ASSESSMENT ON THE EFFECTIVENESS OF TECHNOLOGY TRANSFERS THROUGH THE USAID-AIMS PROJECT IN MOZAMBIQUE

Agricultural Input Markets Strengthening (AIMS) III

June 2015

Clara Bene Measuring Maize Yields from Her AIMS III-Supported Demonstration Plots in Sussundenga District, May 2014, Following Harvest

Demonstration Plot on Cassava in the Use of Fertilizer Blends in Ribaue, Nampula

This publication was produced for review by the United States Agency for International Development. It was prepared by Latha Nagarajan, Agricultural Economist for IFDC, supported by the IFDC Mozambique Country Team comprised of Alexander Fernando, Wilson Leonardo, Aniceto Matias and Ginga Goncalvez. The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

ASSESSMENT ON THE EFFECTIVENESS OF TECHNOLOGY TRANSFERS THROUGH THE USAID-AIMS PROJECT IN MOZAMBIQUE

Agricultural Input Markets Strengthening (AIMS) III

June 2015

This study was conducted as part of the activities of the IFDC Agricultural Input Markets Strengthening (AIMS) project, funded by USAID through the Platform for Agricultural Research and Technology Innovation (PARTI) in Mozambique (Grant BFS-G-11-00002).

IFDC demonstration farmer Tome Blaunde in Vanduzi next to his best-performing hybrid maize using IFDC improved fertilizer blends, February 2014

DISCLAIMER
The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

Table of Contents

Page

Executive Summary iii

1. Introduction 1

1.1 AIMS Project and Technology Transfers 2

1.2 Objectives of the Assessment 4

2. Method and Sampling 5

2.1 Sampling 5

2.2 Limitations of the Assessment 8

3. Results 10

3.1 Socio-Economic Characteristics 10

3.2 Access to Inputs, Technology and Information 11

3.2.1 Sources of Information on Agro-Inputs 12

3.3 Demand for Inputs 16

3.3.1 Demand for Inputs 16

3.4 Technology Transfers Under AIMS 18

3.4.1 Farm Demonstrations by AIMS Direct Participants 19

3.4.2 Adoption of New Technologies 20

3.4.3 Effectiveness of Farm Demonstrations 21

3.4.4 Adoption of Other Key Technologies by AIMS Beneficiaries 23

3.4.5 Impact on Yields of Maize – AIMS Direct Beneficiaries 25

3.4.6 Effect of Dissemination Mechanisms 26

3.5 Market-Based Dissemination Mechanisms Under AIMS 28

3.5.1 AGRIMERC Demonstrations Effect 28

3.5.2 FIPS Demonstrations Effect 31

3.6 Constraints in the Use of Inputs 33

3.7 Expectations of Farmers From Input Suppliers 34

4. Conclusions 36

Acronyms and Abbreviations

AGRA	Alliance for a Green Revolution in Africa
AGRIMERC	Agricultura e Mercados Organização para o Desenvolvimento Sustentavel (Sustainable Development Organization for Agriculture and Markets)
AIMS	Agricultural Input Market Strengthening
CSFS	Commercialized Sustainable Farming Systems
FAO	Food and Agriculture Organization of the United Nations
FIPS	Farm Input Promotions
IFDC	International Fertilizer Development Center
ISFM	Integrated Soil Fertility Management
NGO	Non-Governmental Organization
NPK	Nitrogen, Phosphorus and Potash
OPV	Open-Pollinated Variety
PARTI (PIAIT)	Platform for Agricultural Research and Technology Innovation in Mozambique (Portuguese Acronym)
SMNs	Secondary and Micronutrients
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
VBA	Village-Based Agents
VCR	Value:Cost Ratio

Assessment on the Effectiveness of Technology Transfers through the USAID-AIMS Project in Mozambique

Executive Summary

Mozambique is a low-income developing country with 80 percent of the population engaged in agriculture and dominated by smallholders. The Mozambican government has noted that development of the agricultural sector is fundamental for improving food security and reducing poverty and has implemented several programs to revitalize and strengthen the agricultural sector. Yet agricultural productivity still remains low with yields averaging less than 1 ton/ha for major cereal crops. Some of the major challenges are use of subsistence farming practices and very low use of quality seed of superior varieties, mineral fertilizers and crop protection products. Farmers' access to extension services is very limited and has declined over the past decade: 13 percent of farmers had access to extension services in 2003, and only 8.3 percent had access in 2008 (MINAG, 2010).

The United States Agency for International Development (USAID)-funded Agricultural Input Market Strengthening (AIMS) project, in all its phases of operations since 2006, has effectively demonstrated and disseminated technologies relating to seeds (high-yielding varieties and hybrids), crop management techniques (spacing, tillage, intercropping), improved nutrient management techniques (fertilizer blends, herbicide application) and post-harvest technologies to improve the profitability of smallholder agriculture in a sustainable way. AIMS, in the last seven to eight years of its operation in Mozambique, has used different approaches in transferring technologies related to soil fertility management based on the needs of the micro-niches or location and crops. AIMS technology transfer mechanisms can be described as both *demand-driven (farmer-conducted demonstrations) as well as supply-driven (agro-dealer-conducted demonstrations)* to enhance the accessibility and availability of fertilizers and other agro-inputs to smallholders.

The survey sampled from 516 farmers in the Beira and Nacala corridors who benefitted indirectly through field days and farmer-to-farmer interactions from 168 farm demonstrations conducted through AIMS between 2009 and 2013 related to soil fertility management. These were conducted exclusively in 12 districts in three provinces (Manica, Sofala and Nampula). Additionally, demonstrations were conducted

through agro-dealers during AIMS phase II (104 agro-dealers) and in phase III, partnering with the Sustainable Development Organization for Agriculture and Markets (AGRIMERC) (100 agro-dealers). AIMS project also partnered with Farm Input Promotions (FIPS) recently toward disseminating soil fertility-related technologies on an extensive scale to 36,000 smallholders, using starter or test kits in Manica province. With these partnerships, technologies were transferred through farmers and agro-dealers in 23 districts from five provinces – Manica, Sofala, Zambezia, Tete and Nampula.

The current assessment was undertaken knowing the effectiveness of technology transfers through the USAID-funded AIMS project in the last five to six years in Beira and Nacala corridors. Such an assessment would provide a few key meaningful insights on streamlining technology-related rollouts – in particular, on soil fertility management issues in the target areas – along with the opportunity to understand small farmers' access to and demand in the use of agro-inputs. Considering the logistical limitations on time and resources, we decided to conduct the assessment on technology transfers through AIMS and its partners in 14 districts from four provinces, viz., Manica, Sofala, Tete and Nampula.

On analyzing the effectiveness of AIMS technology transfers, we were able to compare three groups of farmers, viz., direct beneficiaries, or lead farmers of AIMS who conducted demonstrations in their fields, and indirect beneficiaries who attended the field days conducted by the AIMS direct farmers. We compared these two categories with – a "control" group of farmers who had no previous exposure to farm demonstrations conducted by AIMS or other projects. The assessment also included responses from AIMS partners such as FIPS and AGRIMERC, through whom technologies were disseminated among farmers. Our final assessment sample consists of farmers (143) and agro-dealers (18), covered through AIMS, AGRIMERC and FIPS programs from Beira and Nacala corridors. The final assessment sample is made up of 54 AIMS direct beneficiaries, 25 indirect AIMS farmers and 23 (control group) non-AIMS farmers. In addition, we interviewed 41 farmers who benefited from applying FIPS-technology input kits and agro-dealers who conducted successful demonstrations in partnership with AGRIMERC.

A. Comparison of Direct vs. Indirect vs. Non-Beneficiaries of AIMS Project

Characteristics of Farmers

- Overall we found that more than 20 percent of beneficiary farmers in the sample were female farmers. AIMS in general encouraged women farmers' participation in technology transfers – of our total sample of direct AIMS participants (168), we had more than 30 % women engaged in demonstrating technologies.

- The mean age of the farmer-participant ranged from 36 to 46 across the groups, indicating a relatively young age of the population in the surveyed areas.
- The average size of the household was seven across all three groups of farmers sampled; farming was the primary occupation among the adults in the family. Almost all were smallholders with an average cultivable area of 2.8 to 4 hectares (ha).
- Survey results further indicate that there is a significant reduction in distances to access agro-inputs in the last five years across all three categories. More than 50 percent of the respondents in all three groups revealed that compared to five years previous, they could currently access inputs within 10 km of their location. The major reasons attributed were improved road and input retailers network in the last five to six years.
- Farmers in our surveyed locations responded that the nearest asphalt or tarmac road to their location is as far as 11.2 km (in Nampula province) and as close as 1-2 km (Manica province) among all the locations surveyed.
- Sixty-eight percent of the respondents among the groups surveyed found access to at least one agro-dealer or input supplier shop within their communities of a 5- to 6-km radius.
- The majority of farmers surveyed usually bought inputs for vegetable cultivation year round; field crops like maize, beans and cassava (on a limited scale in the recent years) are the three major crops for which farmers usually buy external inputs.

Access to Information and Inputs

- The AIMS direct participants used both traditional – informal sources of information that include neighbors and farmers in their communities – and formal sources like agro-input shops, the government extension system, non-governmental organizations (NGOs) and mass media.
- Sixty-four percent of AIMS direct beneficiaries owned mobile phones compared to only 32 percent of indirect AIMS beneficiaries and 19 percent of the non-AIMS beneficiaries.
- AIMS direct participants have benefitted mostly from interacting with government extension officers (24 percent) and also with farmers in their communities (26 percent) vs. 80 percent among indirect AIMS beneficiaries and 69 percent of non-participants of AIMS. AIMS participants in general had access to many sources of information, apart from extension officers.
- Thirteen percent of AIMS direct participants also received information from agro-input dealers compared to only 4 percent of AIMS indirect participants.

- Of the control group farmers, apart from neighbors, they also accessed information on inputs by their interactions with government extension (13 percent) and agro-dealers and local market traders (9 percent each).
- We further found that there were very few extension services in Mozambique rural areas and only 30 percent of AIMS direct, 44 percent of indirect and 24 percent of non-AIMS could meet an extension officer once a month. More than 50 percent of farmers surveyed could contact their extension personnel only on a yearly basis.
- The source(s) of input purchases varied among the three groups. The AIMS direct farmers purchased directly from input suppliers within and outside their district. The indirect participants depended heavily on suppliers within their own district and the government agencies. The non-participants used agro-dealers in their local communities as their major source of inputs purchases.
- Agro-dealers and government agencies play a significant role in inputs provision, especially among input voucher beneficiaries. In our sample, voucher participation was highest among non-participants (41 percent) vs. indirect participants (32 percent) and direct AIMS participants (27 percent).

Demand for Inputs

- Irrespective of categories, all farmers demanded improved maize seeds.
- Farmers who were directly involved in AIMS, in conducting demos demanded more external inputs for maize crop - such as seeds (70%) and fertilizers 41% and purchased them from various sources.
- Over all the demand for fertilizers is higher among AIMS direct beneficiaries and also found higher among indirect beneficiaries of AIMS project, who had observed the performance of fertilizers that enhances yields.
- The “awareness in technical knowledge and its use” played a crucial role toward demand for inputs. The AIMS direct beneficiaries had better knowledge through conducing demos, and also access to various sources of information.

B. Effectiveness of Technology Transfers Through AIMS

The USAID-AIMS project disseminated the technologies related to soil fertility and crop management conducting farm demonstrations at the farmer’s level (AIMS direct participants) and influenced other (indirect) farmers in the communities through field days; demonstrations were also conducted through agro-dealers or input suppliers in the farming communities. To have a wider impact since the 2013-14 cropping season, the AIMS project also partnered with other development partners such as FIPS (in Manica province) and AGRIMERC.

- Of 54 farmers who conducted demonstrations on soil-related (integrated soil fertility management [ISFM], commercialized sustainable farming systems [CSFS]) and other crop management technologies, 67 percent of them have conducted demonstrations under AIMS at least once and the rest conducted demonstrations more than once since 2007-08.
- Most conducted demonstrations on new seeds, use of fertilizers and crop management technologies (spacing, herbicides, planting time, intercropping) related to three prime crops – primarily maize and beans in Beira corridor and maize, beans and cassava in Nacala.
- Of the participants, the effect of demonstrations on AIMS direct participants was evident toward the continued use of improved maize seeds (22-91 percent); 16-72 percent among indirect beneficiaries since demonstration.
- The adoption of improved varieties of bean also improved significantly among AIMS direct and indirect participants.
- The fertilizer use also had increased, especially among indirect participants – "Farmers have started using fertilizers for crops other than maize."
- We found that 64 percent of AIMS direct and 36 percent of indirect beneficiaries still practice one or more technologies that they demonstrated for the project.
- The farmers in Beira corridor are much more active in the use of new technologies for maize especially compared to farmers in Nacala corridor.
- The most popular technology adopted (80-90 percent adopted) more widely by direct and indirect beneficiaries across all three crops is spacing, followed by right planting time for maize.
- Eighty-five percent of AIMS direct beneficiaries realized increased yields (141 kg/ha) by adopting improved spacing and planting methods alone, and adoption of seeds and NPK blends resulted in yield increases of 220 kg/ha for maize grown during the 2012-13 cropping season.
- Seventy-two percent of AIMS indirect beneficiaries shared information on technologies they learned from direct participants.
- AIMS-based technologies demonstrated through its partners also had a significant impact on yields and input sales, especially among dealers of the AGRIMERC project in Beira corridor.
- Dealers also apparently benefitted by increased sales of inputs in their shops after demonstrations at their locations.
- Another partnership of AIMS with the FIPS project also yielded a significant impact toward increased knowledge of agro-input use among farmers in a more extensive coverage.

- We found more than 50 percent of FIPS beneficiaries in our sample showed a keen interest in adopting simple crop management techniques such as right time of planting and proper spacing in the following seasons.
- Though only 24 percent showed a willingness to adopt fertilizers for maize cultivation, they further expressed the importance of fertilizers toward improved yields.

C. Constraints Toward Adoption of Technologies

- Lack of cash toward purchase of inputs during planting season was the major constraint affecting all the groups of farmers interviewed in our assessment.
- There is still a huge gap in the provision as well in the availability of technical knowledge in the use of inputs and technologies.
- In the absence of public agricultural extension services, farmers often rely on other sources for reliable information in the use of technical inputs.
- While government and donor-aided programs have been effectively engaged in successful technology transfer activities, there is still a huge demand for technical knowledge in the use and availability of inputs. Other constraints related to output markets also exist.

One can conclude that though donor-driven technology transfer programs operate on a very limited scale, the contribution toward adoption of improved inputs cannot be underestimated. This is evident from the current assessment, which clearly shows that in general both farmers (direct and indirect beneficiaries) and agro-dealers in the AIMS target districts perceived an increased demand for agricultural inputs among farmers in the last five years. For example, among the direct beneficiaries of AIMS, the average use of fertilizers for maize has increased from as low as a half bag (25 kg) to two bags (100 kg) – combination of 12:24:12 and urea. In the case of indirect beneficiaries, this amount still remains around one bag of fertilizer use in maize from "almost nothing five years back." The increased use of inputs can be attributed to improved access to farm inputs, i.e., the distance traveled by farmers to access farm inputs has reduced substantially with improved dealer networks, as well as increased awareness through demonstrations and extension. In the absence of vibrant extension services, there is need for such programs to bridge the gap and provide the required technical knowledge to small farmers.

In summary, one could clearly see the evolution of technology transfer approaches of the AIMS project since phase I in 2006-07 until now in three ways:

- Increased use of inputs, particularly use of improved seeds and fertilizers among major crops – maize and beans.

- Improved efficiency and uptake of soil nutrients through better crop management practices (ISFM).
- Improved adoption of better inputs through increased soil nutrients efficiency (e.g., blends, secondary and micronutrients [SMNs]) that are profitable to smallholders through better input value chains.

"If the goal is to develop balanced fertilizer recommendations for a wider area, there is an urgent need for development of soil maps to better understand macro-, secondary and micronutrient deficiencies to address the yield-limiting factors to scale up the fertilizer recommendations." Technologies related to soil should be equally supported through improved planting material – still there exists a huge gap in adopting good quality seeds. Future activities, need a more comprehensive approach that addresses the key issues of soil fertility and subsequent fertilizer use among smallholders at a much more localized scale. The approach should utilize best-bet technologies that are adoptable and create incentives for continued adoption.

Assessment on the Effectiveness of Technology Transfers through the USAID-AIMS Project (2008/09 - 2013/14) in Mozambique

1. Introduction

To successfully increase agricultural productivity in a sustainable manner, development and adoption of best agricultural practices or technologies are a prerequisite. Most smallholder farmers have very limited or no experience with improved seed and mineral fertilizers. Millennium Development Goals (2005) also articulate the need for building efficient input delivery mechanisms and improved technologies to poor farm households to improve food security. In Mozambique, apart from low input use among farmers, knowledge of best agricultural practices is limited.

Farmers generally benefit from the adoption of any new technologies that can lower production costs but improve use of inputs, which lead to higher production. New technology, such as new crop varieties or use of fertilizers, may change the optimal levels of inputs used. Thus, an understanding of the effect of new varieties on input demand and productivity is crucial for better understanding of potential diffusion of the technology among farmers. Widespread adoption of new production technology might also be expected to have important market effects.

It is well known that the efficiency of fertilizer use on maize in sub-Saharan Africa (SSA) is considerably higher on experiment station plots and researcher-managed farm trials than on plots managed exclusively by smallholders. Often technology transfer mechanisms disregard this fact and make a huge mistake of scaling out or transferring such technologies directly to farmer-level adoption. Also, there are certain technology transfer mechanisms that are very efficient in terms of their use, but the rollout programs more often do not foresee the supply-side issues related to delivering such technologies on a sustainable basis. These programs usually run into failures resulting in no adoption or low adoption of “improved inputs” among smallholders. Hence, it is important to design technology transfer programs effectively to address the needs of the smallholders, taking into account the constraints (economic, farm and market) on improving productivity, efficiency and profitability of crop enterprises.

The USAID-funded Agricultural Input Market Strengthening (AIMS) project has been in operation in Mozambique since 2006, with an overall objective to *establish open and competitive markets and input*

networks as the primary mechanisms to improve farmer access to appropriate agricultural technologies for accelerated growth in agricultural production in Mozambique. To achieve this objective, AIMS, in all three phases of its operations (2006-2014), emphasized effective technology transfer mechanisms to improve farmer demand and access to quality inputs.

1.1 AIMS Project and Technology Transfers

The USAID-funded AIMS project, in all its phases of operation since 2006, has effectively demonstrated and disseminated technologies relating to seeds (high-yielding varieties and hybrids), crop management techniques (spacing, tillage, intercropping), improved nutrient management techniques (fertilizer blends, herbicide application) and post-harvest technologies to improve the profitability of smallholder agriculture in a sustainable way.

During *phase I (2006-2008)* of the project, AIMS was interested in improving the crop productivity levels of selected cereals (maize, rice) and legumes (pigeon pea, cowpea) in target areas of Beira and Nacala corridors. The role of the IFDC-implemented AIMS project was to improve the availability and accessibility of farm inputs (primarily seeds) by developing a strong supplier network. Hence, most of the technology demonstrations were focused on using improved seeds of maize and legumes in smallholder farms, establishing the impact in terms of yield and economic potential. This approach was modified during *phase II (2009-2012)* of the AIMS project, as the Platform for Agricultural Research and Technology Innovation in Mozambique (PARTI) members realized the need to improve fertilizer use among farmers to enhance productivity levels. Given the low fertility status of soils in Mozambique compared to other SSA countries, during this phase much emphasis was placed on transferring technologies to soil fertility management – which included dissemination of integrated soil fertility management (ISFM) practices. It is proven that in Africa, the adoption of ISFM has a high potential to increase the agricultural productivity and income of smallholder farmers in a sustainable manner. During *phase III (2012-14)* of AIMS, the project was implemented by partnering with like-minded organizations (AGRIMERC, FIPS and others) engaged in technology transfer to achieve wider impact.

AIMS in *phase III (2012-2015)* built on AIMS I and II but with a slightly different focus. AIMS III is an integrated program for technology generation and transfer that builds improved public research and development capacities and a skilled private agricultural sector. Specifically, it seeks to strengthen the capacities of public sector partners to develop and transfer best practices for commercialized sustainable farming systems (CSFS) to improve the profitability of smallholder agriculture. This approach helped AIMS to achieve two things:

- *First*, to disseminate profit-driven, efficient technologies to farmers by linking through existing public or donor-driven input development programs (e.g., input voucher programs, Alliance for a Green Revolution in Africa [AGRA]).
- *Second*, to partner with private firms engaged in production, commercial input suppliers and other stakeholders in the input value chain to ensure sustainability of input supply – thus, improving both access and availability issues related to agro-inputs. In other words, improving the farmer access to inputs in a sustainable way.

Commercialized Sustainable Farming Systems (CSFS) is an approach followed in AIMS phase III that provides a context for developing profitable farming systems, of which ISFM (AIMS II) is a component. While ISFM focused on development and demonstration of locally adapted technologies that address increasing productivity and nutrient use efficiency, CSFS is a market-driven approach that combines both agronomic and economic efficiencies to optimize the overall value-cost ratio (VCR). The rationality behind CSFS is that of profit-driven adoption. One of IFDC's soil fertility technologies supporting the CSFS approach is to demonstrate new improved fertilizer blends as an alternative for the traditionally recommended fertilizer (NPK 12:24:12 for maize and single superphosphate [SSP] for soybean) as well as testing of new fertilizer blends for cassava stem and root production. These blends are designed to maximize farmer return on investment (profits) by delivering soil- and crop-appropriate nutrients, including micronutrients.

To achieve the above, AIMS adopted two major mechanisms of dissemination. The first was conducting demonstrations at the farm (er) level by farmers (popularly known as farmer demonstrations). In this, the lead AIMS farmer will be assisted for a cropping season on his own plot of land in designing experiments on different AIMS technologies called "treatments" along with a "control plot" – "no technologies used or the existing state of use" to compare and show the effects of such technologies. During this process, farmers were also encouraged to conduct field days – inviting fellow farmers from their own and neighboring communities to observe the "treated" vs. "control" plot to assess the impact of such new technologies.

In addition to this, AIMS also followed another approach, i.e., demonstrating technologies through agro-dealers or input suppliers. As more farmers become aware of new technologies, there is always a demand for such "improved inputs." However, if the markets are not there or are poor in supplying such inputs, the adoption will be very low. In order to build an effective input supply system based on a demand-driven approach, AIMS trained agro-dealers or input suppliers on conducting farm demonstrations in the farming communities to improve the accessibility to inputs continuously.

1.2 Objectives of the Assessment

The programs designed to transfer technologies, especially soil-related, are often complex and it's difficult to know their impact. The mechanisms involved in transferring such technologies need intensive capacity building activities, i.e., training farmers in understanding the knowledge and constant follow-up to ensure proper adoption. AIMS technology transfer mechanisms can be described as both *demand-driven (farmer conducted demonstrations) as well supply-driven (agro-dealer conducted demonstrations).* The current assessment was undertaken to understand:

- To what extent farmers have access to inputs, information and knowledge.
- The effectiveness of such AIMS technology transfer mechanisms on yields, farm-level adoption of inputs and demand for such inputs.

2. Method and Sampling

Measuring the effectiveness of a project in developing and transferring improved technologies to end-users is an important step in assessing its impact. Under AIMS, we adopted two kinds of approaches in transferring technologies – farm demonstrations of profitable, best input technologies through farmers and agro-dealers. The eventual impact is on improved use or adoption of technologies by farm households.

The survey sampled from 516 farmers in the Beira and Nacala corridors who benefitted indirectly through field days and farmer-to-farmer interactions from 168 farm demonstrations conducted through AIMS between 2009 and 2013 related to soil fertility management. These were conducted exclusively in 12 districts in three provinces (Manica, Sofala and Nampula). In addition, demonstrations were conducted among agro-dealers during the phase II (104 agro-dealers) and in phase III with their partners – AGRIMERC covering nearly 100 agro-dealers. AIMS in partnership with FIPS, has also started demonstrating the use of effective fertilizer technologies among 36,000 smallholders – through seed and fertilizer starter or test kits. With these partnerships, technologies were transferred through farmers and agro-dealers in 23 districts from five provinces – Manica, Sofala, Zambezia, Tete and Nampula.

2.1 Sampling

In response to USAID's request for impact indicators from AIMS activities and to inform the next phase of the platform and USAID-funded activities, IFDC decided to undertake an impact assessment of USAID-funded technology transfer activities through existing AIMS funding. During October-December 2014, plans were made and IFDC Mozambique staff subsequently undertook rapid technology transfer assessment surveys.

During our agro-dealer assessment, we also held a few focus group discussions in Beira and Nacala corridors where the dealers conducted farm demonstrations to disseminate technologies. These focus group discussions also served as a pre-testing tool to know the various sources through which farmers received technical information on agro-inputs use. Based on those discussions as well as from our own experience with the AIMS project, we decided to include three different types of farmer-participants in the technology transfer assessment surveys. They are direct beneficiaries of the AIMS project, indirect beneficiaries of the AIMS project and non-beneficiaries of the AIMS project.

- Direct beneficiaries are the farmers who partnered with the AIMS project to conduct farm demonstrations.

- Indirect beneficiaries are the farmers who benefitted from attending technology trainings and field days conducted through farm demonstrations and benefited.
- Non-beneficiaries are farmers who never attended any farm demonstrations conducted by AIMS, its partners or other sources.

Considering time, budget and logistical constraints, it was decided to conduct a rapid assessment on knowing the impact of technology transfers undertaken primarily by AIMS, and to an extent through its partners, among direct, indirect and non-AIMS beneficiaries in 14 districts from four provinces (Manica, Sofala, Tete and Nampula).

Our final assessment sample consisted of farmers (143) and agro-dealers (18) covered through AIMS, AGRIMERC and FIPS programs. The final assessment sample is made up of 54 AIMS direct beneficiaries, 25 indirect AIMS farmers and 23 (control group) non-AIMS farmers. In addition, we interviewed 41 farmers who benefited through adopting FIPS-technology input kits and agro-dealers who conducted successful demonstrations in partnership with AGRIMERC. The final sampling on direct participants represented 32 percent of total sample size, selected randomly across these 12 districts. In the case of indirect and non-participants, the sampling was representative as the numbers are larger to carry out proportionate sampling. The same holds true in the case of FIPS and AGRIMERC participants also.

Table 2.1. Sampling Details for Technology Transfer Assessment Work

Farmer-Beneficiaries	Beira	Nacala	Total
AIMS Direct	19	35	54
AIMS Indirect	10	15	25
Non-AIMS	15	8	23
FIPS	41	0	41
AGRIMERC*	18	0	18

Note: * The sample here refers to agro-dealers; in all the other categories, sample refers to farmers.

The survey instruments were designed separately for direct, indirect and non-AIMS participants and pre-tested during focus group discussions. Our main focus was to capture the effectiveness of AIMS technologies (seed, soil and crop management related) that were transferred through farm demonstrations and field days conducted by farmers in the last five years. Hence, this survey focuses mainly on activities conducted through AIMS on technology transfers between the 2008/09 and 2012/13 seasons.

Focus Group Discussion with Farmers in Malema District, Nampula

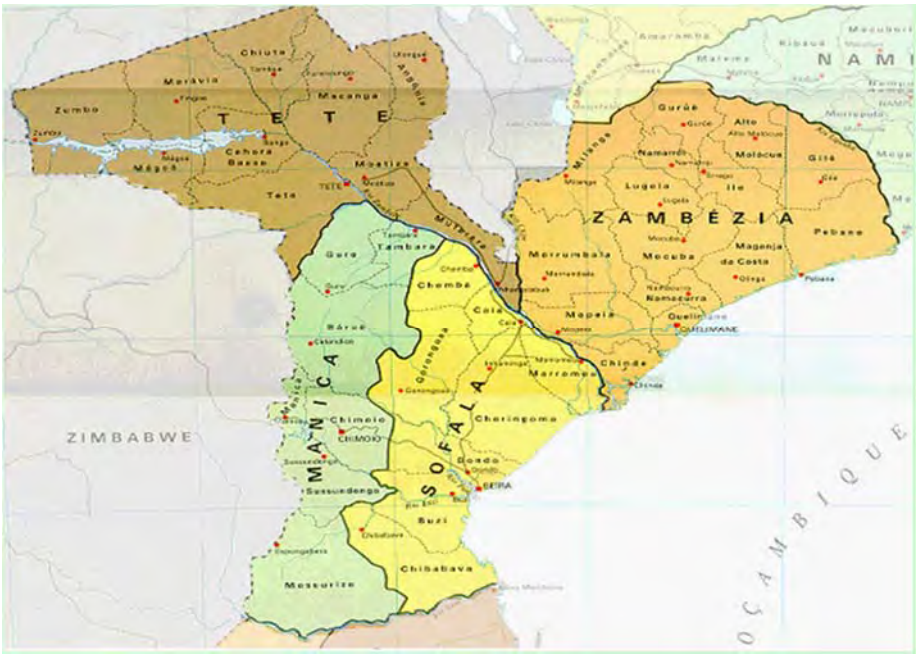
The surveys consisted of questions on capturing few key socio-economic details related to their demography, education and labor participation and land particulars as well as inquiring about farmers' current access to agro-inputs, technologies and information. It was also important for us to understand the existing demand for agro-inputs to know their perceptions on input use. In order to know the effectiveness of AIMS technology transfers or farm demonstrations, which affects their yields and input demand, we asked specific questions related to the adoption of technologies that were demonstrated through the AIMS project. We also discussed in detail the constraints farmers face in the adoption of technologies learned through these demonstrations in addition to the services they expect from the input providers of such technologies.

We also designed separate survey instruments for FIPS and AGRIMERC participants in order to capture information of their impact on farmers' demand and use of agro-inputs and AIMS technologies transferred through them.

Enumerator conducting technology transfer assessment in Mecubari district, Nampula

2.2 Limitations of the Assessment

Also, the AIMS project, in phase III from 2012/13 onward, has undergone significant improvement in terms of introducing new, innovative technologies related to soil fertility – such as introducing new crop-specific fertilizer blends, including new crops in the soil fertility management (e.g., cassava, soybean). The assessment could not capture the complete impact or effect of such technologies among farmers. Most of these technologies are part of an extensive rollout which was the focus of the later years of AIMS III. So the current assessment may not provide any precise impact toward demand for such products or technologies. However, from our observations, it provided a few key insights to carry forward toward any future implementation. Also, partnerships of AIMS with FIPS, AGRIMERC and other partners are of very recent origin (the past two seasons – 2013/14 and current season). We did not emphasize much toward exploring their effectiveness in detail. Also, both AGRIMERC and FIPS have concentrated their efforts mainly in Beira corridor, mostly in Manica province (FIPS) and to a limited extent in Sofala, Zambezia and Tete by AGRIMERC. Hence, comparing the effectiveness of AIMS activities uniformly across all the projects was also a constraint, as the mode of operations and coverage of these projects differs widely across locations.



Map 1. Provinces in Beira Corridor Covered by AIMS (Manica, Sofala, Zambezia), FIPS (Manica) and AGRIMERC (Tete, Sofala, Zambezia)

Map 2. Nampula Province in Nacala Corridor Covered by AIMS (Nampula)

3. Results

In this section we present key findings from our surveys assessing the effectiveness of technology transfers through the USAID-AIMS project. As described in section 2, this is primarily compared across three sets of beneficiaries of the project viz., direct beneficiaries of AIMS; indirect beneficiaries who observed or participated in few activities conducted by direct beneficiaries; and as a control group of farmers who never participated in any of such technology transfer programs related to improved use in these communities. The fourth category of farmers included in our analysis, viz., FIPS project beneficiaries. During the year 2013-14, AIMS partnered with the FIPS project in transferring a few of the technologies related to soil fertility and crop management.

3.1 Socio-Economic Characteristics

One of the objectives of the AIMS project is to improve the participation of women in the use of new, improved technologies thus enhancing their ability to participate in the economic decision making of the household. We found significant numbers of women (20 percent or more) were engaged in conducting farm demonstrations across all the groups and they were actively involved in adoption as well as in sharing their knowledge with others in the communities where they live. AIMS in general encouraged women farmers' participation and though our current sample reflects less participation compared to other groups, in our total sample, we had more than 30 % women engaged in demonstrating technologies.

Table 3.1. Characteristics of the Sample Farmers Surveyed

Characteristics	AIMS Direct	AIMS Indirect	Non-AIMS
Total farmers surveyed	54	25	23
Female	22%	44%	35%
Male	78%	56%	65%
Age	46	42	36.4
Educational status			
None	13%	20%	17%
1-5 grade	44%	56%	43%
6-10 grade	43%	20%	30%
>10 grade	0%	4%	0%
Household size (mean)	7	7	7
Male	4	4	4
Female	4	4	3
<14 years	4	4	4
On-farm/off-farm participation of household			
On-farm	100%	100%	100%
Off-farm	7%	12%	22%
Mean cultivated area (2013-14 season) ha	4.0	3.6	2.8

Most of the farmers were relatively young across all the groups of farmers, and their average age ranges from 36 to 46 years of age. It is often the case that the young farmers are always interested to learn new technologies. Most of the farmers surveyed in our sample were educated; nearly half of them had completed at least an elementary education. Almost all the farmers engaged their own family members in the farming operations, and very few of them were engaged besides farming (outside the farm activities). The average size of the household is seven, and half of them are adults who are primarily involved in farming activities. Most of the farmers were smallholders with an average cultivable area of 2.8 to 4 ha – which also contributes to involving more family members in the farming operations, thus avoiding hired labor expenses.

3.2 Access to Inputs, Technology and Information

One of the major reasons for low agro-inputs usage is the lack of access to source inputs at the right time, i.e., during the cropping season. Our recently concluded assessment on agro-dealer development in Mozambique found that there is significant reduction in distance traveled in sourcing of inputs by farmers both in Beira and Nacala corridors. It further found that since 2006, with increasing number of input retailers operating in northern and central Mozambique (with donor and government supported programs supporting input suppliers network development), and currently the average distance to access inputs is around 30 km (longest distance being 60 km). But compared to other countries in the region – eastern and southern Africa, the density of input suppliers in Mozambique is very low.

Table 3.2. Distance(s) Traveled by Farmers to Purchase Agro-Inputs (Now vs. Five Years Back)

Distances Traveled (km)	AIMS Direct		AIMS Indirect		Non-AIMS	
	Now	5 Years Back	Now	5 Years Back	Now	5 Years Back
0 to 5	35%	17%	39%	19%	53%	33%
5 to 10	12%	8%	28%	13%	26%	11%
10 to 20	24%	25%	22%	44%	16%	28%
>20	29%	50%	11%	25%	5%	28%

From our survey analysis (Table 3.2), it is evident that the situation has improved tremendously over the last five years among farmers in Manica and Nampula provinces. The farmers responded that the distance to access agro-inputs have been significantly reduced. More than half of the respondents could access inputs required for cropping within 10 km of their location. This proportion is higher among non-AIMS participants, who are also aware of the significant reduction in the distances traveled to access inputs. One

of the major reasons is due to new road development, especially in Beira corridor, along with improved input retailers' network due to efforts of donor-driven agro-dealer development programs (AIMS, AGRA) supported further by government programs in the last five to six years. Farmers in our surveyed locations responded that the nearest asphalt or tarmac road to their location is as far as 11.2 km (in Nampula province) and as close as 1-2 km (Manica province) among all the locations surveyed. Also, it was evident that 68 percent of the locations and farmers in our survey have access to at least one agro-dealer or input supplier shop in their communities. In other words, each of these villages or locations has at least one agro-dealer shop.

In general, farmers in our sample purchased inputs toward cultivation of vegetable crops all through the year; among the field crops, maize, cassava and beans are the three major crops that induced farmers to participate in input markets, especially during the main cropping season. Farmers in our sample have all accessed input markets using different modes of transportation, ranging from foot to motorcycle and from bicycle to public transportation. The farmers located in Nacala corridor have mostly used motorcycle or public transportation to reach input markets, since the villages are located far from the nearby towns or commercial centers (as far as 60 km). Farmers in Manica province traveled by foot (20 percent), bicycle (24 percent) and motorbike (18 percent); the rest of them used a combination of public transportation, bicycle and foot.

3.2.1 Sources of Information on Agro-Inputs

In most of the sub-Saharan African countries, there are few government-sponsored extension mechanisms and the ones available are very weak. Hence, farmers search for information on new varieties, technologies and crop management practices from a variety of sources, including formal and informal institutions. It was evident from our surveys that the project participant-farmers of AIMS have more sources of information compared to other groups of farmers. In general, the AIMS direct participants used both traditional – informal sources such as neighbors and farmers in their communities to agro-input shops and the government extension system; they also benefitted by participating in NGO-sponsored agri-development activities and mass media (radio primarily). Notably, among the AIMS direct beneficiaries, 64 percent (34 of 54) have owned mobile phones. This proportion was much lower among indirect AIMS beneficiaries (32 percent), and only 19 percent of the non-AIMS beneficiaries had access to a cell phone.

AIMS direct participants have benefitted mostly from interacting with government extension officers (24 percent) and also through exchange of information with farmers in their communities (26 percent); they also participated in NGO-sponsored demonstrations (e.g., IFDC and its partners) regarding agro-

input use. The AIMS participants also received information from agro-input dealers (13 percent) as they interacted frequently when purchasing inputs, compared to 4 percent AIMS indirect participants who used agro-dealers as the source of technology and information. Eighty percent of indirect AIMS beneficiaries sourced information regarding the use of agro-inputs and technology mostly from their neighboring farmers or from their own community. AIMS participants in general have many other sources to access information compared to indirect and non-participants as evident from figure 3.1.

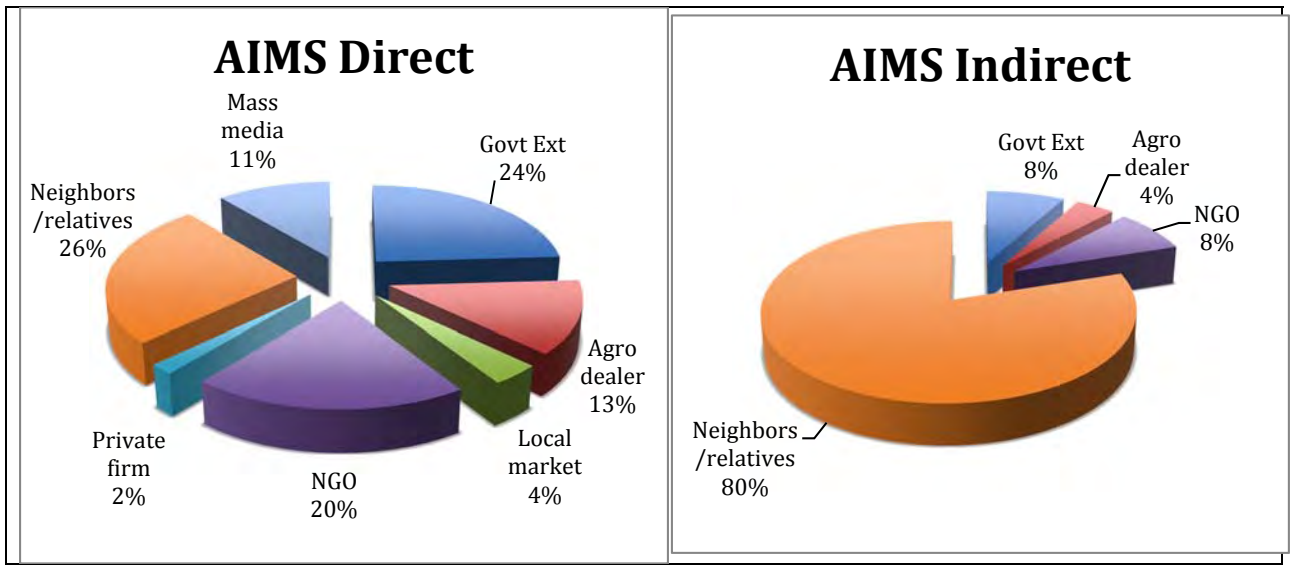
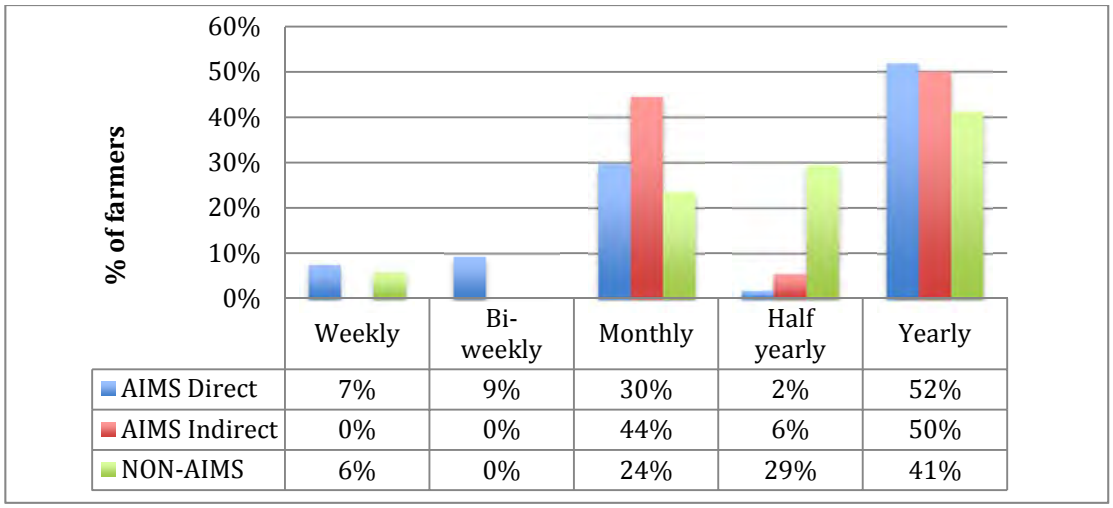


Figure 3.1. Sources of Information on Agro-Inputs

Neighboring farmers or farmer-relatives were the major sources of technical information on agro-inputs for 69 percent of the non-participant farmer group (i.e., control group). This was followed by their interactions with government extension personnel from time to time (13 percent) and agro-dealers and local market traders (9 percent each).

Of the formal means of technology transfers, government extension personnel play a key role toward disseminating technologies or exchange information with farmers periodically. However, the government extension system is very weak or thin in Mozambique. The number of extension personnel serving the farmers in each locality is far stretched (one extension officer per 5,000 farmers). However, they are still the primary sources through which genuine and reliable information regarding agro-inputs are exchanged among farmers.



	Weekly	Bi-weekly	Monthly	Half yearly	Yearly
AIMS Direct	7%	9%	30%	2%	52%
AIMS Indirect	0%	0%	44%	6%	50%
NON-AIMS	6%	0%	24%	29%	41%

Figure 3.2. Frequency of Contact with the Extension Agency on Agro-Inputs Information

For instance, from our surveys we found that most of the farmers could contact or see an extension officer once in a month (30 percent of AIMS direct, 44 percent of indirect and 24 percent of non-AIMS), and half of the farmers surveyed in our sample could contact their extension personnel on a yearly basis. There are many reasons for this, from a low number of extension personnel available per farmer or farming community to lack of awareness among farmers about the services offered through them.

In general, the farmers purchased or accessed their inputs from the source information, i.e., from government extension agencies, local markets and input suppliers located in their own village or in district headquarters. However, the purchase sources vary with the type of inputs, i.e., seeds, fertilizers or chemicals. In the case of AIMS direct participants, most of them purchased or accessed from input suppliers from outside their district, where they live and also depend on agro-dealers in their locations and district headquarters.

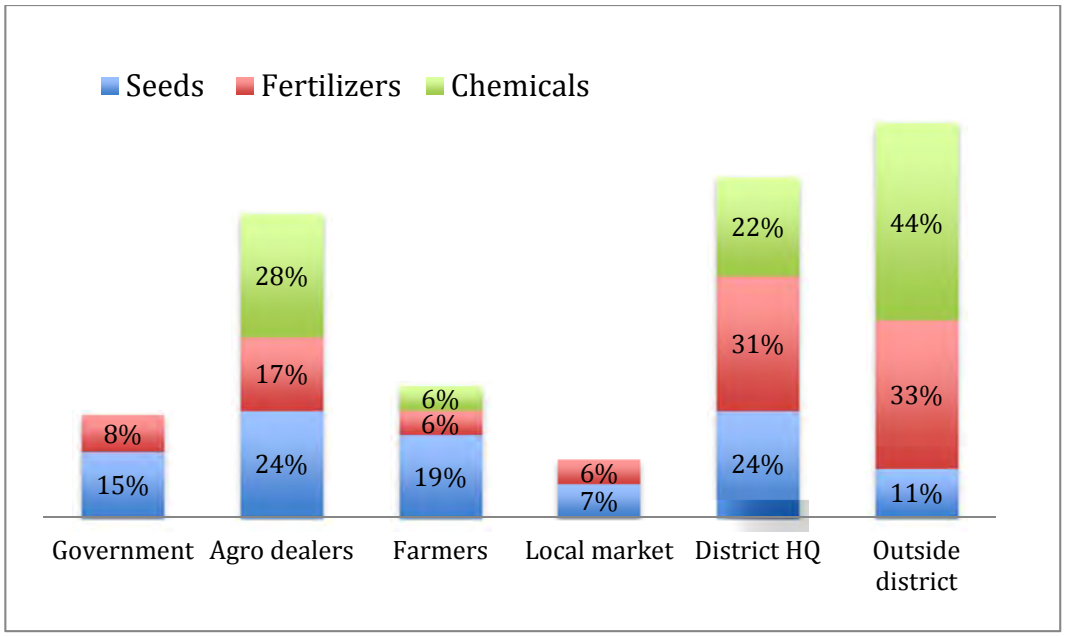


Figure 3.3. Sources of Agro-Inputs Purchase (AIMS Direct Beneficiaries)

The indirect and non-participants of the AIMS project significantly differ in the sources where they access or purchase the agro-inputs. The farmers who benefitted indirectly or were influenced through AIMS beneficiaries purchase their inputs mostly from input supplier shops located at the district headquarters. This has been the case in both Beira and Nacala corridors. Most of the farmers in Beira corridor traveled to Chimoio (from Manica province) or Beira town (Sofala province) where five to six input suppliers (wholesale or distributors) are located. In the case of Nacala, most of them purchased inputs from district headquarters, since the input suppliers in Nacala are more concentrated in district headquarters or in major towns than in remote areas.

Agro-dealers and government agencies also play a significant role in the provision of inputs – especially to farmers who receive benefits through input voucher programs. The role of agro-dealers is very significant in the case of non-AIMS participants as they accessed and purchased almost all their fertilizer (63 percent) and chemicals (83 percent) from these shops. In addition to input suppliers, nearly 25 percent of *farmer exchanges or purchase of seeds from lead farmers or seed producers in the villages* were very common and evident in all categories of farmers.

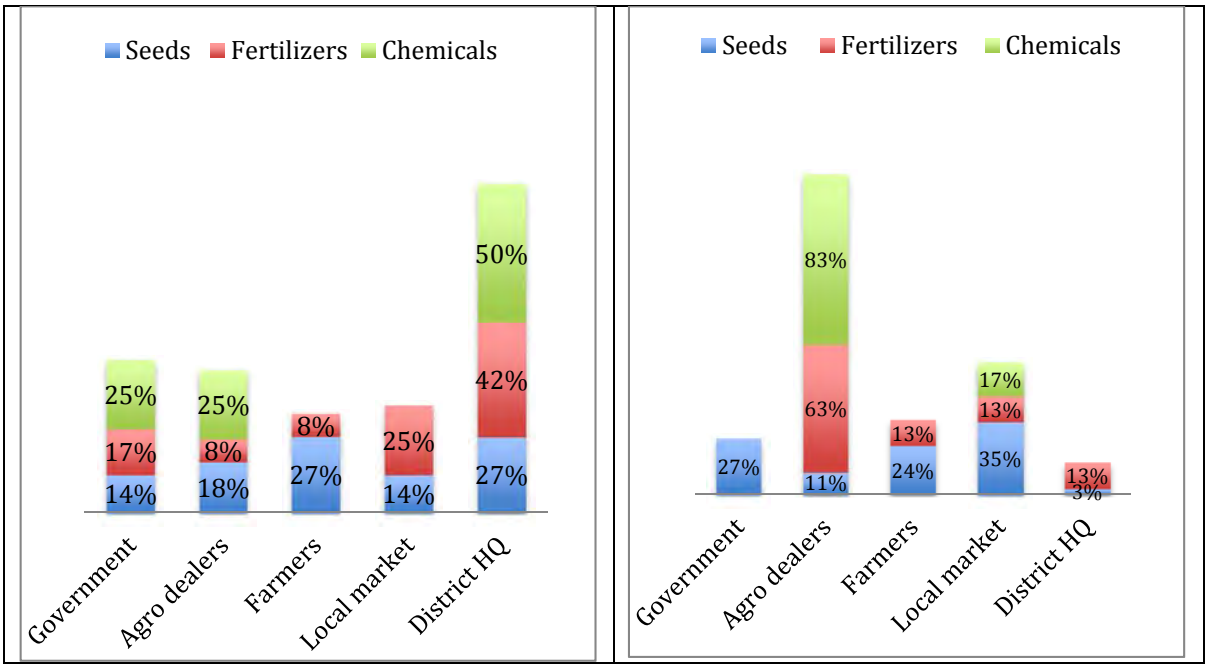


Figure 3.4. Sources of Agro-Inputs Purchases (AIMS Indirect [left chart]) vs. Non-AIMS Beneficiaries (right chart)

In addition, the purchase and use of agro-inputs for the crops were also influenced by participation in input voucher programs. Input voucher participation was highest among non-participants of AIMS (41 percent) vs. indirect participants (32 percent) and direct AIMS participants (27 percent).

3.3 Demand for Inputs

Increased crop yields are often held back by inadequate use of modern inputs, improved technologies and appropriate crop management practices. In spite of efforts to increase access to knowledge and inputs by several programs, the input use or demand for improved inputs is still low among farmers in Mozambique. Therefore, we further probed AIMS beneficiaries vs. non-beneficiaries regarding their demand for "two major external inputs" – that enhance productivity, viz., improved seeds and fertilizers in our assessment.

3.3.1 Demand for Inputs

Overall there exists a continuous demand throughout the year for the seeds of improved vegetable crops among farmers in the surveyed regions. However, we were interested in determining the demand for field crops such as maize, beans and cassava – the staple crops of the smallholders in northern and central Mozambique. We found that there exist significant differences among crops and also across three different categories of farmers regarding the input demand.

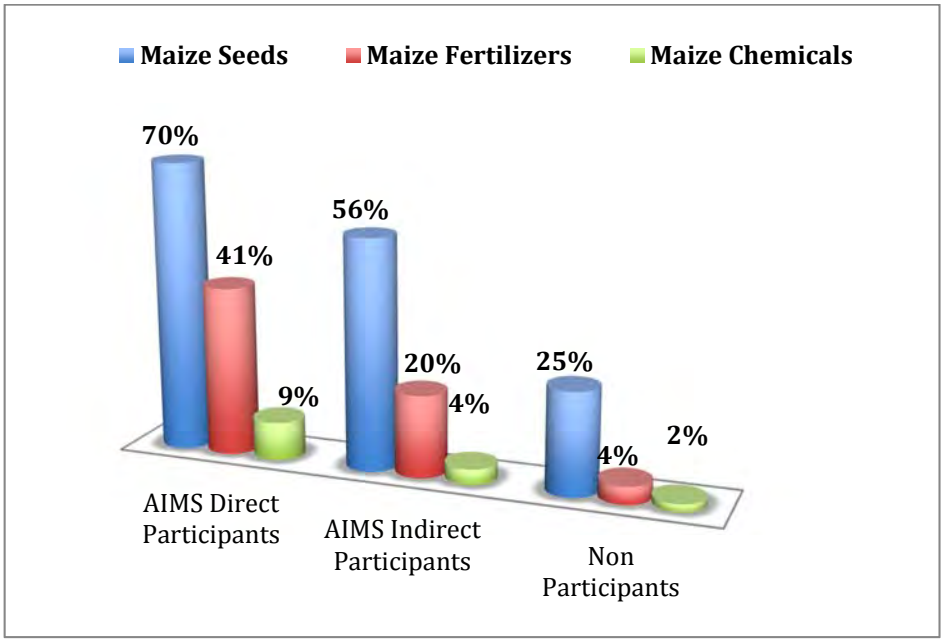


Figure 3.5. Input Demand for Maize Among AIMS vs. Non-AIMS Beneficiaries

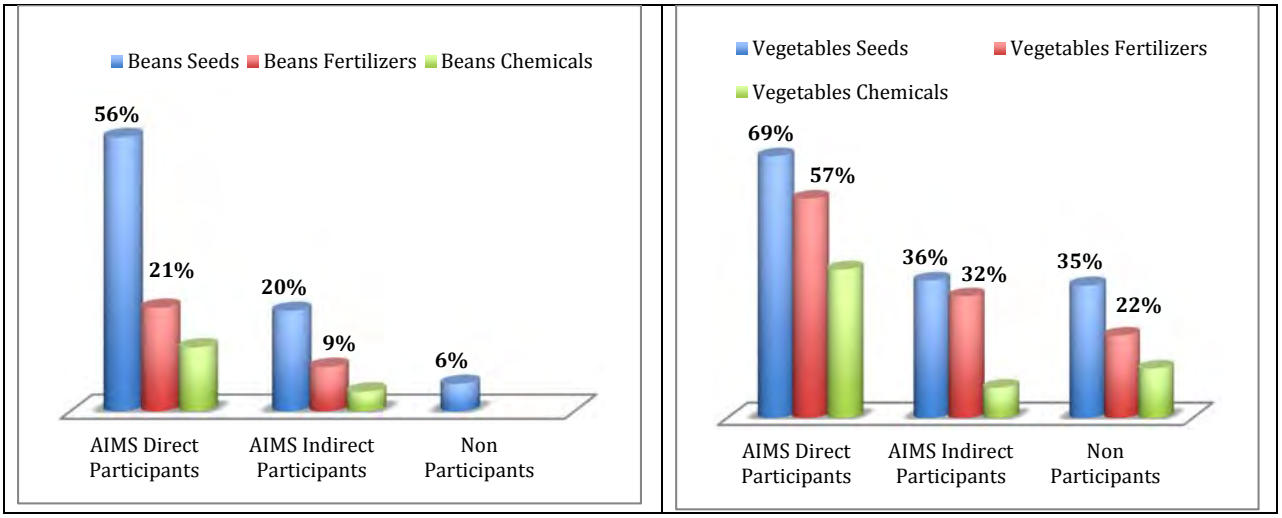


Figure 3.6. Input Demand for Beans and Vegetables Among AIMS vs. Non-AIMS Beneficiaries

As expected, "awareness in technical knowledge and its use" played a crucial role toward the demand for inputs, as we noted in our previous section, the AIMS direct beneficiaries have had access to multiple sources to access information compared to other groups. Farmers who were directly involved in the AIMS project in conducting farm demonstrations demanded more external inputs such as seeds (70 percent), fertilizers (41 percent) and chemicals and purchased them from different sources. Irrespective of

categories, all farmers demanded improved maize seeds. The demand for fertilizers for maize is higher among AIMS direct beneficiaries compared to other farmers – but also found higher among indirect beneficiaries of the AIMS project (20 %), who had observed the performance of fertilizers toward improved productivity. The demand for external inputs was highest for vegetable crops cultivation. Both beneficiaries and non-beneficiaries have significant demand in the use of all three major external inputs, viz., improved seeds, fertilizers and pesticides. Except for seeds, demand is low for other inputs among the bean growers.

3.4 Technology Transfers Under AIMS

As explained in the previous section on methods, the USAID-AIMS project disseminated the technologies related to soil fertility and crop management through different pathways, depending on the nature of information delivery. Primarily, two ways were adopted: one conducting farm demonstrations at the farmer level (AIMS direct participants) and another via agro-dealers or input suppliers in the farming communities. Further, the direct participants of the AIMS project (who conducted farm demonstrations sponsored by AIMS) facilitated information exchange in the communities where they lived by conducting field days and which AIMS indirect participants attended.

Virginia Jose, AIMS Demo Farmer at Chimbua Community, Sussendenga District

In addition, to have an extensive impact among larger farming communities, since the 2013-14 cropping season, the AIMS project also partnered with FIPS in disseminating technologies related to fertilizers and soil management in Manica province. The effectiveness of partnering with FIPS and AGRIMERC was not captured here, as it did not have a sufficient length of time in operation to know its operational effectiveness. However, we have captured the impact of partnering through such programs and its implications in the subsequent section.

3.4.1 Farm Demonstrations by AIMS Direct Participants

The AIMS project, in all its phases of operation since 2006, has effectively demonstrated and disseminated technologies relating to seeds (high-yielding varieties and hybrids), crop management techniques (spacing, tillage, intercropping), improved nutrient management techniques (ISFM, CSFS-including fertilizer blends, herbicide application) and post-harvest technologies to improve the profitability of smallholder agriculture in a sustainable way.

Intercropping of Maize with Legumes by AIMS-Trained Farmer in Sofala Province

Our current survey, which included 54 farmers who conducted AIMS demonstrations over the last five years in Beira and Nacala corridors, has been conducting demonstrations since 2007-08. Of the 54

participants, 67 percent of them have conducted demonstrations under AIMS at least once, 30 percent of them conducted demonstrations twice and 4 percent of the farmers have conducted AIMS demonstrations – three times since 2007-08.

Table 3.3. Crops and Technologies Demonstrated by AIMS Direct Participants (2008-09 to 2013)

Crop	Technology Demonstrated		
	New Seeds	Fertilizers	Crop Management*
Maize	52%	56%	90%
Maize + Beans	30%	44%	74%
Beans	28%	19%	39%
Cassava	33%	30%	67%

Crop management includes spacing, tillage, intercropping, planting density and time of operations and herbicide use.

As evident from the table, most of the farmers were involved in demonstrating technologies related to maize, beans and cassava – the prime food security crops of the region. Farmers in Nacala corridor undertook the cassava-based demonstrations primarily along with maize and beans, whereas farmers in Beira corridor demonstrated effectively the technologies related to maize and beans. In both locations maize is often intercropped with beans (including legume crops like pigeon pea in Nacala corridor); hence, technologies related to maize-bean intercropping were also proven effective and popular among farmers.

3.4.2 Adoption of New Technologies

Definition of Adoption: We were very careful in using the word "adoption" in our analysis as it might sometimes refer to actual versus perceived use of technologies. Because the USAID-AIMS project has been implemented since 2007-08 and is now in phase III, to an extent, it was possible for us to know the range of technologies "used" by farmers in subsequent seasons since they were observed during farm demonstrations. As explained earlier, the direct participant farmers who have been included in this assessment have been conducting farm demonstrations since 2008-09 in the project areas. The indirect participants are those who attended or participated in the field days conducted by AIMS direct participants since 2008 till 2012/13 seasons.

The major purpose of this assessment exercise is to know the effectiveness of such technology transfer programs on the increased use of fertilizers and improved seeds among farmers in the project areas. Therefore, the questions were designed to capture the extent of adoption – in other words, increase in demand for inputs/increase in use of inputs for specific crops among farmers in the surveyed areas.

Adoption in our analysis is defined as:

i. Farmers who purchased (using their own resources) or used external inputs *since* conducting or observing the technology demonstration. ii. Thus refers to use of external inputs (such as seeds or fertilizers) at least two or more seasons in their farm.

3.4.3 Effectiveness of Farm Demonstrations[1]

We further explored the effectiveness of these farm demonstrations in terms of participants' input usage, impact on yields and an exchange of information or dissemination of such proven technologies to others in their community. This was compared between AIMS direct vs. indirect participants. Overall we found that agro-input use among both direct and indirect participants of AIMS has increased. This was evident from farmers' perceptions regarding the actual adoption of improved seeds and use of fertilizers toward cultivation of maize, cassava and beans.

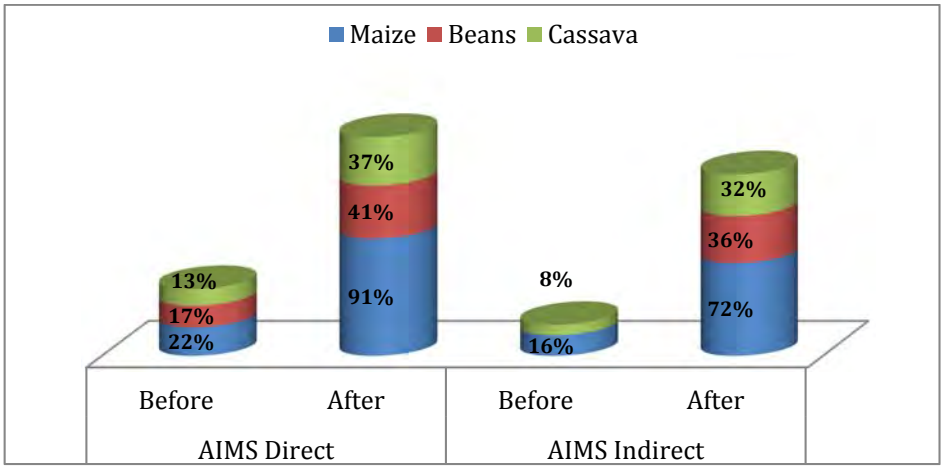


Figure 3.7. Adoption of Improved Seeds by AIMS Direct vs. Indirect Beneficiaries (Since Conducting/Observing Farm Demonstrations)

Traditionally, improved seeds and fertilizer use were more prevalent among vegetable growers and for their cultivation. Increasingly, farmers have realized gains in use of improved seeds and fertilizers for crops like maize and cassava in the surveyed districts. From our analysis, it could be seen that the use of improved seeds of maize has substantially increased among AIMS direct (22-91 percent) and also for AIMS indirect farmers (from 16 to 72 percent). One significant contribution of AIMS technology transfers is the adoption of improved varieties of bean in both categories of farmers (41 percent), particularly among AIMS indirect beneficiaries (36 percent from almost nothing).

[1] The exact asked related to this was "Please tell us about your use/adoption of following inputs in crops (maize, beans, cassava) *before and after* you conducted / observed demonstration".

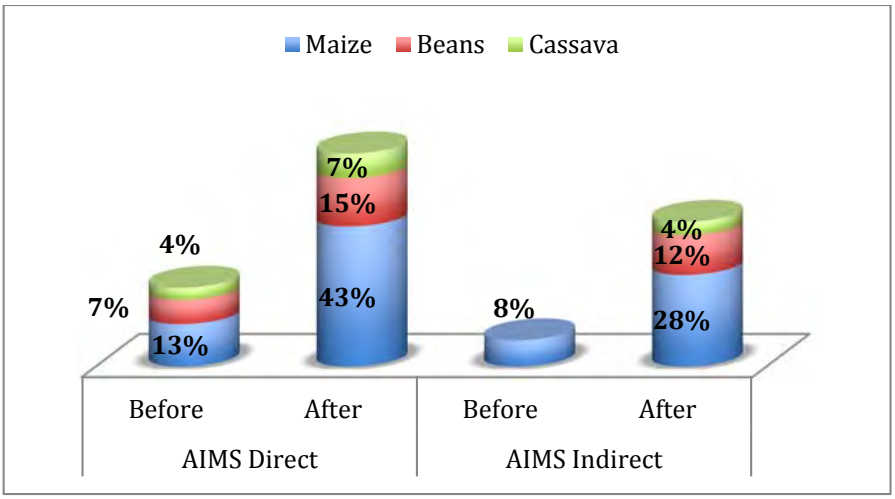


Figure 3.8. Adoption of Fertilizers by AIMS Direct vs. Indirect Beneficiaries (Since Conducting/Observing Farm Demonstrations)

In the case of fertilizers, though farmers have increased their use for field crops cultivation, the impact among indirect AIMS participants is highly significant, especially "farmers have started using fertilizers for crops other than maize." Among direct participants of AIMS also, the number of farmers using fertilizers for crops other than maize has increased substantially. In the case of cassava, though farmers rarely use fertilizers in Nampula, it was especially evident among AIMS direct participants who conducted farm demonstrations on the use of fertilizer blends during the 2012/13 cropping season. The survey results, however, indicate few farmers have used NPK (12:24:12) for cassava in the subsequent season.

Farmer Tomé Blaunde Helps Promote New Fertilizer Blends

Tomé Blaunde, a lead farmer in Vanduzi district, Manica Province, has set aside a quarter-hectare plot on his 12 ha of land to test and demonstrate improved farming techniques through the USAID AIMS III project. The project has developed improved fertilizer blends, which are soil- and crop-specific, and is demonstrating these in a complete package together with other improved technologies to maximize farmer profits.

"Every year, I try to increase the size of my fields by bringing new land under cultivation. The problem is, I am always looking for new areas because every new piece of land loses its fertility after two or three years.

"In the 2012/13 season, I hosted an IFDC demonstration plot for fertilizers and herbicides. I wanted to see for myself, and compare the income earned from my regular field and from the demonstration. I could see the difference clearly. The demonstration field gave much bigger yields, and required only one weeding, because of herbicides. My main fields required at least two weedings."

Blaunde is a model farmer. He is quick not only to adopt improved practices, but also to promote these practices within the community. For example, he mobilized his neighbors to jointly purchase herbicides, which they then shared among themselves, which was available only in 20-liter packs, too big for an individual farmer. Blaunde also has big plans to increase his use of agro-inputs – use fertilizer on at least 1 ha and herbicides on at least 3 ha.

In general, both farmers (direct and indirect beneficiaries) and agro-dealers in the AIMS target districts perceived an increased demand for agricultural inputs among farmers in the last five years. For example, among the direct beneficiaries of AIMS, the average use of fertilizers for maize has increased from as low as a half-bag (25 kg) to two bags (100 kg) – combination of 12:24:12 and urea. In the case of indirect beneficiaries, this amount still remains around one bag of fertilizer use in maize from "almost nothing five years back." The increase in use of inputs can be attributed to improved access to farm inputs, i.e., the distances traveled by farmers to access farm inputs have been substantially reduced with improved dealer networks along with fertilizer voucher programs as well as increased awareness through demonstrations and extension.

Fertilizers Blend Treatments Ready for Application on Different Treatments in AIMS Farmer Demonstration Fields, Sussundenga, December 2013

3.4.4 Adoption of Other Key Technologies by AIMS Beneficiaries

The farmers (direct and indirect) in our sample were asked a simple question on:

> *"Have you adopted the new technology since conducting or visited or observed the AIMS farm demonstrations?"*

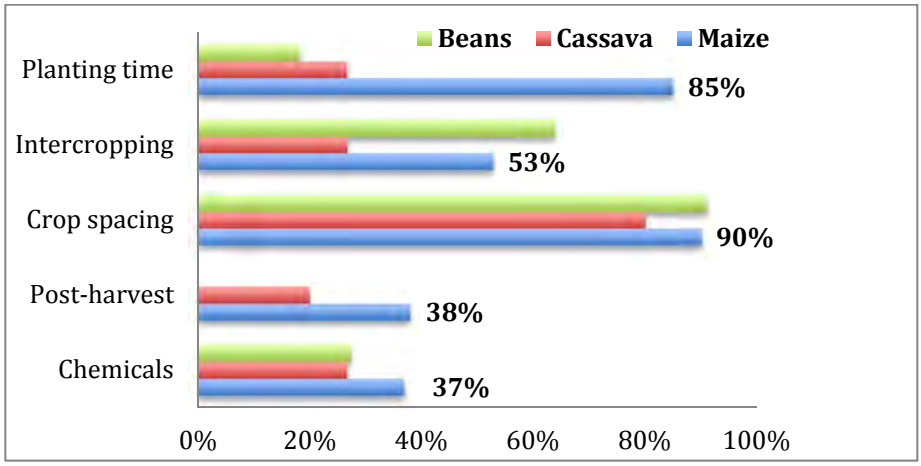


Figure 3.9. Adoption of Key Technologies for Maize, Beans and Cassava by AIMS Direct Beneficiaries (N=54)

We found that 64 percent (35 out of 54 farmers surveyed) of AIMS direct beneficiaries still practice one or more technologies that they demonstrated under the AIMS project. Thirty-six percent (9 out of 25) of AIMS indirect beneficiaries continued practicing a few key technologies learned from observing the farm demonstrations conducted through AIMS in their locations. However, there were differences among farmers in the use or practice of such technologies across corridors.

The farmers in Beira corridor are much more active in the use of new technologies for maize especially compared to farmers in Nacala corridor. Of the technologies demonstrated through AIMS, the most popular technology among farmers that resulted in significant adoption (80-90 percent) is spacing for all three crops, followed by right planting time for maize. The most popular and simple technologies to adopt were intercropping of beans with maize and use of chemicals to control pests in the case of beans. The maize farmers also used chemicals – apart from controlling pests (shoot borer), but few farmers have used herbicides to control weeds on their farms. Eight farmers in our AIMS direct beneficiaries have tried using herbicides (2-4 D or glyphosate) to control weeds since the demonstration.

Among the indirect beneficiaries of AIMS, besides use of improved seeds and fertilizers primarily for maize cultivation, the key technologies adopted by them include adopting right crop spacing or planting at the right time or season. The farmers have also used some chemicals to control pests in maize and in cassava. The use of chemicals for beans cultivation was not evident among indirect beneficiaries.

Table 3.4. Adoption of Key Technologies for Maize, Beans and Cassava by AIMS Indirect Beneficiaries (N=25)

	Maize	Cassava	Beans
Chemicals use	17%	25%	0%
Post-harvest	20%	25%	0%
Crop spacing	85%	50%	63%
Intercropping	50%	25%	38%
Planting time	83%	50%	13%

3.4.5 Impact on Yields of Maize – AIMS Direct Beneficiaries

On further analysis of the effect of technology adoption by AIMS beneficiaries, it was revealed that farmers realized increased yields due to the adoption of one or more key technologies. This was evident more in the case of maize than in other crops as the data were more robust compared to other crops. This was only possible to measure for direct AIMS farmers since they could "recall" the increase in yields prior to adopting few technologies in the last cropping season (2012-13).

Table 3.5. Technology Adoption and Increase in Yields Among AIMS Direct Beneficiaries (N=54)

Technologies Demonstrated	Mean Quantity Increase in Yields (kg/ha) vs. Traditional
Seeds + Fertilizer	220
Spacing/planting time	141
Improved seeds	120
Herbicides	85

Note: Traditional here refers without using any new technology.

Among the AIMS direct participants who grew maize during 2012-13 season, 85 percent of respondents (46 farmers) achieved increased yields (141 kg/ha) by adopting improved spacing and planting methods, adoption of improved varieties of seeds and use of NPK blends resulted in increased yields of around 220 kg/ha for their maize crop. However, these yields are to be interpreted with caution, as there was no proper "control" to compare the impact of technologies in a more rigorous way. Most of the responses given by farmers were subjective and relative to what they usually get in the absence of adopting such technologies.

Demonstrations and Training Empower Farmers to Use New Technologies

For Jabulane Simango, knowledge is money. Using skills he learned at IFDC training programs, he has nearly doubled productivity on his farm, expanded his small agro-dealership and earned the respect of every farmer in the community. The 30-year-old father of three has 10 ha of land in Vanduzi District, Manica Province. He plants about 4 ha every season, "resting" the remaining land or using it to graze his cows and goats. He has set aside 0.4 ha as a demonstration plot, where he promotes new maize varieties and correct fertilizer and herbicide practice, through the USAID-funded AIMS III project. In 2010, Jabulane volunteered for an intensive nine-day training program for agro-dealers from IFDC. In 2011, he again underwent more training and is now able to advise other farmers on the best farming methods or how to apply for a bank loan.

"I want to plant more land, but it is too difficult to weed. In the 2012-13 season I learned about herbicides through the AIMS Program, and hosted a demonstration plot on my farm. I could immediately see the difference. In the first season I harvested 2.6 tons/ha from the demo plot – much higher than my normal field. The second year, I got 4.2 tons, because I had replaced my open-pollinated maize variety with a new hybrid maize variety. By applying fertilizers, I was even able to harvest from pieces of land that I had abandoned because of low yields."

Jabulane's farm profits continue to increase. He expanded his shop and purchased a maize mill, which became an extra source of income. The demonstration plots, which he continues to host, have helped his business as well, encouraging other farmers to buy his fertilizers and herbicides. Now Jabulane is not only a successful farmer and businessman, but also an "unofficial" extension agent.

In the case of indirect beneficiaries of AIMS technology transfers, in general farmers have realized an increase in the yields (in some cases) but perceived the "impact of adopting new technologies learned from these demonstrations" and this results in increased adoption and continued use of such technologies as evident in Table 3.4.

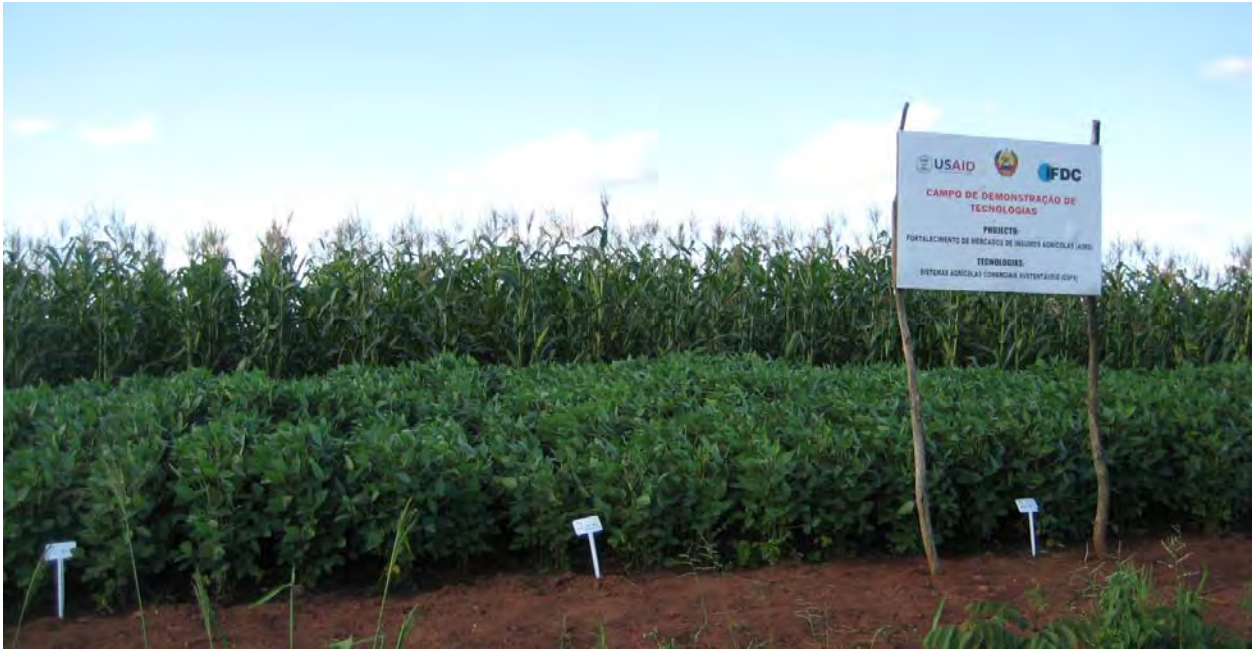
3.4.6 Effect of Dissemination Mechanisms

Here we compared the effectiveness of technology transfers, i.e., through AIMS direct beneficiaries vs. dissemination through AIMS project partners such as AGRIMERC and FIPS. Since the 2013-14 season, AIMS has made efforts to partner with other similar projects engaged in technology transfers related to agricultural inputs use, especially in districts of central Mozambique (i.e., in Beira corridor).

Table 3.6. Dissemination and Reach of Technologies Among Farmers

Technology Transfers (mean #)	AIMS Direct	AGRIMERC	FIPS
Field days conducted/farmer or dealer	2	2	1
Participants/field day	54	39	13
Villages covered	5	3	2
Radius in km	15.2	12.1	11.8

We further inquired among the indirect AIMS participants regarding sharing of information learned through attending farm demonstrations with other farmers/friends or relatives. As evident in Figure 3.1, “neighbors-farmers-relatives” were the major source of technical information for indirect AIMS participants. Seventy-two percent of the AIMS indirect beneficiaries revealed that they shared the information with other farmers in their village locations. Further, it was noted that AIMS indirect participants were very effective in sharing information, and it reached as many as 27 farmers (mean number of farmers was 10/farmer) and covering two villages located in their communities.



AIMS Demonstration of Secondary and Micronutrients in Soybeans and Maize (2013-4 Cropping Season) in Sussundenga District

This reveals that AIMS, in comparison to its partners, was most successful in its technology reach by attracting more field participants from as far as 15 km radius, covering more villages. It should be noted that demonstrations under AIMS and FIPS are conducted at farmers’ fields, whereas AGRIMERC conducts its demonstrations through agro-dealers – next to their shop premises for the most part. Often agro-dealers also used these farm demonstrations to improve their sales and were not constrained (financially) in the use of expensive inputs. Hence, the adoption rates are much higher in the communities where agro-dealers conduct their demonstrations compared to farmer-led demonstrations.

3.5 Market-Based Dissemination Mechanisms Under AIMS

As part of scaling up these technologies, the AIMS project collaborated with wide range of partners in order to extend its reach. Any rollout mechanisms on technology would be successful unless sustainability element is built in it. This requires working through existing agribusiness networks and enterprises toward a sustainable mechanism of delivery of these new technologies to farmers. Hence, marketing demonstrations undertaken by AIMS through agro-dealers form an important component of the AIMS scaling-up strategy. The main purpose is promoting awareness among farmers and agro-dealers/promoters. AGRIMERC and FIPS are the IFDC partners in the marketing demonstration trials. AGRIMERC works directly with agro-dealers while FIPS works with village-based advisors (VBAs).

An Unofficial USAID-AIMS "Project Ambassador" – A Farmer, Agro-Dealer and Entrepreneur

Why has the USAID AIMS project been so effective in disseminating new technologies? Because of farmers like Alfonso Caxtava, an unofficial "project ambassador" who persuades his neighbors by example.

Caxtava lives in Gurue district, Zambezia province. He juggles three jobs: farmer, agro-dealer and government employee in the education department. He has 30 ha of land, of which two-thirds is for soybean seed production. The rest is planted with a variety of crops – maize, beans and rice (2 ha each), groundnuts, pigeon peas, sorghum, cassava and vegetables.

For many years Caxtava never used fertilizers except on his vegetables. He had heard about the benefits but wanted proof. In 2013 he volunteered to host an AIMS demonstration plot to test new improved fertilizer blends – and hasn't looked back.

"I can clearly see the differences between fertilized and non-fertilized plots, the maize cobs are big and heavy, the plants grow very fast."

Caxtava has conducted two field days on his farm, creating a huge interest within the community. He is positive that his customers will soon begin demanding maize fertilizer and plans to introduce small, affordable packs of blended fertilizers, containing precisely the right combination of nutrients for maize.

In 2012 Caxtava opened a small shop selling agricultural inputs. "There is demand for good quality seeds, but not many shops. And there was no place to rent a tractor or a sprayer." The shop, run by Caxtava's wife, expanded rapidly and now sells vegetable and maize seeds (he is an authorized agent for Pannar Seeds) and rents out tractors, irrigation pumps and sprayers.

3.5.1 AGRIMERC Demonstrations Effect

The AGRIMERC approach consists of demonstration plots established by an agro-dealer in collaboration with public extension agent at the beginning of each cropping season. IFDC provided AGRIMERC with the improved fertilizer blends for maize for this purpose as well as the protocols for application and technical support. With technical backing from the AIMS-IFDC project, 97 demonstrations were established directly by agro-dealers since it began operations in the 2012-13 cropping season in four

provinces (Zambezia, Manica, Sofala and Tete) in 13 districts. About 516 farmers indirectly benefited from these demonstrations by attending field days organized by the agro-dealers.

For this assessment, we sampled 18 AGRIMERC agro-dealers located in Tete and Manica provinces to know the effectiveness of their dissemination mechanisms. Since we conducted a detailed assessment on agro-dealer efforts to technology transfers under AIMS, this exercise was primarily carried out to know the efforts of the partners. All the sampled dealers conducted their demonstrations during the 2013-14 cropping season, and demonstrated technologies on maize and maize-based legume system.
The technologies demonstrated were related to spacing, planting time, use of fertilizers and new seed varieties and herbicide application in maize. It is evident from their demonstration trials that by using fertilizer and improved seeds, there is an additional increase in yields up to 200 kg/ha. Simple technologies such as planting at the right time, space and seeds alone would yield more than 100 kg of maize per hectare. Dealers demonstrated the effectiveness of herbicides to prevent yield losses caused by weed growth. This has resulted in significant yield increases of around 150 kg/ha.

Table 3.7. Technologies Demonstrated Through AGRIMERC Dealers in 2013-14 Cropping Season in Beira Corridor

Maize Technologies	% Dealers	Increase in Yields* (kg/ha)
Fertilizer + Seed	56%	217.5
Spacing + Planting time+ Improved Seeds	33%	131
Herbicide** + Seed	11%	155

Note: *These are average yield increases reported by agro-dealers compared to their “control” plots where such technologies were used during demonstrations. All are maize+legume based cropping system.
** Only two agro-dealers conducted demonstrations on using herbicides in maize fields. This was used in pure maize crop.

Maize Field with Basal Fertilizer (NPK) Intercropped with Pigeon Peas in Malema District, Nampula (2009-10, AIMS Phase II)

We further inquired of the dealers regarding the impact of such demonstrations toward input sales in their shop, whether increased or decreased for the next season or after the trials. Seventy-eight percent of the dealers responded positively; of them, 36 percent of them had an increase in sales of improved maize seeds, 14 percent realized an increase in sales of both seeds and fertilizer sales and 50 percent of the dealers showed significant improvement in sales of fertilizer, seeds and chemicals from their shops. Thus, it could be seen that such technology demonstrations have, in fact, induced demand and in turn sales of agro-inputs in the communities.

Table 3.8. Perception of Agro-Dealers on Agro-Inputs Sales in the Last Five Years

Demand for Agro-Inputs	Increased (x times)			Decreased	Same
	2X	3X	4X		
New seed varieties	44%	33%	17%	6%	0%
Fertilizers	71%	12%	6%	6%	6%
Chemicals	65%	0%	0%	24%	12%

Overall, the agro-dealers have perceived significant sales increases in their shops toward selling improved varieties of seeds – including vegetables and maize in particular. Few dealers realized decrease in sales of seeds due to poor quality of seeds – in the case of beans and maize. The fertilizer sales in the shops in general have been increasing – there is demand for small packs of fertilizers for vegetables and increasingly fertilizers for maize and soybeans. The agro-dealers also revealed that the chemical use in vegetables has increased substantially due to higher incidence of pests and diseases and also number of chemicals available in the market. These results concur with the recently concluded AIMS agro-dealer assessment also.

3.5.2 FIPS Demonstrations Effect

The FIPS model consists of working with two types of farmers: lead farmers and "ordinary" farmers undertaking mother and baby demonstrations and using VBAs. During the 2013-14 cropping season, a total of 36,400 farmers were involved on baby trials (113 mother trial farmers) with maize varieties and hybrid. It is important to note that FIPS lead farmers in turn sold seeds of improved varieties to the nearest wholesale agro-dealers. During this assessment, we interviewed 41 farmers who were benefitted through FIPS in Manica province of Beira corridor. The AIMS project partnered with FIPS during the cropping season 2013-14 toward transferring soil fertility and crop management technologies among FIPS beneficiaries. The FIPS is implemented only in Manica province of Beira corridor in four districts, viz., Manica, Sussendenga, Barue and Gondola.

Table 3.9. Characteristics of FIPS Beneficiaries

Characteristics		FIPS
Total farmers surveyed		41
	Female	39%
	Male	61%
	Age	40.1
Educational status		
	None	17%
	1-5 grade	39%
	6-10 grade	39%
	>10 grade	5%
Household size (Mean)		7
	Male	3
	Female	4
	<14 years	3
On-farm/Off-farm work of household		
	On farm	100%
	Off farm*	10%
Total cultivated land (2013-14 season) ha		2.5

Note: * The family members who are engaged in off-farm are also involved in farming activities.

As evident from the table, 39 percent of FIPS beneficiaries were female. More than 80 percent of farmers were educated; the average farm household size of FIPS beneficiaries was around seven and all the adults in the family are actively engaged in farming, though few farmers are involved in off-farm activities besides farming. The characteristics of FIPS beneficiaries are typical smallholders as that of AIMS beneficiaries in our sample. All the FIPS beneficiaries in our sample planted maize, which is very typical of the selected districts, where maize is the major food crop.

The purpose of including FIPS beneficiaries in our assessment is to know how far AIMS partners are able to disseminate technologies effectively and influence farmers' perceptions in adopting new technologies. AIMS facilitated 10 tons of IFDC's improved maize fertilizer (5 tons each of topdressing and basal) to use in FIPS' mother demonstrations and small input packs, which farmers can test on a 10x10 m^2 of "baby" trials. As the technology disseminated through FIPS more extensively compared to AIMS (where technology demonstrations were done through few participants), it will be interesting to find out if these two approaches have any "difference in impacts" created toward input purchases by farmers. However, the major limitation for not being able to do this is FIPS has just completed their demonstrations for one year and now the second year of partnering with AIMS is in progress. But we have captured few major indicators of input demand and perceptions on adoption from FIPS beneficiaries wherever possible. Farmers who adopted the FIPS package during the 2013-14 cropping season have benefitted immensely

in terms of learning new techniques and crop management practices in addition to use of seed and fertilizers for maize. The following table provides evidence on the perception of different technologies that farmers might find useful toward adoption in the future.

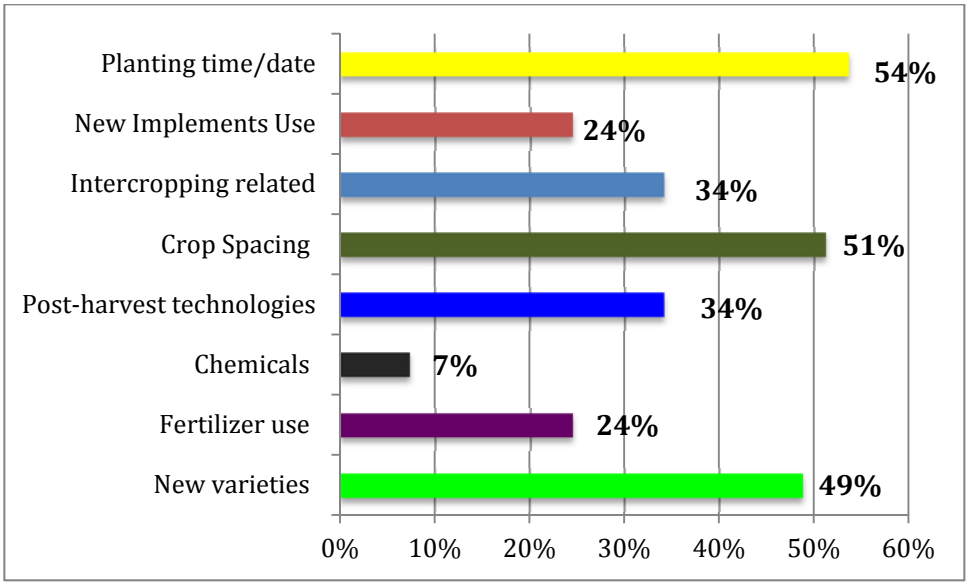


Figure 3.10. Perception on the Usefulness of Different FIPS Demonstrated Technologies in Maize (N=41)

We found that nearly half of the farmers interviewed revealed that simple crop management techniques such as planting at the right time and adopting proper spacing between crops (especially in maize, legumes cropping) and also rows of maize can help in achieving higher yields. They also found new seed varieties (*Matuba*) and hybrids of maize (Pan 63 and 67) very productive and high yielding. The use of fertilizer is perceived as useful by only 24 percent of the farmers. Farmers who did not find it useful reasoned that they are expensive and may not be possible to adopt in larger maize plots. We also found that very few FIPS beneficiaries could take part in the input voucher program (12 percent) as these are very resource-poor smallholders who cannot afford to purchase even subsidized inputs. Overall, our discussion indicates that 34 percent of farmers are willing to adopt new technologies – purchase of external inputs from agro-dealer shops.

3.6 Constraints in the Use of Inputs

Farmers in general face cash constraints, especially during the planting season. This, in turn, affects the purchase of bulk inputs such as fertilizers as well as other improved seeds, especially hybrid varieties. Another major reason is lack of technical knowledge among non- and indirect participants of AIMS in the

use of inputs. Though indirect participants received some knowledge by participation in field days conducted by lead farmers, there is still a huge gap in provision of knowledge updates and technical information in the existing system. As discussed in the previous section, the information and contact with formal sources of extension are very limited. In the absence of public agricultural extension services, farmers often rely on other sources for reliable information in the use of technical inputs.

Table 3.10. Constraints in Adoption or Use of Technologies

Major Constraints	Direct AIMS	Indirect AIMS	Non-AIMS	FIPS
Cash/low affordability	56%	72%	70%	80%
Not available in input shop	15%	14%	17%	12%
Proximity to input access	9%	8%	12%	15%
Cannot afford bulky fertilizer purchase	27%	38%	45%	17%
Poor quality products	4%	8%	13%	17%
Poor or no technical knowledge	6%	34%	55%	12%

Programs such as AIMS and other organizations have been effectively engaged in technology transfer activities that have yielded strong results. However, continued awareness creation, together with improved access, affordability and availability of agro-inputs, is needed to have a wider impact. AIMS have already reoriented its efforts on technology transfers by piloting integrated ready-to-go technology packages in partnership with development partners and the agro-inputs sector (fertilizer and seed companies and agro-dealers).

Lack of cash to buy inputs is the major constraint among FIPS beneficiaries as these are smallholders, and they often face financial problems during the planting season. Other constraints such as knowledge, quality and input access also play a key role in low use of inputs and technologies by farmers.

3.7 Expectations of Farmers From Input Suppliers

From our assessment, it was apparent that in the absence of public agricultural information, farmers often depend on input suppliers – local and at the district headquarters – for technical information and purchase of inputs. One of the objectives of the USAID-AIMS project is to improve the capacity of existing agro-dealers or input retailers and establish a strong vibrant network of retailers in northern and central Mozambique.

Many farmers still lack access to good quality agro-inputs and technical knowledge. Hence, through AIMS in addition to transfer technologies through farmers (i.e., farm demonstrations at the farmers' fields), regular crop demonstrations were also conducted through agro-dealers located in these communities. They served two purposes: (1) it provided access to farmers toward technical information on inputs in their community and (2) these demonstrations also served as advertising mechanisms for the dealers toward improving their business operations. Our recently concluded assessment of AIMS agro-dealer development activities in Beira and Nacala corridors concluded that farm demonstrations through agro-dealers improved the continued demand for seeds of maize, beans, rice and vegetable crops. In the case of fertilizers, the dealers indicated, "A positive and significant awareness has been created among farmers on the use of fertilizers for maize."

Though significant benefits were realized through agro-dealer shops and their technology transfer approaches, still many farmers lack access to these input suppliers. In addition, the services offered by these input suppliers are not as reliable in many cases. In this regard, we asked farmers about their perceptions toward the functioning agro-input suppliers/retailers and their expectations toward efficient functioning of such networks.

Our survey results indicated that most of the farmers face higher prices of inputs compared to neighboring countries in the region, offered through these retail networks; in addition, there is a need for information on prices of inputs (among all the categories) and output prices (especially among non-AIMS beneficiaries) among farmers in these communities. In the absence of effective extension services, they also expect the input retailers to provide them with proper technical information regarding the use of inputs. Cash is the major constraint farmers face in purchasing inputs; the formal institutions that offer agricultural credit are also limited, and even if they present, the interest rates are very high. In such cases, input credit offered by the input suppliers will enhance the demand and use of inputs.

Table 3.11. Expectation of Services Offered Through Agro-Dealers

	AIMS Beneficiaries		
	Direct	Indirect	Non AIMS
Lower input prices	46%	52%	74%
Increased input credit	39%	28%	47%
More technical advice	22%	52%	68%
More demonstrations needed	20%	40%	22%
Input price information	30%	32%	48%
Output price information	15%	12%	96%

4. Conclusions

Low use of agro-inputs by farmers is a major constraint in improving productivity levels of staple crops in Mozambique. The reasons for low use among smallholders range from lack of or (low) accessibility to farm inputs to non-availability of technical information on inputs and non-affordability of capital-intensive farm inputs. Several government and donor-funded mechanisms have addressed this issue by establishing extensive input supplier networks and extension services to transfer technical knowledge among farmers. Each of these programs has their own pitfalls and often policymakers have always questioned the sustainability of such initiatives.

The IFDC Experience: Improving Technical and Economic Efficiency of Fertilizer Blends – Toward Sustainable Outcomes

Fertilizer is key to improved yields and agro-dealer effectiveness. If effective fertilizer formulations are not promoted, impact is likely to be limited. One of the major issues facing fertilizer usage in Mozambique has to do with the 12:24:12 fertilizer formulation, used universally across maize, legumes and cassava. This formulation omits essential secondary and micronutrients and does not provide a crop-appropriate NPK balance. Through prior trials from MIM and AIMS II, IFDC was able to develop an improved maize formula containing a soil and crop specific NPK blend as well as micronutrients sulphur, zinc and boron in collaboration with Greenbelt Fertilizer Company in Beira, Mozambique. Following application over the past three season through demonstrations conducted at farmer's fields indicate that the results contrasted significantly with farmers using 12:24:12 formulation. Encouraged by positive results on using appropriate fertilizer blends, AIMS has re-oriented its efforts on technology transfers by piloting integrated ready-to-go technology packages in partnership with development partners and the agro-inputs sector (fertilizer and seed companies and agro-dealers).

i. Technology Perspective – Soil and Fertilizer Focus

The on-farm trials regarding soil fertility technologies (blends) for maize, soybean and other crops should be seen as one step in developing balanced fertilizer recommendations for different agro-ecologic zones. If the goal is to develop balanced fertilizer recommendations for a wider area, there is an urgent need for development of soil maps to better understand macro, secondary and micronutrient deficiencies to address the yield limiting factors to scale up the fertilizer recommendations. Whenever it is possible, environmentally friendly sources such as dolomite with multiple functions (acidity correction and nutrient supply) should be tested.

IFDC has been working with partners including IIAM and the Fertilizer Platform to develop soil maps. Soil nutrient maps identify nutrient deficiencies —including secondary and micro-nutrients and soil

acidity constraints which serve to inform national policy on micro-nutrient deficiencies and facilitate the development of balanced fertilizers on commercial scale without the need for soil testing.

ii. Improved Planting Material Availability

The Swedish Development Corporation study on Seeds in Mozambique (2011) estimates that total seed use for "grain" crops 17 is approximately 90,000 tons, of which no more than 10 percent is improved seed. The rest comes from farmers' retained seed as well as seed purchases from or exchanges with other local farmers. Also, the seed retail prices in general are more than five times higher than farm-gate prices in Mozambique (e.g., five to six times in open-pollinated variety (OPV) maize and up to nine times in hybrid maize). Though there are 35 registered seed firms in Mozambique, only 18 are involved in producing seeds – restricted to open-pollinated varieties mostly from IIAM. Pannar – the only multinational – is active in the hybrids market. Hence during planting season, often farmers rely on their own seeds or seeds from local markets or "fly-by-night traders" that bring seeds from neighboring countries.

Though our survey results indicate a higher adoption of "improved seeds" in recent years among farmers, the availability of quality or certified seeds (planting materials for cassava) during the planting season is still a major issue. Farmers who have benefited through government (input vouchers or other means) and donor-aided programs are more likely to use improved seeds. However, many farmers have very smallholdings and are unable to access or participate in programs that promote quality seeds.

AIMS Demonstration Farmer at Chimbua Community, Sussendenga District

Considering these issues, AIMS in its capacity worked with agro-dealers toward improving the supply of quality materials through the vast network of input retailers. The technical farm demonstrations conducted through AIMS directly and indirectly through its partners such as AGRIMERC have resulted in significant outcomes, especially in creating demand for quality seed varieties for few crops (maize and beans). It is important that future agro-dealer development work should continue work through hub agro-dealers toward improved supply; however, in order to sustain the demand for input retailers, it is important for crops like maize and beans. It is important that AIMS should focus more toward working with farmer associations wherever possible (e.g., soybean and maize) to have a wider impact. Also, smallholders often face a huge constraint in getting good prices for the surplus they produce in their farm. In this regard, for crops like maize, it is important to work with farmer associations or enterprise backed value chain networks to ensure that the input and output market needs of smallholders are taken care of.

iii. Input and Credit Access to Farmers

Farmers often complain the low adoption of input use, especially fertilizers, is due to low purchasing power. Credit is a major constraint toward the purchase of improved seeds and fertilizers among smallholders. The smallholders are often excluded from formal financing methods due to high collateral requirements and interest rates. However, in Mozambique to start with, there are very few formal sources or channels that extend credit to farmers. In this regard, it is necessary that any technology transfer program should also address the issue of “cash constraint” toward the purchase of external inputs during the planting season.

U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Tel: (202) 712-0000
Fax: (202) 216-3524
www.usaid.gov