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Chapter 9

LAND USE CHANGE FROM SUBSISTENCE TO COMMERCIAL FARMERS IN MOZAMBIQUE

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ABSTRACT

The support/facilitation of subsistence farmers to establish commercially viable intensive production systems is a major opportunity and challenge in the development of many agricultural lands in rural Sub-Saharan Africa. The identification of suitable models of engagement, partners, organisations, and others, is an ongoing learning process. This chapter includes previously unpublished group interviews with upper management of an international food company to understand the existing and potential supply chain in Mozambique, and clarify their activities within the context of fostering selected farmer clusters to increase agricultural intensification to meet commercial food standards. Developing local capacity to supply commercial demands requires access to modern capital, technology, cultivars, and inputs for improving farm productivity, alongside the demonstration of improved production techniques over time. This requires some creativity in technology adaptation for specific production and socio-economic needs. It also fundamentally requires a market-led approach to land use in terms of intensification, potentially through a social venture capital partner organisation to look for strategic investments with the aim of joining the commercial links and minimising coordination failures when they occur in developing markets. Such a partnered facilitation to communicate global food demands back to producers to enable adaptation, and also improve local access to farm inputs to enable them to achieve quality and quantity targets on a commercial basis. This chapter is derived from an unpublished report commissioned

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INTRODUCTION

Advancement in technology is one of the most important drivers of agricultural productivity growth, and how new technology is designed and managed has a major impact on such growth (Hazell and Wood, 2008). As subsistence farmers are traditionally resource poor in terms of land, capital, and access to new technologies, a distinction must be made between emergency relief and creating an environment to enable participation in productive and profitable agricultural commerce (Opara, 2011). The only continent to not achieve sustained food surpluses is Africa, and has not enjoyed the technological and institutional changes in agricultural and modern input resources (Hazell and Wood, 2008). The rural and subsistence producers in African nations will be the most vulnerable to the effects of numerous insecurities and changes, including climate change (Conway, 2008). Yet, in areas with high population densities and small farms, agricultural intensification and improved yields from high input use enables a parallel decrease in food insecurity and associated production emissions (Palm et al., 2010). Management decisions to utilise intensive agricultural systems will determine the extent to which farmers are able to adapt to changes (market, climate, and other changes), and the associated production system resilient to that change (Lal et al., 2011). Countermeasures that contribute to greater resilience can include social, economic, and technological developments, and can be both a qualitatively and a quantitatively measured (Conway, 2008). However, in numerous locations in countries of Africa, agricultural producers remain using inferior and/or outdated technology and knowledge, including unimproved varieties and stock (Counguara and Moder, 2011; Lynd and Woods, 2011).

It is well known that most small farms in Africa are becoming increasingly unviable under existing production systems with low land productivity (Jayne et al., 2010), with the average cropped area in Mozambique only 1.5 ha per household (Counguara and Moder, 2011). At unimproved levels of production, small-scale operations are unable to meet quality, reliability, and consistency standards even when market access exists (Opara, 2006). Furthermore, postharvest technologies are fundamental to reducing losses and meet standards of safety, and around 50% of bumper crops may be lost due to lack of postharvest handling technology adoption (Opara, 2011). Yet, post-harvest waste reduction requires collective investment at the local scale to make use of suitable local storage and transport opportunities, needing collective investment in and transfer of existing technology (Godfray et al., 2010; Opara, 2011).

Infrastructure, education, and agricultural extension investments have long lead time horizons, and a farmers' ability to adopt new technologies and farm inputs over time requires greater supply chain stability (both input price and farm gate price) (Jayne et al., 2010). A strong market demand is required to underpin increased agricultural sector investment

towards commercial production (Woodhouse, 2009), and more consideration should be given to long-term policies attracting the private sector to provide agricultural inputs and services over at least a 20 year period (Speielman et al., 2010; Opara, 2011). Therefore, achieving sustained production intensification and diversification will need to occur in parallel with improved access to input and output markets (Thornton et al., 2010). However, small-scale farmer production, capacity building, extension services, and marketing activities remain disintegrated, and their integration under-emphasised in current development activities (Jayne et al., 2002; Lynd and Woods, 2011). The authors believe that human elements of agricultural management decision-making are key considerations in development activities; as ultimately it will be the farmers who implement and adapt such management decisions (Lal et al., 2011).

This chapter seeks to leverage detailed baseline information of selected existing production systems in the Beira Corridor which are typical of large areas of southern Africa (Dixon et al., 2001), and involve local farmer and food company consultation, and explore the development of suitable linkages between the existing supply systems and demand. The aim is to develop local capacity to produce suitable volumes of commercial agricultural produce through cooperation along the value chain. Developing local capacity to supply commercial demands requires access to modern capital, cultivars, and inputs for improving farm productivity, alongside the demonstration of improved production techniques over time through market-lead land use changes in terms of intensification.

METHODS

The research method was semi-structured group interviews and site visits with open-ended questions with selected representatives of the upper management of Vanduzi, a wholly owned subsidiary of Mozfoods in Chimoio, Mozambique. The objective was to explore Vanduzi's existing and potential supply chain, and clarify their activities within the context of fostering selected local farmer clusters to increase agricultural produce supply in the region that could meet commercial food supply requirements. During the site visits, observational data were collected in the form of photographs. Both the semi-structured interviews and the site visits were undertaken on 18 January 2013, and took approximately three hours in total. The majority of the interview notes were derived from the most senior representative.

A quantitative exploration of increasing chilli productivity with the addition of portable thin-film semi-transparent solar thermal/PV driers was undertaken. A simple prototype constructed out of cheaply available materials demonstrated the ability to successfully dry the chillies within one day. The performance of the semi-transparent PV module was simulated using primary climatic data (daily, and monthly mean) using meteorological ground-station data at Chimoio, Mozambique, Lat.(N): -19.1, Long.(E): 33.5, 731 m above sea level. The transformed climatic data were sourced from RETScreen's (version 4) climate database, incorporating the improved NASA Surface Meteorology and Solar Energy Dataset. The technical simulations were performed using HOMER version 2.68 beta, which simulates the operation of the renewable energy system over 5 minute intervals for a one year period. Monthly average meteorological solar and temperature data were used to simulate the technical performance of the PV module to supply a stand-alone application.

INTERVIEW BACKGROUND

The Mozfoods subsidiary Vanduzi imports, produces, and fosters local production of horticultural products for export and local extractive companies by using off-take agreements. Vanduzi has traditionally supplied European export markets with a focus on baby corn. In 2012, the company sought and won supply contracts with Mozambican based mining and oil and gas companies. This has led to an expansion of the company's business, resulting in additional importation of horticultural products to meet the variety, quantity, and quality requirements needed by the extractive industries. At the same time, the company is aggressively implementing a strategy of local substitution of supplied products where the varieties and growing conditions are suitable in Mozambique. This includes exploring farming at higher altitudes to extend the range of crops available, and to generate new information regarding agronomic requirements to assess cultivars of marketable vegetables capable of meeting commercial standards of growth and marketability in the unique agro-ecological conditions in and around Chimoio and Tete. This expansion plan includes a strategic leveraging the availability of local smallholder farmers, and actively fostering smallholder capacity to initially displace Vanduzi's need for food imports to supply local markets, and eventually build sufficient smallholder capacity to enable net exports.

This expansion is accompanied by significant investment to support third-party farmers in the form of training and a process of continual improvement, guaranteed off-take, and supply of farm inputs (seed, seedlings, fertilisers, and chemicals if needed). To date most success has been observed with 'birds eye' chilli's, both for export and also incorporated into the Mozambican staple flavour of 'Peri Peri'/'Pilli Pilli' (Figure 1). The smallholder farmers also have the opportunity to sell or add value to produce that does not meet Vanduzi's requirements for export, principally already mature red chillies . These ripe chillies are very suitable, however, for drying and the research team discussed with Vanduzi management the application of a PV-enabled novel chilli dryer that may prove both cost-effective and produce high value, high quality, dried chillies.

Figure 1. Vanduzi-supported local smallholder chilli producer (left), using the 'birds eye' F1 hybrid.

INTERVIEW RESULTS AND DISCUSSION

Since 2004 Vanduzi has developed both farms and outgrowers, exporting exotic vegetables to the UK. They have developed an expertise in exported baby corn, and this remains the focus to date. Other products include export sugarsnap peas and chillies, predominantly to the UK. The produce is grown in small-scale facilities within a 90 km radius from Chimoio. Vanduzi are now supplying the oil and gas companies in Mozambique, and the major extractive companies operating in Tete with high value horticultural produce principally sourced from outside of Mozambique as local producers are not currently able to supply either appropriate quality or quantity. At the same time Vanduzi is committed to a strategy of local product substitution. In other words, they have secured the market opportunity first, and have then embarked on developing and then incorporating local supply.

At present, to facilitate supplying the local market using local produce, Vanduzi have established a small 'market garden', which will become one hectare. The purpose is to establish local agronomic knowhow to produce mushrooms, cucumbers, peppers on a year-round basis to supply first local and then international demand. Vanduzi's intent is to establish the local smallholder production capacity to source a range of commercially viable produce that their growing customer base wants to see 'seven days a week, 52 weeks of the year'. Prior to developing a local customer base supplied by local smallholders, they need to address a number of fundamental local agronomic challenges that are at present preventing local smallholders from growing local produce at a sufficient volume and quality to meet the growing customer demand. Vanduzi readily acknowledges that the extractive industries are not going to provide a sustained customer base of sufficient scale, but rather provide a 'spring board' to underpin the smallholder production expansion. Over time, the strategy is to develop capacity to compete in larger international markets proximal to Mozambique, such as South Africa. Vanduzi representatives stated that "as we are 1,500 miles closer than Kenya, in theory we should be able to compete with Kenyan food suppliers for the South African market." In this competitive space, the role of better utilising transport backhauls also brings a competitive edge to aggregating local smallholder production in Mozambique. However, Vanduzi representatives clarified that that is a long-term goal, but now the focus is on how do we get the local smallholders producing to required specifications, and how to supply the large international companies in Mozambique. So for Vanduzi in the short-term, the parallel foci are generating the agronomic knowledge for specific produce, and developing the interactions and capacity between the smallholder farmers and the larger companies. Vanduzi representatives said that "Anadarko is an energy company, and Vale is a mining company. They are not in the business of being a bridge between a farmer and the mine. That is the space where this company wants to be."

SMALLHOLDER FARMER INVESTMENT AND TRAINING

Vanduzi representatives stated they are very interested in the whole supply chain and are willing and able to invest to the point where they will be able to replicate this model to expand their operations. They described that they had a number of smallholder farmers with off-take agreements that are very good and meeting their exacting requirements. However, they are unable

to produce more on their small land holdings, and with the limited amount of labour (as they do not use mechanical implements), Vanduzi would like to leverage them to improve the capacity of other smallholders, and retain their ability to maintain producing to specifications. Vanduzi representatives were asked if the training process was easy or difficult. They categorically stated that this model is time consuming, and at present they have been attempting to use this model for three years. “You can’t just give people seed, and they can grow it. The second year they’ll do a lot better. The first year was a disaster. They’ve taken a few years of continual improvement.” The Vanduzi representatives noted that commercially viable aggregated production at scale is not happening yet. The authors note that a cluster marketing approach would be a valuable introduction to Vanduzi’s process.

In terms of protecting their investment in this model, the Vanduzi representatives acknowledged that the proprietary knowledge protection will be difficult. They view that with their primary commercial products (such as baby corn), the agronomic and production inputs and management will be protected as best as they can by developing balanced and integrated fertiliser and disease prevention programs. The unique soils and climatic conditions in the region will somewhat play to their advantage, yet will also be a challenge to overcome in the short-term. Vanduzi representatives noted “because these crops have not been successfully grown here before, the knowledge that’s missing is the horticultural methods, species, cultivars, and skills, particularly to grow with the lack of a colder season.” Vanduzi is at present identifying various products that can be grown by making use of higher altitudes in the local area that can provide colder conditions to grow produce that requires a ‘cold snap’. Vanduzi believes there is a huge opportunity for collaborations between government institutions, and the universities in the region to increase the level of research underway in suitable agricultural production systems, particularly within development corridors that have a critical mass of scale, investment, interest, and local populations. When asked how to translate agronomic research and development into the capacity building and training of local smallholder farmers, rather than simply establishing or sourcing from larger farming companies. Vanduzi representatives stated “Yes, the small scale farmers are different, they have a model where they work with the existing farmers, and don’t ask them to do what we ourselves don’t already know what to do. We develop a program that supported it. If it becomes commercially viable, then that’s the way to go, and charity won’t work.”

The authors asked Vanduzi representatives about the financial arrangements with the smallholders, “How do they go about setting up a market price mechanism for the smallholder?” Vanduzi representatives stated “it is based on a percentage of their gross margin, and if farmers believe they can supply what we want, they can get a substantially greater price for what they produce than what they can get in the local market.” Vanduzi supplies the chemical and fertiliser inputs, alongside expert advice as part of the off-take agreement. Vanduzi representatives clarified “while the risk is on the farmer technically, we don’t just leave them alone, and they have lots of people going there during the season to ensure they have the best chance of meeting our standards and needs. “We establish a ‘training plot’, and also grow our products alongside contracted farmers in the first instance. This is how you plant, this is what you need to do, so people can come and see how it all works through the season.”

SMALLHOLDERS AND NEW TECHNOLOGY

Vanduzi representatives discouraged investment in mechanisation. “We don’t think mechanisation is the answer due to the small plot sizes”. The site visits demonstrated that the

smallholder farms are very small in the local area, mostly less than one hectare, and typical fields are even smaller and unsuitable for even small tractors. For example, the chilli and maize plots in Chimoio were 30 x 30 m^2. This small plot size was discussed widely as being inappropriate to larger mechanisation infrastructure, including two-wheel tractors, both in terms of the physical impracticality, and also being out of reach financially to most smallholder producers. Furthermore, there is a lack of historical use of subcontracting for major seasonal agricultural tasks; traditionally subcontractors used animal traction, and in many developing regions of the world these subcontractors have been the early adopters of various new mechanisation technologies as a logical progression of their business model. However, in the production systems in Mozambique, low-intensity manual labour remains the dominant energy input, due primarily to low wages and a risk-averse investment culture, which depresses demand for mechanisation options at the level of two-wheel tractors and above. This is despite many similar needs and benefits associated with their use in this region similar to many other regions of the world. The authors noted that the combination of the small areas, the crops grown, and the mechanisation requirements are such that if any mechanisation is needed, it would be a combination of small hand-held implements (primarily for weed control), hand sprayers for chemical weed control, and small portable postharvest processing options. As pre-planting weeding and between the rows during the growing season is a labour intensive element of smallholder systems, the use of nitrogen fixing legume intercropping can suppress some weeds, and reduce nitrogen input costs, and is a suitable grazing feed after harvest, thereby reducing residue burdens for the next crop. If animal-based residue management options are unavailable or impractical, the introduction of simple backpack sprayers can be used for a variety of herbicide applications, in addition to fungicide and pesticide control if/when needed in and around rows and cropped plants. Furthermore, the use of additional climate control and processing technologies (such as driers, and shade/grow houses) also have a major potential to increase both value and productivity in the region. With the high level of incident light in Mozambique all year, there is the possibility of drying the chillies that do not meet specification. The hot climate is a major consideration for the smallholders, as new crop weeding is impractical during the hours of 10 a.m. and 4 p.m. when it is commonly around 36 degrees Celsius. There is also a barrier to the entry of two-wheel tractors, as there is not a widespread pre-existing culture of outsourcing of ploughing in the region as there is in SE Asia. Therefore, the use of appropriate mechanisation and equipment would need to be critically trialled to determine their cost effectiveness and practical benefit. These trials require consideration of the supply chain, as many parts and support services are unavailable in the area, and also fuel and electricity supplies are generally unreliable, expensive, or non-existent.

Exploring post-harvest options further, the authors inquired about the ‘cold chains’ in use at Vanduzi’s Chimoio facility: “What does Vanduzi do to ensure smallholder produce is maintained at the correct temperatures?” Vanduzi representatives noted that for their current produce, they don’t really need much stationary cold storage, apart from the chillers already on site. The refrigerated truck transport from the farm to the facility, and the facility to the buyer provides quality control. In contrast, the Vanduzi representatives stated that some of their large customers in Mozambique have surprisingly poor cold storage facilities. This also means there is little hygiene barrier, and the regions which they supply in Mozambique are known for being hot places for the majority of the year.

The authors asked how Vanduzi might be able to provide additional benefits to their local large customers, for example targeting the head chef/individual who is designing the nutritional requirements for meals at the mining organisation. Vanduzi representatives stated that "at present it is often as simple as; this much green leafy vegetables, this much fruit, etc., and they are not looking at the options that are here locally to provide the right nutrition that can be procured locally. A major question is how do you educate them for seasonal availability, and can they get options that are acceptable to the people working at the mine". Vanduzi believe it is possible to shift the food procurers from the familiar mindset of the western commercial cooking styles using traditional western vegetable combinations. They stated that system elements are assessed in isolation rather as a whole, and become difficult to introduce innovation: "There is a supply, a demand, and then there are the nutritional requirements, then the procurement companies are told what to source. These systems are relatively inflexible." The authors noted the large scope for exploring 'chef adventurism' in mining companies in Africa may be a possible new marketing angle to promote the local procurement of produce, and generate interest in the food supply chain, and how it impacts local communities.

TECHNICAL RESULTS AND DISCUSSION (CHILLI DRYING)

The annual average clearness index at Chimoio was 0.594, the annual average horizontal plane solar irradiance was 5.647 kWh m^{-2} day^{-1} (Figure 2), and the annual average temperature was 24.4 degrees Celsius (Figure 3). HOMER calculated energy balance calculations of the PV module incorporating climatic variables from the Chimoio station. The basic components of the simulated PV system was a small 0.090 kW_p PV module, and a small standard maximum power point tracking control unit able to provide DC power from the modules maximum $137V_{OC}$ and 1.1A short-circuit current, on a simulated off-grid 12V DC bus. Figures 4 and 5 show the electrical energy simulation results at 5 minute intervals for January, monthly daily averages, and the monthly average, respectively. The total annual average output of the small PV module was slightly under 0.02 kW to provide an average total annual net production of 146 kWh (Figure 6). The simulated daily average available PV output is around 400 Wh, a useful amount of energy particularly for modern personal consumer devices requiring low-voltage DC power that have in-built storage, such as mobiles phones, laptops, and LED lighting.

The selected module angle was 20 degrees from the horizontal, the derating factor was 85%, and ground reflectance was 20%. The module 's effect of temperature was simulated with a temperature coefficient of power of -0.269% per degree Celsius, and a nominal operating cell temperature of 46 degrees Celsius, and an efficiency at STC of 6.3%. The performance of the PV module is somewhat simplified, as if the PV module continuously tracked on the horizontal axis, the resulting increase in total annual output was 164 kWh. It is common that solar driers are adjusted in this manner to obtain the maximum available beam component of the solar irradiance. However, no influence of the increased operating temperature of the module was simulated when installed as a component of the solar drier. The expected loss is expected to be within 10%, as when a consistent annual ambient temperature of 60 degrees Celsius was arbitrarily selected, the annual total module output

simulated dropped to 132 kWh from 146 kWh. Therefore, a horizontally tracked module with a higher operating temperature would produce an approximately equivalent level of output as a non-tracked module operating at ambient temperatures, although with slightly different daily output profile.

The experimental prototype drier (Figure 7) was trialled using fresh 'bird's eye' chillies yielding a visually appealing dried product within 24-36 hours (Figure 8). Maximum temperatures internal to the dryer were observed during the process to be approximately 48 degrees Celsius. The drier proved to be an effective post-harvest technology that can increase the smallholder's ability to add value to red ripe chillies that would not meet the strict standards of international export. This also enables the smallholder to effectively store their produce, rather than sell on the local market before the products spoils, and an ability to command better prices. The simple substitution of a conventional drier's glass top with a relatively inexpensive semi-transparent PV module can provide additional benefits to the smallholder in Mozambique, particularly in the majority of the country with no access to electricity. This research demonstrated that the single semi-transparent PV module output could provide sufficient electrical energy to supply an average household in rural Mozambique with their basic electrical needs. There are clear advantages for smaller, more appropriate small-scale mechanisation options that are suited to the region and the socio-economic context to increase producer productivity.

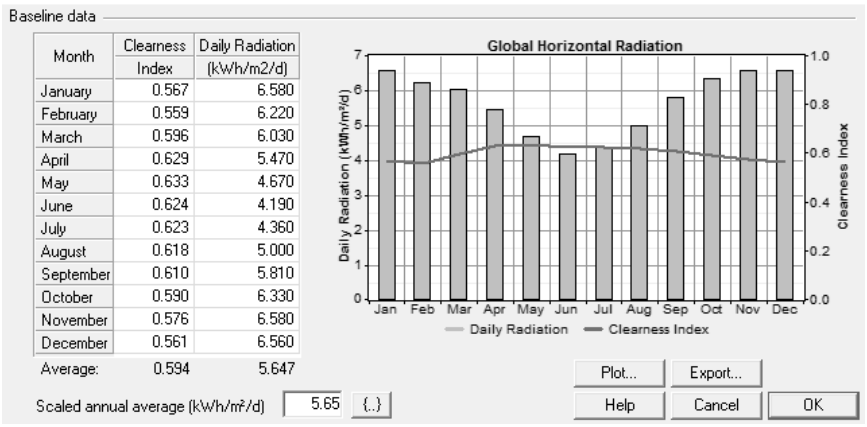

Figure 2. Chimoio's clearness index and horizontal plane solar irradiance data.

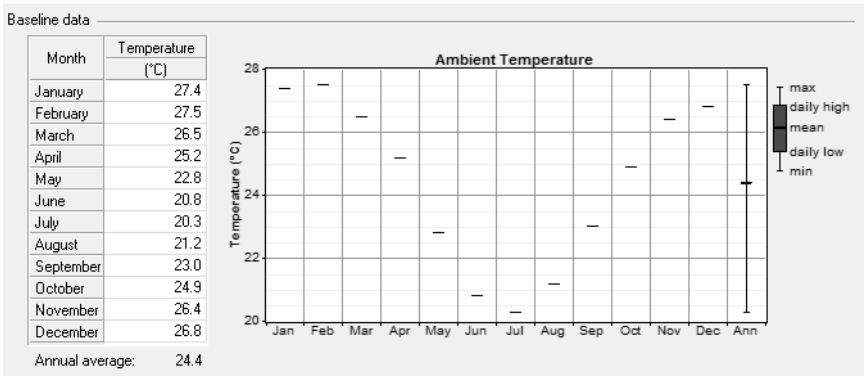

Figure 3. Chimoio's monthly average temperature data.

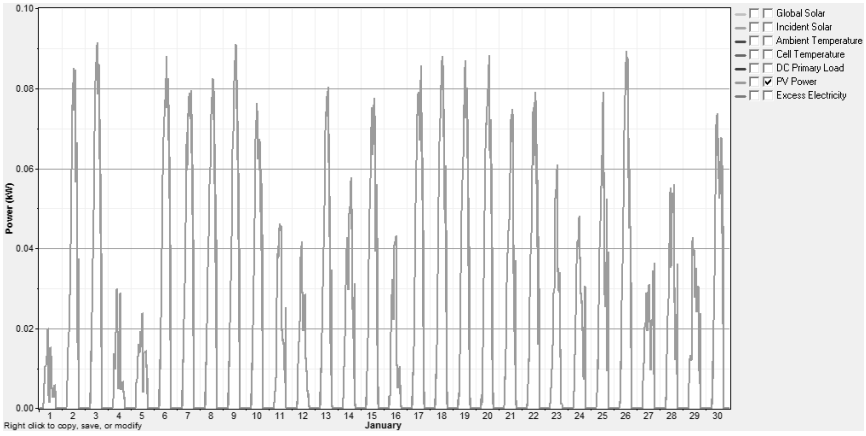

Figure 4. PV array daily simulation results for January.

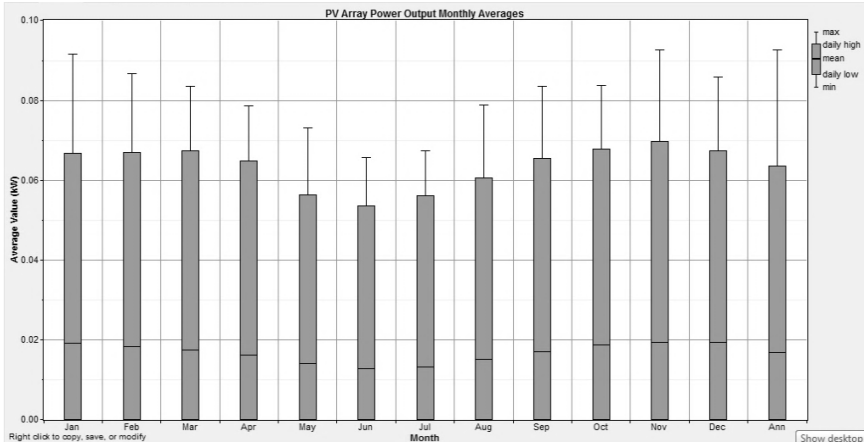

Figure 5. PV module daily max, high, mean, and low simulation results.

Cost Summary | Cash Flow | Electrical | PV | Emissions | Hourly Data

Quantity	Value	Units
Rated capacity	0.0900	kW
Mean output	0.02	kW
Mean output	0.401	kWh/d
Capacity factor	18.6	%
Total production	146	kWh/yr

Quantity	Value	Units
Minimum output	0.00	kW
Maximum output	0.09	kW
PV penetration	0.00	%
Hours of operation	4,380	hr/yr
Levelized cost	0.00	$/kWh

Figure 6. PV module simulated annual production for all intervals in the simulated year.

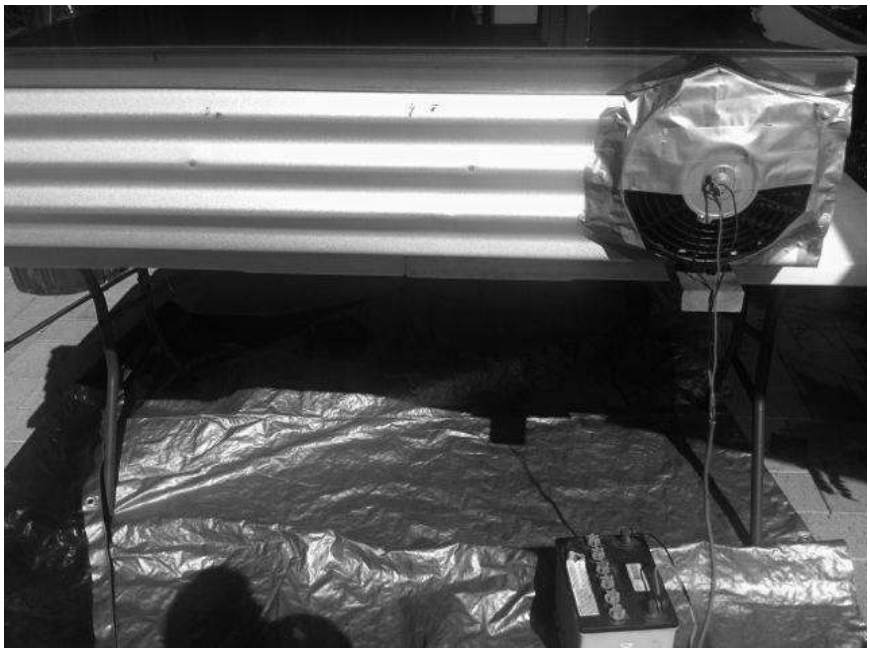

Figure 7. The solar thermal/PV chilli drier prototype.

Figure 8. Dried chillies produced in the prototype.

ROLES OF SMALLHOLDERS AND SOCIAL VENTURE CAPITAL ORGANISATIONS

There is generally a need to broker corporate, smallholder, and public partnerships, such as large buyers with small to medium enterprises (SMEs) and institutions in areas with an undeveloped commercial service sector. Social venture capital partner organisations (SVCPOs) look for strategic investments in the value chain with the aim of creating the commercial links and minimising coordination failures when they occur. There is sometimes a requirement to modify existing supply chains, to take account of how local producers can meet demand on a commercial basis. Fundamental to these activities are a detailed understanding of the incentives and constraints for each player in the supply chain, and also barriers to entry or expansion, such as public goods, infrastructure, agronomic knowledge, and post-harvest infrastructure. The active participation in a commercial supply chain is the distinction between social venture capital partner organisations, and standard social venture capital loan facilities offered by various charity or philanthropic organisations.

Smallholders and SMEs engagement with the food producing company in the Beira corridor is mediated and facilitated through a social venture capital organisation-type model. During the season, no cash outlay by the smallholder is needed, only a willingness to receive personalised training and skills, implement recommended inputs and activities based on the crop requirements and performance, and to provide the land and labour. Rather than being a passive recipient of agricultural RD&E, in the 'model farm' they become an active participant in training, generating new knowledge, analysing results, and implementing measures to ensure a good yield and produce quality as it is in their best interest. They have access to business and agronomic professionals, agricultural inputs, transport and other post-harvest technologies provided by intermediate food companies from the transparent off-take agreement, improving the probability of smallholders achieving maximum yields and receiving a net profit after input costs are subtracted. The intermediate food company can procure these inputs and expertise at scale, reducing unit costs in the area for the smallholder. Outside of the off-take agreements and income received from participating, smallholders are free to use the produced surplus, and their land for their own preferences. They are also free to not sign an off-take agreement at any subsequent time, and remain in control of their lands. A smallholders' primary risk is not being able to supply sufficient produce that meet the quality and quantity required by the off-take agreement. However, as it is in the interests of the food company and the social venture capital partner organisation to ensure that their own supply contracts and customers receive their produce, they have a vested commercial interest in ensuring smallholders produce the required quality and quantity. By maintaining good relationships and commercial interest from smallholders in a region, the food companies can expand their operations, and decrease the level of intensity of training for more experienced smallholders over time as they become more self-sufficient and commercially viable.

This new 'model farm' concept could be conceptualised as a demonstration unit operating multiple technologies and improved systems under realistic local farm management. However, the fundamental difference is this 'model farm' is managed by a private smallholder on a commercial basis through off-take agreements and/or social venture capital partner funding, without direct government subsidies/funds, and generally without traditional 'Agricultural Department' support. The commercial supply chain thus provides the

funding and capacity to increase smallholder productivity that is rarely provided by governments and aid agencies. In this model, smallholders can achieve 'best practice' production to supply international and new local food markets, and demonstrate new production systems that can be implemented locally, underpinning external increases in agricultural productivity on a commercial basis that is sustained.

ROLES OF THE INTERMEDIATE FOOD COMPANIES

The intermediate commercial food companies both create confidence in the supply chain to enable local mining procurers and subsistence producers to participate in the growing need for quality and safe food in the region that meet international standards. The intermediate food companies provide infrastructure, inputs, knowledge, technology, and support, all on a commercial contractual basis via seasonal off-take agreements with the smallholders. This allows commercial food companies to expand operations in Africa while avoiding the numerous limitations of owning/leasing and self-operating farming lands, and moves the companies towards a model where they train and support local smallholders to meet their supply contracts. An active and intensive smallholder capacity building and training program is required to become a major new element of their business, ensuring that local smallholder producers have the ability to supply commercial quality foods suitable for local and international exports. The end result is that intermediate commercial food companies will invest in developing local 'model farms' on smallholder plots that provide the companies with a balance between production flexibility and risk, and enable cost-effective rapid expansion and contraction of production to meet commercial supply contracts in a dynamic global food market.

The intermediate commercial food companies create confidence in the supply chain to enable local mining procurers and subsistence producers to participate in the growing need for quality and safe food in the region that meet international standards. The intermediate food companies provide the needed infrastructure, agronomic expertise, inputs, knowledge, technology, and support, all on a commercial contractual basis. An active and intensive smallholder capacity building and training program is required to become a major new element of their business, resulting in local 'model farms' on smallholder plots. This provides companies with a balance between production flexibility and risk, and enables cost-effective rapid expansion and contraction of production to meet their own commercial supply contracts in a dynamic global food market.

CONCLUSION

At present the primary limitation to the conversion from quasi-subsistence production to commercial production is the cost-effective use of improved technology, varieties, and inputs, and replacing manual human labour with machinery as an unaffordable cost to subsistence farmers – in a context of market oriented institutions and policies. When planning associated interventions, programs, and policies to engender such change, the entire geographical supply chain and associated entities needs to be the focus in the region. There are generally clear and

logical reasons why 'more modern' technologies and land uses do not feature in the current agricultural systems in Mozambique. Modern commercial agricultural systems, institutions, and technologies are co-dependent. For example, new high yielding farming systems generally require better land management and control, more soil moisture, moderate fertilizer, and chemical applications, reasonable growing conditions, and require a higher level of agronomic expertise to ensure high quality production at a consistent level to attract a premium price. If the yield is good, then additional processing, storage, and transport infrastructure and services are needed, and suitable customers and reliable supply contracts are necessary. In simple terms, without modern agricultural systems, institutions, and technologies, it is unlikely that commercial agricultural land uses will occur to any meaningful extent in the foreseeable future, and people will continue to depend on subsistence strategies. The question is how to attract commercial entities to invest in the region, and how local smallholders can take part in the development benefits, rather than be excluded in the transition for subsistence to commercial agricultural land uses?

The semi-structured interviews with Vanduzi, as a representative commercial food company, actively involved with smallholder farmers, demonstrates the potential commercial options to leverage agricultural capacity and productivity. Partnerships between multi-national mining companies and food companies, and the potential to engage smallholder farmers in a coordinated fashion that provide cost-competitive agricultural produce in aggregate with off-take agreements are a major development opportunity in the region. If geographically clustered smallholder farmers are supported to supply commercial qualities of produce, and are assured a premium price, food companies are able to expand production with a lower level of risk (particularly in relation to land-use and ownership associated risks). Produce unacceptable to the premium market could be sold in the local market by smallholder farmers, although the additional production investment will likely result in less than a cost-effective activity. However, when smallholders do not meet food company specifications, the authors have demonstrated it is possible to introduce effective technologies that add value to some produce, providing further opportunities to smallholders. For example, the fresh ripe chillies unsuitable for direct sale to the export market, are suitable for conventional solar drying, and subsequently can be exported or procured by large entities locally - and at a premium price to the smallholder.

The identification of suitable industry partners, intermediate commercial food companies, suitable social venture capital partner organisations, and others, is an ongoing process – and will generally be site and chain specific. The identification of suitable produce and supply chain inputs is also a fundamental activity that requires ongoing analysis. These activities include: partner communication and trust; mapping the value chains; mapping key policies and institutions; establishing the key drivers, trends and issues; exploring scenarios and their implications; and identifying and selecting smallholder producers; collating and disseminating agronomic and crop research and information, supporting local input and infrastructure customisation (including fuel supply, mechanisation, agronomy, crop establishment and post-harvest handling). The geographical concentration of economic activities along corridors such as the Beira Corridor facilitate the development of effective such chains to provide the needed catalyst for the land use change from subsistence land uses towards agricultural land intensification and diversification.

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