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Smallholder Cashew Development Opportunities and Linkages to Food Security in Nampula Province, Mozambique: **Summary of Findings and Implications for Policy, Research and Extension Efforts**

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Abstract

Cashew is among the leading export crops in Mozambique. However, very little is known about the costs and returns to cashew production for the millions of smallholders who produce it and depend upon it as a source of income and food security. In addition, there is a cashew productivity decline at the farm level that cannot continue to be ignored. This study uses existing macro information, and gathers detailed input/output data through multiple visits to 40 smallholder cashew households in three different regions of Nampula, currently the most cashew producing province of Mozambique. Secondary data is also used to construct crop budgets which feed into a smallholder linear programing model to examine strategies to improve cashew productivity and management practices in a context of a whole-farm system. The paper concludes that improved technologies and management practices examined still have limited potential to raise on-farm cashew productivity. However, can be improved if current efforts are e accompanied by a stronger institutional and market reform investment program to improve incentives to cashew growers, and make investments in rural infrastructure as well as technology research and extension services in order to bring about greater increases in cashew productivity to raise smallholder income, improve food security conditions and reduce poverty.

1. INTRODUCTION

As the economy of Mozambique moves forward, more challenges emerge and workable strategies are required to address the issues of sustainable economic growth, particularly in rural areas. Clearly creating opportunities for those who constitute the majority in agricultural production should be placed among the country's list of priorities for development. Part of this community of agricultural producers are cashew growers, as in the Northern Province of Nampula, where more than half of the national cashew output is produced and marketed every year.

Significant cashew production declines, both in quantity and in quality, have-s been attributed to among others, the neglect of many of the cashew trees after independence as a result of war, economic crisis which reduced the incentives to farmers to invest in cashew, and reduced funding for agronomic research and effective extension efforts. Although these factors seem to be well understood, important challenges remain to doing something effective about them. Lack of farm level data makes it difficult for policy makers, researchers and extension workers to address specific smallholder constraints or to evaluate alternative policies targeting this important segment of the economy. For instance, currently a great challenge is figuring out the relative importance of factors responsible for the productivity decline at the farm level, and finding practical ways to solve them to facilitate economic development of the cashew industry as a whole.

Overall, Mozambique is in desperate need to reverse the declining trend in cashew production especially to benefit the million smallholder farmers who grow it. A fundamental and complex policy challenge is how to structure available technological options (and to further enhance these) for smallholder cashew producers to increase both quantity and quality produced from either existing or newly planted trees. Also needed are improved market rules and industry coordination arrangements so as to provide policy induced incentives to adopt new technology. The challenge extends to the domestic cashew processing industry as well, calling for an adjustment and restructuring to improve productivity and management in order to be able to compete internationally.

2. OBJECTIVES AND METHODS

This paper reports findings of an economic evaluation study of alternative smallholder cashew technologies to increase production. The objective of the study was to provide farm level insights to help evaluate returns to smallholders' resources, particularly to the labor time smallholders allocate to different competing enterprises under alternative crop production technologies. Key research questions included: (a) under what conditions is it financially attractive for Mozambican smallholder farmers to expand production and improve quality of cashew nuts? (b) related to these, what are the investment decisions and available alternative technological options smallholders need to consider in order to achieve the expected cashew production increases and quality improvements? (c) What incentives and institutional support will be required for smallholders to adopt these alternative and new technologies in an environment where cashews are not the main crop?

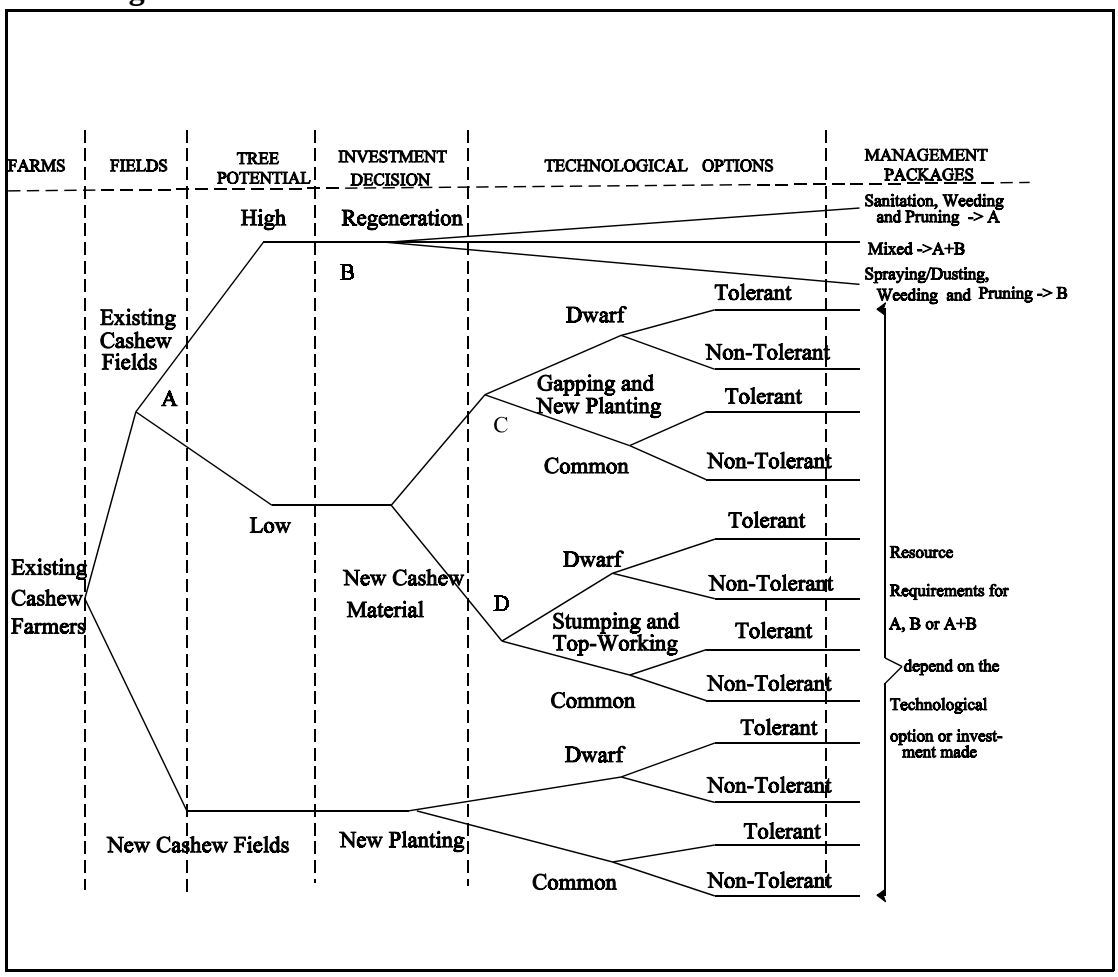
Field and tree level data from a farming system survey of 40 cashew producer households in three districts of Nampula was complemented with analysis of existing survey data, and with researcher and policy maker consultations within the cashew sub-sector in Mozambique.

3. KEY FINDINGS

Cashew Development Strategies

A decision tree of smallholder technology choices can be formulated from the best available knowledge about smallholder investment and technical decisions with respect to technologies and management practices, heterogeneity in cashew tree status or potential, and the high cost to ascertain a tree's potential (Figure 1.). Based on this framework, farmers as well as researchers should consider the following strategies : (1) start by focusing on existing cashew farmers and the actual field where their trees are located, rather than aiming development efforts at farmers not yet accustomed to cashew growing, or at fields where cashew is not currently planted; (2) to the extent possible eliminate all low potential and unproductive cashew trees that are older than 25 years through thinning

Figure 1: Smallholder's Choice of Technological Options and Management Packages



and replanting of improved material selected from either local mother trees with proven tolerance to diseases, and with high yielding capacity, or use adapted material from other countries (option C); (3) top-work all the cashew trees that are unproductive and less than 25 years old (option D); and (4) subject to sanitation, and improved management practices all diseased cashew trees with reduced productive capacity, but high potential for regeneration (option B).

However, given the different labor requirements of these technology options, and different labor and land availability among smallholder farmers, further analysis of the farming systems in which these strategies might be applied was completed. This was based on a farming systems analysis in provinces and districts where cashew is currently been grown, taking into account characteristics of existing cashew farmers and existing fields where cashew is grown. This analysis was done to develop a typology of farmers to provide insights about the potential for adoption of these techniques and the likelihood of success for the diverse group of farmers in the smallholder sector in Northern Mozambique.

Typology of Smallholder Cashew Farmers

A typology can be specified by grouping farmers by available land area per household adult equivalent (L-AE) as in Table 1 and describing differences across groups of smallholders in terms of resource endowment, including the number of cashew trees by cropping system. This framework suggests that there seem to be significant micro level diversity among smallholder cashew farming households, and taking these differences into account will have likely important advantages for policy making and improvement of technology strategy design for the smallholder sector as a whole. For instance, there seems to be a wide distribution of farmer's income, which results particularly from a non-uniform access to productive assets such land and cashew trees.

Table 1: Household Size and Resource Availability for Small, Medium, Large and Typical Smallholder Cashew Farmers in Surveyed Cashew Areas in Nampula, Mozambique, 1997/98

Indicators	Smallholder Farm Category by Land per Adult Equivalent (L-AE)			Typical Smallholder Farm
	Low	Medium	High	
Demographics				
Household Size	5,0	3,6	3,8	4,2
Age of Head of Household (years)	41	46	59	48
Resources				
Labor Adult Equivalents (LAE)	2,7	2,4	1,9	2,4
Land Area per Household (Ha)	2,7	3,4	4,7	3,5
Cashew Trees per Household (trees)	48	73	60	63
Number of Households	13	15	12	40

Source: Smallholder Cashew Production Technology Survey, MSU/MADR/ FSProject, Nampula 1988.

Furthermore, the typology clearly show that households in the low land per adult equivalent category had a relatively larger household size and potential for a bigger labor force. This seems to implies that households with more members to feed for the same number of adults as other categories, have a high dependency rate. As a result, with less land and fewer cashew trees, these farmers are likely to be more vulnerable and less capable to engage in riskier activities.

These findings are consistent with those found by Marrule et al (1998) when they examined poverty and rural growth prospects in Mozambique. These authors found an heterogeneous rural sector characterized by two distinct groups: on the one hand, a group which can be termed as "less poor" with more productive assets, earning relatively higher incomes and achieving relatively higher levels of calorie intake, and on the other, the "most poor" with an opposite welfare status and asset ownership. Among these groups there exist a strong and positive association between land and cashew tree concentration - those households with more land also have more cashew trees. Furthermore, this relationship extends to income and consumption patterns. Households with less land, have fewer cashew trees and lower levels of income and calorie consumption. Thus recognizing farmer´s diversity and keeping an open mind to the fact that there are no likely universal solutions, will hopefully help in devising a range of policy targets and technology options which would possibly avoid the exclusion of some farmers due to ignoring their specific constraints.

Factors Affecting Cashew Tree Productivity

Analysis was conducted of factors affecting tree productivity (Chapter 5, Section 5.5). Results show that, apart from the genotype factors found to be significant in explaining yields, red sandy loam soils, tree density and variations in farm type characteristics were found to also significantly influence tree yields. Another important finding is a possible negative (although statistically insignificant) effect of labor on cashew yield. This result most likely reflects the current weak incentive structure for farmers to invest labor on cashew tree improvement, particularly for the weak incentive for labor to be used at the right time of the cashew growing cycle. Currently the more comprehensive approaches to improved tree management and disease control calls for labor to be used on cashew improvement practices when it conflicts to a large extent with activities needed on food crops. The lack of reliable rural food markets and cash earnings opportunities for many smallholders, along with the low economic incentives for cashew, forces farmers to set priorities for working on food cropping activities, and thus shifting labor for cashew activities to be done later in the agricultural season. Since some of the recommended cashew activities with potential strong impact on yield cannot be done later in the year, they are simply not executed. This has also been one of the major reasons for the current high incidence of disease spread and declining cashew productivity at the farm level.

These findings help to inform questions about supply response in the current cashew policy debate and therefore provide directions for research. Lowering disease incidence levels, improving the current genotype material, developing where possible low labor using cashew cultural practices and creating an environment for improved incentives to increased smallholder farm investments in cashew production, particularly labor use, are urgent issues in the forefront of the cashew industry success requirements.

Overall Cashew Profitability

When cashew is examined from an enterprise perspective across smallholders in the three L-AE farm categories, differences in financial profitability across enterprises and/or farm categories is driven by differences in crop productivity, and by differences in labor applied per unit of land. For instance, farms in the low L-AE category allocate significant labor resources on fields where manioc and peanuts are the most important crops, compared to farms in other L-AE categories. This apparent food crop orientation (in contrast to cashew orientation) is a result of relative scarcity of land in the low L-AE farm category, which forces farmers to more diversification among food crops, rather than concentrating more on cashew as compared to farms in other L-AE categories. This provides insights about low L-AE smallholder farm's risk avoidance attitude, which results from land constraints and the need to produce sufficient food for the households own consumption.

Alternatively, the low levels of labor use observed in sole cashew cropping across all smallholder cashew farm categories also provide insights about perceived effects of the current economic conditions on farmer's incentives to take care of existing cashew trees. It seems that farmers feel that the cost is high (high labor requirement) of dropping cashew production from the farms crop portfolio by clearing the fields from potential uneconomic cashew trees to allow profitable crops cultivation. This explains, in part, farmer's reluctance to get rid of unproductive cashew trees present on much of the household's needed land. Recall that earlier analysis has indicated that there may be alternative ways to help farmers improve upon these uneconomic trees and to thus increase returns to the land, which is mostly worthless under the current cashew cropping system.

Cashew Technology Profitability

Three cashew productivity enhancing technologies and improved management practices packages were examined: (1) chemical control of PMD[1] (*CCPMD*); (2) top-working in combination with chemical control of PMD (*TWCPMD*) [2]; and (3) a bundle of these two packages with thinning and replanting (*ICM*) of some cashew trees in a given field. The *CCPMD* package was evaluated from the stand point of its individual profitability using crop budgeting analysis, and results were compared to current (traditional) practices. The crop budgeting information was then fed into a smallholder cashew household linear programming (LP) model to evaluate the *CCPMD* technology in a context of a whole-farm system. Given the importance of the time pattern of costs and yield impacts of the *TWCPMD* and *ICM* investments, a multi-period capital budgeting model was used to stress risk considerations and the need to put in place strategic support services to increase the likelihood of farmer's adoption of potential technologies/management practices.

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[1] PMD stands for Powdery Mildew Disease which attacks newly formed panicles and flowers of the cashew trees. The specific PMD on cashew trees is the *Oidium Anacardii*. Its control is undertaken by either spraying trees with wettable sulphur before the flowering season, or by sulphur dusting techniques applied using blowers during the flowering season.

[2] *Top-working* a tree involves cutting it down to the trunk first, and the side-grafting on the shoots sprouting from the trunk with improved material.

The findings show that, with prevailing input and cashew prices, the *CCPMD* technology was not profitable under sole cashew cropping conditions across all farm categories. The net returns per labor day were all negative. Under mixed cashew cropping conditions (intercropped cashew with different food crops) , the impact on net returns proved to be unambiguously an improvement over the traditional practices only when the CCPMD package was applied to cashew trees intercropped on manioc and peanuts fields by farms in the low and high L-AE categories.

The results of the whole-farm household model results show that land constrained farmers in the low L-AE category tend to grow more mixed food crops with no cashew, while allocating a small portion of land to both sole and mixed cropped cashew. In contrast, farms in the medium and high L-AE categories allocated more land to cashew cropping under both sole and mixed crop conditions, and to monocropped food crops. At the current low price levels for cashew, farmers select to improve only some of their cashew trees. As found in the partial budgeting analysis, these trees tend to be in those fields where cashew is mixed cropped. For instance, an increase in cashew prices of up to 115 percent, led to medium L-AE farms selecting the *CCPMD* package to improve about 41 percent of their trees mixed cropped with manioc, beans and peanuts, at 39 trees per hectare density. Under this cropping system, farms in the low and high L-AE categories would have improved all and about 78 percent of the trees, if cashew prices had increased by 120 percent and 125 percent, respectively. However, price changes of about 115-125 percent do not offer sufficient incentives for farmers to improve trees located on cashew sole cropped fields.

Furthermore, the results show persistently that farmers across categories leave the traditional sole cropped cashew in their optimal cropping plan. Possible explanations for this are: (a) persistence of low cashew prices leads to low investments in labor for sole cropped cashew because of the higher relative profitability of marketable food crops, and (b) when farmers allocate resources to various household activities they give high priority to food security. The latter is particularly true for resources such as household labor, which seems to be a constraining factor for some households.

Also, differences in crop productivity were found to be one source of the wide gap in the net income earned across farm categories, particularly for those households with a smaller portion of land for crops to meet food security requirements. A comparison of alternative scenario results, with results from the baseline model, shows that farmers across all categories require relatively high cashew prices or alternatively large increases in cashew yields as incentives to adopt more new technological packages to improve cashew trees.

For example, for a typical farm an optimal improvement plan on the traditional sole cropped cashew field occurs only in combination with a 150 percent increase in cashew prices. With price changes of this magnitude, this farm would have selected the *CCPMD* package to improve the 52 tree per hectare density fields with traditional sole cropped cashew trees. These percentage changes in cashew prices correspond to nominal producer prices of about $0.82-$0.95 per kg of raw cashew nuts. These prices are very high compared to about $0.53 per Kg received in the 1999-2000 cashew marketing season. It is not very realistic to expect cashew price increases of this magnitude. Clearly changes in both research and extension to improve cashew productivity will be required to give

farmers adequate incentives , even with substantial efforts to promote increases in cashew marketing competition. This will in turn depend on more public investments to improve rural infrastructures to help reduce transaction costs for both farmers and traders.

An alternative to price changes is an improvement in current cashew yield. For instance, farmers in the low and high L-AE categories would have adopted the *CCPMD* package to improve trees under mixed cropping, if cashew yields had increased by about 100 percent. Changes in cashew yields of the same relative magnitude would also have been sufficient to stimulate a typical farm to adopt the *CCPMD* package on trees mixed cropped with manioc, beans and peanuts at the 39 tree density. Similar behavior would have been observed on farms in the medium L-AE category, if cashew yields had increased 15 percent over and above that required by low and high L-AE farms.

The main reason for differences in the magnitude of changes both in cashew prices and yields required for adoption of improved technologies seems to reside in the relative scarcity for labor across farms as shown by the labor shadow prices. We note that farms in the high L-AE category faced binding labor constraints in most of the months in the agricultural season. These constraints are reflected by higher labor shadow prices compared to those faced by farms in the low and medium L-AE categories for which labor constraints were not as binding. The high labor shadow prices for high L-AE farms are consistent with high cashew prices and yield changes which these farmers required to adopt alternative yield improving technologies and managements practices. It was also found that farmers in the low L-AE category were land-poor. This was reflected in consistently high land shadow prices these farms faced compared to farms in other categories.

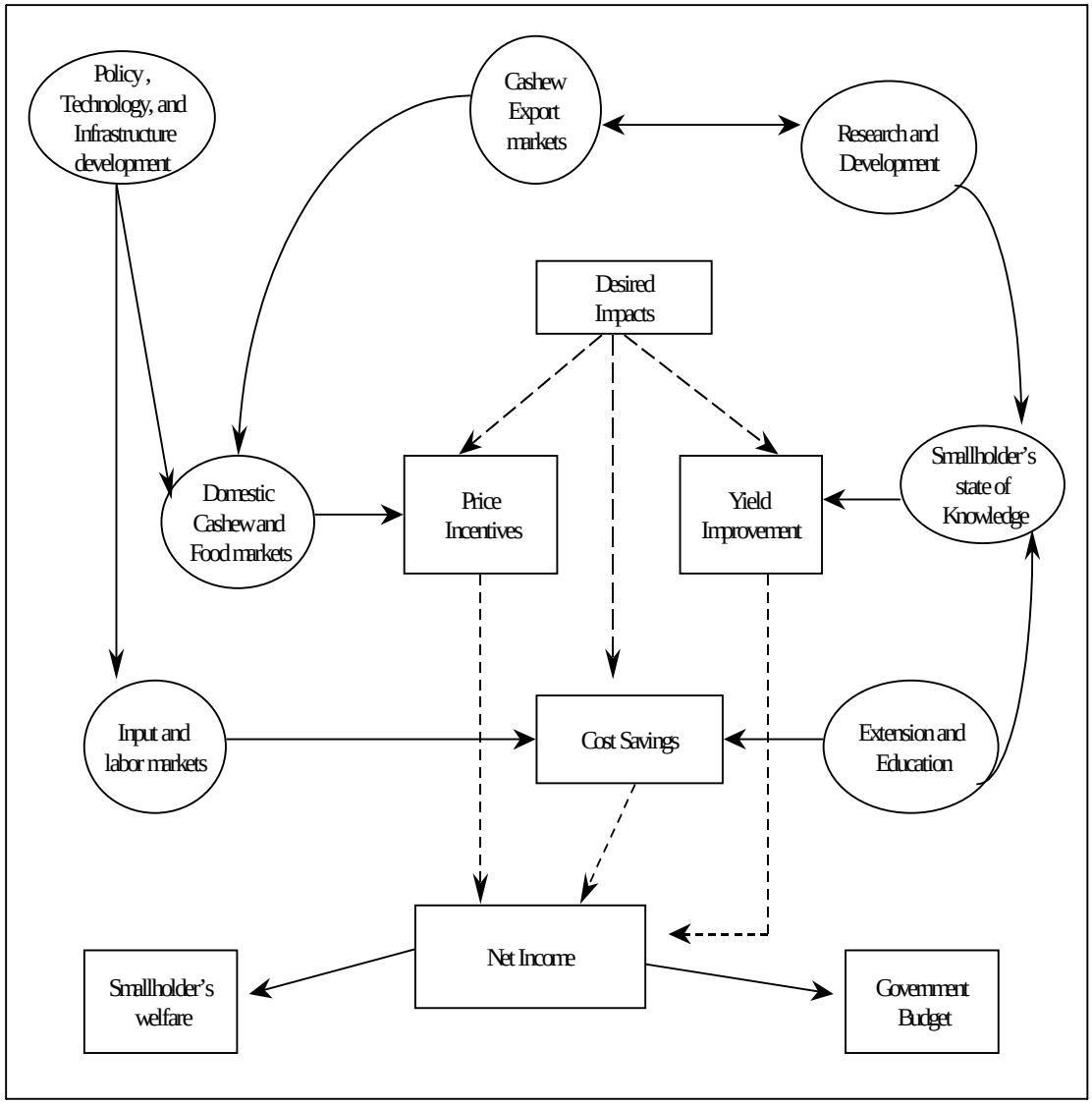
These findings suggested that the success in changing farmer's current behavior towards improving cashew trees could be better achieved through a diversified incentive structure which includes price incentives, but also includes yield improving strategies and production cost saving practices. This called for directing efforts in three main areas: (a) changes in technology to raise incremental output, (b) lowering costs of production through changes in cashew technology, and (c) improving markets to improve prices to farmers. These three areas are critical to move the smallholder cashew sector forward. However, the first of the three areas seems to require long term efforts in research and extension to provide farmers with adequate technologies to improve current yields at low cost. The third area is where short-term results may more likely be achieved. To date liberalized cashew marketing seems to have shown a potential for raising producer prices. Prices during the 1998-9 and 1999-2000 cashew marketing seasons provide an example. Prices have increased, since liberalization. During the 1999-2000, farmers received about $0.53 an increase of about 40 percent compared to the 1998-9 crop season. Although one may argue about the effects of whether on production, it is clear that more competition and pressure from export demand contributed to a large extend for the increase in producer prices. Keeping an export window open for raw cashew nuts is just one way to provide an opportunity for farmers to gain from a more competitive environment for the nuts they produce. Thus further efforts need to be undertaken.

3. POLICY, RESEARCH, AND EXTENSION: IMPLICATIONS AND RECOMMENDATIONS

Policy

Many of the causes of declining productivity in the smallholder cashew sector have been well discussed on several occasions. The real challenge is facing up to these factors in - ways that develop cashew as a viable smallholder crop that continues to provide broad based benefits to rural growth. Figure 2 below shows interrelated areas which need to be addressed to obtain desired impacts in the cashew sub-sector: (1) impacts from efforts to raise cashew yields, (2) impacts from efforts to raise cashew prices, and (3) impacts of actions to help lower farmer costs of cashew production.

Figure 2: **Linking Key Elements needed to Increase Production and Raise Smallholder Income in a Cashew Sub-Sector Development Framework**



Obtaining these results is not easy and often requires a combination of changes in policy, research, and extension activities. Unfortunately some progress is needed in each of these areas to help raise cashew related income earned by farmers.

The lack of sufficient price incentives and yield improvement ---the goal of the alternative technologies and improved management practices --- examined primarily in this study are two of the major explanations for the declining cashew productivity problem in Mozambique. Not long ago, agricultural prices were liberalized, including those of cashew nuts. With relatively free export of raw cashew nuts, it was expected that smallholder cashew producers would benefit from increased competition between traders/exporters, and the domestic processing industry. Although some of the effects of these changes started to work their way down to farmers, more needs to be pursued to assure continuity and to overcome remaining bottlenecks in the process. As suggested above, from 1998-9 to 1999-2000 crop seasons producer prices have increased about 40 percent. Given the high export demand, most likely these prices could have been higher if the export tax was not in place, and the marketing structure had not been highly taxed by "monopoly like" conduct of few traders. An open option for export of raw nuts allowed an internal and more competitive environment in the marketing chain during periods of high export demand. Yet, it should be clear that even an uninhibited export market for both raw and processed cashews is not enough. Other measures are also needed. For instance, rural markets for cashew and other crops are still underdeveloped. Poor marketing infrastructures including transport and lack of better roads to cashew producing areas reduce farmers' profit from sales of surplus production.

Despite increased effort to make market information on cashew prices available, dissemination is still far from sufficient to make farmers aware of better selling opportunities. Some non-governmental organizations have been concerned with this issue. For instance, CLUSA in Nampula has been involved in assisting farmers to form cashew producer associations. INCAJU, in their efforts to improve spraying activities have been concerned with their role in getting these institutions formed and trained. Both institutions are concerned with farmers gaining better access to market information and more bargaining power with cashew buyers. INCAJU, in particular feels that farmers associations could be a good monitoring device of returns to investments made in the cashew production sector. Market information cannot yield the full benefits with lack of communication between rural communities. In addition, during the marketing season, raw cashew export demand signals are weakened when reaching farmers in rural areas because high transport/transaction costs tend to depress farm level cashew prices. These transaction costs also increase on-farm costs of production.

Furthermore, constrained access to credit at the onset of the cashew marketing season prevents a larger segment of the cashew industry (especially rural buyers) from participating actively in marketing, so as to improve competition in buying at the farm level. This has led to concentration and lower cashew producer prices in some areas. Lack of enforceable grades and standards prevent also farmers from getting a premium from high quality nuts.

Alternatively, export markets whether they are for raw or processed kernels are an important window for smallholder cashew producers to experience improvements in the

price discovering process, and a good mechanism to improve domestic prices. Export market signals, however, can only be transmitted to them through more developed local markets both for cashew and food crops. For this to happen, liberalized markets are necessary, but not sufficient, if rural infrastructure is still resulting in high transaction costs to traders/exporters and domestic processors. Cashew marketing agents/participants want to maximize margins, and without sufficient competition will to easily depress prices paid to farmers. Marketing infrastructure and competition must be improved if continuous price transmission from the export market demand can be expected to reach farmers in cashew producing areas. This is true for cashew, inputs and food and non-food goods sold in most remote areas of rural Mozambique and, in particular, in cashew producing areas.

Another important factor in low productivity in Mozambique smallholder cashew sector is lack of access to improved technologies, particularly disease resistant/tolerant cashew material. Although some adaptive research and testing is taking place by either the public or NGO/private sectors, this effort is still significantly below the needs of the smallholder sector. While the most critical cashew research institution (INIA) has very few trained cashew researchers, the policy making institute (INCAJU) was recently created and still lacks resources to finance and coordinate activities in cashew producing areas. Research undertaken by NGOs and the private sector is concentrated in a few provinces and cannot meet the broad demand of cashew producers. Where new technologies are identified, delivery mechanisms are either weak or absent. Furthermore, investment in these new technologies are risky. An environment in which public, NGOs and private sectors collaborate on concrete actions could reduce the risk to both these participants and to adopting farmers.

At the same time , the present study shows clearly that for smallholders, cashew production must be seen in a whole-farm perspective, especially in conjunction with food crop production. Promoting cashew productivity increases along with food productivity changes is the most desirable path. Furthermore, creation of more off-farm employment opportunities, particularly those of labor intensive nature (ex. local processing of cashews) could provide a greater impact on incentives for farmers to invest more in cashew. Development of local cashew marketplaces, and/or improving farmer bargaining power through group selling actions as well as market awareness activities, as opposed to each farmer "selling in the store" could provide incentives to on-farm storage and the development of larger markets with economies of scale. This would also help prevent a few resourceful and "monopoly like" trader groups or individuals from trying to act together to pay lower prices to uninformed farmers.

In this context the perceived notion that taxing exports will redirect raw nuts supply to domestic processing and thus provide sufficient price incentive to farmers, must be seen with caution. As mentioned earlier, the export market offers an opportunity window for farmers to receive incentive signals from a wider market for their product. Whether farmers can get these signals depends on the structure of the domestic market. This includes export tax policy as well as the numbers and types of traders and processors who bid for smallholder's cashew surplus. Fewer traders and processors will not likely guarantee a competitive environment to raise producer prices. More traders and processors may increase the likelihood that such an environment is created, but more

resources need to be directed to complementary areas such financing, market information and infrastructures. Concurrently, reforms on the land tenure system would allow land-poor and relatively labor abundant households to acquire more land, and to invest their labor to on-farm production activities with a potentially significant positive impact on smallholder's income and food security conditions.

Overall, relying as much as possible on the potential of world market forces for both raw and processed cashews seem to help create the conditions conducive to a broad-based approach to rural development which could be more favorable to the expansion and improvement of cashew production while improving smallholder's welfare, and yet staying within the government budget.

Research and Extension

Yield increases require improved capacity in research and development of new cashew varieties with high yielding potential, as well as well supported extension and education services programs. For instance, in the short-run farmers may decide to try to spray their trees and neither top-work nor thin them. The effects, although significant, may not be substantial enough due to the aging of the trees and the quality of the planting material that farmers have in the fields. But it is very difficult for a farmer (or anyone else) to judge the age and potential of an existing cashew tree. So an important implication of this is that more research and effort is needed to try to discover reliable ways that would work for farmers to better judge what kind of tree they are dealing with, and which treatment might best apply. This is important to avoid uneconomic spraying, as well as to reduce risk and improve efficiency of application of which ever treatment farmer use.

As indicated in Figure 2, extension and education services and related programs can affect the smallholder state of knowledge of available technologies and management practices as alternatives to the traditional management systems under which cashew has been produced for many years. Improvement here to suit the needs of cashew producers requires consistent planning and carefully set priorities by government, private companies and NGOs involved in cashew research and extension.

Research and development are crucial. As of today, efforts in this area are undertaken by either INIA, and a few NGOs and private companies on limited number of nurseries in selected cashew producing areas. Although this is an important step, ill-funded government research institutions cannot, in the long-run, fulfill cashew research and development needs when priorities often are set on crops with direct impact on food security of the smallholder sector as a whole. The development of new varieties and adaptation of others require funds for infrastructures and scientific research and training. Furthermore, research findings on improved technologies and alternative management practices need to be disseminated. This requires a functional and reliable extension service network which can reach farmers with the right message. Scattered efforts by different actors while making some contributions, cannot have the desired impact on smallholder's state of knowledge in cashew production across the nation. This requires a coordinated effort and a long-term institutional commitment from the government with strong support from commercial companies (marketing and processors), donors, and NGOs.

A valuable resource in these areas is regional and international cooperation. Research experiences from other countries may, for instance, may well shorten the cycle of developing new and improved planting material. Tested material may only require adaptation as opposed to attempting domestically developing genuine solutions. Furthermore, adaptation research and development of completely new material are not mutually exclusive. Some of these efforts are currently taking place, but need to be part of a continuous program of a useful long-term strategy.

4. MOVING FORWARD: AREAS OF FUTURE RESEARCH

While there seem to be well advanced steps towards accumulating knowledge about biological constraints to cashew production in Mozambique, understanding smallholder cashew producer's behavior is an area in which many primary steps have yet to be taken. The present research generated new data, and used the existing data, to built a framework that gathers knowledge of smallholders management strategies and constraints facing different types of smallholders in cashew producing areas in Mozambique. Consistent empirical evidence and analytical insights to inform smallholder adoption of new technologies and improved management practices to increase cashew production and quality under the current smallholder sector setting is scanty. And it is hard to generalize over many possible smallholder cashew production areas. This study also suffers from the same pitfalls. The present research findings are in no circumstances to be generalized to all areas where cashew is produced in Mozambique. However, it must be noted that given the importance of the study area in cashew production, these results provide significant insights about the importance of studying smallholder cashew producer behavior. The suggested approach of using a household characterization or typology, and the household whole-farm analytical model developed for analysis will need to be expanded in a number of ways. First, more detailed observation and records of household behavior over a longer period will help to correct events which may have been recorded, but do not constitute a regularity in a given household. In depth data collection, and more systematic records of farmer's resource allocation would provide a better understanding of household allocation processes. This empirical examination of household economies is needed to clarify potential dependencies and possible opportunities of more resource-poor households.

There are technical aspects which the whole-farm (LP) model did not handle particularly well. For instance, the model assumed, based on best available knowledge, that activities for a given technology take place at a particular period in the year. Most of the times these activities were in conflict with food cropping activities on the farm. One possibility to alleviate farmers from these constraints is shifting some of the activities away from high labor demand periods. In order to impose these possibilities on the model, more technical information about the potential costs and benefits of such shifts is necessary from agronomic research as well as better knowledge of the farming systems. This calls for a much close collaborative efforts between social, agro-forestry and biological scientists.

A great part of the modeling process was adjusting secondary data to estimate or simulate how changes might behave under smallholder conditions in Mozambique. This estimation process has to be done, because some of the technologies were not, and some still are not, available on-farm in Mozambique. As more research is done both on-station and on-farm

(as appears to be the case in the study area), findings from these experiments can now be integrated into the model to reflect real conditions of current farming systems and practices in cashew producing areas. Concurrently, as labor becomes a constraint for many households a concerted scientific effort may help technology developers to design packages that are both technically and economically feasible, and take into account a range of factors specific to the cashew farming systems. For instance, designing specific research programs to help farmers identify better and with less risk, which of their existing trees should receive what treatment could have a very high pay-off to farmers. From a technological stand point this may be difficult, but it would help reduce risk that farmers are investing in the wrong trees, and/ or the wrong technology package. The bottom line is developing technologies which raise cashew output while lowering cost and reducing risks of adoption of new approaches for farmers.

In summary, the paper concludes that policy makers, researchers and extensionists need to join forces to understand better the needs of the farmers and thereby develop technological solutions which fit into the smallholder setting. A commitment of policy making institutions involved in providing sufficiently credible signals to smallholders is also necessary and critical to foster smallholders willingness to invest more of their resources in cashew production.

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