Agricultural Intensification in Mozambique

Lessons from Ten Villages
— AFRINT 2 —

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Introduction

Mozambique comprises 799,390 km² and has 20,366,795 people (INE 2007). With a human poverty index (HPI) of 50.6, it ranks 101st among 108 developing countries for which the index was calculated and, with a human development index (HDI) of 0.366, it is 175th out of the 179 countries analysed (2007/8 UNDP report).

Since more than 70% of the country's population is rural where agriculture is the main source of income and food security, government claims that agriculture is an important vehicle for development and the main weapon to fight poverty.

Mozambique offers a great, but sorely underutilized agricultural potential. The country covers 36 million hectares of arable land including 3.3 millions hectares of land that could be irrigated. Only nine million hectares are used for production, and merely 55.000 hectares (1.6%) is currently irrigated (MINAG 2004). In general agriculture contributes less than 7% into the total GDP, but contributes to about 36% of the employment.

Agriculture in Mozambique is dominated by the small farmers who mainly grow food crops for family sustenance. The farm systems differ in the north, centre and south. Shift cultivation for maize, sorghum, millets, cassava and groundnuts is a common in the north, where maize and groundnuts are tradable crops. In the central region, maize, beans and cassava are important food crops, and beans and potatoes are the marketable ones. In the centre and north, tobacco and cotton are the main non-food cash crops; cashew nuts are grown both as food and a cash crop sold to local and export markets. Lastly, since the south has less agricultural potential, farmers there usually engage in extensive agro-pastoral activities (Mole 2006:3).

Research Focus and Methodology

As part of a ten-country study examining the trends in agricultural intensification among small farmers and searching out what works well in Africa and why, the 2005 and now the 2008 Afrint study selected and focused on the same 10 villages and used the same list of interviewed households, which were randomly selected from a purposive frame of villages and agro-ecological zones. The selection criteria deliberately excluded disastrous and extremely successful examples, preferring instead to choose districts and villages representative of the gamut of the most common experiences, the best of which might serve as useful models for widespread adaptation.

In each of the ten villages, 40 households were selected and administered a structured questionnaire while another questionnaire was used to interview village leaders. The district agricultural directors or, now, the chief economic officers as well as the local extension workers were interviewed to understand better the policy, infrastructural, climatic, commercial and other agricultural factors shaping the context in which the villages operate.

For the study, the principal researchers trained three teams of six or seven interviewers, one team for each region. With rare exceptions, most of the interviewers had had prior experience administering agricultural questionnaires.

The AFRINT Geographical Area

Mozambique has 10 quite diverse agro-ecological zones (Annex 1). All of Gaza province falls into the R3 zone. With limited annual rainfall (between 400mm to 600mm), it is one of the country's most arid regions, especially in the province's interior. In Chibuto district in southern Gaza, the present study chose two villages close to the confluence of the Limpopo and Changane Rivers (Ministério de Administração Estatal, 2005). The district has 5,878 km²

and 197,214 people (2007 census), a 9% increase since the 1997 census.[1] Largely free of tsetse flies, the district has both agricultural and livestock potential.

Sofala and Manica, the central provinces, are more diversified and include four agro-ecological zones (R4, R5, R6, R10). R4 is a medium-altitude region, which consists of land between 200 and 1,000 metres above sea level. Annual rainfall varies between 1,000 to 1,200 mm. The R5 zone is a low-altitude region with an annual rainfall of 1,000 mm to 1,400 mm and diverse the soils rangng from sandy to fluvisols and vertisols. While, R6 integrates areas below 200 metres of attitude and annual rainfall between 500 mm to 800 mm. In contrast, the R10 zone has annual rainfall more than 1,200 mm and mainly ferrasols. In Sofala, Afrint has selected Nhamatanda district in the central western part of the province, with an overall area of 3.897 km^2 and 210.757 habitants (2007 census). As for climate, the two dominant types are Savanna tropical rainy and humid temperate tropical zones.

In eastern central Manica Province, Gondola is another Afrint study district. It has 5,739 km^2 and 262,412 habitants as of the 2007 census. The annual rainfall ranges from 1,000 mm to 1,500 mm.

In the North, Nampula and Zambézia provinces were chosen for this study. They have R5, R6, R7, R8 and R10 agro-ecological zones. The R7 zones comprise the medium-altitude regions including sub-planaltic and low and mid planaltic zones with altitudes from 200 meters to 1,000 meters and annual rainfall of 1,000 mm and 1,400 mm. While the R8 is the coastal littoral line up to Cabo Delegado characterised by sandy to heavy soils and annual rainfall between 800 mm and 1,200 mm.

The Selected Villages and Sampled Households

The criteria for selecting the districts in 2005 was based on their agro-ecological characteristics and agricultural potential ranging from low or medium to high. Given the agricultural importance of the centre and north, the researchers studied four villages in the north, four in the centre, and only two in the south, with the villages coming from five of Mozambique's ten provinces (Table 1).

Within each district, the research team explained Afrint's criteria for sample selection to the district agricultural officer and worked with agricultural extension services to contact the administrative posts and, through them, the villages or communities. The present study revisited those villages and communities though, if for any reason (e.g., death, migration) the household could not be contacted, another household was selected to replace it. Preferably the substitute household would be related to the previous, in other words, a household descended from the absent one. Otherwise, the missing household was substituted with another from the village. In most of the selected areas in the south and north, we could identify the same household that had participated in 2005. In the centre many substitutes were needed to replace absent households. This occurred especially along the transportation corridor, such as in Inchope, where people are highly mobile. The percentages of substitutes in each district are: Nhamantada (10.3%), Gondola (28.2%), Chibuto (5%), Gilé (…??) and Murrupula (…??).

Kommentar [N1]: Pls Peter, add figures missing here

[1] www.ine.gov.mz

Table 1: *Distribution of interviewed household by region and district*

District	Village	Region			Total	Agricultural potential
		North	Centre	South		
Morrupula	Nacocole Nihesiwe	41			41	Medium to high areas
	Naminhalo Chinga	41			41	
Gilé	Nacuali Alto Ligonha	40			40	
	Namali Alto Ligonha	39			39	
Nhamantada	1º Bairro Siluvo		33		33	Medium to high areas
	5º Bairro Siluvo		26		26	
	8º bairro Siluvo		19		19	
Gondola	Inchope Bendicar		25		25	
	Inchope 3 de Fevereiro		40		40	
	Bendicar Inchope		20		20	
Chibuto	Chaimite Bairro 2			37	37	Medium to low areas
	Chaimite Bairro 4			42	42	
Total		**161**	**163**	**79**	**403**	

Source: Afrint II Micro study survey, 2008, Econ Policy Research Group, Ltd.

Overall, 20.6% of the head of households in the 2005 sample were women whereas 22.6% were women in the 2008 sample (Table 2). Though small, this variation might be explained by the substitution made or may also mean that some of male headed households had transformed into female headed household, an interpretation consistent with INE (2007) data and the World Bank online database (2008) which reveals that females have a longer life expectancy than males in addition to the greater tendency of males to emigrate from their villages in search of work. On the other hand, the HIV pandemic afflicts women more readily and kills them faster than men.

Table 2: *Distribution of interviewed households by sex and region, 2005 and 2008*

Sex of head of household	Region					Total	
	North	Centre		South			
	2005		2008	2005	2008	2005	2008
Male	134	138	128	44	47	316	312
	83.8%	86.3%	78.5%	56.4%	59.5%	79.4%	77.4%
Female	26	22	35	34	32	82	91
	16.3%	13.8%	21.5%	43.6%	40.5%	20.6%	22.6%
Total	160	160	163	78	79	398	403
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Mole (2006) and Coughlin (2006)

Smallholder Agricultural Intensification: Findings from Mozambique's Micro-Level Data

The Afrint study gathered and assessed variables regarding crops, agricultural production and marketing as well as the socio economic characteristics of the farming households in order to trace the differences in production performance over time, levels of intensification as well as in resources access for different regions. Data were analysed and presented and discussed in separate section and sub section according to the main survey topic.

Household Socio-Economic Characteristics

Rural areas are normally characterized by mud houses with thatched roofs as, indeed, 78% of our sampled households do. Only 12.8% own mud houses with corrugated iron roofs though, in the north, less than 1% did as against 26% in the south. Very few (9.5%) have better houses constructed with blocks or bricks and an iron roof.

Table 3: *Type of houses owned by the households by region*

Housing standard		Region			Total
		North	Centre	South	
Mud house with thatched roof	Count	160	109	42	311
	%	99.4%	67.3%	54.5%	77.8%
Mud house with corrugated iron roof	Count	1	35	15	51
	%	0.6%	21.6%	19.5%	12.8%
Block or brick house with a corrugated iron roof or other more advanced housing types	Count	0	18	20	38
	%	0.0%	11.1%	26.0%	9.5%
Total	Count	161	162	77	400
	%	100.0%	100.0%	100.0%	100.00%

Most households (56%) have no means of transport while 42% use a bicycle to travel and transport their goods. With less than 1% of the farmers owning a car, truck or tractor, bicycles are an important physical capital for accessing markets, selling products, and getting inputs.

Table 4: *The most advanced means of transport used by the interviewed household*

		Frequency	Valid %
Valid	Foot	223	**56.6**
	Bicycle	166	**42.1**
	Motor bike	2	**0.5**
	Car, tractor, truck	3	**0.8**
	Total	394	**100.0**
Missing		9	
Total		403	

According to interviewers' assessment of household capital assets and appearance, 43.9% of the households were ranked as below average wealth and 38.7% were deemed very poor. This does not diverge significantly from national statistics on poverty incidence. Poverty assessments from INE (1997 and 2003) indicated that the overall poverty headcount figure decreased from about 69% in 1996/7 to about 54% in 2002-3, representing 15% of reduction (Virtanen 2007:3). Within the same period, rural poverty had declined 16%, about 37% more than the observed reduction in urban areas (World Bank 2005:5).

In all the three regions, radios and bicycles are the most frequently owned assets. Bicycles are somewhat more common in the north and centre than in the south, while the possession of radios is similar in all regions. Mobiles or fixed telephones are very rare in the north, more frequent in the centre, and very common in the south. This may well be due to lack of

network coverage in the sample villages in Nampula province. Moreover, those villages were remote and most farmers suffered manifest poverty.

Table 5: *Percentage of interviewed households in each region owning specific assets*

	North	Centre	South
Wired electricity/power (c503)	0.0	6.7	2.5
Mobile or stationary telephone (c504)	0.6	29.4	55.7
Diesel power generator or similar (c505)	0.0	0.6	2.5
Water pipe to house (c506)	0.0	0.0	0.0
TV-set (c507)	4.3	6.1	5.1
Radio (c508)	34.8	73.6	51.9
Tape recorder (c509)	21.7	41.7	11.4
Bicycle (c510)	55.9	45.4	41.8
Sewing machine (c511)	3.1	4.3	6.3
Kerosene stove or other modern stove (c512)	0.6	4.3	6.3
Battery torch (c513)	17.4	31.5	8.9

Education is another development indicator. TIA data for 2002 indicate that 27% of heads of households had no schooling, 44% had started but did not complete primary education, and 17% had finished primary school. The Afrint data shows the same trend. In general, most farm managers are illiterate or at least had some primary school education. The sample villages in the south have the highest percentage (56%) of illiterate farm managers while only 13% of those in the centre along the Beira-Manica transportation corridor were illiterate. Overall, 48% had attended one to four years of primary school. The sample villages in the central region also had the highest percentage of farm managers who have attended primary school plus a few who had attended secondary school (Figure 1). Though literary facilitates the transmission and adaptation of extension messages, none of the interviewed village or district leaders mentioned education as a priority of great relevance for agricultural development. Some of the NGOs active in our sample districts sponsor functional literacy programmes though participation is low. When asked why, villagers argued that their agricultural and domestic tasks inhibit their participation.

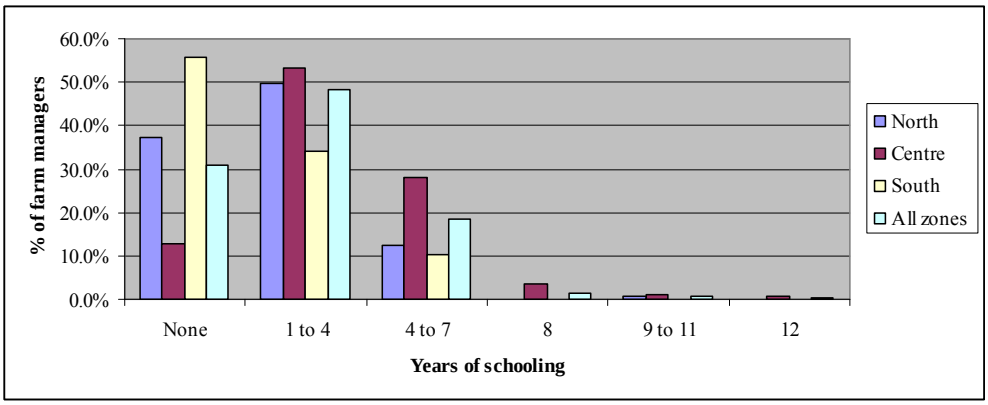

Figure 1. *Years of schooling of farm managers (comparative regional percentages)*

Farm, Crop and Livestock Management

Crops

Maize and cassava are dominant staple crops in all the three regions. Sorghum and rice are important to the centre and north regions but are usually not suitable crops in the south. Only a few semi-arid zones in the interior of Gaza and Inhambane provinces grow sorghum. Crop diversification is less in the south also due to the cyclical droughts that have afflicted the region. Though cassava is drought tolerant crop, the only 19% of the farmers in the south plant it. They argued that, since cassava multiplication is through stalks, the drought shrivels and kills them before sprouting. In recent years, except for irrigated areas, the exceptionally prolonged drought in the south sabotaged crop production.

Table 6: *Percentage of farmers in each region who plant selected crops*

Crop	North	Centre	South	All zones
Maize (c118)	63.8	100.0	100.0	85.6
Cassava (c119)	96.3	52.8	19.0	63.4
Sorghum (c120)	22.5	68.1	0.0	36.6
Rice (c121)	43.1	14.1	0.0	22.9
Other food crops and vegetables (c122)	91.9	35.6	89.9	68.7
Cash crops, non-food crops (c123)	36.3	9.9	0.0	18.5

The crop variations between the current and prior seasons were mostly tiny (Table 7). In the centre, some farmers stopped raising cassava and rice while in the north and south, a few others started to grow other food crops and vegetables. In the dry season, vegetables such as tomatoes, cabbage, onions, green leaves and lettuce are grown in wetlands for later sale. Opportunities for new crops arose in some areas. For example, in central Mozambique, Africare introduced a contract farming scheme for sesame, providing seeds to the farmers and guaranteeing purchase of the entire crop.

Table 7: Variation of *staple crops produced on the last two periods*

Crops	North		Centre		South		All zones	
	Previous crop	Recent crop	Previous crop	Recent crop	Previous crop	Recent crop	Previous crop	Recent crop
Maize (c118)	69.4	63.8	99.4	100.0	97.4	100.0	87.0	85.6
Cassava (c119)	96.9	96.3	60.7	52.8	23.4	19.0	68.0	63.4
Sorghum (c120)	25.6	22.5	66.9	68.1	0.0	0.0	37.5	36.6
Rice (c121)	40.6	43.1	19.0	14.1	0.0	0.0	24.0	22.9
Other food crops and vegetables (c122)	84.4	91.9	36.2	35.6	83.1	89.9	64.5	68.7
Cash crops, non-food crops (c123)	34.4	36.3	8.0	9.9	1.3	0.0	17.3	18.5

Between 2002 and 2008, the amount of land dedicated to maize changed very little for most families (Table 8). Nevertheless, 31.9% of households in the centre increased their maize cultivation whereas, in the south, the 21% of the people had cut back on maize. Based on the focus group discussions, two main factors explain this trend. In Manica, maize commercialization improved, thus inducing farmers to plant more. For instance, DECO Company goes to the villages and buys all the available maize. Though some farmers complained that local prices were low and that selling in Beira was more profitable, transport constraints compel them to sell to DECO.

In the south, the cyclical drought has forced many farmers to reduce the cultivation of maize. Some are abandoning agriculture and starting small business, including buying and selling agricultural products, like vegetables.

Table 8: *Average size of the land under maize in the most recent season compared to 2002*

Region		What was the average size of the land under maize in the most recent season as compared to 2002?				Total responses
		Did not grow maize in 2002	Less now	Same	More now	
North	Count	5	16	64	17	102
	%	4.9%	15.7%	62.7%	16.7%	100%
Centre	Count	15	15	79	51	160
	%	9.4%	9.4%	49.4%	31.9%	100%
South	Count	4	15	46	6	71
	%	5.6%	21.1%	64.8%	8.5%	100%
Total	Count	24	46	189	74	333
	%	7.2%	13.8%	56.8%	22.2%	100%

Livestock & Fish

According to the farm census, 99.7% of the country's livestock comprises small animals (birds, rabbits, goats, sheep). Poultry is common in all regions; cattle are concentrated in south, especially in Gaza province (Table 9). The southern villages are major cattle growers and about a third of the farmers interviewed have cattle whereas less than 2% do in the centre and north (Table 10). The north has little livestock. Overall, 59% of households own poultry but merely 5% have cattle (TIA 2005). Very few of the interviewed households fish and those who do live mainly in the north and consume most of their catch (Table 11 and Table 12).

Kommentar [K2]: Is this correct? Or should it say that 99.7 of the farmers only have ?small stock.

With steady encouragement by the extension officer, the village of Nacocolo, Nampula Province, has tripled, in the last three years, the number of fish pounds (now 43) along a creek that passes through the village. Each pond is maintained by individual families, sometimes diligently, sometimes, lackadaisically. The fish harvest is small and mainly consumed by the farmer's family.

Table 9: *Livestock ownership by region*

	North		Centre		South	
	Sum	Mean per farmer	Sum	Mean per farmer	Sum	Mean per farmer
Cows (c447)	3	0	4	0	106	1
Oxen (c448)	3	0	1	0	82	1
Goats/sheep (c449)	140	1	224	1	112	1
Camels and donkeys (c450)	2	0	0	0	0	0
Pigs (c451)	61	0	138	1	12	0
Poultry (c452)	455	3	1433	9	259	3

Table 10. *Percentage of farmers who own animals, by region*

	North	Centre	South	Total
Cows	1.9%	1.2%	32.9%	7.7%
Oxen	1.2%	0.6%	32.9%	7.2%
Goats/sheep	29.8%	25.2%	40.5%	30.0%
Camels/donkeys	0.6%	0.0%	0.0%	0.2%
Pigs	18.6%	16.0%	10.1%	15.9%
Poultry	67.7%	77.2%	46.8%	67.4%
Do you regularly sell any animal produce, like milk etc.?	2.4%	0.8%	3.4%	1.9%
Do you regularly sell animals?	16.1%	9.1%	5.0%	11.1%
Do you use your livestock for draught or transport?	0.0%	0.0%	37.5%	7.0%
Do you stall-feed any cattle?	10.6%	3.4%	12.1%	8.1%

Table 11: *Access to fish ponds or fishing waters*

Zone	Do you have:	No	Yes	Total respondents	% yes
North	A fish pond?	149	12	161	7.5%
	Access to fishing waters?	83	75	158	47.5%
Centre	A fish pond?	159	0	159	0.0%
	Access to fishing waters?	148	12	160	7.5%
South	A fish pond?	76	2	78	2.6%
	Access to fishing waters?	59	17	76	22.4%
All	A fish pond?	384	14	398	3.5%
	Access to fishing waters?	290	104	394	26.4%

Table 12. *Main reason for fishing by region*

	North		Centre		South		All zones	
	Count	%	Count	%	Count	%	Count	%
Household uses/ own consumption	36	90%	9	0.9	1	33%	46	87%
Commercial purposes	4	10%	1	0.1	2	67%	7	13%
Total	40	100%	10	1	3	100%	53	100%

Technology and Inputs

Despite the general availability of additional land for farmers who want it, most farmers (61.3%) only cultivate 0.5 to 1.5 hectares, few (2.9%) have access to irrigated land and few use fertilizer on maize, often their principal food crop (Table 17). Many farmers (17%) think they could not cultivate any more land at all even if they wanted to, while 40% think they might manage to farm another quarter hectare, 13% another half hectare, and 16% up to another hectare (Table 15). But they do not expand their cultivated land. Why? The farmers' technological, capital and labour constraints are usually too severe to permit them to cultivate more land. For distant, isolated villages, marketing or transport costs are further problems. Stuck with using traditional storage techniques with high losses, the farmers have little incentive to store crops for later sale during the high-price hungry season. Fearing losses, they sell soon after the harvest despite the low prices received, low prices that make high-input high-yield farming impossibly risky and comparatively less profitable than traditional techniques.

Fear, risks and poverty comprise a vicious cycle of low prices and incomes, low-yield, low-risk techniques, and urgent, untimely sales depressing, again, prices and incomes. Meanwhile, traditional extension services focusing on simple, low cost technologies and improved marketing—but meagre capital investment—have proved insufficient to break the poverty cycle for most small farmers. Few expand, few progress though land, in Mozambique, is plentiful.

Might other techniques exist that, with a rotating, temporary infusion of capital, can double or triple peasant incomes—sustainably? With ingenuity and systematic persistence, can the cycle be broken? Are quantitative leaps possible? Can our Afrint villages help us to understand better the options? The following discussion explores a few options.

Cultivation and Transportation

Most of the Afrint households are subsistence farmers using rudimentary techniques such as hoe cultivation and rain-fed agriculture without other inputs apart from seeds. Of the interviewed households, 86% use hoe cultivation. The north relies exclusively on this technique whereas, in the south, most of the interviewees (53.8%) use ox ploughs though many (46.2%) still hoe their fields (Table 14). The small farmers focused by this study rarely used tractor ploughing services and, then, only in central Mozambique, though the central government plans to use district development funds[2] to promote the use of animal traction through.[3] A few farmers use tractor ploughing services but, then, only in central Mozambique.

Gaza province has an agro-pastoral system, which takes advantage of the availability of animal traction for land preparation. In no region, however, did our interviewers use animal drawn transport to bring crops to nearby town markets where, depending on the crop, they could receive 17% to 114% more than what merchants buy them for in the village (Table 13). In this regard, Nacocolo village, situated 20 km from the main road and another 7 km to the nearest city, Murrupula, may exemplify how animal drawn transportation can improve marketing and enhance farmers' incomes.[4] Given that maintenance costs are very low,[5] a pair of oxen and a cart would fetch, on average, roughly 59% more income from crop sales

[2] Starting with ProAfri II, the Central Government of Mozambique began to decentralize by sending more funds to the districts (7 million meticais to each district), which, in turn, set the priorities on what to spend the money on.
[3] interview with Dinis Caetano Livasse, Provincial Director of Agriculture, Chimoio, Manica, 13/5/08
[4] Trypanosome resistant breeds would be needed in Nacocolo.
[5] See Table 37 for an examination of the profitability of animal draught power, mainly for cultivation and on-farm transportation in South Africa.

though not all of that would go to the farmers.[6] Some would go to the driver and the owner of the cart and team. Along the agricultural year, the animals would also earn income by providing ploughing, seeding and weeding services.

Table 13. *Extra income earned by transporting crops to roads or nearby cities from Nacocolo village, Nampula Province*

Crop	Price in village (Mt/kg)	Price along main road (Mt/kg)	Price in nearest city* (Mt/kg)	Village/City increase (%)	Average sales per year (tons)	Total increase in revenue if sold in city (Mt)	Increase in revenue if sold in city (US$)
Rice	7.00	10.00	15.00	114%	3	24,000	889
Milho	3.25	4.25	6.00	85%	13	35,750	1,324
Amendoin grande	12.00	14.00	14.00	17%	4	8,000	296
Sorghum	2.00	n.a.	2.50	25%	3	1,500	56
Onions	3.53	4.71	n.a.				
Cabbage	3.53	0.59	n.a.				
Total increase in income from crop sales						**69,250**	**2,565**
Weighted average increase in income						59%	59%
Cost of carriage, harness, and two bulls							**US$**
Ox cart[1]							380
Plough with chain[1]							184
Harness[2]							380
Two bulls[3]							360
Total							**1,304**

[1] Mattick (2000:34).
[2] Galindo (1977:5)
[3] "The breeds used are landims or improved crossbreds (offspring of restocking animals) and all are purchased locally in Mutarara or in and around the city of Tete. The buying price varies with the weight of the animal from US$130 to $180 per head" (Mattick 2000:).

Table 14: *Main methods for preparation of land for maize, by region*

Method	North	Centre	South	All regions
Hoe cultivation	100.0%	96.3%	46.2%	86.0%
Ox plough	0.0%	0.6%	53.8%	12.5%
Tractor plough	0.0%	3.1%	0.0%	1.5%
Total %	100.0%	100.0%	100.0%	100.0%
Total respondents	102	163	78	343

Except for intercropping, many farmers claim to know specific improved agricultural techniques but far fewer apply them (Table 15). For example, whereas 59% claimed to know about crop rotation and 55% about fallowing, less than half of those same farmers reported actually using these techniques. For less commonly used techniques, the gap between knowledge and practice is often yet greater. For example, 55% of all respondents know about irrigation but only 1% use it and 18% know about the use of pesticides and herbicides but only 2% use them. Clearly, mere knowledge and encouragement is not enough. To apply it,

[6] In a proper cart, "a team of oxen, correctly utilized, can easily transport … a tonne of cargo from 20 km to 30 km in eight hours" (INA 2007:3).

farmers need capital, access to markets and inputs, adequate transportation, attractive prices, and sufficient labour to implement the technology.

Fallowing, intercropping with nitrogen fixing crops (e.g., beans), use of animal manure, and crop rotation were the most frequently mentioned agricultural management techniques though subsistence farmers use intercropping to maximise the use of land, labour and rainfall, not as a soil improvement technique. However, especially for the most frequently used improved agricultural techniques, male farmers were more likely than females to report knowing about them (Table 16). This may be because females get less exposure to these techniques though they are the main actors in the subsistence agriculture.

Of all the respondents, 59% know about crop rotation but only 27% use it. In the north, 56% of the farmers use this technique while less than 10% in the centre and south do. Intercropping is frequently used in north (94%) and centre (82%), while intercropping with beans is popular in the north (83%) and south (84%). Overall, the farmers in the north and centre had been more prone to experiment with additional techniques than those in the south (except for the use of manure). Compared to male farm managers, female managers tend to use intercropping, crop rotation, and fallowing less frequently.

Table 15. *Area irrigated, cultivated or potentially cultivated, by region*

Hectares	North			Centre			South			All regions		
	Total hectares irrigated	Total hectares cultivated during most recent season or year	How much extra land could you farm if desired?	Total hectares irrigated	Total hectares cultivated during most recent season or year	How much extra land could you farm if desired?	Total hectares irrigated	Total hectares cultivated during most recent season or year	How much extra land could you farm if desired?	Total hectares irrigated	Total hectares cultivated during most recent season or year	How much extra land could you farm if desired?
nil	99.3%	0.6%	20.1%	95.1%	0.0%	8.6%	97.0%	0.0%	28.9%	97.1%	0.3%	17.1%
0 ≤ 0.25	0.7%	1.9%	51.7%	4.2%	6.2%	44.4%	1.5%	1.3%	5.3%	2.3%	3.5%	39.5%
0.25 ≤ 0.5	0.0%	5.6%	6.7%	0.7%	18.0%	13.6%	0.0%	10.3%	25.0%	0.3%	11.5%	13.2%
0.5 < area ≤ 1.0	0.0%	31.7%	10.1%	0.0%	41.0%	14.2%	1.5%	47.4%	30.3%	0.3%	38.5%	15.8%
1.0 < area ≤ 1.5	0.0%	26.7%	2.0%	0.0%	15.5%	9.9%	0.0%	24.4%	2.6%	0.0%	21.8%	5.4%
1.5 < area ≤ 2	0.0%	12.4%	4.7%	0.0%	9.9%	4.3%	0.0%	6.4%	3.9%	0.0%	10.3%	4.4%
2 < area ≤ 3	0.0%	11.2%	2.7%	0.0%	5.6%	3.1%	0.0%	7.7%	2.6%	0.0%	8.3%	2.8%
3 < area ≤ 4	0.0%	3.7%	0.0%	0.0%	1.2%	0.6%	0.0%	2.6%	1.3%	0.0%	2.5%	0.5%
4 < area ≤ 5	0.0%	3.7%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	1.5%	0.3%
5 < area ≤ 8	0.0%	1.9%	1.3%	0.0%	1.9%	0.6%	0.0%	0.0%	0.0%	0.0%	1.5%	0.8%
8 < area ≤ 10	0.0%	0.6%	0.7%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.3%
area > 10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total respondents	138	161	149	142	161	162	67	78	76	347	400	387

Table 16. *Percentage of respondents knowing or using improved agricultural techniques, by sex and region*

Technique	% of all respondents within each region								% by sex of farm manager			
	North		Centre		South		All three regions		Male		Female	
	Knows	Uses	Knows	Uses	Knows	Uses	Knows	Uses	Knows	Uses	Knows	Uses
Crop rotation	81%	56%	37%	7%	61%	9%	59%	27%	62%	31%	53%	18%
Intercropping	99%	94%	89%	82%	58%	56%	87%	82%	93%	89%	73%	65%
Intercropping with nitrogen fixing crops (beans etc.)	91%	83%	60%	42%	96%	85%	79%	67%	80%	66%	77%	69%
Fallowing	80%	57%	36%	4%	44%	8%	55%	26%	60%	29%	44%	19%
Improved fallowing	3%	1%	7%	1%	5%	3%	5%	1%	5%	1%	6%	2%
Animal manure	21%	0%	45%	1%	62%	5%	39%	2%	37%	1%	42%	3%
Zero or minimum tillage	1%	0%	23%	23%	63%	61%	22%	21%	14%	13%	43%	41%
Breaking the hard pan	1%	0%	12%	4%	18%	5%	9%	3%	7%	3%	14%	3%
Green manure/compost/residue incorporation	6%	0%	24%	19%	25%	1%	17%	8%	16%	8%	20%	7%
Chemical fertilizer	22%	0%	33%	0%	39%	0%	30%	0%	30%	0%	31%	0%
Soil and water conservation (level bunds, grass strips, terracing etc.)	21%	7%	13%	1%	27%	1%	19%	3%	18%	4%	20%	2%
Improved planting practices	24%	6%	48%	31%	38%	16%	36%	18%	35%	17%	39%	19%
Integrated (Soil) Nutrient Management (INM)	1%	0%	4%	0%	5%	0%	3%	0%	3%	0%	2%	0%
Integrated Pest Management (IPM)	1%	0%	6%	0%	5%	1%	3%	0%	4%	0%	3%	0%
Agroforestry	3%	0%	7%	1%	3%	0%	4%	0%	5%	0%	3%	0%
Pesticides/herbicides	18%	1%	25%	4%	4%	0%	18%	2%	20%	1%	12%	2%
Rain water harvesting	4%	0%	11%	1%	37%	3%	13%	1%	11%	1%	20%	1%
Irrigation	54%	0%	47%	3%	76%	1%	55%	1%	56%	1%	55%	2%
Average number of respondents per question	160	161	163	160	79	78	401	398	280	277	121	121

Inputs

The input market in Mozambique is very limited. "Among small farmers, only 2.7% use fertilizer and 4.5%, pesticides, and those who do are mostly contract farmers who use them almost exclusively for cash crops such as cotton and tobacco" (Coughlin 2006:23). In fact, increases in rural production usually arise from farming *more land* rather than from the use of improved inputs and technology. Given the farmers' lack of capital and the risks due to plagues, drought and floods, subsistence agriculture is not profitable enough to justify the use of commercial inputs. For example, during the late 1990s, Howard et al. (1999:7) concluded that, "in general, profits from the use of Sasakawa-Global technology [input kits for maize] are not significantly higher than low-input technologies (after farmers pay their input loans) and the use of high-external-input technologies is riskier than low-input technologies". Even with irrigation, unless the crop's sale is delayed to the hungry season, maize production with only moderate yields renders negative or little profit after subtracting the costs for chemicals, diesel fuel, and other inputs (Annex 3). Thus, without credit and guaranteed sales (e.g., to large concessionaires), small farmers rarely use improved inputs. Moreover, for input merchants, the transaction cost of selling tiny quantities of inputs to small farmers is higher than for selling in bulk to big farmers. This reduces the small farmers' access to inputs and explains why they create farm associations or cooperatives to get access to inputs.

The Afrint sample reflected these overall patterns. Nearly all of the farmers (98.8%) in the sample had **no** irrigated land and applied **no** fertilisers (Table 17). Indeed, to benefit fully, one technique demands the other. Irrigation infrastructures are more common in the south due to irregular rains and frequent droughts. Indeed, some of the interviewed households (1.2%) in south report using both irrigation and fertiliser since each of the selected villages has a small, but expanding irrigation project. In the north and centre, the need for irrigation varies from province to province, for example, Zambézia, Tete and Manica have the same irrigation patterns as the southern. However, a few ONG-supported farmers do use improved agricultural techniques and inputs and benefit from the ONG's extension services as happens in both Chaimite and Mukotweni in Chibuto District in the south (Box 1).

Table 17: *Level of irrigation and fertilizer use for maize, by region*

Region		During the most recent season, what portion of the total land planted with maize was irrigated?			What was the amount of chemical fertilizer used on maize in the most recent season as compared to 2002?		
		None	1/4	1/2	No fertiliser applied at that time	Amount decreased since then	Amount unchanged
North	Count	99	2	1	99	1	1
	% within region	97.1%	2.0%	1.0%	98.0%	1.0%	1.0%
Centre	Count	161	1	0	153	0	1
	% within region	99.4%	.6%	.0%	99.4%	.0%	.6%
South	Count	79	0	0	75	1	0
	% within region	100.0%	.0%	.0%	98.7%	1.3%	.0%
Total	Count	339	3	1	327	2	2
	Overall %	98.8%	.9%	.3%	98.8%	.6%	.6%

Overall, in all regions, very few (less than 1%) of the farmers in our sample reported getting regular advice from governmental or other extension workers and less than 5% reported getting advice even rarely. On the other hand, in the south, 12% of the farmers report getting advice regularly or rarely, a reflection of the irrigation projects in the two

villages studied there. These statistics are lower than the national average. For example, during 2002/2003, 14% of the farmers sampled by the agricultural census had received advice from an extension worker (MADER 2003).[7] Perhaps more importantly, when asked where they learned the techniques they use, less than 1% of the respondents claimed the knowledge came from an extension worker of the time and, then, for only some of the techniques, even the most popular like intercropping, fallowing, and crop rotation (Table 19).

The government has, however, started giving agricultural training in rural primary schools. If run properly, this could greatly assist in improving the farming practices of future farmers and, more immediately, even influence the present practices of their parents. Unfortunately, though recommended in the Ministry's of Agriculture's preparatory document for ProAgri II, the national extension service and the Ministry of Education still have not initiated any systematic cooperation—aside from a teaching manual—to help teachers in charge of such courses from receiving occasional assistance from extension workers in their districts (MADER 2004:115). Another difficulty is that the students plant their trial gardens in November and early December and then all go on vacation till early February. By then, their fields are overrun with weeds and insects. Totally unpersuasive, this is a didactic disaster.

Table 18. *Frequency of extension advice received by farmers, by region*

Region	Frequency	Have you received advice from extension staff (governmental) at any time during the last year?	Have you received advice from non-governmental extension services at any time during the last year?
North	Never	97.5%	96.3%
	Rarely	2.5%	3.1%
	Regularly	0.0%	0.6%
Centre	Never	92.6%	97.5%
	Rarely	6.7%	2.5%
	Regularly	0.6%	0.0%
South	Never	92.4%	88.5%
	Rarely	6.3%	10.3%
	Regularly	1.3%	1.3%
All zones	Never	94.5%	95.2%
	Rarely	5.0%	4.3%
	Regularly	0.5%	0.5%

[7] As opposed to TIA's estimate of 14.1% coverage, Perumalpillai-Essex (2005:17) uses a different and rather vague concept, *access*. Accordingly, in 2002, 32% of communities "had *access* to extension services over the past 12 months ... [though] only 20% of the households in villages *with an extension service,* actually benefited from it".

Table 19. *Agricultural techniques applied and how they were learned*

Technique	Not practicing this technique	If used, from where did you learn the technique?							Total %	Total respondents
		My parents or a family member	A fellow farmer or a neighbour	An extension agent, an NGO or other formal organization	The radio, newspaper or TV	An NGO	An input supplier or private trader	Another source		
Crop rotation	68%	25%	6%	1%				1%	100%	344
Intercropping	13%	73%	12%	1%				1%	100%	373
Intercropping with nitrogen fixing crops (beans, etc.)	28%	59%	11%	1%	1%				100%	377
Fallowing	68%	23%	8%	1%				1%	100%	346
Improved fallowing	98%	1%	1%						100%	335
Animal manure	99%		1%						100%	333
Zero or minimum tillage	76%	22%	2%	1%					100%	355
Breaking the hard pan	96%	3%	1%						100%	336
Green manure/compost/residue incorporation	91%	7%	1%						100%	339
Chemical fertilizer	99%								100%	334
Soil and water conservation (level bunds, grass strips, terracing etc.)	96%	1%	3%						100%	334
Improved planting practices	81%	10%	8%	1%		1%		1%	100%	345
Integrated (soil) nutrient management (INM)	100%								100%	335
Integrated pest management (IPM)	100%								100%	336
Agroforestry	100%								100%	336
Pesticides/herbicides	98%		1%	1%					100%	336
Rain water harvesting	99%								100%	335
Irrigation	97%	1%	1%						100%	336

Note: A blank means zero. Rows may not sum exactly due to rounding.

Storage Techniques

On average, 82% of the farmers use traditional granaries though a significant minority (18%) use bags usually stored inside their homes. This is especially common in the south where 42% use bags stored inside their homes (Table 20). In the south, of the farmers that use bags, 32% place them on the rafters under the ceiling while 60% use the worst possible method: they leave the bags directly on floor, easily exposed to humidity, insects and rats (Table 21).

Table 20: *Storage means by region*

Method	North		Centre		South		All zones	
	Count	%	Count	%	Count	%	Count	%
Bags inside house	23	14.3%	11	6.7%	32	41.6%	66	**16.5%**
Bags in a proper store	6	3.7%	0	0.0%	1	1.3%	7	**1.7%**
In a granary	132	82.0%	152	93.3%	44	57.1%	328	**81.8%**
Total	**161**	**100.0%**	**163**	**100.0%**	**77**	**100.0%**	**401**	**100.0%**

Table 21. *If you store the bags inside your house, how do you store them?*

Method	North		Centre		South		All zones	
	Count	%	Count	%	Count	%	Count	%
In bags straight on the floor	17	20.5%	18	29.0%	34	59.6%	69	**34.2%**
In bags on pallets on the floor to allow for air circulation	52	62.7%	42	67.7%	5	8.8%	99	**49.0%**
In bags under the ceiling	9	10.8%	1	1.6%	18	31.6%	28	**13.9%**
Other methods	5	6.0%	1	1.6%	0	0.0%	6	**3.0%**
Total	**83**	**100.0%**	**62**	**100.0%**	**57**	**100.0%**	**202**	**100.0%**

Sustainability of Projects to Improve Farm Productivity

Sustainability is a grave problem for some projects. Many initiatives to build farmers' ability to improve their agricultural systems and practices collapse after the projects end? The case of the Foundation Against Hunger *(Fundação Contra Fome)* in Nhamantada suggests the need for serious reflection. The foundation organised farmers into groups or associations and provided them with improved seeds (cowpeas and other beans like *bambara* nuts, pigeon peas, *sorroco*; groundnuts, sorghum), field assistance by an agricultural extension agent, and a rotational credit and saving programme. According to the farmers we interviewed, the extension agent taught improved agricultural practices including better planting methods (e.g., use of appropriate plant spacing and alignment), use of botanic pesticides produced with available local plants, better land preparation, soil improvement techniques, and introduction of fruit trees (oranges, papaya, litchis and avocado). During the project, the farmers in the association were reportedly happily engaged on these activities. But after three years, the project stopped and the group could neither sustain the activities or nor adopt the disseminated techniques in their fields. According to the village leader, the program for agricultural credit stopped with the project though the rotational credit and saving scheme for small businesses survived and still has 30 members divided into seven groups.

The organizational collapse after the project stopped and the subsequent demoralization of the farmers happened for two interrelated reasons: *(i)* the project's two extension workers stopped orienting, mobilizing and encouraging the farmers and *(ii)* the project had not been structured to build up the farmers' capital and strengthen their association so that, after the project ended, they would have sufficient funds and organizational ability to continue to purchase and utilize improved inputs and farming practices.

What is the lesson? It seems that adoption of improved practices must occur together with a steady, programmed improvement in the farmers' investment capacity (capital). Without that, when the project ends, impoverished farmers will *necessarily* revert to traditional, low-input, low technology farming systems. How can projects avoid such a relapse? Box 2 proposes a low-tech, easy to manage solution, valid for some circumstances. As opposed to the use of central or village level grain storage facilities with their concomitant managerial difficulties and risks, it suggests low-volume, hermetically sealed grain storage bins needing no chemicals, initially managed as an inventory credit scheme but quickly transitioning the farmers into becoming bin owners and *savers* instead of borrowers. As savers, they avoid treatment costs, interest charges, and the worst consequences—a huge drop in net income—if hungry season prices fail to rise above post-harvest prices.

A sustainable improvement of agricultural productivity can be achieved if farmers adopt yield-increasing inputs and significantly improved managerial practices while market efficiency is also improved (MADER 2004). However, improved crop varieties have been released in many sub-Saharan Africa countries, less than 10% of farmers use them. Indeed, in our sample, only 3.3% of the households have been using improved seed maize despite various promotional efforts (Table 22). In the south, only the few farmers in the irrigation projects use improved seeds though, according to Chibuto's administrator,[8] the improved seed program is a priority in Chaimite. In the north, only 4% of the sampled farmers use improved or hybrid seeds, and in the centre, only 6%.

These low usage rates for improved seed reflect the very slow rate with which farmers use improved inputs and techniques, a result that Uaiene (2006) argues arises because, at harvest-time prices, such technologies are sub-optimal or even make a loss. For example, using prices from 2004, if maize were sold soon after the harvest, the improved input package lost $25.47/ha as opposed to a gain of $27.35/ha with traditional seeds and technology.[9] Only if the crop is sold at a high price during the hungry season does the improved package earn more ($86.71/ha) than traditional inputs ($57.95/ha) (Annex 7). Based on this analysis, Uaiene also advocates inventory credit schemes, better storage, and delayed sales.

[8] interview with Zacarias Souto, Chibuto District administrator, 6/5/08
[9] $ = United States dollars

Table 22: *Variety of maize used within regions*

Region		During the most recent season, what was the main variety of maize planted?			Total
		Traditional	Improved variety (OPV, composites)	Hybrid	
North	Count	93	1	3	97
	% within region (c002)	95.9%	1.0%	3.1%	100.0%
Centre	Count	149	10	0	159
	% within region (c002)	93.7%	6.3%	0.0%	100.0%
South	Count	79	0	0	79
	% within region (c002)	100.0%	0.0%	0.0%	100.0%
Total	Count	321	11	3	335
	% within region (c002)	95.8%	3.3%	0.9%	100.0%

Box 1

The *Uronga* Development Program in Chibuto District

The World Relief Program has an integrated development program consisting of education, health and agriculture. The organization is church based and the education program mainly provides scholarships for orphans and poor children. The health component deals especially HIV/AIDS through prevention campaigns, home care, and counseling for people living with HIV. For this, it has trained numerous local volunteer *socorristas* (community heath workers) and trainers. A subsidiary program financed by World Relief, AfricaWorks, sponsored an agricultural project as a complementary activity to provide food and income for the schools. To get the project running quickly, AfricaWorks took advantage of the organized network of dedicated and assiduous trainers and *socorristas* (90% of whom are women) by selecting them to be the first farmers in the project. This also rewards them for their dedication and creates synergy between the two projects.

So far the farm project has started in four villages where farmers initially get an irrigated 40m x 50m plot (0.2 ha) and an irrigation pump and pipes plus free agricultural technical assistance and, with time, their plots will be expanded to one hectare. Currently, the project is starting up in a fifth village where the members will receive one hectare right from the beginning. Initially, the plots use gravity irrigation but, once the farmers prove industrious, the project furnishes an integrated sprinkler system to be paid for gradually from crop receipts. This technology nearly eliminates the risk of salinization.

Project areas and numbers of members

Village	Hectares farmed	Potential number of farmers	Actual number of farmers
Chaimite	16	80	80
Mkotweni	20	100	65
Licilo	15	75	75
Giujá	16	80	68

Source: interview with Tinashe Chitambira, senior manager, AfricaWorks, 13/1/2009

Initially the farmers were little involved in the managerial decisions for the project in their village and felt little ownership in it. This plus the inclination of some to shirk work if others would do it for them, greatly slowed the initial ground clearing and preparation and the laying of pipes and, at Mkotweni, reduced the first harvest. To curb such behaviour, the extension worker believes that the project should have paid those who did that work and charge each member's share of the cost against her receipts from the first harvest.[2] With workers would be paid and shirkers, penalized, many more hand would have been available to speed the land preparation.

The project also lends them inputs (fuel, seeds, pesticides and fertilizers) worth about $39 per season per farmer to be reimbursed at harvest time. For various reasons, including excessive rain, the inappropriate choice of cowpeas, a low value crop, and the poor productivity of some farmers, the rate of reimbursement was low during the first harvest: 32% at Mkotweni and 64% at Chaimite. During the second harvest, the farmers in Mkotweni caught up, repaying 98% of their loans for the first crop and 70% of those for the second; Chaimite's members paid very little additional on the first loan and even less for the second loan (44.7%) leading their association to expel nine recalcitrants. To encourage timely reimbursements, the project now refuses to give seeds to a member till she repays the loan from the prior crop and it is urging the associations to discipline or even expel members who avoid communal tasks or fail to attend their fields properly and attain the targeted yields. Their plots are then reassigned to new and, hopefully, better farmers. If, with these measures, repayments stay low, the associations may need to assume control of the harvested crops, releasing only the surplus after the loan repayment.

Loan repayment rates

Village	Reimbursement of loans for		
	1st crop immediately after its harvest	1st crop *after* harvesting 2nd crop	2nd crop immediately after its harvest
Chaimite	64.0%	68.3%	44.7%
Mkotweni	32.0%	98.1%	70.1%
Licilo	n.a.	n.a.	n.a.
Giujá	n.a.	n.a.	n.a.

Source: interview with Tinashe Chitambira, senior manager, AfricaWorks, 13/1/2009

Beans and onions are the preferred crops because, after harvesting, they last long and fetch a good market price. Nevertheless, since the farmers retain up to 90% of their crop for personal consumption and food security, they also plant maize. This raises a strategic economic issue for the both the project and the members: since beans earn far more per kilo than maize and the farmers still get very low maize yields/ha, they would earn far more by switching more land to beans. For example, the project's farmers in Mkotwene produce two-thirds maize whereas those at Chaimite, one-third. When the farmers become more confident about their food security, they will be able shift, in part, to more profitable crops.

□□□

[1] Antonio Paulo Inguane, agribusiness project coordinator, AfricaWorks, 17/12/2008
[2] Osvaldo Macular, project extension worker at Mkotweni, Gaza.

Box 2

Small, Profitable, Business-Oriented, Hermetic Storage Bins

A Sustainable Way to Promote Agricultural Credit and Intensification?

At harvest time during the last two years, the local market around Chibuto could not absorb all the production from the Chaimite project and, simultaneously, the farmers did not have proper silos or storage facilities to keep the harvest for later consumption or sale.[1] Since, in southern Mozambique, prices nearly double between harvest time and four to eight months later during the hungry season, the project is considering encouraging the establishment of a private entrepreneur with a grain silo or warehouse in each village. Such facilities would be very lucrative. Under this scenario, however, most of the profit from storing grain or produce and later selling it during the "hungry season" would go to the private agent, not to the farmers.

Alternatively, the project could facilitate the establishment of village storage facilities owned by the associations. Under this scenario, the project would supervise their financial and inventory controls and train the association to prevent storage losses. The association could also allow members to use any excess storage space to store grains or produce harvested from non-project lands thereby reducing the village's crop losses due to inadequate storage techniques. This scenario would have far greater poverty-reducing distributive effects than a privately run silo or warehouse.

Since, with irrigation, the farmers grow three crops a year, one with maize, two with beans, the payback period for investment in improved storage would be very quick assuming current yields: just 18 months even if yields were 20% *less* than average, 14 months with average yields, and just 11 with yields 20% better than normal (assuming conservatively a 75% increase in prices from trough to peak) (Annex 3). These calculations assume that the farmers use numerous airtight one-ton hermetically sealed grain storage bins, which suffocate insects, fungi and aerobic bacteria and, hence, require no chemicals. Being small and family-owned, they are also easier to administer and more cost effective than grain cocoons or a large warehouse that requires chemicals and careful, strict administration (Annex 4).[2] If properly run and harvests were normal, improved storage would increase the *net* income per hectare per season of maize from $175 to $764 and, for beans, from $503 to $1,206, a huge income for a small farmer (Annexes 3, 4 and 5). Given one crop of maize and two of beans in a year, total *net* income would increase from $1,180 to $3,175. For beans, additional profit could be earned if the village association packaged the beans in one kilo bags for sale to wholesalers. Assuming the farmers retained the average amount of beans and maize consumed by a five-member household in Mozambique, net annual **cash** income per family would shoot up from $886 to $2,662. Even if, during the first year or so, the farmer pays $308 in annual interest charges for harvest-time loans equal to 80% of the then market value of his crop, her net cash income would still be $2,354—a huge value for a tiny farmer (Annex 7). If prices rise at least 75% from trough to peak, she could even pay off the entire loan for the seven hermetically sealed bins obtained in May that year and still have a big cash surplus.

Box 2 (cont.)

Inventory Credit Schemes

Compared to the private route, the usual way to improve the distributive effects is to create an inventory credit scheme[3] whereby the farmers' store their harvest with their local association to guarantee proper storage till prices rise later during the "hungry season". To facilitate this, the association or a cooperating financial institution lends them money equal to 50% to 80% of the current market value of their crop, while holding the stored crop as collateral. "After harvest the farmer deposits his crop in a licensed warehouse and receives a Certificate of Title (CT) and a Certificate of Pledge (CP). The warehouse will only release the crop to the owner of both documents" (Giovannucci, Varangis, Larson 2001). The financier keeps the CP; the farmer, the CT. After the farmer sells the crop, the merchant or processor takes the CT to the bank, repays the loan and obtains the CP. With both documents in hand, he can then fetch the stored crop from the warehouse.

Though some schemes have failed, especially when financial oversight was weak or the government's policies largely evened out seasonal price fluctuations, elsewhere they have been very successful, e.g., Argentina's $1 billion warehouse receipts program or TechnoServe's program in Ghana. "Since 1989, the NGO TechnoServe has worked closely with the Department of Co-operatives and the Agricultural Development Bank (ADB) in Ghana in encouraging small-scale farmers to form cooperatives and use warehouse receipts to store their crops for sale in the lean season…. From 1992 to 1996, participating farmers in this region were able to increase their profits on grain sales by an average of 94% per year, even despite the high interest rate of 42% charged on the short-term loans used. By 1997/98, more than 130 farmers groups were being assisted and for over eight years, the loan repayments have been an impressive 100%" (Giovannucci, Varangis and Larson 2001). Well run, these schemes created "confidence between farmers and financial institutions thus allowing farmers to have access to farm credit from such institutions using their collective grains in a community warehouse as collateral" (Langyintuo and Mekuria 2005:17).

Simplifying Administrative Costs and Structures

The system, however, implies administrative burdens, costs and risks. To reduce these, a different storage technology might help. For example, one-tonne hermetically sealed storage bins or large grain cocoons store grain hermetically. With airtight seals, these devices suffocate insects and bacteria within 8 to 10 days and, if initial humidity is low, stop the growth of moulds and fungi, thus obviating the need to use of chemicals (Hickman n.d.; Ferizli 2001; and Villiers, deBruin and Navarro 2006).

To permit the stored grain to be used as collateral, the bins or fenced cocoons should be centrally located. A central location permits the issuance of bankable crop-storage certificates and helps to prevent the deliberate adulteration of good grain by mixture with contaminated ones while bagging at the time of sale. If , at harvest time, farmers receive credit for food, investment and occasional emergencies, their association would emit crop storage certificates,[3] but *not* handle the cash. The latter would be the function of a financial institution. If hermetically sealed bins are used, each would need two locks, one kept by the farmer, the other by the lender's local representative *if* a loan had been obtained against the stored grain. No loan, no extra key.

Once the weaned off credit, the individual farmer would manage his or her family-owned storage facility. This would slash administrative costs. Such farmers would rely on the farmers' association for information and, probably, collective negotiation with merchants desperate to buy the villagers' stored grain when prices peak. Moreover, to ensure the scheme's long-term sustainability, the project should quickly phase out harvest-time loans and oblige farmers to use savings from peak-price sales instead of borrowing for school fees or during the hungry season. Loan free, the farmers would have no need for expensive and problem-ridden warehouse management. Moreover, if the farmers were savers rather than borrowers, the rare year when post-harvest prices fall a little or fail to rise would not spell financial disaster—a risk that has discouraged the initiation of other more formal inventory credit schemes following the "elevator company" model (de Vletter 2003:44-46). After the project ends, the farmers would be using their own savings—not loans with stiff interest charges—to finance their needs before selling the crop. With technical and financial administration on site and simplified, chemicals unneeded, and the risks of faulty or corrupt management or of financial ruin if post-harvest prices fall, virtually eliminated, post-project sustainability would be guaranteed.

But how can the transition be financed?

Obtaining Financial Support

Credit or collateral? Which comes first? Though AfricaWorks runs a credit program with six branches and 3,000 members, it cannot risk granting additional unsecured loans to the farmers. However, without a grain storage facility, the farmers cannot offer secure collateral to get a supplemental loan to buy maize while waiting to fetch better prices for their beans. Thus, the absence of a proper grain storage facility and complementary credit hinders the project from fully achieving its objectives: a big jump in the farmers' income.

If the basic conditions for success prevail—i.e., high seasonal price variations, good financial controls and monitoring, institutional support, and proper training—the principal remaining problem is how to both arrange for and minimize the required financial support. For example, for all 50 farmers assumed in Annex 3 to get a loan equal to 80% of the harvest-time value of all three of their crops would require $47,200 in the first season plus about $64,022 for the hermetic bins—the easiest technology to administer and the most cost effective—plus other investments for working capital for initial expenses. That is big money and perhaps hard to raise.

All, however, need not be done at once! The capital costs can be slashed. Since this technology permits a gradual increase in the number of storage units, implementation can be in steps without, thereby, creating inefficiencies. Since maize requires much storage capacity and is a low value crop compared to beans, farmers might initially focus on storage only for beans. For example, **all members** could receive, on loan, two hermetic bins in April in time for the first bean harvest. With that timing, they would use these bins to store beans, the most profitable crop for sale in December. Two one-ton units would nearly suffice to store two bean harvests (in May and August) though a farmer would have little or no storage space left for maize. After selling her stored beans in the December hungry season and repaying her harvest-time loan ($783) plus interest ($139) and paying for the two bins ($366) plus interest ($9), each farmer would still receive, in cash, $565 and thereafter own the two storage units (Annex 7). The expected surplus is so large that the sponsoring NGO could easily justify charging for the cost of an extension worker plus his or her transportation (one for every village) previously supplied for free, i.e., roughly $46/year per farmer.

If, by prior agreement, the association paid this surplus out in three equal payments over the next crop year, her need for a harvest-time loan would be less than during the previous year and, given the by-then exceptional profits, nil in the third year. Moreover, since the association will have recuperated all funds while also setting aside the farmers' profits to be paid out gradually over the next crop year, it would have funds to accelerate the purchase of the hermetic storage bins or expanding the project's coverage to additional farmers in the second and subsequent years. Meanwhile, any farmer unable to utilize fully her storage facility might be encouraged to allow others to store some of their harvest in it for later sale or consumption.

Operating on a rotating basis, this more gradual scheme would cut the total investment to $50,452 and be finished in three to four years in each village unless the scheme's membership or cultivated land were expanded. Once all members obtain sufficient storage capacity, the credit program would stop in the first village and the focus would shift elsewhere. Since the storage would, by then, be individually managed, the scope for corruption would be small and administrative tasks would be limited to market surveillance and sales coordination plus the purchase of additional storage for replacements or capacity expansions—tasks that, presumably, the farmers' association could do.

By then, the farmers would have tripled or quadrupled their incomes, acquired improved storage, and accumulated sufficient savings to pay for and continue to use improved techniques or invest to further enhance productivity. That and the sharp reduction in administrative costs would ensure post-project sustainability. Moreover, with their newly robust finances, the farmers could, if desired, continue employing an extension worker—an investment likely to have a high return especially since the farmers would have resources to invest yet further in expanding yields and cultivated land. Hitherto, agricultural extension workers have been hampered by the peasants' lack of capital and consequent inability to adopt highly productive farm techniques and inputs. The scheme would alleviate that constraint.

By slashing storage costs (including finance charges), the farmers would also increase the geographic range in which their crops could sell competitively. Indeed, "within the six major southern African countries" including Mozambique, "storage costs, in particular differences in real interest rates, are a significant determinant of comparative advantage and hence the pattern of [regional] production and trade" (Cruz 2006:iii).

Seizing the Opportunity

Relying on small hermetically sealed storage bins (needing no chemicals), the scheme is structured to rapidly convert the farmer from a borrower into a saver and, hence, eliminate one of the major vulnerabilities typically plaguing inventory credit schemes: the dire implications if the hungry season price doesn't rise substantially. Moreover, since the bins are owned by individual families, the other vulnerability—corrupt management—is much reduced.

The scheme also has the advantage of enabling small farmers to take much fuller advantage of advice from extension workers, hitherto fettered by the peasants' utter lack of capital. Nationwide, the extension workers' mandate could be expanded to include the promotion of improved storage facilities and inventory credit projects, in conjunction with existing or new NGOs and financial institutions. Systematically rotating funds from one village to the next would speed the effort to make improved techniques economically attractive and create the resources and the motivation for small farmers to invest and adapt them sustainably.

That is the opportunity. The challenge is in the scale. How fast can the model be adopted and spread? Can existing institutions and personnel be used to speed the process **especially** in **irrigation schemes** or areas where farmers have expanded their **cultivated land** or attain **exceptional yields?** By contrast, low-yield systems might require communally owned rather than family-owned storage.

With adaptations, can family- or community-controlled, hermetically sealed storage become a model for promoting agricultural credit and intensification and greatly increasing the farmers' net incomes? If partly saved, perhaps as a condition for participating in the project, those profits could gradually finance investments in other improved agricultural technologies. Indeed, past failures teach that a project's post-aid sustainability turns on its ability to simplify management and engender profits, capital accumulation, and reinvestment.

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[1] Similarly, Uaiene (2006:vi) found that, even with less than maximum yields, high input farming methods are technologically optimal and quite profitable in Manica Province *if* hungry season prices are obtained but, with harvest-time prices, become financial losers. As a consequence, he argues that "without new marketing strategies, adoption of new technologies will not occur…. These results indicate that the use of new improved cultivars and fertilizers can be accelerated if farmers can … benefit [from] the seasonal price variation by selling when the prices recover."

[2] Though other producers also make hermetically sealed grain storage bins, our calculations were based on GrainSafes produced by GrainPro.

[3] Being run on strictly business principles, inventory credit schemes have a far better success rate than cereal banks largely because the latter have both economic and social goals, selling grain at subsidized prices to needy farmers, and very often lacked tight financial controls, external oversight, and proper monitoring and evaluation. In West Africa, these inadequacies led 1,200 of 1,500 cereal banks in Burkino Faso to go bankrupt "within five years of their creation"; in Niger, 90% failed and only one of 100 cereal banks started by FAO survived after external assistance stopped; and, in Ghana, all those started by the Catholic Relief Services collapsed after support was withdrawn (Yangyintuo 2005:8). Unlike elsewhere, however, the failures of FAO's Niger schemes arose largely because "in four of the eight years, millet prices either declined or increased only modestly" and, thus, inventory credit was "risky, both for borrowers and lenders" (Languintuo and Mekuria 2005:10).

Market Conditions

In the north and centre, more than 80% of the households that had sold selected crops in 2002 opined that, **after** 2002, market access improved. In the south, crop production and commercialization was jeopardized by the cyclical drought and other biophysical conditions. Since most households in the south could not produce enough even for their own subsistence, few were in a position to opine about changes in market conditions (Table 23 and Table 24).

In the south, few of the interviewees—except lucky ones possessing irrigated land—reported selling any of the selected crops even if they grew them (Table 25). In the north and centre, more farmers enter the market and sell some of their maize, cassava, sorghum or paddy. Throughout the country, a few farmers sell sorghum or paddy.

Table 23: *Changes in market access as perceived by farmers who sold selected crops in 2002*

Market access in 2008 compared to 2002	Maize	Cassava	Sorghum	Paddy
	North			
Worse	1	1	0	0
No change	2	6	2	2
Better	40	28	4	5
Total	43	35	6	7
	Centre			
Worse	1	0	0	1
No change	3	2	1	0
Better	26	14	5	2
Total	30	16	6	3
	South			
Worse	3	0	0	0
No change	0	1	0	0
Better	0	0	0	0
Total	3	1	0	0
	All three regions			
Worse	5	1	0	1
No change	5	9	3	2
Better	66	42	9	7
Total	76	52	12	10

Table 24. *Growers who sold selected crops in 2002*

Sold this in 2002?	Maize	Cassava	Sorghum	Paddy
	North			
no	14	34	63	83
yes	41	2	6	7
	Centre			
no	0	44	118	62
yes	29	2	8	1
	South			
no	0	3	3	5
yes	3	1	0	0
	All three regions			
no	14	81	184	150
yes	73	5	14	8
Total	87	86	198	158

Table 25: *Percentage of all interviewed households growing selected crops within each region that sold or intended to sell some of their harvest*

Crop	North	Centre	South	Average
Maize	37.7%	30.2%	2.5%	26.5%
Cassava	28.4%	20.3%	11.1%	24.1%
Sorghum	3.1%	1.7%	0.0%	2.1%
Paddy	7.8%	1.6%	0.0%	5.1%

Rural-Urban and Rural-Rural Linkages

Rural-urban and rural-rural linkages are reflected, in part, by social networks and the extent to which farmers share their production with relatives in and outside their village. In our sample, farmers in the north and centre tend to support other relatives much more than those in the south. Still, in all regions, at least half of the farmers do **not provide** relatives outside their village with grains or other produce.

Table 26. *Comparative regional percentages of respondents that send any stable crop to relatives residing outside their village*

		North	Centre	South	Total
Yes	Number of respondents	76	56	15	147
	% within region	50.0%	37.1%	19.2%	38.6%
Total	Number of respondents	152	151	78	381
	% within region	100.0%	100.0%	100.0%	100.0%

Crop Diversification

Besides growing the four main crops, the north and centre reveal, by far, the greatest crop diversification. Though, in all regions, most farmers grow beans, those in the south rarely grow additional crops. Farmers in the north and centre often grow groundnuts, bananas and sweet potatoes while, in the north, many also plant peas (Table 27). Despite its favourable agro-ecological conditions, the centre shows far less crop variability than the north. By contrast, due to its climate, the south has the least crop diversity.

As for commercialization and cash income, in the north, 54.7% of the respondents sold groundnuts and some also sold bananas, beans and peas (Table 28). In the centre and south, very few interviewees sell any of their harvests. Nearly everything was for home consumption (Table 28). In the south, besides the four main crops, beans were nearly the only crop that our interviewers (merely 4.5%) sold; other crop sales were trivial.

Table 27. *Comparative regional percentages of respondents **growing** other crops*

	Number responding "yes"				% within region		
	North	Centre	South	Total	North	Centre	South
Bananas	55	11	2	68	36.7%	19.3%	3.0%
Beans	133	41	64	238	88.7%	71.9%	97.0%
Peas	114	0	0	114	76.0%	0.0%	0.0%
Irish potatoes	2	0	0	2	1.3%	0.0%	0.0%
Sweet potatoes	42	18	8	68	28.0%	31.6%	12.1%
Millet	22	0	3	25	14.7%	0.0%	4.5%
Groundnuts	125	32	9	166	83.3%	56.1%	13.6%
Yams	2	1	0	3	1.3%	1.8%	0.0%
Cocoyams	0	0	1	1	0.0%	0.0%	1.5%
Vegetables for local market	21	9	2	32	14.0%	15.8%	3.0%
Fruits for local market	10	0	1	11	6.7%	0.0%	1.5%
Other	1	23	10	34	0.7%	15.2%	15.2%
Total respondents (yes or no) in region	150	57	66	273	n.a.	n.a.	n.a.

Table 28. *Comparative regional percentages of respondents who have **sold** one of the other crops grown*

	Count				% within region		
	North	Centre	South	Total	North	Centre	South
Bananas	29	2	0	31	19.3%	3.5%	0.0%
Beans	19	2	3	24	12.8%	3.5%	4.5%
Peas	13	0	0	13	8.8%	0.0%	0.0%
Irish potatoes	0	0	0	0	1.3%	0.0%	0.0%
Sweet potatoes	10	2	1	13	6.7%	3.5%	1.5%
Millet	4	0	0	4	2.7%	0.0%	0.0%
Groundnuts	82	4	0	86	54.7%	7.0%	0.0%
Yams	1	0	0	1	0.7%	0.0%	0.0%
Cocoyams	0	0	0	0	0.0%	0.0%	1.5%
Vegetables for local market	6	5	1	12	4.0%	8.8%	1.5%
Fruits for local market	9	0	1	10	6.0%	0.0%	1.5%
Other	1	3	0	4	0.7%	5.3%	0.0%
Total respondents (yes or no) in region	150	57	66	273	n.a.	n.a.	n.a.

Agricultural Tasks and the Gendered Division of Labour

Land preparation, weeding, harvesting, and crop transporting require much labour. A key factor in the gender divisions of labour is the sex of the farm manager and, by inference, the availability of male workers. As expected, when the manager is a women, very few tasks—except tending livestock—are assigned mainly to men. For roughly two-thirds of the respondents, tending to livestock was predominantly a male task regardless of the sex of the manager though it was main done by women 16% of the time in homes with a male manager and 23% of the time when the manager was female. Most homes reported that men and women participated equally in doing many tasks, e.g., planting, weeding, harvesting, transporting crops. Fertilising was predominantly men's task and, in the north, land

preparation and fertilising were far more often deemed men's tasks than that in the centre and south (Table 29).

Institutional Conditions

The main ways that government and private institutions can help small farmers are: access to land, extension services, general education, agricultural research, credit, market facilitation, and infrastructure. With seven hectares of agricultural land available for every one that is utilized, land is rarely a constraint in Mozambique. Extension services, however, are far from reaching most farmers adequately. For example, except in Nacocolo (in the north) where the government extension worker is promoting fish ponds complemented by a pedal pump for vegetable farming on the creek's banks and in Chaimite and Mkotwene (in the south) where an NGO is furnishing extension workers and promoting irrigation, the other villages we studied are receiving no or very little agricultural training and advice. As for research, the government's efforts to develop cassava variants resistant to brown streak disease has had significant impact in the villages studied since most farmers report using improved variants and this was visible in the fields.[10] With the exception of an NGOs effects to finance irrigation and cultivation for a minority of farmers in Chaimite and Mkotwene, credit is virtually non-existent in the other villages. Improved roads have helped various villages gain easier access to markets especially by facilitating the more frequent passage of crop buyers. Even mobile telephone services have been extended to all but one of the villages under study thus reducing transportation and communication costs for those communities.

Assistance helps those who get it, but the beneficiaries are few and most schemes and extension workers rotate their efforts and resources onward to new farmers and villages only slowly if at all.

[10] "Brown streak is a problem that can be addressed by effective agricultural research and extension. Indeed, a partial solution to brown streak can be found in the region in the form of several sweet varieties that succumb to the disease but do not express root symptoms…. The national survey data [from 2002-2003] also pointed to a paucity of effective options to adjust to risk of CBSD which affected (an astonishing) 57% of the roots sampled over four years in the Save the Children field surveys. The demand for Nikwaha is strong because it tolerates root damage and scores favourably on consumption characteristics. Based on comprehensive field-survey data and conservative assumptions, the economic superiority of Nikwaha is reckoned at 25% per plant which is equivalent to about $70 per hectare at a median planting density of 3,000 plants (McSween, Walker, Salegua and Pitoro 2006:vi).

Table 29. *Division of work by task and gender*

Region	Sex of farm manager	Sex of farm manager (% in each region)	Who does each task?	Land preparation	Planting	Weeding	Fertilising	Watching crops	Harvesting	Transporting crops	Tending livestock	Other
North	Male	85%	Mainly men	71%	12%	37%	77%	10%	1%	5%	60%	14%
			Mainly women	0%	16%	7%	5%	24%	15%	4%	20%	6%
			Equal participation	29%	72%	56%	18%	66%	84%	90%	21%	81%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Female	15%	Mainly men	33%	4%	17%	50%	5%	4%	13%	57%	0%
			Mainly women	54%	63%	54%	50%	68%	61%	57%	43%	100%
			Equal participation	13%	33%	29%	0%	27%	35%	30%	0%	0%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
Centre	Male	74%	Mainly men	30%	10%	14%	50%	43%	5%	22%	77%	50%
			Mainly women	8%	13%	9%	0%	20%	10%	4%	0%	40%
			Equal participation	61%	76%	77%	50%	37%	84%	74%	23%	10%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Female	26%	Mainly men	14%	5%	9%	0%	18%	2%	7%	17%	14%
			Mainly women	57%	63%	53%	100%	70%	49%	48%	50%	71%
			Equal participation	29%	33%	37%	0%	12%	49%	45%	33%	14%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
South	Male	32%	Mainly men	20%	4%	0%	50%	0%	0%	9%	67%	0%
			Mainly women	32%	36%	38%	0%	26%	24%	14%	8%	100%
			Equal participation	48%	60%	63%	50%	74%	76%	77%	25%	0%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Female	68%	Mainly men	7%	2%	8%	29%	2%	0%	18%	82%	0%
			Mainly women	74%	75%	73%	57%	86%	47%	48%	7%	100%
			Equal participation	19%	23%	19%	14%	12%	53%	34%	11%	0%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
All zones	Male	70%	Mainly men	49%	10%	24%	73%	22%	3%	12%	63%	21%
			Mainly women	6%	17%	11%	4%	22%	14%	5%	16%	15%
			Equal participation	44%	73%	65%	23%	56%	83%	82%	21%	64%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Female	30%	Mainly men	15%	3%	10%	33%	8%	2%	13%	67%	9%
			Mainly women	64%	68%	62%	58%	77%	50%	50%	23%	82%
			Equal participation	21%	28%	28%	8%	15%	48%	37%	10%	9%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Either sex	100%	Mainly men	39%	8%	20%	61%	17%	3%	13%	64%	19%
			Mainly women	24%	32%	26%	21%	39%	25%	18%	18%	28%
			Equal participation	37%	60%	54%	18%	44%	73%	69%	18%	53%
			Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
Total respondents (number)				400	400	397	38	355	395	389	155	58

Incomes and Expenditures

Farmers' sources of income varied greatly between regions. The farmers studied in the northern villages got 78% of their income from agriculture whereas only 22% in the centre and 17% in the south did (Table 30). Though, in part, these big variations reflected how close the villages were to good roads and nearby commercial centres and whether their region had suffered a prolonged drought. Also, many families (36%) in the south benefited from remittances from absent household members due to the job opportunities in Maputo and South Africa. Nearly half (48%) of the farm families studied in the centre derived the biggest portion of their income from micro enterprises because the villages studied there were along a major east-west transportation corridor.

Only one in seven farmers reported having borrowed while, in the north, 47% and, in the centre, 58% reported that they can usually save each year for future needs. In the south, struck by a prolonged drought, only 13% could normally save for the future.

Table 30. *Farmers' **major** source of all income, by region*

		North	Centre	South	All zones
1	Sale of food staples	40.5%	14.6%	2.8%	22.5%
2	Sale of other food crops	24.3%	4.5%	1.4%	11.7%
3	Sale of non-food cash crops	10.1%	1.9%	1.4%	5.0%
4	Sale of animals/animal produce	3.4%	1.3%	8.3%	3.4%
5	Leasing out machinery (e.g. tractors) and/or equipment, oxen	0.0%	0.0%	2.8%	0.5%
6	Work on others' farms/agricultural labour	4.1%	1.3%	30.6%	8.0%
7	Non-farm salaried employment	1.4%	11.5%	9.7%	7.2%
8	Micro business	12.2%	47.8%	6.9%	26.0%
9	Large-scale business	0.0%	1.3%	0.0%	0.5%
10	Pensions	0.0%	4.5%	0.0%	1.9%
11	Remittances from absent household members, children etc.	4.1%	11.5%	36.1%	13.3%
12	Total %	100.0%	100.0%	100.0%	100.0%
13	Valid responses	**148**	**157**	**72**	**377**
14	Share of income from agricultural sources (rows 1+2+3+4+5)	78.4%	22.3%	16.7%	43.2%

Table 31. *Farmers' **major** source of agricultural income, by region*

	North	Centre	South	All zones
Sale of food staples	49.1%	73.6%	14.3%	55.5%
Sale of other food crops	28.9%	15.3%	21.4%	23.5%
Sale of non food cash crops	17.5%	5.6%	14.3%	13.0%
Sale of animal produce	4.4%	4.2%	7.1%	4.5%
Leasing out machinery(e.g. tractors) and/or equipment, oxen, push carts etc.	0.0%	1.4%	42.9%	3.5%
Total %	100.0%	100.0%	100.0%	100.0%
Valid responses	**114**	**72**	**14**	**200**

Table 32. *Farmers' saving and borrowing*

	North	Centre	South	All zones
In the past year, have you borrowed money to be able to cover your expenditures?	15.3%	15.3%	9.0%	14.0%
Are you normally able to save some money every year for future needs?	46.5%	58.6%	13.2%	44.9%

When asked to compare all the costs for purchased inputs in farm production and ranking them according to how much they had spent, results show that farmers spent cash mostly on seeds, hired labour, and transport. Regardless the sex of the household head, rare was the farmer who purchased fertilizer or pesticides, rented land, or used machinery for land preparation or land improvement. A significant minority did buy seeds, hired labour, and paid for transportation services. Male headed households were more female headed households likely to spend cash to hire labour (Table 33).

Of those who buy seeds or hire labour, most spend a low or moderate amount of cash. Most respondents (82%) spent no money buying seeds, preferring instead to use seeds saved from previous seasons, especially for maize or beans. The interviewees reported using seeds from even three or more seasons back. In addition, farmers who purchased seeds did so mostly for vegetables, not cereals.

Table 33. *Productive expenditures by major categories*

Expense category	No cash outlay	Low or small cost	Moderate cost	Very significant cost	Total number of respondents
Seeds	82%	12%	3%	4%	391
Chemical fertilizer	99%	1%	0%	1%	372
Pesticides	95%	4%	1%	1%	372
Hired labour	79%	8%	8%	5%	378
Land rented	99%	1%	0%	0%	375
Machinery/ implements for land preparation	99%	0%	0%	1%	376
Transport	76%	6%	9%	9%	385
Land improvement measures (conservation structures, irrigation etc.)	100%	0%	0%	0%	367

For sustenance, the northern farmers in the villages studied buy far less food crops than those in the centre or south but most farmers everywhere buy fish. Overall, 62% of the farm households buy meat and 26% buy milk though, with few cows in the north, only 6% of the households there report buying it (Table 34).

Table 34. *Which food crops did you purchase during the past year?*

	North	Centre	South	All zones
Maize	9.9%	15.4%	45.6%	19.2%
Cassava	3.1%	22.8%	31.6%	16.7%
Sorghum	1.2%	9.9%	2.5%	5.0%
Rice	11.8%	50.6%	73.4%	39.6%
Bananas	7.5%	68.3%	40.5%	38.4%
Beans	7.5%	69.8%	69.6%	44.8%
Peas	0.6%	11.7%	5.1%	6.0%
Irish potatoes	1.2%	37.0%	17.7%	18.9%
Sweet potatoes	3.1%	48.1%	32.9%	27.1%
Millet	0.6%	6.2%	1.3%	3.0%
Groundnuts?	9.9%	55.6%	75.9%	41.3%
Vegetables	3.7%	73.5%	62.0%	43.3%

Table 35. *Which animal produce/food did you purchase during the past year?*

	North	Centre	South	All zones
Milk	5.6%	43.2%	31.6%	25.9%
Meat	44.7%	81.5%	57.0%	61.9%
Fish	85.1%	96.3%	72.2%	87.1%
Egg	19.9%	47.5%	24.1%	31.8%

Conclusions

Capital poor and rarely receiving advice from extension workers, Mozambique's small farmers are ensnared in a low-technology, low output trap. Though strategic infrastructural investments in roads and communication help them reach and benefit from markets and agricultural research helps them confront threats or improve productivity, these efforts have, so far, been too gradual and insufficient to change their fundamental reality: low productivity, low incomes and dire poverty.

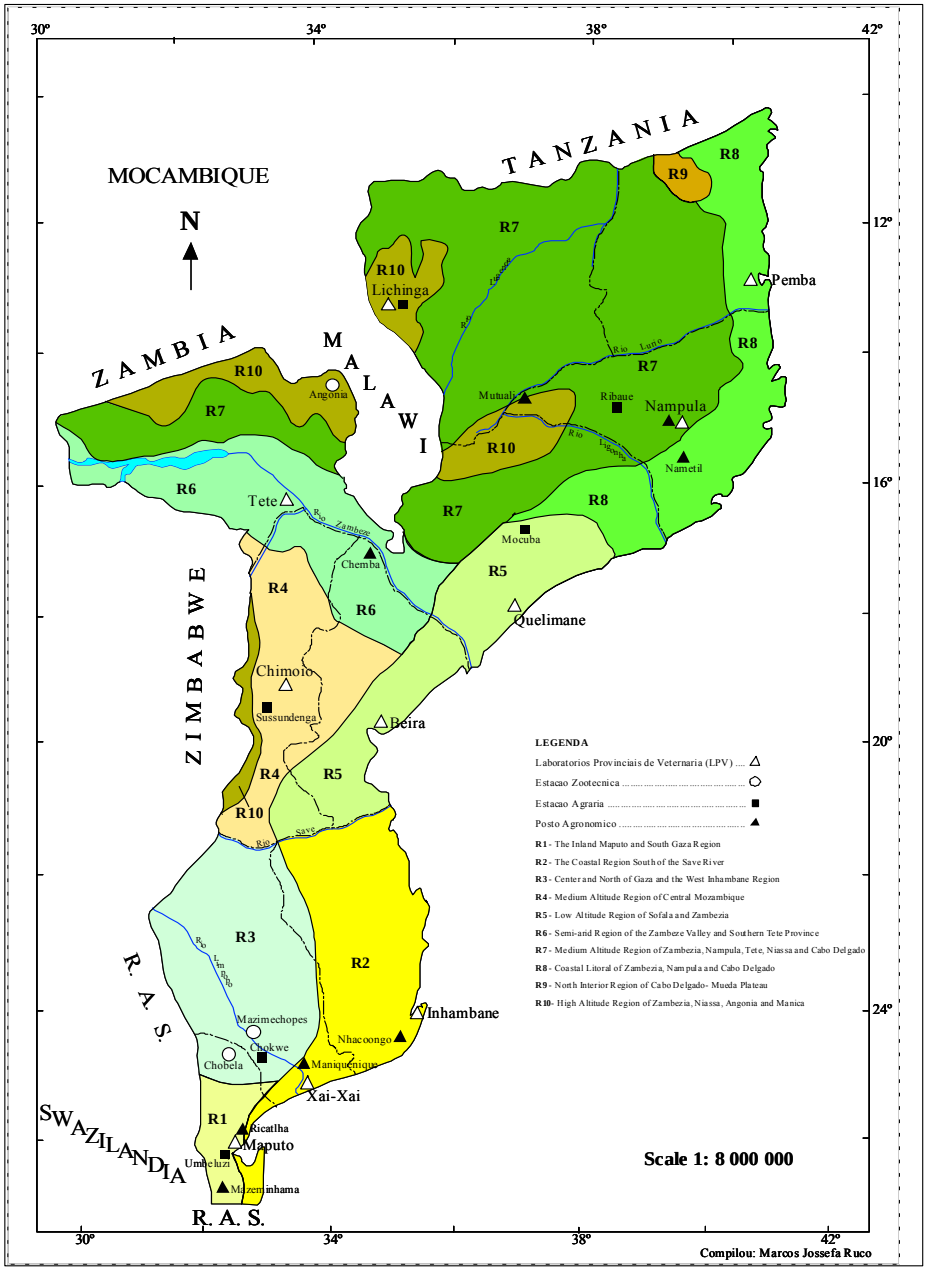
Though escape certainly requires large and synchronized infrastructural and industrial investments to facilitate commerce and create value chains, *in the village* it requires capital investment—focused, moderately sized, short-term and, preferably, rotational so that the funds move on to other farmers and villages. In some circumstances, very profitable inventory credit projects can be initiated, preferably with a fast transition to saving instead of borrowing and to individual instead of village-level management made more viable by use of small hermetic grain bins that require no chemicals to control pests and fungi. This strategy would allow farmers to avoid the most serious risks and vulnerabilities of such projects: *(i)* corrupt or incompetent management and *(ii)* the occasional big fall in net income (after interest charges and other costs) in the rare year when hungry season prices fail to rise or

even fall below harvest-time prices. In other situations, animal traction especially—but not exclusively—for transporting crops to nearby cities instead of merely selling to merchants who go to remote villages and offer farmers far from advantageous prices.

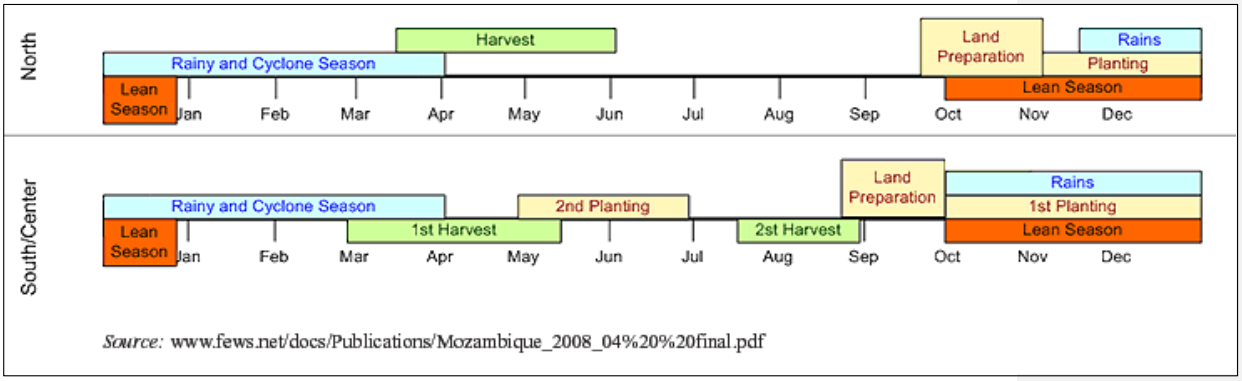
Investment may also enhance farmers' receptivity to and application of the messages promoted by extension workers. At least in the 10 villages studied, extension workers reach few farmers, and the farmers themselves aver that the vast majority of the agricultural techniques they know about or use comes from family, friends and neighbours, but very little and very rarely from the extension workers. There was, however, an exception: the farmers benefited greatly when advice came in the context of significant investment, for example, in irrigation or in fish ponds complemented by pedal pumps.

For villages like these—none inside of concessionaire zones—the ability to inject capital to boost output and incomes significantly may well be crucial to enhancing the relevance and productivity of extension workers.

Annex 1. Agro-ecological zones in Mozambique



Annex 2. *Timing of agricultural seasons in Mozambique*



Source: www.fews.net/docs/Publications/Mozambique_2008_04%20%20final.pdf

Annex 3. *Profitability and payback periods for investment in a GrainSafe storage silos*

		Units	Sold when harvested			Sold only during hungry season in December					
			No storage			Traditional storage			GrainSafe silos*		
		Yields:	-20%	Average	+20%	-20%	Average	+20%	-20%	Average	+20%
	Number of farmers	number	50	50	50	50	50	50	50	50	50
	Plot size	hectares	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	With improved storage?	No/Yes	No	No	No	No	No	No	*Yes*	*Yes*	*Yes*
Maize *(1 season)*	Assumed yield	kg/ha/season	3,600	4,500	5,400	3,600	4,500	5,400	3,600	4,500	5,400
	% sold after storage losses	%	100%	100%	100%	75%	75%	75%	99%	99%	99%
	Price per kilo sold	$/kg	$0.20	$0.20	$0.20	$0.35	$0.35	$0.35	$0.35	$0.35	$0.35
	Gross income from sale	$/ha/season	$720	$900	$1,080	$945	$1,181	$1,418	$1,247	$1,559	$1,871
	Total farm, operating and marketing costs	$/ha/season	$725	$725	$725	$725	$725	$725	$795	$795	$795
	Total *net* income per hectare per season	$/ha/season	-$5	$175	$355	$220	$456	$693	$453	$764	$1,076
	Crops per year	number	1	1	1	1	1	1	1	1	1
	Total net income per farmer per year	**$/farmer**	**-$5**	**$175**	**$355**	**$220**	**$456**	**$693**	$453	$764	**$1,076**
	Total net yearly income of project for ***all*** farmers	$/year	-$250	$8,750	$17,750	$11,000	$22,813	$34,625	$22,625	$38,218	$53,810
	Increase in total net income per farmer due to ***any*** storage	$/year	n.a.	n.a.	n.a.	$225	$281	$338	$458	$589	$1,076
	Increase in farmers' total net income due to improved storage (GrainSafe - traditional)	$/year	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	$11,625	$15,405	$19,185
	% increase in *net* income compared to traditional storage	%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	105.7%	67.5%	55.4%
Beans *(2 seasons)*	Assumed yield	kg/ha/season	1,000	1,250	1,500	1,000	1,250	1,500	1,000	1,250	1,500
	% sold after storage losses	%	100%	100%	100%	75%	75%	75%	99%	99%	99%
	Price per kilo sold	$/kg	$0.83	$0.83	$0.83	$1.45	$1.45	$1.45	$1.45	$1.45	$1.45
	Gross income from sale	$/ha/season	$830	$1,038	$1,245	$1,088	$1,359	$1,631	$1,436	$1,794	$2,153
	Total farm, operating and marketing costs	$/ha/season	$535	$535	$535	$535	$535	$535	$589	$589	$589
	Total *net* income per hectare per season	$/ha/season	$295	$503	$710	$553	$824	$1,096	$847	$1,206	$1,564
	Crops per year	number	2	2	2	2	2	2	2	2	2
	Total net income per farmer per year	**$/farmer**	**$590**	**$1,005**	**$1,420**	**$1,105**	**$1,649**	**$2,193**	**$1,693**	**$2,411**	**$3,129**
	Total net yearly income of project for ***all*** farmers	$/year	$29,500	$50,250	$71,000	$55,250	$82,438	$109,625	$84,667	$120,554	$156,442
	Increase in total net income per farmer due to ***any*** storage	$/year	n.a.	n.a.	n.a.	$515	$644	$773	$1,103	$1,406	$3,129
	Increase in farmers' total net income due to improved storage (GrainSafe - traditional)	$/year	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	$29,417	$38,117	$46,817
	% increase in net income compared to traditional storage	%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	53.2%	46.2%	42.7%
All 3 seasons	**Total net income per farmer per year**	**$/farmer**	**$585**	**$1,180**	**$1,775**	**$1,325**	**$2,105**	**$2,885**	**$2,146**	**$3,175**	**$4,205**
	Total net yearly income of project for all farmers	$/year	$29,250	$59,000	$88,750	$66,250	$105,250	$144,250	$107,292	$158,772	$210,252
	Increase in total net income per farmer due to ***any*** storage	$/year	n.a.	n.a.	n.a.	$740	$925	$1,110	$1,561	$1,995	$4,205
	Increase in income due to improved storage	$/year	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	$41,042	$53,522	$66,002
	Total net *cash* income if farmer retains maize & beans for consumption	**$/year**	**$291**	**$886**	**$1,481**	**$812**	**$1,592**	**$2,372**	**$1,633**	**$2,662**	**$3,692**
	Payback period for investment in GrainSafes (versus traditional storage)**	months	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	18	14	11
	Payback period for investment in GrainSafes (versus **no** storage)	months	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	10	8	6

* This summary compares traditional methods against GrainSafe, a technique that, though initially more expensive, has much lower administrative costs and risks a warehouse using fumigants or large grain coccons.

** Since storage usingtraditional methods for four to eight months till selling during the hungry season risks serious attacks by insects, bacteria and fungi, few farmers do this except for the portion of the crop they intend for household consumption. Thus, the most relevant calculation for the payback period is made by comparing the results against sale soon after the harvest.

Annex 4. *Cash-flow analysis for two cycles of beans and one of maize per year, including repackaging, assuming farmer retains some beans & maize for personal consumption**

	Units	1 maize crop + 2 bean crops per year				
		Sold at harvest with minimal storage	Sold only during hungry season in December			
			Traditional storage	Ware-house	Grain cocoons	1.0t Grain-Safes
Total net income without repackaging	**$/ha/year**	**1,180**	**2,105**	**3,008**	**2,988**	**3,175**
Minus: Valueof maize & beans kept for household consumption	$	374	654	654	654	654
Total *net cash* income without repackaging	$/ha/year	**806**	**1,451**	**2,354**	**2,334**	**2,522**
Increased net income due to storage	$/ha/year	n.a.	645	1,548	1,528	1,716
% increase in net income due to storage	$/ha/year	n.a.	80%	192%	190%	213%
Total additional profit/year if packaged in 1.0 kg plastic bags	$/ha/year	234	234	234	234	234
Total *net cash* income per year with repackaging	$/ha/year	**1,040**	**1,685**	**2,588**	**2,568**	**2,756**
% increase in net income due to storage and repackaging	$/ha/year	29%	109%	221%	219%	242%

* assumes that an average 5.5 member retains and consumes 314 kg/yr of maize and 375 kg/yr of beans, which corresponds to the national average.

Annex 5. *Profitability and payback periods for various storage technologies for maize*

		Units	Maize				
			Sold at harvest with minimal storage	Sold *only* during hungry season in December			
				Trad. storage	Ware-house	Grain cocoons	1.0t Grain-Safes
	Revenue						
	Average yield (kg/ha)	kg/ha	4,500	4,500	4,500	4,500	4,500
	% sold after storage losses	%	100%	75%	99%	99%	99%
	Price/kg (USD)	$/kg	0.20	0.35	0.35	0.35	0.35
A	**Total revenue per season/ha**	$/ha/season	**900**	**1,181**	**1,559**	**1,559**	**1,559**
	Costs						
	Farm costs						
	Tillage	$/ha/season	210	210	210	210	210
	Seed	$/ha/season	75	75	75	75	75
	Fertilizer	$/ha/season	380	380	380	380	380
	Chemicals	$/ha/season	10	10	10	10	10
	Irrigation	$/ha/season	50	50	50	50	50
B	**Total farm costs/ha/season**	$/ha/season	**725**	**725**	**725**	**725**	**725**
	Cost of storage and marketing						
	Insurance cost	$/ha/season			23.39	23.39	0.00
	Storage facility's depreciation cost	$/ha/season			6.75	21.48	27.05
	Interest charges on dollar loan	$/ha/season			8.10	12.89	2.35
	Administration costs	$/ha/season			20.57	13.22	0.00
	Security	$/ha/season			0.08	0.08	0.00
	Other overheads	$/ha/season			40.50	40.50	0.00
	Fumigation & chemicals	$/ha/season			9.00	0.00	0.00
	Marketing expenses	$/ha/season			40.50	40.50	40.50
C	**Total storage and marketing costs**	$/ha/season	**0**	**0**	**149**	**152**	**70**
D	**Total farm, operating and marketing costs (B + C)**	$/ha/season	**725**	**725**	**874**	**877**	**795**
E	**Net income without repackaging (= A - D)**	$/ha/season	**175**	**456**	**685**	**682**	**764**
	Increased net income due to storage	$/ha/season	n.a.	281	510	507	589
	% increase in net income due to storage	%	n.a.	161%	292%	290%	337%
F	**Additional profit/seacon if packaged in 1.0 kg plastic bags**						
	Net profit per kg for packaging	$/kg	n.a.	n.a.	n.a.	n.a.	n.a.
	Net increase in profit per hectare/season due to packaging	**$/ha/season**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**
G	**Total net income per season with repackaging**	$/ha/season	**175**	**456**	**685**	**682**	**764**
	% increase in net income per season	%	n.a.	161%	292%	290%	337%
	Memoranda						
	Investment cost	$	0	0	31,500	50,115	63,107
	Life expectancy of structure	years			20	10	10
	Reduction in losses on grain kept for household consumption due to improved storage (valued at hungry season price)*	$	0	0	24	24	24

* assumes that an average 5.5 member retains and consumes 314 kg/yr of maize and 375 kg/yr of beans, which corresponds to the national average.

Annex 6. *Profitability and payback periods for various storage technologies for beans*

		Units	Beans				
			Sold at harvest with minimal storage	Sold only during hungry season in December			
				Trad. storage	Ware-house	Grain cocoons	1.0t Grain-Safes
	Revenue						
	Average yield (kg/ha)	kg/ha	1,250	1,250	1,250	1,250	1,250
	% sold after storage losses	%	100%	75%	99%	99%	99%
	Price/kg (USD)	$/kg	0.83	1.45	1.45	1.45	1.45
A	**Total revenue per season/ha**	**$/ha/season**	**1,038**	**1,359**	**1,794**	**1,794**	**1,794**
	Costs						
	Farm costs						
	Tillage	$/ha/season	210	210	210	210	210
	Seed	$/ha/season	170	170	170	170	170
	Fertilizer	$/ha/season	125	125	125	125	125
	Chemicals	$/ha/season	10	10	10	10	10
	Irrigation	$/ha/season	20	20	20	20	20
B	**Total farm costs/ha/season**	**$/ha/season**	**535**	**535**	**535**	**535**	**535**
	Cost of storage and marketing						
	Insurance cost	$/ha/season			26.92	26.92	
	Storage facility's depreciation cost	$/ha/season			3.75	11.93	15.03
	Interest charges on dollar loan	$/ha/season			4.50	7.16	1.31
	Administration costs	$/ha/season			11.43	11.43	
	Security	$/ha/season			0.30	0.30	
	Other overheads	$/ha/season			11.25	11.25	
	Fumigation & chemicals	$/ha/season			2.50		
	Marketing expenses	$/ha/season			37.50	37.50	37.50
C	**Total storage and marketing costs**	**$/ha/season**			**98**	**106**	**54**
D	**Total farm, operating and marketing costs (B + C)**	**$/ha/season**	**535**	**535**	**633**	**641**	**589**
E	**Net income without repackaging (= A - D)**	**$/ha/season**	**503**	**824**	**1,161**	**1,153**	**1,206**
	Increased net income due to storage	$/ha/season	n.a.	322	659	650	703
	% increase in net income due to storage	%	n.a.	371%	564%	559%	589%
F	**Additional profit/seacon if packaged in 1.0 kg plastic bags**						
	Net profit per kg for packaging	$/kg	0.11	0.11	0.11	0.11	0.11
	Net increase in profit per hectare/season due to packaging	$/ha/season	138	138	138	138	138
G	**Total net income per season with repackaging**	**$/ha/season**	**640**	**962**	**1,299**	**1,290**	**1,343**
	% increase in net income per season	%	n.a.	50%	103%	102%	110%
	Memoranda						
	Investment cost	$			31,500	50,115	63,107
	Life expectancy of structure	years			20	10	10
	Reduction in losses on grain kept for household consumption	$			12	12	12

* assumes that an average 5.5 member retains and consumes 314 kg/yr of maize and 375 kg/yr of beans, which corresponds to the national average.

Annex 7. *Analysis of capital requirements for 50 farmers: Loan value assumed to equal 80% of net harvest time value minus production expenses including depreciation: two scenarios*

		Tons stored	Months stored	Loan	Interest charges[1]	Total harvest-time loan & interest repayment in December	Expected net income from sale[2]	Net amount *after* harvest-time loan and interest payments
Full financing for 7 GrainSafes per farmer								
	1st bean crop	1.3	7	$402	$152	$554	$1,137	$582.40
	2nd bean crop	1.3	4	$402	$87	$489	$999	$510.30
	Maize crop	4.5	9	$140	$68	$208	$716	$507.69
A.	Total	7.0		$944	$308	$1,252	$2,852	$1,600.39
						Minus purchase of 7 GrainSafes		$1,280.44
						Interest on loan for 7 GrainSafes		$44.82
						Net cash received		**$275.13**
	Memorandum:			**Each farmer**	**All farmers**			
	Number of GrainSafes needed			7	350			
	Harvest-time loans			$944	$47,200			
	Loan for GrainSafes			$1,280	$64,022			
B.	Total capital required (A+B)			$2,224	$111,222			
Financing for only 2 GrainSafes per farmer								
	1st bean crop	0.0	7	$0	$0	$0	$0	$0.00
	2nd bean crop	2.0	4	$643	$139	$783	$1,723	$940.16
	Maize crop	0.0	9	$0	$0	$0	$0	$0.00
C	Total	2.0		$643	$139	$783	$1,723	$940.16
						Payment for 2 GrainSaftes		$365.84
						Interest on loan for 2 GrainSafes		$9.15
						Net cash received		**$565.17**
	Memorandum:			**Each farmer**	**All farmers**			
	Number of GrainSafes needed			2	100			
	Harvest-time loans			$643	$32,160			
D	Loan for GrainSafes			$366	$18,292			
E	Total capital required (C+D)			$1,009	$50,452			

[1] assumes the exorbitantly high annual interest rate (~ 65%) often charged by local savings and loan companies. For example, in 2005, the modal interest rate charged (on a declining balance) by microfinance institutions in Mozambique was 4% to 5% per month while some charge 10% or even 16.7% per month (de Vletter 2006:22-23). "GAPI lends to MFIs and the associations at the same rate. In early 2006, the wholesale rate was 18% per annum. Associations usually provided credit to their members at 3% higher than the rate provided by GAPI" (de Vletter 2006:54). IRAM/CCCP lends to associations "at a rate of 20% p.a. in the south and 12%9 in the north. In turn, associations on-lend to their groups at 4.5% per month (declining balance) in the south and 3% in the south" (de Vletter 2003:25). As for the loans to buy the GrainSafes, we assume that the organizing NGO would charge farmers an international interest rate herein assumed to be 6% p.a.

[2] minus crop retained for household consumption

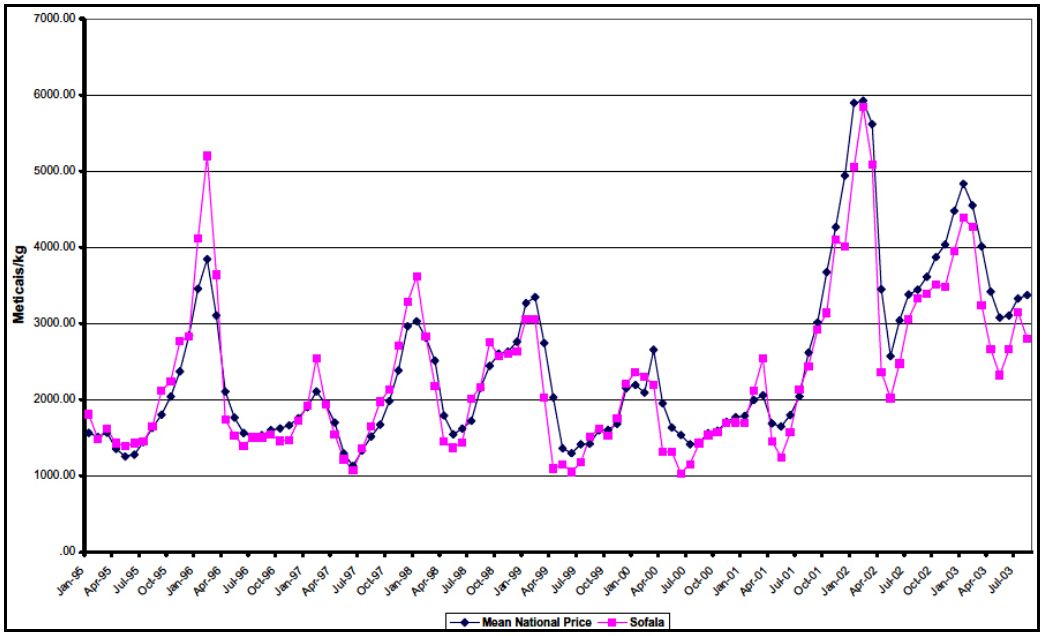
Annex 8. *Partial budget analysis of maize with two different sale periods in Manica, 2004*

Costs, incomes and rates of return	Technology and commercialization period			
	Traditional (July)	Traditional (Dec.)	Improved package (July)	Improved package (Dec.)
Expected grain production (kg/ha)	750	713*	2,750	2,613*
Grain price ($/kg)	0.04	0.10	0.04	0.10
Variable costs				
Seeds ($/ha)			25.15	25.15
NPK ($/ha)			41.92	41.92
Urea ($/ha)			33.54	33.53
Additional labor (person-days/ha)			25.15	25.15
Storage cost	0	10.75	0	39.43
Total variable costs ($/ha)		10.75	125.77	165.19
Gross income ($/ha)	27.35	68.70	100.30	251.90
Net income ($/ha)	27.35	57.95	-25.47	86.71
Marginal net benefit ($/ha) from storage over traditional without storage		30.59	-52.82	59.35
Marginal rate of return (%) from storage	-	285%	-	151%

Source: Survey data by Uaiene (2006:10)

Note: Seed cost: 20 kg/ha at $0.84/kg of improved seed. The improved package includes improved OPV and fertilizer.

Annex 9. *Seasonal variation in maize prices, 1995 to 2003*



Source: Arndt, Barslund and Sulemane (2006)

Table 36. *Cost, lifespan, daily work, and daily working hours for different modes of traction*

	Units	Donkeys	Oxen	Horses	Human power	Tractor (50 kW)
Purchase price (rands)	US$	7 to 43	141 to 282	113 to 16,900	N/A	120,000
Working life	Years	12 to 25	6 to 10	15 to 20	N/A	15 to 20
Daily work*	hectares	0.25	0.5	0.5	0.1	5
Daily working*	hours	4	6	5	6	10

Table 37. *Profitability of animal draught power in South Africa, 1998 (US$)*

	Oxen (n = 7)		Donkeys (n = 4)		Horses (n = 2)	
	Plough only	Plough + cart	Plough only	Plough + cart	Plough only	Plough + cart
Total gross margin**	885.00	885.00	703.00	703.00	717.68	717.68
Depreciation	7.73	18.23	7.73	18.23	7.73	18.23
Maintenance & repair	8.59	20.26	8.59	20.26	8.59	20.26
Veterinary costs	19.17	0.00	n.a.		19.17	
Net farm income***	849.51	827.35	686.68	664.52	682.19	660.02

Source: Simelanga, Belete, Mzeleni, N.; and Jongisa (2000:233)

Note: Net farm income for the different scenarios is calculated on the basis of the average farm size which is 2.5 hectares. Using the exchange rate of 1 U$ = R 6.00, this table was converted to US dollars.

** The total gross margin represents a gross income per farm.

*** Evidently Simelanga et al. did not consider that the cart might raise incomes by transporting their own and neighbors' crops to the market to fetch higher prices. Nor did they consider the potentially costly risk of an animal dying or being stolen.

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