Introducing New Millet Production Systems in Mali

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Abstract

In developing a pilot project and then broadening it with an action agency (2004-2012-pilot; 2010-2013-IICEM) we were concerned in these field studies with the continuing performance in three areas, technology introduction, marketing performance, and institutional evolution. On technology the concept of using inorganic fertilizers and better agronomy was pervasively accepted for millet (and sorghum). Farmers recognized and appreciated the yield differences with common practices. Not surprisingly once implemented on a larger scale there was some technology erosion. Fertilizer recommendations were not followed well and the seed not renewed sufficiently. Farmers consistently recognized the advantages of DAP over the NPK now predominantly used as a substitute. The availability of DAP has become a macro policy issue. Creating a sector of seed producers is critical to most crop programs continuity.

On marketing the farmers' associations developed in our pilot and IICEM activities have taken over some of the collecting and storing to get higher prices by avoiding the post-harvest price collapse. They are also focusing on clean grain to obtain a price premium from that. However, changing market structures to obtain part of the marketing margin for the farmers' associations obviously threatens the margins of other agents in the system as well as their present networks. So it is not surprising to see wholesalers use cartel behavior and fix prices. Now the farmers' associations need to be able to respond to this behavior. But this present problem illustrates the evolution of the farmers' associations as they have become significant players capable of dealing directly with wholesalers rather than with local collectors or the smaller regional "commercants" (merchants).

The farmers' associations have developed excellent repayment behavior from farmers in repaying the input credit and maintaining the revolving funds. They have set up bank accounts, hold regular meetings for transparency and group decisions, and have rules about non-compliance that are being implemented. However, our main metric of the quantities farmers allowed the associations to sell for them voluntarily was still extremely low.[1] As farmer confidence increases in the farmers' association and farmers' production increases we expect these voluntary sales through the association to increase. This is a nice metric combining farmer confidence in their associations and the associations' ability to market better and to be transparent so that the farmers know they will be paid well.

So we conclude that there was good continuing performance in all three areas but several activities that now need to be focused on to continue the momentum.

[1] This was in addition to repaying the input credit loans in kind as was required by the revolving fund.

Introduction

Improved seed of a well-known millet cultivar (Toroniou) was introduced to farmers' associations along with moderate fertilization and a series of marketing measures in a pilot project (the Production-Marking project of INTSORMIL) in four Sahelian countries focusing on Mali from 2008-2013. From 2010-2013 another project, IICEM, was commissioned by USAID to extend this pilot project on to a larger scale in Mali and to involve the banking sector to finance inputs especially fertilizer.

Here we review the continuity of the three principal components of the pilot project, the technology package, the marketing concepts, and the institutional components. In the movement from a pilot to a larger scale diffusion there are often various adjustments made. For example, the recommended fertilizers may be difficult to obtain. One field research problem then is how much these adjustments have affected productivity and incomes and what can be done to return to the productivity levels of the pilot. On the marketing side, there is a learning by doing aspect as the farmers' associations learn how to find better markets, improve timing of their sales, add value, and market larger quantities. We are concerned with how much of the marketing strategy has been implemented and what else can be done to raise the marketing margin obtained by the farmers' associations especially given the natural resistance from the present marketing system to a new comer taking part of their marketing margins. Finally, we evaluate the farmers' associations evolution with several measures reflecting their performance in introducing the technologies and marketing strategies and in gaining the confidence of the farmers.

Before evaluating the continuing performance we lay out the methods and review the pilot project objectives.

Evaluation method

This project was initially undertaken to respond to the criticism that agricultural researchers continue to do research on the station and with regional trials but do not make the effort or do the research to actually get their improvements onto farms especially with the staple crops often referred to in a derogatory fashion as subsistence crops. So we defined a technology based upon our analysis of the constraints and including regional testing and farmer acceptance of a new cultivar. With the national agricultural researchers we identified a moderate fertilizer dose, better agronomic methods, and with the farmers a potential high yielding cultivar, that they appreciated. Other components included new market strategies to pay for the use of higher input levels and a new (or improved)[2] institutional structure to implement the diffusion process.

Then we began this project in 2004 in collaboration with extension services and some NGOs for the farmer contacts. Ultimately, we had programs in villages in four Sahalian countries (Niger, Mali, Senegal and Burkina Faso). In 2010, USAID-Mali requested Abt Associates then running the Economic Growth project, IICEM in the AID portfolio, to scale up our pilot project by following our

[2] In the villages we generally found farmers' association just not associations concentrating on millet (or sorghum).

technologies and strategies and adding in their bank contacts to provide input credit to farmers' associations.[3]

For the quantitative analysis here, we interviewed in the primary millet production regions of Mopti and Segou. The focus of the interviewing was with the implementing agency officials of the farmers' associations and their farmers who attended the meetings. There were 46 farmers' associations involved. The interviewing was deliberately done in the priority regions of the coordinating agencies (IICEM in Mopti and Sasakawa in Segou) as these were our models for the rest of the country. The survey was an appraisal of continuity and changes in the technologies, market strategies and institutional approach of our model. We evaluated the present status of the farmers' associations with which IICEM or we had worked for performance and for their adherence to project recommendations. Then we made recommendations for continuing development. There were a number of features of our project, which the farmers' associations had continued well and even expanded on. There were also some major erosions in the technical recommendations as would be expected as development agencies experience practical problems in implementation or made their own modifications. On the marketing side there was some evidence of price fixing or cartel behavior among the wholesalers as the systems responded to new entrants wanting part of the marketing margin.

Model Program

The objectives of our field pilot program were:

1).Introduce a new technology for millet (and sorghum) based upon inorganic fertilizer and a variety responsive to fertilizer. Combine these two with water retention techniques and improved agronomy to reduce the risks from rainfall variability and to further increase yields;

2)Train farmers in the farmers' associations in marketing strategies to offset the two price collapses (annual harvest time and good year) suffered by primary product producers, increase value added of the millet, and improve the bargaining power of the farmers in the marketing system;

3) Develop the farmers' associations as a vehicle for facilitating a more rapid introduction of the technologies and marketing strategies.

a) The principal yield constraint for millet and sorghum is soil fertility. Sahelian soils are often deficient in N and P. Unfortunately, popular wisdom is that millet does not respond to fertilization and even if they did, it would not be profitable or farmers would not do it. One primary objective of the Production-Marketing project of INTSORMIL was then to disprove these myths. So we introduced a moderate dose of inorganic fertilizer higher than the micro-fertilization being promoted by many agencies including AGRA but lower than the physical maximum often recommended by experiment

[3] Neither project continued after 2012.Both projects were prohibited from working with governmental agencies after the coup in March 2012.

stations. The initial recommendations were two sacks of NPK and one sack of Urea. Over time we shifted to one bag of DAP and one bag of Urea. This provided the nitrogen and phosphorous but not potassium.[4] The shift to DAP is a substantial savings for the farmers especially when fertilizer prices jumped up after 2008.

b) The second basic project component is a series of marketing strategies. The objective of these marketing strategies is to assure that farmers can pay for the increased inputs and to moderate some of the price collapses suffered by producers of basic staples. With increasing fertilizer and other input prices, many have argued for low inputs, reducing fertilizer levels, or searching for low input solutions. This has been tried with no significant yield effects for the past twenty years and it is now time to return to the basic needs of the plant. You would not ask a malnourished kid to try to save money by eating less. Do not try to reduce essential nutrient levels of plants. Rather than reducing fertilizer costs increase revenues with the marketing strategies.

How? First, reduce or eliminate the cereal price collapses, the annual collapse at harvest time and the collapse in good rainfall years. With storage facilities get the farmers' associations to hold the cereals at harvest until there is price recovery thereby responding to the harvest price collapse.[5]For the good year price collapse, develop the secondary markets, ie. millet food processing and sorghum in the animal feed. There is a value added possible at the farm and farmers' association levels. Millet food processors and the relief agency, PAM, are prepared to pay a price premium for cleaner millet. This protects the machines of the processors and reduces the cleaning costs. There is also a concern with the deliberate adulteration of the cereals. Over time, a price premium is being paid for clean cereals usually in the 15 to 25 cfa/kg range. This premium can be greater as in Burkina Faso where there has been much slower technology introduction for millet than in Mali hence a slower rate of expansion of clean millet. PAM (the UN program for food aid for low-income individuals) has created its own system for screening, sacking and identifying the producers.

By selling in quantity and holding the cereal until there is a better price the farmers' associations perform many of the functions of the collector and regional merchant enabling them to sell to the big wholesaler (Table 1). The farmers' association still need to invest more in market information and negotiation as is indicated by the substantial difference in PAM[6] prices and those paid by the wholesalers in Mopti (Tables 1 and 2). But the farmers' associations are gradually learning from their experience. One response of merchants when farmers' associations refuse to sell at harvest, the low price period, is to fix prices at low levels among themselves for the later period when prices normally go up so that the farmers' associations (and hence the farmers) do not benefit from the seasonally higher prices. Over time, farmers will get better at the tough negotiation process and lean to overcome cartels with arbitrage. Arbitration means moving the cereal outside the area

[4] African soils generally are not deficient in potassium. Over time as higher cereal yields are attained, they will become deficient but presently we need to get N and P levels up and keep the costs down.

[5] Because there is a rotating fund for purchasing inputs for the next crop season part of accumulated cereals will need to be sold by the end of May

[6] PAM argues that they pay the market price at the time of purchase plus a premium. The premium has been substantial.

where the cartel is operating. Many farmers' associations and certainly the collaborating villages around a pole or central farmers' association are big enough to hire their own truck and to find better markets with more market search. So we will evaluate here how the farmers' associations have done with respect to both technology introduction and the use of these marketing strategies.

c). The third component of our program was developing strong farmers' organizations. The first objective is to use the associations for rapid diffusion of the new technology and better practices. Farmers often do not believe in technology recommendations from outsiders. Involving 50 (first year) to 150 people (third year) in the village was the objective of the pilot. We expected 40 to 60% of the farmers would follow the technology recommendations to make sure that they continued to have access to the fertilizer with credit from the revolving fund. Then in the second year, those farmers not following well the recommendations would learn from these successful farmers. This assumes that the rainfall conditions and other stochastic factors affecting yields are not adverse in the first years of the program.

Secondly, the farmers' association is responsible for implementing the marketing strategies. The farmers' associations control the storage, the quality checks for clean cereal, the tracking process through labeling of the sacks, the market search, the handling of the revolving fund, the bank account of the revolving fund, the search for input credit, and most importantly the negotiation process for selling the cereal including timing and search for better offers. We will discuss various elements of the progress of the farmers' associations below. But, we will focus on reimbursement of the input credits from the revolving fund and the quantity members allow the association to sell for them once they have paid off the reimbursement. The latter is our best measure of the confidence farmers have in the association to sell well for them and to make reasonable charges for storage.

Evolution of the Program in 2010-2013

Our project was implemented on a small pilot or demonstration scale. For example we only had seven village sites in the Mopti region in the period 2010 to 2013. In 2010 IICEM, would work with over a hundred farmers' associations in the Mopti region. To assure bank interest IICEM made contracts with the wholesalers. IICEM provided a guarantee fund for the first two years of the program. With good monitoring and training IICEM was successful in getting high repayment rates and their farmers' associations' fulfilling the contracts in 2010 and 2011 in the Mopti and Sikasso regions. The repayment rates were so high in the first two years that the guarantee requirement was programmed to be zero in 2012. Then in 2012 there was the war in the north, a coup, a beating of the President by a mob, and the French intervention to stop the rebels from advancing south.

Banks closed in the north. USAID intervened with a grant through the farmers' associations for fertilizer in the Mopti region to cover 5,500 ha at two sacks per ha (Goita, former field supervisor for IICEM in the Mopti region, March 2015). As in our program, the farmers were asked to repay the loans in cereal at harvest to the farmers' association to set up a revolving fund. The Dutch

government made a similar grant in the south including the Segou and Sikasso regions through the farmers' associations. Here the reimbursement requirement was only half of the loan to be paid to the farmers' associations.

Revolving Fund

The most significant factor in the surveying was the continuing effects of the rotating funds of the farmers' associations from the emergency relief of the US and the Netherlands in 2013. The other important factor was the evolution of direct sales of the farmers' association to the large wholesalers in Mopti and to the food relief agency of the United Nations, PAM, [7] inSegou.

In 2010 and 2011, IICEM had obtained input credits for the farmers' associations by obtaining contracts between wholesalers and the farmers' associations and showing those to the bank (BNDA). As is not too surprising given the differences in bargaining power these contracts were more advantageous to the wholesalers than to the farmers. The contracts insisted on farmers paying soon after harvest and selling more at these low prices than just to pay off the loans. With the grants of 2012, the farmers' associations became independent from the wholesalers' conditions as the bank loans were no longer necessary to obtain input credit. The farmers' associations continued providing input credit to their members with these revolving funds in 2013 and 2014. Nevertheless, many of the farmers' associations continued dealing directly with the wholesalers in Mopti rather than local collectors or the regional merchants in Koro and Bankass.

In the winter of 2015, these rotating funds from 2012 were still operating in both the Mopti and the Segou regions. The structure of this funding was exactly from our project of an initial loan to the farmers' association for inputs. This was extended to farmers, who were then required to repay at harvest in kind. The farmers' association would then hold these cereal stocks and sell them before the next planting season. The sale of these cereals would then pay for another round of input purchases. Additional profits could be used for expanding membership or for other objectives to be decided by the farmers' association.

So how much of the marketing margin did these farmers' associations get from selling to the higher levels of the marketing chain? We compare here the prices received from the wholesalers with the local/regional prices at the same time. The big gains were selling to PAM. Seventeen percent of the farmers' associations sold to PAM and PAM is in the process of expanding its activities in the Mopti region(Table 1).

[7] PAM's designated concern from its UN mandate is to improve the nutrition of the poor. So initially, they were buying from big wholesalers or at lower levels in the marketing chain acting like the standard "commercants" attempting to buy at the lowest post-harvest prices to minimize their acquisition costs. With the initiation of P4P within PAM they became concerned also with low income farmers and began a focus on buying from farmers' associations, obtaining cleaner millet, and eventually setting up a new organization among farmers' associations of a central farmers' organization with 10 to 12 others around them. The central organization would take responsibility for cleaning and transporting the cereal to the PAM central site.

However, the wholesalers in Mopti paid a much lower price than PAM. 48% of the farmers' associations in Mopti sold to the wholesalers (Table 1). The average price gain was 7.7 fcfa/kg from dealing with the big wholesalers rather than the local or regional markets with a range of 0 to 15/kg. For a sack worth 16,000 fcfa farmers were only getting an additional 770 cfa or 5%. The wholesalers did have additional costs of transportation (included in calculation) and some pay the expenses to bring farmers from the village to Mopti to make sure that the cereal arrived and to see the evaluation and weighing. Nevertheless, the bargaining power of the farmers' associations with the wholesalers was still minimal.[8]Moreover this substantial price difference with PAM and the uniform prices paid by the wholesalers, which were often the same or only marginally different than the regional merchant, indicates price fixing and cartel behavior among the wholesalers. Over time, the farmers' associations will be able to negotiate tougher since bypassing marketing stages can also save costs for the wholesaler especially if the cereal is cleaner and more uniform. However, clearly a market structure with an old boy network among the different levels resists changes from newcomers looking for a share of the marketing margin. When facing a cartel and fixed prices, the farmers' associations need to learn to use arbitrage, selling outside the region. They would need market information, to arrange transportation, and for several farmers' associations to work together to sell larger quantities.

Table 1. Crop Area, Markets and Marketing Margins in the Mopti Region

Village	Area (2013-14) (ha)	Markets and prices 2013-2014	Price of Regional or Local Market (transport cost/sack to Mopti)	Price Difference (Local or Regional v. Wholesaler) Adjusted for transport costs
1.Logo (IICEM)	250	PAM (205f/kg) et 2 wholesalers (Moulaye et Mamoudou Guindo)Mopti	Transport : 1000/sack	NA
2.Dimbale (IICEM)	45	PAM through the farmers' association of Logo (185f/kg)	Price : 130 Transport : 1000/sack	45 fcfa/kg
3.Sadia (Projet Production-Marketing)	120	Wholesaler Mopti 160 Members 155	160 fcfa/kg	Local sale[a]
4.Kanikombole (Projet Production-Marketing)	73	Merchant Bandiagara (160 fcfa/kg)	Price : 160	Local sale[a]
5.Telly (IICEM)	103	Merchant (160fcfa/kg)	Price : 160	Local sale[a]

[8] Note that the marketing margin may be low anyway if the regional markets do not provide any services besides aggregation but not this low.

6.Djanwelly (IICEM)	28	Guindo Wholesaler Mopti 160 fcfa/kg	160 fcfa/kg	Local sale[a]
7.Ogotana (IICEM)	82	Mamoudou Gindo Mopti (170f/kg)	Price 160 Transp: 0	10 cfa/kg
8.Ogossagou/IICEM	105	Mamoudou Guindo Mopti(165f/kg)	Price: 155 Transp: 200/sack	8 fcfa/kg
9.Sokoura (IICEM)	84	Mamoudou Guindo(170f/kg)	Bankass 160 Transp: 0	10 fcfa/kg
10.Tinto/Barwe (IICEM)	130	Mamoudou Gindo (165f/kg)	Bankass 165 Transp: 0	0[a]
11.Ogodire (IICEM)	94	Mamoudou Gindo (165f/kg)	Bankass 160 Transp: 0	5 fcfa/kg
12. Pel (IICEM)	60	Moulaye Wholesaler Mopti 165f/kg	Prce 150 Transp : 0	15 fcfa/kg
13.Temegolo (Production-Marketing)	126	Moulaye Mopti(175f/kg)	Price: 160 Transp : 100	14 fcfa/kg
14.Pomorododiou Na (IICEM)	88	Moulaye Mopti (155f/kg)	Price: 155 Transp : 0	0
15.Pomorododiou Begne (Production-Marketing)	125	Baba Wholesaler Mopti (155f/kg)	Price: 140-145 Transp : 0	10 fcfa/kg
16.Yadjenga (IICEM)	105	Wholesaler Moulaye (IICEM) (165f/kg)	Koro: 160 Transp : 0	5 fcfa/kg
17.Tere (Production-Marketing)	63	Village merchant, collector en 2013 (162,5f/kg)	Price : 162,5 Transp : 0	Local sale[a]
18.Tinasasogu (IICEM)	80	Merchant Koro 155 fcfa/kg	Price: 155 Transp : 0	Local sale[a]
19.Togo Tina (IICEM)	120	Wholesaler Guindo a Mopti (175f/kg)	Price: 160 Transp : 0	15 fcfa/kg
20.Birga Dogon (IICEM)	60	Merchant Birga 170 fcfa	Price: 170 Transp : 0	Local sale[a]
21.Kountogoro (Production-Marketing)	73	Merchant Pei (150f/kg)	Price: 150 Transp : 0	Local sale[a]
22. Balirou (IICEM)	290	PAM en 2013 (205,25f/kg) et 2014	Price: 160 Transp :1000/sack	35 fcfa/kg
23.Tendely (IICEM)	450	PAM en 2013 (205,25) et 2014	Price: 160	35 fcaf/kg

			Transp : 1000/sack	

Mean 126 ha 170 fcfa/kg

a. Indicates no advantage between selling to the regional market and the wholesaler so sold locally. Markets are networks set up over time and their participants often do not want to change them. So this lack of difference in prices appears to be cartel behavior. Note the much higher prices paid by PAM in Mopti and Segou. PAM claims to be paying local prices plus a small price premium for quality.

In Segou almost the entire sample received the PAM prices. Hence, a strong stimulant for program participation and reimbursement was created by the PAM purchases (Table 2).

Table 2. Size of Farmers' associations, area, buyer and price paid, Segou, cercle de Baraoueli.

Village	**Gender of Members F H**	**Areas (ha) 2012-2013, 2013-2014**	**Yields (tons/ha) 2012-13, 2013-14**	**Markets and Prices Paid (2013-14)**
1.Merabugu	4 33	4 0 (2013)	2 t in 2013	PAM (200f/kg)
2.Gurele-were	0 38	91 (2013)	1.6 t in 2013	PAM (200f/kg)
3.Konobugu	20 39	60 (2012) 90 (2013)	2.85 t in 2012 2.7 t in 2013	PAM (200f/kg)
4.Badinantu	30 70	100 (2013)	1.2 t in 2013	PAM (200f/kg)
5.Tigui	5 41	60 (2012) 96 (2013)	1.6 t in 2012 1.57 t in 2013	PAM (200f/kg)
6.Koduguni	59 0	15 (2012) 20 (2013)	0.75 t in 2013	PAM (190f/kg)
7.Welingra	0 25	30 (2012) 32.5 (2013)	1.48 t in 2012 1.26 t in 2013	PAM (200f/kg)
8.Diawarala	16 24	80 (2012) 70 (2013)	1.17 t in 2013	PAM (200f/kg)
9.Nugula	25 40	67 (2012) 52 (2013)	1.11 t in 2013	PAM
10.Kenema	12 50	80 (2012) 65 (2013)	1.18 t in 2013	PAM(190f/kg)
11.Diarabugu	2 18	30 (2012) 27 (2013)	1.4 t in 2012 1.8 t in 2013	PAM (190f/kg)
12.Wentibugu	23 23	60 (2012) 50 (2013)	1.8 t in 2013	PAM(200f/kg)
13.Kamba	10 42	57.5 (2012) 21 (2013)	0.46 t in 2013	PAM(200f/kg)
14.Soungola	1 31	50 (2012) 40 (2013)	1.7 t in 2012 0.8 t in2013	PAM(190f/kg)

15.Niontobugu	4 28	10 (2012) 65 (2013)	1.30 t in 2013	PAM(200f/kg)
16.Zana	5 30	110 (2012) 60 (2013)	1.8 t in 2013	Regional merchant(155f/kg)
17.Kokribugu	6 76	55 (2012) 60 (2013)	2.36 t in 2013	PAM(200f/kg)
18.Tingona	0 24	40 (2012) 45 (2013)	1.35 t in 2013	PAM(200f/kg)
19.Tingoni	45 85	185 (2012) 200 (2013)	1.95 t in 2012 1.90 t in 2013	PAM, Two millet processing firms in Bamako (200f/kg)
20.Wela-cura	0 45	30 (2012) 40 (2013)	0.88 t in 2013	PAM(200f/kg)
21.Bomoti-1	3 29	30 (2012) 35 (2013)	1.5 t in 2012 1.40 t in 2013	PAM(195f/kg)
22.Bomoti-2	5 9	25 (2012) 20 (2013)	0.6 t in 2012 0.69 t in 2013	PAM(200F/kg)
23.Segemba wili	1 31	17.5 (2012) 27 (2013)	1.36 t in 2013	PAM(190f/kg) and members(150f/kg)

Technology performance

With an average of 7.5 tons/ha of organic fertilizer and two sacks of inorganic fertilizer Segou producers had average yields of 1.64 tons/ha (Table 3). That should be compared with 800kg/ha to 1 ton/ha for farmers not in the program. So these were good yield achievements in a good rainfall year especially compared with those without the technology package. However, comparison with Tingoni (No. 19), our initial pilot project indicates the potential to obtain another 200 kg/ha if the fertilizer recommendations were followed.[9] These recommendations were either 2 sacks of NPK and one sack of Urea or one sack of DAP and one sack of Urea. When DAP is difficult to obtain or farmers' associations are trying to keep costs down, it is not surprising to see short cuts taken.[10] Unfortunately, this short cut of one sack of NPK for one sack of DAP has serious yield and profitability consequences as is recognized by the most experienced farmers' association in our pilot program, Tingoni.

The use of organic fertilizer is reasonably high and has been increasing, and the Segou farmers are marketing very well to PAM and receiving a good marketing margin. Hence areas in the

[9] Since there was an upward bias of yields from having the same agency doing the interviewing as did the previous program administration and extension we expect that the real yield difference was 400 to 500 kg from the yield erosion of not following the fertilizer recommendations..

[10] From the beginning of the IICEM program in Mopti in 2010 one sack of NPK was substituted for one sack of DAP. This reduces the P level from 23 to 7.5 units per ha. So it is important to get back to the higher level of P.

project have been increasing and incentives to follow recommendations are high (Table 3). So it should not be difficult to get the farmers' associations back on the higher yielding fertilizer recommendation.

Now we move to the second most important millet region, where the rainfall is less and the soils are poorer, Mopti. Here there is less organic fertilizer at 6 tons/ha but not a lot less as the predominant Dogon work intensively to use their resources. Overall yields of both genders are lower than in Segou but at 1.2 tons/ha still substantially better than those outside the program of 400 to 600 kg/ha-unfertilized millet (Table 4). Here the farmers in the farmers' associations are doubling yields in this good rainfall year. However, the inorganic fertilizer utilization is even further from the recommended dose than in the Segou region. In the last two years (2013 and 2014) IFDC picked up many of the IICEM farmers' associations and reduced the fertilizer levels to their new definition of micro-fertilization- 35 kg of NPK and 35 kg of Urea. Then the availability of Urea ran out.

Moreover, the farmers' associations have not been able to obtain sufficient access to the improved seed of Toroniou as the program of IICEM was expanded rapidly here. Unfortunately, millet outcrosses rapidly so programs of seed renewal are especially important for millet and the programs to train association seed producers were not effectively implemented in the Mopti region.[11] So the combination of the appropriate fertilization and improving access to good seed of Toroniou would increase yields another 400 to 500 kg/ha. This is especially important here where the marketing margin was squeezed by the greater bargaining power of the big wholesalers.

Moreover, there is a serious disparity between the levels of organic fertilizer used by the women and the men in the Mopti region and probably also in the Segou region (Table 3). The women are using much less organic fertilizer per ha. The women always mention that they are the last ones to get access to the carts to bring the organic fertilizer to the field. They also have less access to the organic fertilizer available. Since the women generally follow better than the men the agronomic recommendations, giving them equal access to resources especially organic fertilization will enable them to compete with and push the men for increasing millet yields.

On the areas in each association, the Mopti farmers' associations had substantial variation but on the average was much closer to our ideal size of around 150 ha. The Mopti average was 131 ha. The men were supposed to have just one ha but this was not implemented by IICEM. Women obtaining land had access to either one quarter or one-half ha. The average area per association in Segou was much smaller at 71 ha. There was some collaboration between these smaller size villages in storage and marketing. However, management talent for keeping books and pursuing markets is limited so a bigger area and membership is useful.

[11] The pilot program attempted to create a cadre of seed producers in the regions worked.

Table 3. Area, fertilization, and yields in Segou, cercle de Baraoueli

Village	Area (ha) 2014-15	Inorganic Fertilizer (t/ha)	Organic Fertilizer (t/ha)	Variety	Yields (t/ha) 2014-15[a]
1.Merabugu	50	1 NPK 1Urea	7.5	Toroniou	1.5
2.Gurele-were	50	1 NPK 1 Urea	0	Toroniou	1.9
3.Konobugu	118	1 NPK 1 Urea	12.6	Toroniou	3.05
4.Badinantu	100	1 NPK 1 Urea	4.2	Toroniou et locale	1.5
5.Tigui	120	1 NPK 1 Urea	6.72	Toroniou	1.5
6.Kodougouni	25	1 NPK 1 Urea	0	Locale/sanio	1
7.Welingra	50	1 NPK 1 Urea	--	Toroniou	1.35
8.Diawarala	60	1 NPK 1 Urea	13.8	Toroniou	1.27
9.Nugula	82	1 NPK 1 Urea	7.5	Toroniou	1.12
10.Kenema	60	1 NPK 1 Urea	7.5	Toroniou	1.33
11.Diarabugu	45	1 NPK 1 Urea	6	Toroniou	2.7
12.Wentibugu	45	1 NPK 1 Urea	7.68	Toroniou	2.4
13.Kamba	58.5	1 NPK 1 Urea	6	Toroniou	2.26
14.Soungola	45	1 NPK 1 Urea	1.02	Toroniou	1
15.Niontobugu	75	1 NPK 1 Urea	5.46	Toroniou	1.16
16.Zana	55	1 NPK 1 Urea	2.4	Toroniou	1.8
17.Kokribugu	85	1 NPK 1 Urea	4.2	Toroniou	2.6
18.Tingona	80	1 NPK 1 Urea	10.98	Toroniou	1.9
19.Tingoni	215	2 NPK 1 Urea	21.6	Toroniou	1.85
20.Wela-cura	45	1 DAP 1 Urea	14.46	Toroniou	1.05
21.Bomoti-1	45	1 NPK 1 Urea	15.96	Toroniou	1.7

22.Bomoti-2	25	1 NPK 1 Urea	5.22	Toroniou	0.71
23.Segemba wili	30	1 NPK 1 Urea	3.36	Toroniou	1.17
Mean	70.6 ha		7.5/tons/ha		1.64 tons/ha

[a.]Yield data are biased upward. We interviewed the leaders of the associations and asked for the mean yields in the association but probably they often give their own mean yields. Generally these are the best farmers in the group.

Table 4. Crop Area and Yields (2014-15), Levels of Organic and Inorganic Fertilizers in the Farmers' Associations in Mopti with a Gender Division

Villages	**Area (2014-15) (ha)**	**Gender** **H** **F**	**Organic Fertilizer (t/ha) (2014-15)**		**Inorgnic Fertilizer (t/ha) 2014-15**			**Variéty**	**Yields (t/ha) 2014-2015**
			Men	**Women**	**Fertilizer levels (kg/ha)**				
					DAP	Urea	NPK		
Logo	230	0 275	-	3	0	50	50	Toroniou et locale	1.0
Dimbale	150	100 0	6	-	0	35	35		0.8
Sadia	120	130 40	9	2	50	50	0		1.0
Kanikombolé	90	59 25	7	2,50	50	50	0	Toroniou and locale	1.0
Telly	131,5	50 4	8	2,50	0	35	0		1.4
Dianwély	28	50 20	7	2,50	35	35	0		1.1
Ogotena	82	50 12	7,50	1,50	0	35	35		1.6
Ogossagou	105	106 31	6,50	2	0	35	35	Toroniou Locale	1.1
Sokoura	105	50 30	5	2	0	35	35		0.9
Tintoa. barwé	60	37 75	6	3	0	35	35	Toroniou Locale	1.3
Ogodiré	47	75 26	7,50	4	0	35	35	Locale	1.5
Pel	80	30 70	5	2	0	50	100	Locale	1.4
Témégolo	126	66 60	9	5	0	50	50	Toroniou	1.0
Pomorododi ou Na	88	72 28	6	6	0	50	50	Toroniou	1.0
Begné		114 80	4,50	3	0	0	100	Toroniou	1.0

	185								
Yadianga	130	95 35	6	3,50	0	50	35	Toroniou locale	1.0
Téré	91	60 45	3	1,50	0	0	100	Toroniou	0.9 in 2013 1,2 in 2014
Tinassansagou	90	60 20	1,50	0,4	0	50	50	Toroniou New bobo	1.2 T in 2013 1.0 T in 2014
Togo-tina	120	60 20	5	3	0	50	50	Toroniou New bobo	2013 : H=2 ; F =1.5 ; 2014 : H=1.8 and F=1.5[b]
Briga-dogon	70	142 6	4	2	0	35	35	Toroniou New bobo	0.9 in 2013 1.0 in 2014
Kountogoro	146	100 60	7,50	1	0	0	100	Toroniou	0.85 in 2013 1,2 in 2014
Balirou	145	53 67	6	1	0	50	50		H= 1,2 F= 1,0
Tendely	580	200 225	5	5	0	35	35	Toroniou Locales (2)	1,4
Means	131 ha		6t/ha	2.65 tons/ha					1.16 tons/ha

a. Same comments as for Table 3.
b. H and F: separate yields obtained by the men and the women respectively

Marketing Strategy Performance: There is widespread adhesion of several of the strategies of the original program.[12] This includes storage and later sales, producing clean cereal, and insisting on a price premium for the clean millet. Certainly, PAM has helped to increase the price paid. One farmers association in the Segou region (Tingoni) continues to work with the Bamako millet food processors

[12] Many programs including AGRA and OXFAM have been promoting village storage systems. Our program linked storage facilities to the revolving fund to set aside funding for input credits. With the establishment of the importance of repayment, this revolving fund can be substituted for with bank financing especially for those farmers' associations that have established accounts in the banks with their revolving funds.

in spite of the availability of PAM purchase. But the dominant phenomenon in this Segou sample is PAM.

PAM has largely changed from buying solely on a large scale from wholesalers to also being concerned with low-income farmers producing millet. PAM sets up a structure with one principal farmers' association in the center and then ten to twelve other farmers' associations in a circle around this pole or center. The outer farmers' associations bring their millet to the central association. There it is screened several times to clean it and put into PAM sacks with the name of the farmers on them. Then the central farmers' association pays for transportation and the PAM sacks and ships the millet to the PAM central facilities in Bamako or Mopti.

There are two indicators of progress of the farmers' associations. First the re-imbursement rates. There were only two cases of less than 100% repayment in Mopti and none in the Segou region. In these two cases, the members were thrown out of the association until they repaid. They were expected to repay in 2015. IICEM did an excellent job in instilling the need for repayment. Given the historic problems with repayment in the Sahel, this is evidence of institutional evolution. To pay for reimbursement required from 5 to 22% of production (except for one case of yield collapse) with an average of 14% in the Mopti region (Table 5). These rates were higher in the Segou region at 9 to 36% (again with one case of poor yields leading to 54%) with an average of 18% (Table 6). Even though it was more expensive in grain production to repay for the fertilizer in Segou the substantial price premium from PAM resulted in a strong incentive to maintain the program and repay.

Our preferred indicator for the farmers' association performance is the sales the farmers allowed the association to make for them after repayment for the input credit. This indicates farmer confidence in the farmers' association to get them a good price and not charge high costs for the storage or other services. Note that neither region did well by this indicator. In Mopti, these sales ranged from zero (52% of the observations) to 6% with an average of only 1% of production. In Segou closer to the main commercial center, Bamako, these sales took up more of production but were still rarely over 5% (Table 6).The average was only 2% of production. *Farmers asserted that their principal benefit from the program especially in the Mopti region was obtaining larger quantities to store longer for food security.* As farmers can sell more they can also achieve more food security. In many sites farmers reported that they did not even know about the potential of selling more of their cereal through the association. Larger quantities sold by the association would result in more bargaining power. Hence, these low quantities of cereals relegated to association sale also indicates an important weakness in the interaction between those running the associations and their membership.[13]

[13] Another interpretation is that the members needed the rest of the millet for food security or later village sales to be able to buy necessities at the local markets.

Table 5. Importance of Reimbursements and Other Sales through the Farmers' Associations in the Mopti Region.

Villages	Area 2013-14 (ha)	Production (t)	Reimbursement (2013-14) (t)	Reimbursement as a Percent of Production Quantity %	Member Sales through the Association[a] (t)	Additional Sales through the Association as a Percent of Production Quantity (%)
Logo	250	300	50	16,66	0	0
Dimbale	45	22,5	9	40	1	4,44
Sadia	120	120	14,8	12,33	0	0
Kanikombolé	73	91,25	15,2	16,65	0	0
Telly	102,85	133,70	7,2	5,38	0	0
Dianwély	28	35	5,6	16	0	0
Ogotena	82	106,6	13,2	12,38	0	0
Ogossagou	105	115,5	21	18,18	5,5	4,76
Sokoura	84	75,6	5,8	7,67	1	1,32
Tinto-barwé	130	169	12	7,10	5	2,95
Ogodiré	94	137,05	9,4	6,83	0,3	0,21
Pel	60	84	12	14,28	2	2,38
Témégolo	126	151,2	25,2	16,66	0	0
Pomorododiou Na	88	88	17,6	20	0,5	0,56
P. Begné	126	151,2	18,75	12,40	0	0
Yadianga	105	105	21	20	6	5,71
Téré	63	56,7	12,6	22,22	0	0
Tinassansagou	80	96	16	16,66	0	0
Togo-tina	120	240	24	10	0,3	0,125
Briga-dogon	60	54	12	22,22	0	0
Kountogoro	72,5	61,62	11,70	18,98	0	0
Balirou	290	348	29	8,33	4	1,14
Tendely	450	630	50	7,93	2	0,31
Mean (excluding Dimbale on reimbursement)				14.1		1.0

a. In addition to the reimbursement

Table 6. Importance of Reimbursements and Other Sales through the Farmers' Associations in the Segou Region.

Village		Area (ha) 2013	Production Tonnes 2013	Rembours ement Tons	**Reimburseme nts as a % of Production (%)**	Other Sales (tons)	**Other Sales as a % of Production (%)**
1.Merabugu		40	80	10	**12.5**	0	**0**
2.Gurele-were		91	145.6	22.75	**15.6**	0	**0**
3.Konobugu		90	243	22.5	**9.3**	32	**13.2**
4.Badinantu		100	120	12.5	**10.4**	10.5	**8.7**
5.Tigui		96	150.72	24	**15.9**	0.7	**0.5**
6.Koduguni		20	15	5	**33.3**	0	**0**
7.Welingra		32.5	40.95	8.12	**19.8**	1.2	**2.9**
8.Diawarala		70	81.9	17.5	**21.4**	1	**1.2**
9.Nugula		52	57.72	13	**22.5**	0.2	**0.03**
10.Kenema		65	76.7	13	**16.9**	1.8	**2.3**
11.Diarabugu		27	48.6	6.75	**13.9**	2	**4.1**
12.Wentibugu		50	90	12.5	**13.9**	3	**3.3**
13.Kamba		21	9.66	5.25	**54.3**	4	**41.4**
14.Soungola		40	32	10	**31.2**	1.4	**4.4**
15.Niontobugu		65	84.5	13	**15.4**	0	**0**
16.Zana		60	108	12	**11.1**	0.5	**0.5**
17.Kokribugu		60	141.6	15	**10.6**	1	**0.7**
18.Tingona		45	60.75	11.25	**18.5**	2	**3.3**
19.Tingoni		200	380	45	**11.8**	16	**4.2**
20.Wela-cura		40	35.2	10	**28.4**	0	**0**
21.Bomoti-1		35	49	7.5	**15.3**	0.8	**1.6**
22.Bomoti-2		20	13.8	5	**36.2**	0	**0**
23.Segemba wili		27	36.72	4.37	**11.9**	0	**0**
Means (excluding Kamba[a])					18.%		2.3 %

a. It was dry early and late. Kamba planted later, waited too long, and got decimated by the drought at the end of the season. Kamba rebounded with yields over two tons in 2014.

Program Summary

In this table the major issues are summarized and recommendations made.

Table 7. Review of the Millet Technology Introduction Process

	Observed	Positives	Negatives	Corrections to Strengthen Outcome
Inorganic Fertilizer	Fertilizer was made available to all farmers' associations though not necessarily of the type or quantity desired. DAP was generally not available and one sack of NPK rather than two often used. (Tables 3 and 4)	The popular myths about the lack of response or profitability of fertilizing millet were definitely refuted.	Not always combined with sufficient organic fertilizer to improve the structure while the inorganic fertilizer improves soil fertility. This was found to be the case most often in women's fields.	Public policy support for making DAP and Urea available to millet producers. Training in improved agronomic methods to insure payoff to inorganic fertilizers.
Organic Fertilizer	Substantial variation in organic fertilizer use and in yields. No clear relationship observed.	Pervasive use. Farmers recognizing importance	Women discriminated against in access to organic fertilizers and carts to move it to the field	Finance carts for women. Discuss access issue for organic fertilizer for women.
Seeds	Use of traditional varieties and older "new varieties." Toronio, sometimes three years out from new seeding.	Toroniou responded well to the other new technologies used.	Need for regular infusion of new certified seed	Improve identification and training of seed producers in the farmers' associations
Credit	Revolving fund system working well for providing input credit and being reimbursed.	Generally revolving funds kept in banks or microcredit institutions. Reimbursement at or close to 100%.	Bank credibility was not used for leveraging of more funds to expand faster and to become involved in other village activities needing financing.	How quickly should these associations use leverage of their capital to borrow more?
Technical Input and Oversight	Program technology: new seed, inorganic fertilizers, organic fertilizer, water retention techniques, better agronomy, storage technology.	Technology as key program component. Increasing yields drives all the rest of program activities.	Technology erosion away from fertilizer recommendations. Failure to renew the seed and to adequately train farmer seed producers. .	DAP and more Urea made available to millet producers. More systematic training and marketing help for small farmer seed producers

	Observed	Positives	Negatives	Corrections to Strengthen Outcome
Governance	4 to 6 farmers' association officers usually observed..	Maintaining strong organizations in period of public chaos (war, coup).	More pro-active marketing by leadership. Winning member confidence for increased voluntary sales	Marketing courses for leadership especially for responding to cartels and price fixing.
Harvesting/handling /cleanliness of the grain	Techniques for clean handing at harvest were also clearly understood, though not always used.	Clean grain is not an issue with the farmers' associations in the group. The process of handling the millet heads as they are harvested through the pounding/threshed/and winnowing processes. The linkage to increased prices for clean millet is clear.	As quantities of millet harvested increase, the pounding will become untenable in Mopti (the amount of time) for the women and girls responsible for the pounding.The next step as in Segou, driving over the grain, leads to dirty millet	Poor thresher history with machines breaking down quickly in the field. Identify and import better models. Also grinders on the village level Financing for above?
Marketing	Almost all the millet in Segou was purchased directly by the UN World Food Program (WFP). Sales often to wholesalers in Mopti but poor prices. Cartel behavior	100% reimbursement. Plus small additional quantities marketed through farmers' associations.	Fixing of pricing with cartel in Mopti. Little private entrusting of millet for sale by farmers' association after repaying credit	In Mopti need to use arbitrage. Sell or be able to sell outside region. More advance contacts and transportation needed. Joining together of various farmers' associations to increase quantities and marketing competence. More work by associations on gaining member confidence
Gender Considerations	Where women were allocated land to produce millet the majority of women interviewed used the program practices and produced millet approximately equal to the men.	Women interviewed in Mopti region, were pleased to learn how to manage and cultivate millet from planning to marketing. The fields allocated to women allowed the women additional income;	Women with little access to land and to carts for hauling organic fertilizer. As the production of millet increases in Mopti, the burden on women to hand thresh the millet will become untenable.	Alternate forms of threshing (small scale and large) need to be a very high priority. Where are the good threshers that hold up a few years? Continual breakdowns observed .Farmers' association commitment to support women's participation in the program insuring access to all needed inputs.

	Observed	Positives	Negatives	Corrections to Strengthen Outcome

Source: Adapted and modified from Jean Harmon, Consultants Report, 2015

Conclusions:

Millet yields increases of 50 to 100% from traditional practices is good performance and we have shown elsewhere the substantial income benefits from doing this (T. Abdoulaye et al, 2008, F. Baquedano et al, 2009;J. Coulibaly, 2010; and J. Coulibaly et al., 2013). However, the fertilizer recommendations have been eroded with the difficulty of getting DAP in Mali. The fertilizer proven recommendation is either one sack of DAP or two sacks of NPK, both combined with one sack of Urea. One sack of NPK is not equal to one sack of DAP.

Moreover, in Mopti and in Segou renewed Toroniou seed needs to be made more widely available. These two returns to program recommendations offer the potential for another 400 to 500 kg/ha of millet per ha. The use of organic fertilizer is also very important. Farmers know this and intensively use organic fertilizer but reminding them that inorganic and organic fertilizer are complements and not substitutes is important for them and for policy makers. The large differences between Segou and Mopti in the use of organic fertilizer indicate the larger numbers of livestock in the Segou region.

The concept of using inorganic fertilizer on the millet and financing it from a rotating fund has been well established in both millet regions. The IICEM program of the farmers' associations bypassing levels in the marketing chain to deal with wholesalers has been continued. Even with the availability of the revolving fund of the fertilizer credits from the US and Dutch governments, most farmers' associations in Mopti have maintained the wholesalers as their principal markets. The rotating funds restore some bargaining power to the farmers' associations, as the farmers' associations no longer need the contracts with the wholesalers to obtain the fertilizer credits. However, as yet this potential increase in bargaining power has not resulted in much increase of the marketing margin for the farmers' associations. By obtaining more millet from their members and working together and arranging transportation, the farmers' associations can break cartel behavior of the wholesalers. The threat of selling outside Mopti is often sufficient as there are advantages to Mopti wholesalers from larger quantities of clean, uniform millet that the farmers' associations can provide. But resistance and counter behavior of wholesalers to maintain their margins and market structures needs to be expected.

Finally, the farmers' associations in Mopti did well with the other components of the marketing strategy including storage and later sales, producing cleaner millet, and selling in quantity. The farmers' associations need to do a better market search and to press harder for a premium price for the clean millet if necessary in Bamako. Mopti millet already has a better reputation for being clean while Segou has a reputation for dirty millet

The PAM is working well for the Segou producers but farmers' associations there should anticipate at some time dealing again with the normal market channels. They need to be investing now in contacts and information about alternative markets.

Specifically for women greater access to organic fertilizer was the primary complaint especially being able to obtain carts and rights to obtain more of the available organic fertilizer.

Improved threshers are also needed in the farmers' associations and would especially benefit women. We have consistently been disappointed with the breakdown of these machines especially those with joint ownership by the farmers' association.

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Appendix A-1 Questionnaire Mopti

Enquête auprès des associations de producteurs du mil : 2015

1. Quel est le nom de votre association ?

2. Quand avez-vous démarré vos activités ?

3. Avec combien de membres avez vous maintenant ?

CRITÈRES POUR L'ORGANISATION DE L' OP UNE BONNE (ET FONCTIONNEMENT) PRODUCTEUR

1. Est-ce que vos membres rembourser leurs prêts ? Quel represente le pourcentage de remboursement ?

   2013
   2014

2, Y-a-t-i l des sanctions prévues pour ceux qui ne remboursent pas le crédit ?

3 Est-que vos membres vous permetent de vendre plus de céréales après le remboursement du prêt ? Combien de sacs Qu'est-ce pour cent de la récolte est ce montant ?

2013

4.Que faites-vous pour trouver des marchés pour votre mil ?
Qui vendez-vous à (collecteur , marchand régionale , grossiste, processeur) .
2013
2014

5. Comment contrôlez-vous la qualité du grain de vous membre?

6.. Que faites-vous quand le prix baisse rapidement dans le prix offert dans la région ?

7. Que faites-vous pour assurer que les membres aient confiance dans votre prise de décision ?

Enquete - Ag Performance - Les agriculteurs

1. Au cours des deux dernières années, quelles ont été vos rendements de mil des hommes, des femmes ?
   2013

   2014

   Les niveles de fumiere organic/ha, hommes, femmes?

   Les niveles de engrais chemique/ha hommes, femmes?

   Les varietes, hommes, femmes?

   Les superfeis, hommes, femmes ?

   Le rendement de pratiques traditionelles (sans engrais chemique), hommes, femmes?

2. Quel prix avez-vous reçu pour votre mil rembourser votre prêt au fonds de roulement ou pour le commerçant ?
   2013

   2014

3. Quelle quantité avez-vous vendu pour rembourser votre prêt ?
   2013
   2014

4. Quelle est la quantité de mil avez-vous tous les OP de vendre pour vous (après remboursement) ?
   2013

5. Quel est le prix que vous ont été donnés pour cette quantité vendue par l' OP ?
   2013

6. Avez-vous vendre un de vos mil vous meme ?
   2013

7. Quel prix avez-vous obtenu pour les ventes de ce mil ?
   2013

STRUCTURE DU MARCHÉ

8. Pour les ventes de mil qui achete le mil ? (négociant, distributeur d'entrée , la transformatrice, collecteur ou quelqu'un d'autre)?
   2013
   2014

9. Conditions du contrat –
   2014 Quelle est la date de vente ?
   Prix du marché ?
   Prix du marché majoré d'une prime ?
   Valeur de la prime ?

   2013 Quelle est la date de vente ?
   Prix du marché ?
   Prix du marché majoré d'une prime ?
   Valeur de la prime ?

10. Avez-vous payé les frais de transport ?

    2013 - Combien?
    2014 Combien?

Cereale Propre- Les Paysans et les OPs

1. Comment est-que vous nettoyez votre cereale ?
   Quand vous coupez les epis de mil vous mettez sur les tiges

   Battage sur bache

   Ou vous utilez le tami

   Autre

2014

Qualite

2. Avez-vous recu un surprix pour le mil propre ? Combien ?

2013

2014

3. Comment est-que le OP peut controller le qualite (cereal propre) de son membres

2014

*Le Cout de Credit-OPs (avec et sans un personne **tierce**, commerçant, vendeur de engrais, transformatrice)*

	Avec Contrat	Sans contrat
Quand vendu		
Prix de vente		
Quantité vendu Seulement pour payer le prêt		
Quantité vendu Plus que le prêt. Combien		

Globalment

1.Qui dans l'association a été chargé l'année passée de revendre le sorgho/Mil collecté ?

2 Quelles sont les raisons évoquées par ceux qui n'ont pas encore remboursé leur crédit ?

3.Comment encouragez-vous les producteurs à vendre leur sorgho/Mil par l'association ?

4. Quelles sont les difficultés majeures rencontrées par l'association?

5. Quelles ont été les points positifs qui ont renforcé l'association ?

6.Quelles sont les résolutions prises par l'association pour améliorer le fonctionnement le future ?

7.Quels critères pensez-vous sont nécessaire pour une très bonne OP ?