama II respondents may have mistakenly reported some of the group assets that they acquired under Fadama II as group assets owned before the project). If the latter case is true (overreporting of initial group assets by Fadama II beneficiaries), then the impacts of Fadama II on the acquisition of group assets are underestimated, and the total effects would be even larger than the estimated effects.
3. It is still too early to tell how FUGs managed and benefited from their productive assets. However, the medium-term review report concluded that the capacity to manage some productive assets was low and there was still need for building the capacity of FUGs to manage their assets efficiently (Anonymous, 2007a).
4. The percentage change of the nonbeneficiaries before and after the project are not reported in the table but are calculated using the following simple formula (symbols are as defined in equation 3):

$$\frac{Y_{np1} - Y_{np0}}{Y_{np0}} \times 100$$

5. See Section 5.4 for details on other benefits that nonbeneficiaries received.
6. The lack of statistical significance of impacts in the estimation subsamples was partly caused by reduced sample size, which reduces statistical power, and does not necessarily mean that Fadama II had no impact in those cases. A larger survey sample would have been required to identify impacts in such subgroupings with statistical confidence.
7. We focus on distance to all-weather roads because the Fadama II project seeks to increase year-round road access.
8. The major problem was missing data on the reasons for change in distance.

6. Impact of Fadama II on Advisory Services

6.1. Overview

Agricultural extension approaches and performance in Nigeria have been changing over the past few decades (Oladele et al., 2004). These changes have been driven by many factors, including the political and policy changes, donors, and recently by participation of nongovernmental organizations (NGOs) in funding and providing agricultural extension services (Oladele et al., 2004; Ozor et al., 2007). Currently, advisory services in Nigeria are largely provided by an agricultural development program (ADP) that evolved from a project funded by the World Bank. The World Bank project started in 1974 and had a broad objective of increasing food production to attain food self-sufficiency (IEG, 2001; Oladele et al., 2004). When the project ended in 1995 with significant success in increasing agricultural production, the federal government adopted its approach and incorporated it into the new ADP. Operations of the ADP are mainly funded by the federal and state governments, and provision of advisory services remains in the hands of public extension workers (Oladele et al., 2004). The ADP has continued to use the traditional supply-driven approach and has also been characterized by poor funding and less effective advisory services (Ozor et al., 2007). These weaknesses have likely limited the impacts of the ADP on agricultural productivity in the country and rural development in general.

The NGOs and projects have also been providing advisory services and other agriculture-related services (e.g., credit services and agricultural input supply). The approaches of the advisory services provided by NGOs and projects have differed, reflecting different focuses and locations in the country. Although the government has allowed and supported NGOs and projects, it has not yet taken bold steps to promote pluralistic advisory services. However, the presence of NGOs and projects has created opportunities for introducing demand-driven advisory services funded by nonpublic sources. Fadama II is one of the projects providing demand-driven advisory services. The project has also introduced the user-fee approach that could help in promoting pluralistic extension services in developing countries (Umali-Deininger, 1997). Fadama II beneficiaries contribute 10 percent of the cost of the advisory services they receive. The experience of the Fadama II project in implementing a user-fee demand-driven approach is likely to serve as a good case study for the government to use to design policies for implementing pluralistic extension services in Nigeria and other developing countries. In the following section, we discuss the performance of the Fadama II project in providing demand-driven extension services and how that has affected provision of production, processing, financial management, and marketing advisory services.

6.2. Impact of Fadama II on the Types of Technologies Adopted and Demanded

Table 6.1 shows that the technology used by a large percentage of respondents to our survey was improved crop varieties, which about one-quarter of the respondents used. Another one-quarter of Fadama II beneficiaries also used financial management technologies, probably due to that being one of the conditions for joining the project. The technology that was demanded by the largest share of respondents differed across types of respondents. Fadama II beneficiaries asked for postharvest technologies more than did non-beneficiaries. The difference in demand for postharvest technologies was significant at $p = .10$. This could be a reflection of the beneficiaries demand to make use of the productive assets they acquired through the pilot asset acquisition subproject. Surprisingly, nonbeneficiaries demanded financial management technologies more than did beneficiaries. This could be a result of having facilitators who "supply" beneficiaries with financial management technologies, preempting the need to ask for such technologies. There was no significant difference between adoption and demand for crop-improved varieties. Nonbeneficiaries' demand for soil fertility management was significantly higher (at $p = .05$) than that of beneficiaries. Only 4 percent of beneficiaries demanded soil fertility management technologies compared with 10 percent of nonbeneficiaries. That reflects the limited emphasis of the Fadama II project on soil fertility technologies. However, the Fadama II project addressed the need to address soil fertility problems by launching the agricultural input support component in 2006 (NFDO, 2006).

Table 6.1 Adoption and Demand for Production, Postharvest, Financial Management, and Marketing Technologies

	Proportion reporting using the technology			Proportion reporting asking for the technology		
Technology	Fadama II beneficiaries ($n = 621$)	All non-beneficiaries ($n = 1107$)	T-test (p value)	Fadama II ben-eficiaries	All non-beneficiaries	T-test (p value)
Crop-improved varieties	0.243 (0.017)	0.248 (0.013)	0.840	0.056 (0.018)	0.093 (0.017)	0.170
Soil fertility management	0.126 (0.015)	0.109 (0.001)	0.327	0.038 (0.022)	0.105 (0.027)	0.041**
Livestock management	0.196 (0.016)	0.150 (0.011)	0.013***	0.047 (0.019)	0.041 (0.015)	0.795
Postharvest handling	0.082 (0.011)	0.061 (0.007)	0.103*	0.271 (0.054)	0.160 (0.041)	0.098*
Financial management	0.246 (0.017)	0.061 (0.007)	0.000***	0.013 (0.009)	0.069 (0.030)	0.022**
Agricultural marketing	0.098 (0.012)	0.072 (0.008)	0.059*	0.016 (0.016)	0.059 (0.026)	0.199

Source: Survey data.
Notes: Figures in parenthesis are standard errors. Statistics are computed using matched sample only.
*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level

Fadama II beneficiaries also used significantly more livestock management, postharvest handling, financial management, and agricultural marketing than did nonbeneficiaries. The results suggest that Fadama II support may have given the beneficiaries incentives to use new technologies and may have contributed to the higher income that beneficiaries realized.

Table 6.2 shows that the ADP is the major provider of production technologies (improved crop varieties, soil fertility management, and livestock production) for both beneficiaries and nonbeneficiaries. The ADP's focus on providing mainly agricultural production technologies is similar to the pattern of public extension services observed in other developing countries (Qamar, 2005). However, it is interesting to note that the State Fadama Development Office (SFDO) was the source of production technologies for about 30 percent of the beneficiary respondents who adopted those technologies.

The sources of postharvest, marketing, and financial management advisory services are mainly NGOs and projects for both Fadama II beneficiaries and nonbeneficiaries (Table 6.3). As expected, SFDO is the major source of information for postharvest, financial management, and marketing advisory services for Fadama II beneficiaries. This demonstrates the orientation that the Fadama II project has taken to support postharvest, financial management, and marketing technologies, which Fadama I did not provide. Surprisingly, SFDO also provided postharvest, financial management, and marketing technologies to nonbeneficiaries. However, the share of nonbeneficiaries who received advisory services on those technologies from SFDO was lower than the share of nonbeneficiaries who received the corresponding technologies from ADP. The results suggest that there is a spillover effect of the Fadama II project to nonbeneficiaries through the advisory services. This implies that free riding is occurring, because Fadama II beneficiaries contribute 10 percent of the costs of advisory services, whereas nonbeneficiaries presumably do not contribute. The results have implications on the user-fee arrangement that Fadama II uses. Collection of user fees from non–Fadama II households could be difficult because they may not be in organized groups and may not have any form of contract that could facilitate collection of user fees. Additionally, some advisory services are provided using mass media, which makes it difficult to collect fees from those who benefit from such services. Even though Ozor et al. (2007) observed that most farmers expressed willingness to pay for advisory services, payment of user fees by poor farmers who produce low-value crops is a major problem in low-income countries (Qamar, 2005), and 100 percent public funding of advisory services for such farmers may still remain the only viable option.

It is also interesting to note that farmer groups and individual farmers are among the important providers of some advisory services. For example, 25 percent of nonbeneficiaries received agricultural marketing advisory services from fellow farmers. This demonstrates the important role that farmers play in providing advisory services. Radio and TV also play an important role in providing some advisory services. Fadama II has used radio and TV programs to promote various technologies. Radio is an especially important tool for disseminating advice on agricultural technologies (Nwaerondu and

Table 6.2 Sources of Advisory Services by Type of Production Technology

Technology and sources of information on it	Proportion of respondents[1]		
	Fadama II beneficiaries	All nonbeneficiaries	T-test (*p* value)
Crop-improved varieties	*n* = 149	*n* = 277	
ADP	0.49 (0.03)	0.55 (0.04)	0.271
Individual	0.05 (0.02)	0.07 (0.02)	0.448
FUG/FCA	0.10 (0.03)	0.08 (0.02)	0.463
Farmer association	0.03 (0.02)	0.01 (0.01)	0.043**
Radio/TV	0.11 (0.03)	0.04 (0.01)	0.011***
SFDO[2]/facilitators	0.31 (0.04)	0.04 (0.01)	0.000***
MANR[3]	0.01 (0.01)	0.04 (0.01)	0.065*
Others	0.08 (0.02)	0.08 (0.02)	0.892
Soil fertility management	*n* = 79	*n* = 133	
ADP	0.59 (0.06)	0.78 (0.04)	0.002***
Individual	0.08 (0.03)	0.07 (0.02)	0.897
FUG/FCA	0.13 (0.04)	0.07 (0.02)	0.128
Farmer association	0.05 (0.03)	0.03 (0.02)	0.509
Radio/TV	0.03 (0.02)	0.04 (0.02)	0.574
SFDO[2]/facilitators	0.36 (0.05)	0.01 (0.01)	0.000***
MANR[3]	0.01 (0.01)	0.04 (0.02)	0.261
Others	0.10 (0.03)	0.09 (0.03)	0.902
Livestock management practices	*n* = 128	*n* = 172	
ADP	0.40 (0.04)	0.52 (0.04)	0.040**
Individual	0.06 (0.02)	0.19 (0.03)	0.002***
FUG/FCA	0.12 (0.03)	0.07 (0.02)	0.143
Farmer association	0.05 (0.02)	0.04 (0.01)	0.574
Radio/TV	0.02 (0.01)	0.03 (0.01)	0.470
SFDO[2]/facilitators	0.32 (0.04)	0.09 (0.02)	0.000***
MANR[3]	0.04 (0.02)	0.17 (0.03)	0.000***
Others	0.08 (0.02)	0.13 (0.03)	0.074*

Source: Survey data.
Note: Numbers in parenthesis are standard deviations.
*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level
[1]Refers to only those respondents who adopted the technology and based on matched sample only.
[2]State Fadama Development Office.
[3]Ministry of Agriculture and Natural Resources (state-level ministry).

Thompson, 1987). Radio communication is becoming increasingly important in rural areas where ownership of private FM radios continues to spread. The major challenge for the use of the mass media is to ensure that programs are accessible to all listeners by using local languages in rural areas. Some SFDOs,

Table 6.3 Sources of Postharvest Handling, Business/Financial Management, and Marketing Advisory Services

Technology and sources of information on it	Proportion of respondents[1]		
	Fadama II beneficiaries	All nonbeneficiaries	T-test (*p* value)
Postharvest handling	*n* = 50	*n* = 66	
ADP	0.41 (0.07)	0.68 (0.05)	0.001***
Individual	0.04 (0.03)	0.17 (0.05)	0.023**
FUG/FCA	0.04 (0.03)	0.07 (0.03)	0.446
Farmer association	0.02 (0.02)	0.00 (0.00)	0.249
Radio/TV	0.02 (0.02)	0.03 (0.02)	0.738
SFDO[2]/facilitators	0.70 (0.05)	0.13 (0.04)	0.000***
Others	0.04 (0.03)	0.10 (0.04)	0.1964
Business/financial management	*n* = 155	*n* = 66	
ADP	0.12 (0.02)	0.28 (0.04)	0.0003***
Individual	0.01 (0.01)	0.09 (0.03)	0.0013***
FUG/FCA	0.07 (0.02)	0.04 (0.01)	0.3084
Farmer association	0.01 (0.01)	0.02 (0.01)	0.3309
Radio/TV	0.01 (0.01)	0.02 (0.01)	0.3309
SFDO[2]/facilitators	0.68 (0.04)	0.07 (0.02)	0.0000***
MANR[3]	0.00 (0.00)	0.01 (0.01)	0.2145
Others	0.03 (0.01)	0.08 (0.03)	0.0267**
Agricultural marketing	*n* = 62	*n* = 77	
ADP	0.19 (0.05)	0.3 (0.05)	0.1360
Individual	0.06 (0.03)	0.25 (0.05)	0.0032***
FUG/FCA	0.11 (0.04)	0.09 (0.03)	0.6175
Farmer association	0.03 (0.02)	0.00 (0.00)	0.1043*
Radio/TV	0.00 (0.00)	0.09 (0.03)	0.0177**
SFDO[2]/facilitators	0.62 (0.06)	0.11 (0.04)	0.0000***
Others	0.03 (0.02)	0.12 (0.04)	0.0578*

Source: Survey data.
Note: Numbers in parenthesis are standard deviations.
*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level
[1]Refers to only those respondents who adopted the technology and based on matched sample only.
[2]State Fadama Development Office.
[3]Ministry of Agricultural and Natural Resources (state level).

such as Lagos, Ogun, and the states in the dry savannah zone, are using local languages in the projects financed by Fadama II.

In summary, Fadama II has focused on providing postharvest handling, agricultural marketing, and financial management advisory services. However, it is only for postharvest advisory services that the beneficiaries

have significantly greater demand compared with nonbeneficiaries (at $p = .10$). On the other hand, nonbeneficiaries reported significantly greater demand for soil fertility management technologies and financial advisory services than did beneficiaries (at $p = .05$). It is not clear why nonbeneficiaries expressed higher demand for soil fertility management technologies than did beneficiaries. It is possible that areas where nonbeneficiaries grow crops are degraded more, because they reported a greater proportion of marketed surplus than beneficiaries (see Section 5.4). The possible explanation for the latter result is that financial advisory services were provided to Fadama II beneficiaries through the capacity-building component, which initially used a supply-driven approach to help beneficiaries to initiate their economic activities on a commercial basis. The results underline the greater demand for postproduction advisory services (especially on postharvest handling) and suggest the need to increase the provision of the processing, storage, marketing, and financial advisory services. Those services are important for implementing the National Economic Empowerment and Development Strategy framework, which aims to reduce poverty by transforming subsistence agriculture to commercial agriculture (NNPC, 2004).

The Fadama II project has had limited impact on provision of production advisory services. On the other hand, the public extension service provider (the ADP) has focused on providing production advisory services using mainly a supply-driven approach. Thus, the two projects appear to be complementing each other but use different approaches. The country has used several extension approaches promulgated by donors and projects (Oladele et al., 2004). As it strives to reform its extension systems toward more pluralistic systems, the government needs to harmonize existing approaches and seek to use those that are complementary rather than conflicting (Oladele et al., 2004). Complementary approaches will certainly increase the effectiveness of the advisory services. For example, the Fadama II project has already gained experience in providing demand-driven nonproduction technologies (postharvest, marketing, and processing technologies), while the ADP has long-standing experience in providing production technologies.

However, technologies that require expensive investments with long-term pay-offs (e.g., soil and water conservation structures) may have low demand (Qamar, 2005); therefore, they may need to use the ADP supply-driven approach initially. It is also important for Fadama II to invest in providing advisory services on production technologies, because the ADP has limited funding to effectively provide such services. Provision of production advisory services will increase the returns from the large investment that Fadama II beneficiaries make when they acquire productive assets. For example, providing advisory services on fish farming could help to increase productivity of the new enterprise.

7. Conclusions and Policy Implications

In its first year of operation, the Fadama II project realized significant positive impacts on households' access to markets, transportation services, and productive assets, and to household income and of asset acquisition. Using propensity score matching and double-difference methods to control for project placement and self-selection biases, we found that Fadama II reduced beneficiaries' distance and travel time to the nearest town and reduced the waiting time and fares for transportation services, relative to nonbeneficiary households in Fadama II LGAs. Household access to productive assets increased dramatically, especially for the poorest households, largely because of the subsidy provided to help finance acquisition of such assets. Household incomes improved substantially more for Fadama II beneficiaries than for nonbeneficiaries, with an average increase in real income resulting from participation in Fadama II of about 60 percent, well above the target of at least 20 percent increase in income that Fadama II set to achieve in six years for 50 percent of the beneficiaries. About 42 percent of beneficiaries increased their incomes by at least 20 percent within one year of Fadama II implementation, indicating that the project nearly succeeded in achieving its income goal within its first year of operation.[1]

Comparison of the income impacts of the project across asset terciles showed that the project did not have a statistically significant impact on income among the poorest tercile (although the estimated coefficient was positive), despite the large and significant impacts on productive assets reportedly available to the poor. However, the project may have a much bigger impact among the poorest beneficiaries in the future because of the lagged effect of productive asset acquisition. Thus, a follow-up study is needed to capture the longer-term effects of productive assets and other changes that farmers experienced as a result of participating in the Fadama II project.

The project also had more-limited impacts on income in the humid forest and moist savannah zones than in the dry savannah zone. That could be a result of the irrigation investments that beneficiaries in the moist savannah zone demanded over other types of productive assets to address the erratic rainfall in the area. Irrigation investments have a larger impact on agricultural productivity in moisture-stressed areas than in more-humid areas.

The income impacts of the project are likely to be higher in the future because the beneficiaries acquired productive assets that are likely to increase their incomes significantly. Further, it is likely to take some time to generate the full impacts on income from investments in infrastructure, possibly by leading to changes in household livelihood strategies (e.g., increased nonfarm activities) and commercialization. The estimated effects on changes in these variables were either insignificant (in the case of nonfarm income) or counterintuitive

(in the case of commercialization). Further research is needed to assess these types of broader and longer-term impacts, after the project has had sufficient time for the impacts to be realized. This study was conducted at an early stage of the project and does not capture its lagged impacts, especially the long-term benefits of productive asset acquisition and rural infrastructure development.

The impact of the Fadama II project on productive asset acquisition is large and statistically significant across all agro-ecological zones, asset terciles, and genders. However, the change in the value of productive assets caused by participation in Fadama II was larger and more significant for jointly owned productive assets. This reflects the policy that the project used to implement the pilot asset acquisition component. The dramatic increase in the value of productive assets resulting from participation in the project was mainly caused by the cash transfer from the 70 percent matching funds that the project provides to Fadama User Groups. The large cash transfer used to implement this project raises the important question of whether this success story can be replicated.

Three major issues that need to be addressed in scaling up this success story are better targeting of poor and vulnerable groups, finding sustainable methods of promoting development of rural financial services, and increasing the capacity of *fadama* resource users to manage productive assets efficiently. These three issues are interrelated and therefore need to be considered simultaneously.

Over the first year that the project operated, the Gini coefficient of consumption expenditure for the beneficiaries decreased by about 9 percent compared with an increase of 2 percent for nonbeneficiaries. This suggests that the project contributed to reduction of consumption expenditure inequality, probably through targeting poor and vulnerable groups. Consistent with this, Fadama II also succeeded in raising the value of productive assets of the poorest asset tercile more significantly than for the other asset terciles. Even though the large increase of value of productive assets suggests that the project succeeded in targeting the poor, analysis of income showed a limited impact of the project on income among the poorer beneficiaries, as previously noted. The weak impact of the project on income of poorer households could be a result of the low capacity of the poor to use and manage the new productive assets. It is also possible that the poor borrowed money from well-off individuals who in turn asked them to pay high premiums or required other agreements that lowered their income returns.

This raises the need to help the poor to access affordable credit services. The supervision mission and the external medium-term evaluation recommended further reduction of the beneficiary contribution to 10 percent for women and the vulnerable (Anonymous, 2007a). Even though this recommendation addresses the short-term objective, it is not likely that the approach will be sustainable after the project ends. The long-term solution for the failure of the poor to pay for productive assets is affordable rural credit services. Fadama II did not involve credit service providers to help beneficiaries to pay for their contribution. There is need to involve credit service providers by helping them

to offer credit at competitive interest rates to the poor using collateral substitutes such as group repayment incentives. For example, the project could help to strengthen the provision of credit services in rural areas by using strong rural associations, as done by the Grameen Bank. The project could also help to foster credit intermediaries or to promote rotating savings and credit associations that can help the poor to access productive assets.

Addressing the low capacity of the poor and vulnerable to manage productive assets efficiently also calls for increased training and development of complementary services, such as advisory services. One of the components of Fadama II is provision of demand-driven advisory services. The project increased the demand for postharvest handling technologies but did not have a significant impact on the demand for financial management and marketing information. Fadama II reduced the demand for soil fertility management technologies, perhaps because of its emphasis on providing postproduction advisory services. As the project plans its third phase, it should consider supporting soil fertility management to enhance the effectiveness of productive assets and other interventions and to address the potential land degradation that could result from higher agricultural productivity.

Overall, the Fadama II project has achieved its goal of increasing the incomes of the beneficiaries in the first year of its operation. The project has also succeeded in targeting the poor and vulnerable in its productive-asset component, even though that did not appear to increase significantly short-term household incomes among the poorest asset tercile. The unique feature that could have contributed to the significant impact of the project in a short time is its broad-based approach, which addresses the major constraints limiting the success of CDD projects that address only one or two constraints. This has implications on planning poverty reduction efforts in low-income countries. Given that the poor face numerous constraints, a CDD project that simultaneously addresses many constraints will likely build synergies that will lead to larger impacts than will a project that addresses only one or two constraints. This suggests the need for the government and donors to pool resources and initiate multipronged CDD projects rather than many isolated projects.

Note

1. However, as noted earlier, the increase does not control for the influence of other factors that could have contributed to an increase in beneficiary income.

Appendix

Probit Regressions of Fadama II Participation (Matched Observations)

	Fadama II beneficiaries compared with:					
	All nonbeneficiaries		Nonbeneficiaries within Fadama II LGAs		Nonbeneficiaries outside Fadama II LGAs	
Explanatory variables	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**	**Coefficient**	**Standard error**
Gender (1 = female, 0 = male)	0.531***	(0.09)	0.592***	(0.11)	0.549***	(0.12)
Household size	0.021***	(0.01)	0.021**	(0.01)	0.023**	(0.01)
Age of respondent (years)	−0.001	(0.00)	0.010**	(0.01)	−0.013***	(0.01)
Level of education of respondent (years of formal education)	0.001	(0.01)	0.007	(0.01)	−0.005	(0.01)
Area of rainfed land (ha)[1]	0.000*	0.00	0.000	(0.00)	0.000***	(0.00)
Agro-ecological zone (compared with humid forest)						
Moist savannah	−0.067	(0.12)	−0.205	(0.14)	−0.088	(0.16)
Dry savannah	−0.039	(0.11)	−0.06	(0.12)	−0.121	(0.13)
Distance to all-weather road (km)[1]	0.000	0.00	0.000	(0.000)	0.005***	(0.00)
Value of productive assets[1] (Naira)	−0.000	0.00	−0.00	(0.000)	−0.00	(0.00)
Value of livestock assets[1] (Naira)	0	0.00	0	(0.000)	0	(0.00)
Constant	−0.660***	(0.23)	−0.773***	(0.27)	0.332	(0.30)
Sample size (*n*)	966		697		614	
R^2	0.037		0.048		0.097	
Prob > χ^2	0.000***		0.000***		0.000***	
Log likelihood	−606.16		−459.91		−379.97	

Source: Survey data.

[1]Quantities reported for the period before the project started.

*Significant at the 10% level; **significant at the 5% level; *** significant at the 1% level.

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