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Retooling Cotton Growers for Improved Productivity in Mozambique: Implications of Integrated Crop Management Practices

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Abstract
In Mozambique average yields of seed cotton range from 400-750 kg/ha on smallholders' farms, while those in research plots average 3,000 kg/ha. To improve productivity, integrated crop management (ICM) practices were promoted in cotton production systems, using farmer field schools (FFS). In addition, relevant information on cotton marketing was provided to the cotton growers. This paper examines the extent to which the initiative contributed to changes in farmer practices, productivity and income. The ICM farmers had significantly larger area ($p<0.01$) under cotton, which was due to an overall average increase of 0.19 ha above that of non-ICM farmers. Ninety seven per cent of the ICM farmers rated cotton as the key contributor to income compared to 80% of the non-ICM farmers. Net incomes from cotton were significantly higher ($p<0.01$) for the ICM farmers. The ICM farmers had better access to information and knowledge of cotton production compared to the other farmers. The ICM farmers used significantly ($p<0.01$) less pesticides by up to US$ 9.27 and realized better seed cotton yields of up to 250 kg/ha above non-ICM farmers. Efficient use of ICM practices contributed to sustained increase in productivity and incomes.
Keywords: Productivity, sustainability, yield, income, pesticides.

1. Introduction

Cotton yields in Mozambique have been significantly lower than the potential yields. Average yields of seed cotton range from 400-750 kg/ha on smallholders' farms, while those in research plots often average 3,000 kg/ha and above (Duncan, 2003; MOA, 1993). In addition, the yields have been declining over time (Chamuene, et. al. (2010); Duncan, 2003). The low and declining yields were mainly due to poor quality of planting seeds, poor and untimely land preparation and inadequate pest comparison measures (Chamuene, et. al. 2010; GOM, 2004). There is wide scope for improvement in production efficiency of the smallholder farmers. In 2009 the Government of Mozambique and development partners started an initiative to improve cotton production efficiency in small-scale farming systems through better vertical integration of the supply chain. This involved formulation and promotion of integrated crop management (ICM) practices in cotton production systems by both the private enterprises and public organizations. Best practice ICM packages were introduced and promoted alongside building stakeholder linkages for sustaining ICM. The ICM strategy was based on a Farmer Participatory Training and Research approach in which farmer field schools were the central component (Williamson, *et. al*. 2000; Kimani *et.al*. 2000).

The ICM activities were implemented in five districts of Nampula Province in Mozambique. Three districts, Monapo, Meconta and Mecuburi were selected from SANAM Cotton Company concession. These districts had a high number of cotton farmers and the need to build farmer capacity in order to increase cotton productivity. Two districts, Ribaue and Lalaua, were selected from OLAM Cotton Company. The two districts had many cotton farmers and were of strategic importance to the company. Under the concession system the two cotton companies are mandated to help in cotton production and purchase the seed cotton produced in the same area. Of the two, SANAM was more advanced in terms of value addition, processing fibre, cooking oil and soap, which was not the case for OLAM. SANAM also had blocks of land where farming was conducted by groups whose land was ploughed by the company and where production and marketing practices were monitored closely for individual farmers after sub-division of the blocks. All farmers contracted to a specified cotton company were obliged to sell seed cotton to the same company. The companies provided seeds, pest control products, cash for production practices and technical advice.

For each of the cotton companies, a single district that was not involved in the initiative was selected for comparison with the districts where ICM was implemented. The districts were Muecate under SANAM Cotton Company and Murupula under OLAM Cotton Company, and had similar socio-economic and natural production conditions as those involved in the initiative. The comparison districts were selected carefully to reduce the possibility of information exchange through interaction with those involved in the initiative. The selection of all the districts was guided by the experts from the cotton companies and the Mozambique Institute for Cotton

(IAM). Cotton production characteristics in each of the districts were documented before and after the end of the activities for those involved in the initiative and those outside the initiative.

Farmers in the five intervention districts were trained on integrated crop management (ICM) practices. Linkages were established and strengthened within the value chain to ensure farmers had access to inputs, technologies and information that would enable them produce more cotton competitively and with greater profitability. A farmer field school (FFS) approach was used to introduce the ICM practices (Erbaugh, *et. al*. 2010). The FFS included both male and female farmers and the average number of members in each FFS was 25. The members worked together by sharing the roles involved in crop production after the training sessions, which were developed to empower the cotton growers to undertake effective integrated crop management. The ICM options that the farmers were exposed to included use of proper spacing, certified seed (CA 324), strip intercropping with maize and cotton, agro-ecosystem system analysis (AESA) and rational pesticide usage. Alongside these practices there were some group dynamics in the FFS relating to how to effectively work together.

After the training, farmers from each FFS established two study plots where one was based on the farmers' practice while the second plot was based on the ICM practices. The size of the plots was 0.5ha each, for the farmers' and ICM practices respectively. The salient differences between the ICM options and the farmers' practice were as follows. The ICM practice used a spacing of 80-70cm by 20-15cm while the farmers' (non-ICM) practice had a spacing of 100 cm by 40 cm. Non-ICM practice involved use of uncertified cotton seed while the ICM used certified cotton seed. In the non-ICM practice pesticides were sprayed based on calendar application (biweekly), while in the ICM pesticide spraying was based on economic level of damage (Bentley, 2009; Musebe *et. al*. 2014). In addition the ICM practices involved strip intercropping (12 lines of cotton + 4 lines of maize) while in the non-ICM practice cotton was grown as a pure stand.

Farmers were also encouraged to use ICM practices on their own farms. In Mozambique cotton production was undertaken under the concession system where different private cotton companies are allocated certain specified areas, by the government, to support cotton production by supplying inputs and purchasing seed cotton produced in their area of jurisdiction. Thus, Mozambique enforced a concession system that protected the ginning company from competition for seed cotton. The activities conducted under the project followed similar methods as those of contract farming. Participation of the cotton agronomists and extension experts was therefore sought. In addition to training, the cotton growers were also provided with cotton seed as was the case under the concession system and the companies undertook to purchase all the cotton produced by the farmers. The cotton growers had regular meetings to participate in the activities meant for cotton production, crop protection, post-harvest handling and marketing.

Following the implementation of activities assessment was conducted to establish the extent to which the initiative helped the cotton farming community in the project areas to improve productivity of cotton and the associated incomes. Information pertaining to the impacts of the activities would pave the way for up-scaling in other cotton producing areas of the country. The assessment was conducted to achieve four specific objectives: (1) assess the extent of use of integrated crop management practices that had been promoted; (2) examine the changes in productivity of cotton through ICM adoption; (3) establish the level of use of pesticides; and (4) measure the contribution of the ICM technologies to the farmers' net incomes.

2. Methodology

Simple random sampling was used for selecting individual cotton growers from the districts involved in the initiative and the comparison districts. Before the start of the activities lists of cotton growers were obtained from the IAM agronomists and the cotton company representatives. Using the lists, 50 farmers were selected from each of the districts to provide baseline data. At the end of the project 50 farmers from each of the participating districts who were active FFS members were interviewed. The lists of the FFS members were obtained from the farmer field school facilitators in the respective districts. Fifty farmers were also interviewed from the comparison districts after the activities in the target districts. The same farmers were interviewed before the start of the activities and after the activities for both the target and the comparison districts. Farmers in the comparison districts practiced cotton production using the farmers' practices and not ICM methods.

Purposive sampling was used to select key informants, who were persons with expert opinion, from different organizations involved in the cotton value chain. Majority of the key informants were extension officers from the Ministry of Agriculture and the Cotton Companies responsible for cotton production activities in the different districts. Agronomists from IAM delegation and lecturers in the University's faculty of agronomy also provided information. Expert opinion was necessary for cross checking some of the information obtained from the cotton growers as well as providing specialist data and information on production, processing and marketing of cotton. Data was obtained from the respondents before the start of the activities (2009) and after the activities (2013) through interviews that were executed using structured questionnaires and interview guides for individual farmers and key informants respectively.

The study used primary data which included variables such as age of the cotton growers, area under cotton, methods of cotton production, types and quantities of inputs used in the production of cotton, education level of the cotton growers, labour, and resource endowment. The other data included crops grown, varieties grown, cotton output and sales, cotton marketing, constraints in cotton production and marketing as well as the extent of use of the integrated crop management practices. The data collected were analysed using descriptive and inferential statistics. Estimates were worked out per hectare for the purpose of making comparisons and drawing inferences (Muller, 2010). Comparisons were made between the ICM and conventional plots in the FFS as well as the individual plots of the ICM adopters and the non-ICM adopters using the 'difference-in-differences' method (Gertler, et al., 2011).

3. Results and Discussions

3.1 Socio-economic characteristics of the cotton growers

The age of the cotton growers, education levels and resource endowment were assessed to give an indication of the differences between the FFS and the non-FFS members. No statistically significant differences ($p>0.05$) were noted between the FFS members and the non-FFS members with regard to age and education levels. In both categories the education levels were lower for the female farmers compared to the male farmers. The level of education did not show any significant difference from the time of inception of the project and the time of impact assessment. All the farmers studied had relatively low levels of education, which suggests that the ideal methods for promoting the use of new technologies need to be more inclined to the use of practical approaches. Similarly, household size of the cotton growers did not show significant changes over the project period.

Cotton was reported to be the key source of income and therefore required support to improve productivity. Other crops were also cultivated in the area but the general view among the farming community in the area was that cotton provided the highest amount of farm income. Cotton was ranked as the first contributor to farm income by both the project and comparison districts (Table 1). In Table 1, rank 1 refers to the highest contribution to crop income, rank 2 refers to the second best contribution to crop income, etc., in terms of contribution to income and the progression continues in descending order with respect to contribution to income. The farmers' views were also supported by key informant interviews. The other crops grown in the area that were considered relatively important in terms of area covered and contribution to income were maize, sesame, peanut, cassava and sorghum.

Table 1: Growers ranking of cotton and other crop enterprises

District category	**Rank**	**% of growers giving the rank**	
		Before the ICM training	After the ICM training
Project Districts	1	68.6	96.5
	2	24.0	3.5
	3	3.5	-
	4	3.9	-
Comparison Districts	1	73.0	79.8
	2	8.0	18.2
	3	14.0	2.0
	4	5.0	-

Note: 1. A dash (-) means that the specified rank was not in the farmers' ranking
2. The comparison districts did not use the ICM practices. Hence, "after the ICM practices" for the comparison districts refers to the period after the project farmers had completed training and adoption of the ICMs

The rank given to cotton in terms of contribution to crop income indicates that the importance of cotton was increasing. Cotton growers under the project appreciated the contribution of cotton to income more than the farmers in the comparison districts. Table 1 also indicates that cotton contribution to income could be increased by improving the farmer capacity in terms of improvement of their production practices through training and where possible facilitating farmer access to inputs. For the same period, the proportion of ICM farmers ranking cotton as the most important source of income among the other crops was significantly higher than the proportion of the Non-ICM cotton growers.

3.2 Cotton production and productivity

Cotton production was based on a zoning (concession) system. The private company in a certain territory promoted cotton by supplying seed for planting, inputs on credit, technical extension service, and procured all the seed cotton produced from the designated area. This was a legal obligation involving the cotton companies as signatories to the concession contracts with the Government of Mozambique. The farmers received guaranteed seeds free of charge. This was not certified seed, but in a few cases seed was produced under contractual

arrangements, where the companies selected an area where they contracted farmers who multiplied the seeds. Some of the seeds supplied to the farmers were coated with systemic insecticides against early season pests e.g. jassid and aphids. Farmers paid for the coated seeds through the same credit system as for the other inputs. The cotton companies also provided crop protection chemicals to the cotton growers under their jurisdiction. The laws governing cotton production and zoning were still as before the initiation of the project activities. The project initiative did not cover policy relating to production and zoning, rather the intention was to increase the productivity of cotton. The project facilitated farmers' access to seeds through the appropriate liaison with the cotton companies allocated different locations for cotton production.

Farmers undertook cotton production using mainly hand hoes. In very few cases (1.5%) tractors were used to undertake cotton production mainly through support of the cotton companies in the area. The cotton variety grown was CA 324. Hand weeding was practiced. Pests and diseases were controlled by spraying pesticides.

There were statistically significant differences between land owned across the different districts ($p<0.05$) and land under cotton. No statistically significant differences exist between land owned by male and female farmers ($p>0.05$) in the project and comparison districts. The land ownership scenario was different for the male and female farmers when compared to the time before the start of the project where men owned relatively larger land parcels. It was not possible to attribute this change to the project given that it did not exclusively target policy issues relating to land use and ownership in the project districts. From the project perspective what was crucial was to generate a positive change in cotton productivity and income obtained from the cotton enterprise.

The land allocated to cotton production increased in more than half of the project areas after the ICM initiatives. In Lalaua there was a decline in area devoted to cotton after the ICM initiatives, while in Ribaue there was no change in area under cotton after the ICM training (Fig. 1). Lalaua and Ribaue joined the ICM initiatives much later and it is possible that the effects of ICM practices had not yet been appreciated by the farming community to encourage more cotton growers to devote more land to cotton production. There was some decline in area under cotton in Murupula District and no change in area under cotton in Muecate District, both of which were comparison districts. Two other issues were identified in the study. Firstly, cotton productivity was affected by lack of the necessary production skills and support, meaning that more technical and material support was required to facilitate cotton production. Also, it was possible to infer that if measures would not be taken to help in the production practices of cotton then the area under cotton could decrease thereby reducing the competitiveness of cotton. The concern in this respect should be for both the quantity as reflected in yield and quality which has implications for the cotton lint. This is in line with the argument by Gerald (2008) that quality management should be considered one of the most important areas of improvement for SSA cotton exporting countries. The second assertion is based on the decline in area under cotton in one comparison district and the participating district that had not been adequately exposed to the ICM practices and other support.

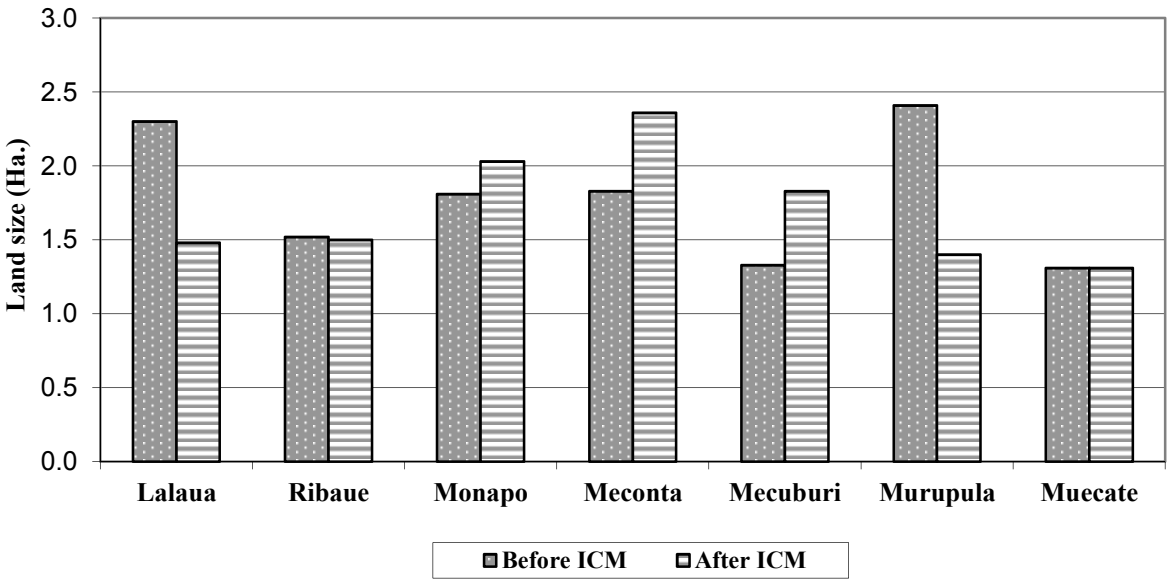

Figure 1: Land under cotton production in the project and comparison (Murupula and Muecate) District
Note: After ICM for the comparison districts refers to the period after the participating districts had completed implementing the ICM practices

3.2.1 Cotton production characteristics in the districts introduced to ICM practices

In order to establish whether or not there were any differences attributed to the use of the ICM practices an initial assessment was conducted for only the districts that were introduced to the ICM practices. In this case a comparison was undertaken for the farmers that used the ICM practices and those that used the farmers' (Non-ICM) methods for cotton production at the same point in time, that is on a with and without basis. The comparison involved area under cotton, yield, expenditure on pesticides and net income from cotton production (Table 2).

Table 2: Cotton area, yield, pesticide use and net income on the farmers' own farms in the project districts

Variable	Practice	Lalaua	Meconta	Mecuburi	Monapo	Ribaue	Muecate*	Murrupula*
Cotton area (ha)	ICM	1.6	2.5	1.9	2.1	1.5		
	Non-ICM	1.4	2.3	1.8	1.9	1.1	1.3	1.4
Yield (kg/ha)	ICM	641.7	557.5	752.4	674.5	554.3	-	-
	Non-ICM	545.2	425.0	711.6	660.3	485.4	428.5	411.9
Pesticide usage (US$/ha)	ICM	11.02	13.9	10.5	10.1	12.9	-	-
	Non-ICM	12.3	14.3	12.0	13.7	14.0	12.2	15.3
Net income (US$/ha)	ICM	195.7	294.4	199.4	146.3	181.0	-	-
	Non-ICM	184.3	263.5	168.8	144.9	171.0	121.6	116.7

Note: 1. *=Comparison district
2. 1 US$ = 30 Mozambique Metical

Area under cotton production was higher for the farmers using the ICM practices and significantly different ($F_{4,193}$=3.7, $p<0.01$) from that of the farmers using conventional methods for cotton production. This is an indication of the fact that the use of ICM cotton production practices encourages the cotton growers to devote relatively more land to cotton production. The cotton yield for the ICM cotton farmers in the same districts where ICM practices had been introduced was higher than those of the conventional cotton growers. However, the yield differences were not significantly different ($F_{4,142}$=2.4, $p>0.05$). This is may be attributed to the spill over effects whereby the conventional cotton growers learnt some production skills from the ICM cotton growers. On the other hand, expenditure on pesticides was lower for the farmers who used the ICM practices compared to the conventional cotton growers. The difference in expenditure was significant ($F_{4,192}$=4.06, $p<0.01$) meaning that there is rational pesticide usage by the ICM cotton growers. This assertion is supported by the fact that the net income of the farmers using ICM practices was higher than that of the farmers that practiced conventional cotton production ($F_{4,171}$= 5.05 and $p<0.01$). These results point to the fact that use of ICM practices is better than the use of conventional cotton production practices. Promoting the use of ICM cotton production practices is a worthwhile venture and could also encourage gains at different levels of the cotton value chain. This assertion is consistent with the findings by Ikiara and Ndirangu (2003).

3.2.2 Cotton production in districts using ICM and comparison districts

Assessment of the ICM cotton production practices using only the districts that had been introduced to the practice can lead to underestimation of the contribution of the ICM practices possibly because of the spill over effects. To reduce and/or eliminate the spill over effects, production characteristics were compared for the farmers practising ICM and conventional cotton production at different points in time for the districts where training had been conducted and the comparison districts where no training had been done on a before and after as well as a with and without basis (Simonyan and Omolehin, 2012; Paul *et. al*. 2010).

In all of the districts, there were increases in the yield of cotton after the adoption of the ICM practices. The cotton yields were better than those before the growers started using the ICM practices (Table 3). There were significant differences ($p<0.05$) in yields between the ICM districts and the comparison districts indicating that the ICM practices had a good contribution to increasing the cotton yields. The cotton yields from the ICM farmers were better than those from farmers that did not use the practices. This means that the cotton growers were likely to benefit from the ICM practices. Given the production potential and productivity differences it is possible to increase cotton production in areas where there is low production.

Table 3: Cotton production on the farmers' own fields in the different districts (kg/ha.)

Name of cotton company	District	Before the ICM (a)	After the ICM (b)	Differences (Yield after ICM less before ICM) (c)	Difference-in-differences (ICM less Comparison) (d)	% Change in yield (d/a)*100 (e)
SANAM	Mecuburi	474.8	752.4	277.6	250.2	52.7
	Meconta	494.3	557.5	63.2	35.8	7.2
	Monapo	595.9	674.5	78.6	51.2	8.6
	Muecate*	428.5	455.9	27.4	-	-
OLAM	Lalaua	510.8	641.7	130.9	32	6.3
	Ribaue	432.2	554.3	122.1	23.2	5.4
	Murupula*	411.9	510.8	98.9	-	-

Note: 1. *=Comparison district

2. After ICM for the comparison districts refers to the period after the participating districts had completed implementing the ICM practices

There were no significant differences ($p>0.05$) in yield between the ICM adopters and the non-FFS farmers in the participating districts. This may be because of information spill over to the non-FFS farmers in the participating districts. The diffusion effect lends support to the fact the ICM practices promoted were preferred by the farmers. It also indicates that FFS generated an environment that facilitated exchange of information and skills.

The cotton growers whose ICM capacity had been built demonstrated good production practices and post-harvest handling of the cotton. They also had improved communication amongst themselves as opposed to the other cotton growers. The interaction could help the cotton growers to negotiate better with the cotton companies that serve the areas where they undertake cotton production activities. Cotton was packed in a better manner in the fields of the ICM farmers although the sorting and grading of cotton did not show major differences between the ICM adopters and the non-ICM adopters. However, adopters of the ICM practice demonstrated improved capacity to source information for use as appropriate.

The production scenario was much better in the FFS study plots. A key observation was that the ICM plots had better yields compared to the conventional practice (Table 4). The ICM plots had significantly higher yield compared to the farmer practice in all the districts and in all the farmer field schools ($p<0.05$). This underscores the importance of building farmer capacity through training in the use of the ICM practices.

Table 4: Cotton production in the farmer field schools (kg/ha)

Name of cotton company	District	ICM Plots		Conventional plots (Farmer practice)	
		Season 1 (2011/12)	Season 2 (2012/2013)	Season 1 (2011/12)	Season 2 (2012/13)
SANAM	Mecuburi	746.2	869.2	441.4	602.0
	Meconta	643.0	720.0	388.0	437.0
	Monapo	711.0	823.3	398.0	635.5
OLAM	Lalaua	772.7	784.1	530.0	627.3
	Ribaue	800.0	888.8	497.6	550.0

3.3 Pesticide usage in the ICM and comparison districts

All the pesticides used were provided by the cotton companies in the project area. The companies advised the farmers on the application methods and the respective target pests. The key pesticides used included Volamiprid, Zakanaka Top, Zakanaka K and Zakanaka Pro. The ICM farmers spend less on the pesticides and the frequency of use of the pesticides was relatively lower among the ICM cotton growers (Table 5). The reduced frequency in pesticide application by the ICM cotton growers could have been due to the timely comparison made possible through the use of agro-ecological system analysis. Pest and disease incidence levels were reported to have declined despite the reduction in the use of pesticides.

Table 5: Expenditures (money spent) on pesticides (US$/ha.)

Name of cotton company	District	Before the project (a)	After the project (b)	Difference (Expenditure after ICM less before ICM) (c)	Difference-in-differences (ICM less Comparison) (d)	% Change in Expenditure (d/a)*100 (e)
SANAM	Mecuburi	14.62	10.48	-4.14	-4.65	-1.06
	Meconta	14.51	13.88	-0.63	-1.14	-0.26
	Monapo	15.41	10.06	-5.35	-5.86	-1.27
	Muecate*	11.69	12.20	0.51	-	-
OLAM	Lalaua	17.05	11.02	-6.03	-9.27	-1.81
	Ribaue	18.19	12.86	-5.33	-8.58	-1.57
	Murupula*	12.07	15.32	3.25	-	-

Note: 1. *=Comparison district
2. After ICM for the comparison districts refers to the period after the participating districts had completed implementing the ICM practices
3. 1 US$ = 30 Mozambique Metical

The comparison districts had relatively higher expenditures on pesticides compared to the project districts. Only Meconta District had average expenditures on pesticides that were higher than those in the comparison district under the same cotton company. In spite of the expenditure in Meconta being high, it was still lower than the time before the ICM project, which still supports the view that the ICM practices contributed to a reduction in expenditure on pesticides. The general low pesticide expenditure in the project districts and for the farmers using ICM suggests a more rational pesticide usage among those trained in ICM and having been members of the farmer field schools. This also demonstrates the importance of FFS as training avenues as also reported by Mancini *et. al.* (2007). In spite of the improved/efficient use of pesticides following the project initiative, the ICM adopters experienced some difficulties in accessing pesticides and using them. The sprayers and the batteries to be used by the sprayers were not readily available. The sprayers were shared by many farmers involved in cotton production. These constraints also affected the non-ICM farmers. It is suggested that the Concession Companies provide more sprayers and the accessories to try to alleviate these problems. Farmers may also pool resources on their own to purchase the sprayers and the accessories.

3.4 Contributions of the ICM to farmers' income

The processes involved in cotton marketing did not change as a result of the use of the ICM technologies. Cotton was normally purchased by the companies that were located in specific areas that were allocated to them by the government. These companies supplied inputs under an arrangement with the farmers for them to purchase the cotton once harvested. According to farmers interviewed, although the companies were mandated to supply the inputs, provide technical knowhow and purchase the seed cotton; the services offered did not meet the expectation of the farmers. Income from cotton production improved more for the cotton growers that participated in the ICM activities (Table 6). Different incomes were reported by the different farmers in the same districts and at the same time some districts obtained lower incomes. For instance, some farmers/districts received low incomes while others received high income. This means that given similar agro-ecological zones, input supply and technical support from the cotton companies it is possible to increase the net income from cotton production in the districts/farmers that received low net incomes.

Table 6: Net income per ha from cotton production (US$)

Name of cotton company	District	Before the project (a)	After the project (b)	Difference (Income after ICM less before ICM) (c)	Difference-in-differences (ICM less Comparison) (d)	% Change in income (d/a)*100 (e)
SANAM	Meconta	209.40	294.39	85.00	75.06	1.19
	Mecuburi	141.55	199.35	57.80	47.87	1.13
	Monapo	133.35	146.34	12.99	3.05	0.08
	Muecate*	121.61	131.55	9.94	-	-
OLAM	Lalaua	184.60	195.74	11.14	4.55	0.08
	Ribaue	170.71	181.02	10.31	3.72	0.07
	Murupula*	116.69	123.28	6.59	-	-

Note: 1. *=Comparison district
2. After ICM for the comparison districts refers to the period after the participating districts had completed implementing the ICM practices
3. 1 US$ = 30 Mozambique Metical

In all the project participating districts, levels of net income were higher for the farmers that adopted the ICM practices compared to the other farmers in the same district. This may be associated with rational input use attributed to the ICM training that contributed to a reduction in production costs. The results indicate that the use of ICM practices was likely to increase net incomes from cotton production which in turn suggests that the cotton growers need to be encouraged to use the ICM practices. Net cotton income from the farmers in the comparison district was lower than that of the farmers that used the ICM practices. This may suggest that farmers trained in ICM practices gained some experience that may have led to the use of improved practices, which generated better yield and hence more income. This underscores the need for capacity building in cotton agricultural production practices. Improved cotton income received by the farmers that adopted the ICM practices could be used to purchase household requirements and thereby improve the livelihoods of the cotton growers. This is crucial given that the cotton growers had limited alternative income generating activities.

4. Conclusion

The analysis established the extent of use of integrated crop management practices, changes in productivity of cotton, level of use of pesticides and the contribution of the ICM technologies to the farmers' incomes. The ICM practices were used to different extents by the cotton growers in the different districts. Intercropping, rational use of pesticides and proper spacing of cotton were the most preferred ICM by the farming community. Intercropping, although noted to be a key ICM practice was less used by the farming community in Mozambique. Given the need for provision of different options for purposes of improving cotton productivity it is necessary for the cotton farmers to be advised on the importance of intercropping. The rational use of pesticides by the ICM farmers in the project areas as demonstrated by less expenditure on pesticides suggests the need for up-scaling the training to other cotton growers.

The cotton yields received by the ICM cotton growers were relatively higher than those of the non-ICM cotton growers. This demonstrates the capacity of the ICM practices to contribute to the increase in cotton yield. There is a need therefore to extend the ICM practices to the other cotton farmers. Scaling-up of the practices need to be accompanied with the formation of active and effective groups that are legally constituted to be able to source for other services. This is attributed to the fact that the farmer field school members indicated in individual interviews that they were better able to interact with the cotton companies as a group. This view was supported by information from the key informants. Interactions among the cotton growers established ownership of services and better planning.

The ICM practices had a significant effect on cotton growers' incomes in addition to better yields. Costs were reduced in ICM plots especially due to reduction in expenditure on pesticides. Farmers could make better use of the benefits obtained from the use of ICM by undertaking cotton production as a business activity. In this regard, activities that enhance business undertaking need to be integrated. Among these are coordinated appropriate record keeping and budgeting. The members of the farmer field schools noted that they were able to plan and work effectively as a team. This suggests that training in group dynamics may be a key to assuring the pooling of resources by the farmers and hence encourage group production as well as information sharing among the group members. The groups formed need to be encouraged to operate in a manner that is consistent with the operations of innovation platforms in order to be able to interact effectively.

The cotton enterprise is a key contributor to the incomes of the farming community in the project area. However, a relatively lower proportion of land is devoted to cotton production. During the project period there was some increase in the land devoted to cotton production as was the increase in cotton yield and income. This indicates that there is potential for increasing the area under cotton production. It is necessary to provide more technical know-how to the cotton growers coupled with promotion of cotton as a profitable enterprise.

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