Assessing the Soybean Value Chain Analysis in Kenya

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List of Acronyms

amsl	Above Mean Sea Level
CARE	Cooperative For Assistance and Relief Everywhere, Inc
CIAT	International Center for Tropical Agriculture
CNFA	Citizens Network for Foreign Affairs, CNFA, Inc
CSB	Corn-Soybean Blend
FtF	Farmer to Farmer
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation - USAID)
KARI	Kenya Agriculture Research Institute
IARC	International Agriculture Research Center
ICAF	International Center for Agro-Forestry
IITA	International Institute of Tropical Agriculture
LBDA	Lake Basin Development Authority
LDC	Least Developed Country
MOA	Ministry of Agriculture
NGO	Non-Government Organization
OPV	Open Pollinated Variety
REAP	Rural Enterprise Agro-Business Project
SDA	Seventh Day Adventist
SME	Small and Medium Enterprise
TSBF	Tropical Soils Biological & Fertility Institute
USAID	United States Agency for International Development
UNICEF	United Nations Children Fund
WFP	World Food Program

Executive Summary

The soybean value chain in Kenya is being promoted in a financially suppressed economy similar to most developed countries. This is an economy in which consumer prices for goods produced in Kenya only 20 to 30% what they are in the USA while imported goods including the fuel necessary for marketing goods are at a premium to the USA prices. However, incomes are even more suppressed between the Kenya and the USA, and could be a low as one twelfth that of the USA. The result can be that many people in rural communities do not have access to as many calories as they are expected to exert in support of value chain enterprises like soybeans. Typically people only have access to about the 2000 calories they need for subsistence without being expected to do any agricultural field work. To diligently work a full day in the field they may need close to a total of 5000 calories. The limited diet can result in their only being able to work three or four hours a day. This impacts on agronomic production for all crops including any value chain enterprises like soybeans by prolonging the time it takes to complete many agronomic activities including initial land preparation. It also limits the area that farmers can cultivate and thus the soybean value chain can only be undertaken at the expense of crops already being produced, and possible force them in short supply, and the benefits of the value chain is the net difference in value between the soybeans and the crop being replaced. If the crops being replaced are also legumes, then the benefits from improved soil will be the net difference between the residual nitrogen fixed by soybeans and the legume it replaces. This analysis need to be carefully and accurately reported and not assume the soybeans are providing a full additional benefit to the farmers either financial or from improved soil fertility.

Also, with the suppressed economy there is a very limited tax base upon which the government can obtain revenues. This result is virtually all the public revenues going for contract obligations to the government officers with very little available for operating expenses of intended services, which become financially stalled. The impact on soybeans is that all the varietal improvement is done by collaborating IARC most noticeable IITA and CIAT. This has resulted in some new varieties being released but the seed multiplication, certification and distribution seems bottle up in the limited budget. It also means most of the soybeans imported from Uganda are poorly recorded so the official records maybe only a fraction of the actual imports.

There is substantial demand for approximately 100,000mt/yr and could require 50,000 ha of land or more. Virtually all of this is imported mostly from Uganda where it is stockpiled directly across the border at Busia. Other soybeans or soybean products come from Malawi, Argentina, Brazil, and India. This demand is mostly for the animal feed industry, but does include some for blending with other grains into breakfast porridge or making into CSB for relief programs associated with refugees, orphanages, hospitals and school lunch programs. Most of the commercial blends only have five to ten percent soybean, while the CBS has 20% soybean. While soybeans is often thought of as an oil crop since soy oil is the most visible consumer product, it really is not an oil crop particularly in Kenya where there is only

one company with the necessary hexane extraction equipment to effectively extract the oil. Even then the oil is more of a by-product of the feed production then a primary output. Thus virtually all soybeans produced in Kenya in the projectable future will be used whole fat, and oil, if extracted, will be a marketable by-product.

As a direct consumer crop particularly in rural areas soybeans are at best awkward. The primary reason is they don't soften upon cooking like other beans. Thus they don't easily fit into traditional dished for rural communities. Thus, the programs developed to encourage soybeans production for soil improvement and use the soybeans locally, need to be very carefully thought through. It is difficult to image they will be financially viable. The exception would be working with SDA or other communities that encourage a vegetarian lifestyle. The SDA community is large enough to encourage going into a soybean processing for direct consumption business. For others it should be considered only as a cash crop.

In producing soybeans there are a couple major concerns. First is retaining seed viability between harvest and the next planting. This has been a concern for soybeans for many years particularly in the warm low elevation tropics where they tend to be stored at ambient temperature, and the ambient temperature is warm. The easiest way to get around this is to concentrate on higher elevation above 1600 m, approximately the elevation of Meru. This could be consistent with the major soybean producing areas of Malawi and Nigeria. Unfortunately, this is away from the current primary promotions in the Rift Valley near Lake Victory. There the interest is with the LBDA and the SDA community. The other problem is developing promiscuous lines that will cross nodulate with native rhizobium. While progress is being made and nodules are forming from local rhizobium, the pinkish color in the nodules that indicate active nitrogen fixation is faint and may indicated only limited fixation. This needs to be compared with other legumes already grown and considerable less awkward for direct consumption in rural areas.

The biggest problem in developing the soybean value chain will be facilitating the marketing links between the farmers in rural areas and processors, both large and small. This really has to go through the already established commodity marketing channel through which all other commodities flow. That would include maize, rice, sorghum, beans, groundnuts, etc. At this point it might be desirable to combine the soybeans value chain with the sunflower value chain, but perhaps emphasized in different areas, with the soybeans in higher elevations to avoid the problems of seed viability and sunflower at lower elevations. It is also necessary to follow the example of other dealers and cover and support dealing in all dry goods commodities and not try and isolated on either soybeans or sunflowers. This is because the overall financial strategy of the smallholder farmers will be to retain their financial assets, which would include their cash crops, in-kind as long as possible, marketing only small quantities to meet immediate case needs. This prolongs the commodity buying season and the need to maintain and pay purchasing personnel even when handling only small amounts of a single commodity.

It may be also necessary to seek a donor funded facilitation project to implement the recommendations contained in this report for about five years. This should work mostly with KSFA to make it a financially viable organization. This should be essentially a facilitation role funded through annual dues and not get involved in business activities either providing inputs, contract tillage, or buying commodities. These should be left to the private dealers.

Assessing the Soybean Value Chain in Kenya

R.L. Tinsley[1]

Introduction

The assessment of the soybean value chain was undertaken as part of the Farmer to Farmer (FtF) program, to evaluate how to increase the soybean production in Kenya particularly among smallholder producers. The underlying assumption was that soybeans have to be an essential component of the overall cropping system in Kenya, since it is a legume that can fix nitrogen and the amino acids that make up the protein component have the best for the human diet. The insistence on soybeans is despite there already being other legumes already an established part the rural Kenya diet and could be providing the bulk of the protein in a form that is considerable easier to consume. The FtF consultancy took place between 7 November and 5 December 2009. It consisted of interviews with various individuals involved with soybeans from producers through to processors including traders and home consumers. It also involved traveling through much of Kenya including Meru in the east beside Mount Kenya and Busia in the west on the Kenya – Uganda border (Fig.1). Daily activities were recorded in a Daily Activity Log (Appendix A). The consultancy is similar to a previous consultancy done for soybeans in Malawi.[2] However, the circumstances are considerably difference as soybean production in Kenya is approximately the level of soybean production was in Malawi in the late 1980s, when the consultant was on a long term assignment with the Malawi Ministry of Agriculture (MOA) and was asked to look at the prospects for soybean production.

Overall Economic Environment

Before going into the details on the soybean value chain, it might be desirable to look at the overall economic environment of Kenya relative to the USA, how this can impact on the Soybean Value Chain, and how production and utilization of soybeans can be enhanced. The best means for doing this is reviewing the consumer food prices in Kenya compared to the USA (Table 1). This can define what might best be described as an economically suppressed economy in which consumer prices are substantially lower in Kenya than in the USA, while incomes are most likely suppressed even more than consumer prices[3]. Often incomes in developing countries are about one twelfth that of the USA. Typically this data shows for goods produced in Kenya, such as fresh fruits and vegetables, the consumer prices is only a fraction of the USA price, often in the range of 25 to 30%. Conversely for goods that need to be imported into Kenya, such as wheat flour and pasta, the price is at a premium to the USA

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[2] http://lamar.colostate.edu/~rtinsley/ValueChainAnalysisSoybeansMalawi.pdf

[3] http://lamar.colostate.edu/~rtinsley/FinancialSuppressed.htm

prices. Included in those goods imported to Kenya at a premium price to the USA is fuel, both petrol and diesel. This naturally is a major part of the marketing costs in getting goods from the smallholder producers to the retail shops for sale to the consumers.

There are several implications these consumer prices will have on the soybean value chain.

Fig. 1. Map of Kenya.

Table 1. Comparative Consumer Prices (Kenya vs. USA)

Commodity	Kenya Price (KSh)		US Price		Adjusted to US$ & Common Unit			Compar-ison Ratio
	Price	Unit	Price	Unit	Kenya	US	Unit	Ke/US
Dry Goods								
Wheat Flour	55	kg	0.33	lbs	0.75	0.73	Kg	1.03
Sugar	110	kg	0.50	lbs	1.50	1.10	Kg	1.36
Salt	25	kg	0.49	lbs	0.34	1.08	Kg	0.32
Pasta	173	kg	0.74	lbs	2.35	1.63	Kg	1.44
Rice	90	kg	0.75	lbs	1.22	1.65	Kg	0.74
Veg.Oil	170	lit	1.54	qt	2.31	1.45	lit	1.60
Tea	1	bag	0.03	bag	0.01	0.03	bag	0.43
Coffee	3,180	kg	9.98	lbs	43.27	21.96	Kg	1.97
Cowpeas	100	kg	1.29	lbs	1.36	2.84	Kg	0.48
Maize Flour	90	kg	0.89	lbs	1.22	1.96	Kg	0.63
Dry Beans	80	kg	1.72	lbs	1.09	3.78	Kg	0.29
Green Gram	100	kg	2.49	lbs	1.36	5.48	Kg	0.25
Soybean	65	kg	1.49	lbs	0.88	3.28	Kg	0.27
Groundnuts	90	kg	1.5	lbs	1.22	3.30	Kg	0.37
Dairy								
Eggs	8	ea	0.11	ea	0.11	0.11	ea	1.01
Milk (UHT)	103	lit	2.19	gal	1.40	0.58	lit	2.42
Milk (Fresh)	60	lit	2.19	gal	0.82	0.58	lit	1.41
Yogurt	146	lit	2.99	qt	1.99	2.81	lit	0.71
Meat								
Beef	240	kg	3.99	lbs	3.27	8.78	Kg	0.37
Chicken	325	kg	1.59	lbs	4.42	3.50	Kg	1.26
Goat	280	kg	3.98	lbs	3.81	8.76	Kg	0.44
Fish	200	kg	5.49	lbs	2.72	12.08	Kg	0.23
Vegetables								
Tomatoes	40	kg	3.99	lbs	0.54	8.78	Kg	0.06
Carrots	80	kg	0.60	lbs	1.09	1.32	Kg	0.83
Beans	70	kg	1.25	lbs	0.95	2.75	Kg	0.35
Onions	60	kg	0.82	lbs	0.82	1.80	Kg	0.45
Eggplant	60	kg	1.59	lbs	0.82	3.50	Kg	0.23
Potatoes	40	kg	0.25	lbs	0.54	0.55	Kg	0.99
Sweet Potatoes	29	kg	1.89	lbs	0.39	4.16	Kg	0.09
Zuccani	60	kg	0.99	lbs	0.82	2.18	Kg	0.37
Cassava	70	kg	0.99	lbs	0.95	2.18	Kg	0.44
Cabbage	40	kg	0.59	lbs	0.54	1.30	Kg	0.42
Cucumbers	50	kg	0.99	lbs	0.68	2.18	Kg	0.31
Green Pepper	70	kg	1.21	lbs	0.95	2.65	Kg	0.36
Spinish	100	kg	2.08	lbs	1.36	4.58	Kg	0.30
Fruits								
Plantain	27	kg	1.49	lbs	0.36	3.28	Kg	0.11
Bananas	115	kg	0.39	lbs	1.56	0.86	Kg	1.82
Pineapples	50	kg	1.14	lbs	0.68	0.52	Kg	1.31
Mango	60	kg	1.71	lbs	0.82	3.77	Kg	0.22
Papaya	48	kg	1.49	lbs	0.65	0.68	Kg	0.96
Other								
Gas	85	lit	2.15	gal	1.16	0.57	lit	2.03
Diesel	75	lit	2.59	gal	1.02	0.69	lit	1.49

Exchange rate US$ = KSh 73.5 Date: 24 November 2009

Business Efficiency & Profit Margins

First, the low consumer prices represent a high level of business efficiency. Since this is mostly done by the private sector, as opposed to the public sector or cooperative business, it represents a very efficient business model that can produce and deliver goods to the consumers at a fraction of the USA costs. It also means that profits are very low particularly for the farmers, and more so for farmers operating in remote areas and have to absorb the off-tarmac transport costs. This again impacts on what they can invest in producing their crops, such as fertilizer, certified seed, crop protection materials as well as contract mechanization for land preparation, and transportation costs, etc. This is all done in a highly fragmented business environment in which few enterprises are larger than what can be managed by a family. It seems that in what is basically an impoverished society, there is just too much temptation to pilferage goods, or try and include some trash such as chaff, stones, and straw with the grain in hopes the traders will not notice. Thus everything has to be closely supervised by someone with a direct vested interest in the overall profit of the enterprise; that is a family member. An important factor of a fragmented business environment is that while the number of independent enterprises encourages competition and provides the smallholder a higher price for their crops, the smaller market volume means the minimum mark-ups have to be higher for the entrepreneur to make a modest living consistent with the effort and business risks involved.

Calorie Energy Balance

Another concern would be if people, particularly those engaged in manual agriculture field work, have enough calories in their diet for the work they are expected to undertake and the energy they are expected to exert for the timely implementation of promoted value chain enterprises. Typically a healthy person requires about 2000 calories per day to sustain basic bodily functions. That would be an office worker or the proverbial couch potato. To engage in agriculture field work an individual requires anywhere from an additional 270 cal/hr for routine gardening such as weeding with a hoe, up to 340 cal/hr for heavy work like basic manual land preparation needed for crop establishment. If someone is expected to work 10 hr/day in attempting to implement many value chains recommendations as part of development projects in a sufficiently timely manner as expected and needed to take full advantage of the value chain enterprise production recommendations, they will need from 2700 to 3400 calories in addition to the 2000 cal for basic substance. This averages out to be about 5000 cal/day. That is an enormous amount of food (Fig. 2). It would require:

- 1.38 kg Maize Flour (8.33 kg cooked), or
- 1.37 kg Uncooked Rice (3.85 kg cooked), or
- 4.09 kg Plantains, or
- 3.43 kg Cassava, or
- 5.83 kg Sweet Potato, or
- 1.37 kg Wheat flour or Pasta.[4]

[4] *http://www.nal.usda.gov/fnic/foodcomp/search/*

*Fig. 2. Five thousand calories derived from 4.09 kg plantains (18 fingers), 5.83 kg Sweet potatoes (21 tube*rs), 3.34 kg cassava (10 roots), 1.37 kg or maize, rice or wheat (2 bowls *on right). Photo opportunity provided by Whole Foods Market, Fort Collins, CO, USA.*

More typically this is well beyond what most farmers or casual agriculture laborers can afford. Using the consumer prices listed above the cost for 5000 cal from the listed foods would vary from US$ 1.42 for plantains to US$ 3.41 for white potatoes (Table 2).

Table 2. Cost of 5000 Calories and Calories & Working Hours for UD$ (KSh 73.5)

Staple Food	Cost/ 5000 cal		Cal/US$ & Working Hours			
	Kgs	Cost (US$)	US$/kg	Kgs	Cal	Hour/Work
Maize Flour	1.37	1.67	1.22	0.81	2956	3.2
Rice	1.37	1.67	1.22	0.81	2956	3.2
Cassava	3.43	3.30	0.96	1.04	1516	No Work
Sweet Potato	5.83	2.27	0.39	2.56	2379	1.3
Plantains	4.09	1.47	0.36	2.77	3386	4.6
Potato	6.33	3.41	0.54	1.85	331	No Work
Pasta	1.37	3.22	2.35	0.42	1532	No Work

Work Day: If a person has an income of US$ 1.00/day, as the normal definition of poverty and spends all of it on the staple food of choice, they could purchase anywhere from 331 cal for white potatoes to 3386 cal for plantains. This would allow them to work anywhere from no work at all up to 4.6 hours, or perhaps half a day. Fortunately, casual agriculture labor in Kenya receives somewhat more than US$ 1.00/day. The best estimate was KSh 100 (US$ 1.36) for a five hour work day plus lunch. This would bring the estimated value to KSh 140 (US$ 1.90). The farmer who provided this information also pointed out that if he asked a person to work a double shift or 10 hr, they would be unable to work the following day. Perhaps this is the clearest confirmation that available dietary energy is restricting agriculture field work including the implementation of value chain enterprises.

Subsistence Stocks: It is understood and appreciated that smallholders retain considerable amount of their produce for subsistence purposes. The best estimate of this in Kenya was a farmer who retained 10 bags of maize and five bags of beans for home consumption of his family of seven persons. If each bag was 90 kg, the total would be 900 kg maize and 450 kg beans. On a per person rate this would be 129 kg of maize and 64 kg of beans per year. This converts to a daily consumption of 353 g of maize and 177 g beans which would provide 1288 cal from maize plus 614 cal from beans for a total of 1902 cal/person/day. This is slightly less than needed for basic subsistence. It is also less than the Malawi estimate made during the soybean value chain assessment of subsistence stock. The Malawi estimate was 200 kg of maize providing a diet of 547 g/day and 2030 cal/day. It is close to the Millennium

Village[5] estimate of 1.1 mt maize/family of 5.7. This comes to 192 kg/year, which equals 528 g/day and provides 1930 calories. In each case it is less than half the 5000 calories needed for a full day of diligent field work. Of course this does not represent all the calories smallholder consume, but should represent the majority of them, and even when supplemented with sweet potatoes or other foods will not come close to the 5000 calories needed for a full day of diligent field work.

This analysis only considers calories for energy and not protein or other essential vitamins and minerals needed for a balanced diet essential of good health. While most staple crops particularly the grains contain small amount of these essential nutrients, most of them are expected to be provide from other foods. These foods such as beans, vegetables and fruits tend to be more expensive then the staple energy foods and can only be obtained at the expense of calories and the energy needed for work, and therefore reduce the workable hours.

Agronomic Impact: The net result of the deficiency in calories and the restrictions that it imposes on the hours a person can be expected or requested to work is a prolongation in most agronomic activities. This is often well beyond the optimal time to take full advantage of many of the maximum yield recommendations associated with value chain enterprises. It ultimately limits the area an individual farmer or smallholder farming community can cultivate. For example, if it takes 300 person hr/ha for manual land preparation using hoes, and people can only work three or four hours a day, it will take over two months for someone to complete one hectare of the land preparation. While recommendations for value chain enterprises rarely place a maximum time for getting activities done, the basic expectation is about two weeks. If instead it takes two months it will be well outside the range when the recommended technologies are fully effective. It might be possible to consider hired labor, but the hired labor pool is frequently other farmers who, for a variety of reasons, opt for a day of causal labor for cash or kind. Thus, the use of hired labor can result in enhancing the value chain on one farm at the expense of another. Most likely it will be the smaller farmers in the community who opt for causal labor. They are the poorest of the poor and the main intended beneficiary for the value chain promotion. For a development project it is necessary to look at enhancing the economic opportunity across a community, and not individual farms at the expense of other farms.

Modify the Basic Premise: This analysis actually reverses the basic premise that has guided the agriculture development effort for the past 40 years. Most of the agriculture development effort for smallholder producers is based on the idea that the accurately observed delay in crop establishment was a deliberate strategy of risk avoidance, and smallholder farmers could easily increase their yields and improve their overall economic well-being with the operational resources already available. It would just require adapting better technology including early planting and motivation for taking more risk. This may need to be replaced with an appreciation that most smallholders are maxed out to the limit their energy will allow, and the farmers loafing around the village in the afternoon are more likely hungry and

[5] *http://www.millenniumvillages.org/index.htm*

exhausted having expended all the calories they had, rather than lazy in need of motivation. In contrast the reality may be that most smallholders are mandatory risk takers with their survival dependent upon that, as with the limited number of hours they have the energy to work, any delays severely risks their ability to produce their subsistence needs, let alone any cash crops as part of a value chain.

Access to Mechanization: One of the realistic solutions to enhancing the resources available to manage their land, expedite crop establishment, and allow more land to be cultivated is to improve the access, as opposed to ownership, of mechanization. This could easily be the underlying reason for the success of the green revolution in Asia as, concurrent with the development of high yielding rice varieties, farmers at their own expense shifted from water buffalo to power tillers. This at least halved the time for crop establishment so a greater percent of the land could be cultivated in sufficiently timely manner to take full advantage of the green revolution technology. Unfortunately, this has gone mostly unrecognized by the development community that continues to concentrate on technology and the assumption farmers have the resources to take full advantage of the technology.

The development community appears to be strangely opposed to promoting mechanization for smallholder communities considering it beyond their capacity to manage the maintenance. However, throughout the Middle East virtually all basic land preparation is done through individually owned contract tractors. This includes countries like Egypt, Pakistan, Afghanistan, and Iraq, etc. In Sub-Saharan Africa access to contract mechanization for basic land preparation is slowly becoming available to smallholder producers. As it was in Asia, this appears to all be self financed and under the radar screen of the development community. It could be a major lost opportunity for the development programs to addressing some critical needs of smallholders. In most African countries it is easily possible to get the quoted rates for contract tillage. This includes Zambia, Uganda, Malawi, Nigeria, Ghana and Kenya, all the African countries this consultant has visited with FtF programs. Most of these tractors are 65 hp units equipped with 3-bottom disc plows or simple chisel plows. The Massy-Furgerson 165 and 265 are the most popular but Fiat is also becoming common. The farmer interviewed in-depth in Meru used contract tillage to prepare some of his fields. It appears highly unlikely that any value chain enterprise including soybeans and sunflowers can be anything but an uncomfortable substitution for crops already produced unless private contract tillage is made available so farmers can expand the lands they are managing. It is also difficult to project anything but limited success in bring the Green Revolution success in Asia to Africa, unless providing access to private mechanization is included.

Public Support Services

Another impact of a financially suppressed economy is there are limited resources for providing public services including agriculture support services. If most of the population is living near the poverty line and spends well over half of their income just to feed and clothe their family, there is very little tax base for government revenue. You cannot tax basic subsistence living but only “discretionary” funds. The result is governments have limited

revenue and most of this revenue goes for contract obligations to the officers in term of salary and fringe benefits that often include housing. The result is there are very limited funds to implement programs in what might best be described as a government being financially stalled. This has nothing to do with the qualification of the officers, or their desire and motivation to accomplish their designated services. It is just there is no revenue money available to do so. For the soybean value chain this impacts on the development and dissimilation of new varieties. Kenya, in what appears to be similar conditions to other parts of Africa, is unable to directly fund the varietal improvement effort for its primary crops including soybeans. This has basically been defaulted to the collaborating International Agriculture Research Centers (IARCs). In the case of soybeans the IARC is the International Center for Tropical Agriculture (IITA) headquartered in Ibadan, Nigeria, but with a substantial presence in Kenya collaborating with the Kenya Agriculture Research Institute (KARI) as part of their outreach program. While this has resulted in the recent release of five new varieties, it is not certain if funds are available to multiple and distribute the seed to the various parties interested in producing and promoting soybeans, who can than provide the seeds to the farmers.

Also, with the limited revenues the government salaries are very low, so that frequently a professional officer might have to spend upward of 60% or more of their salaries on basic necessities. Yet they have international professional qualifications and desire for a lifestyle comparable with their international colleagues. This results in officers frequently seeking informal income opportunities and it is almost a financial necessity to do so. This can impact on a government managed programs such as seed certification that could easily be more a paper phantom program, than an effective certified seed production and distribution program in which a small gratuity will get a person the necessary certificate, without the trouble of making three field visits plus a lab analysis to confirm germination for which the government does not have the funds to conduct, and may have to depend on the patron to subsidize the inspections and analysis which is western terms creates a major conflict of interest.

Thus the seed being sold as certified seed may not have had all the inspections and tests implied by certification label, and be little better than most retained seed. Often even with well inspected certified seed it can be difficult to demonstrate a significant yield difference between retained and certified seed, particularly for self pollinated crops like soybeans. In Tanzania in a trial comparing rice seed distributed by the government sponsored management unit with that circulating between farmers in the villages failed to show and significant differences and the farmer seed actually average slightly higher yields (Table 3). In Colorado certified seed is planted on only 24 to 30% of the wheat fields and the rest is planted to retained seed.

Table 3. Yield Comparison of Project and Farmers' Seed for 3 Varieties In Madibira, Tanzania

Subarimati		**Zambia**		**IR 54**	
Source	**Yield (t/ha)**	**Source**	**Yield (t/ha)**	**Source**	**Yield (t/ha)**
Project	1.72	Project	0.61	Project	1.44
Farmer 1	2.24	Farmer 4	1.11	Farmer 7	0.97
Farmer 2	2.01	Farmer 5	1.01	Farmer 8	1.68
Farmer 3	1.56	Farmer 6	0.42	Farmer 9	2.28
Ave.	1.89	Ave.	0.79	Ave.	1.59
Std. Dev	0.57	Std. Dev	0.57	Std. Dev	0.80

Perhaps, more critical for the soybean value chain is the negotiations at the border crossing between Kenya and Uganda in which a nice gratuity will clear considerable more bags of soybeans than is officially recorded. Thus the official records of soybeans imports may have little to do with reality. Perhaps only five percent of the imports are officially recorded. Since most of the soybeans entering Kenya come from Uganda this would include the official record of soybean imports.

Climatic Considerations

Since soybeans value chain is expected to produce soybeans as a rainfed crop and this is expected to be fitted between two rainy seasons in a bi-model distribution pattern, it might be good to quickly review the overall rainfall distribution and variation. Extensive monthly rainfall data was obtained from two stations one at the Nairobi Airport and the other for Eldoret in Western Kenya (Table 4 & 5). Both locations are reasonable high elevations.

The rainfall data for Nairobi shows considerable less rain than in Eldoret, averaging only 824 mm/yr. It does show the overall bi-model rainfall pattern, but with considerable year to year variation in monthly rainfall often exceeding 100%. Thus in any give year there can be twice the average rainfall or none at all, and still be considered “normal”. For Kenya this is perhaps the most erratic rainfall for a basic agriculture climate and more consistent with nomadic herding environments. This makes it very difficult to use rainfall for detailed agriculture planning and means it is necessary more to respond to the incident rains than anticipate them. It also means there will usually be substantial lulls in the rains during the growing season that will stress the crops and reduce potential yields. As these are completely unpredictable, it will result in some very high variations in the yields between years. Thus there will always be a need for processors to have contingency plans to accommodate both major shortfalls with rapid imports and surpluses with equally exports or good storage facilities to accommodate the normal weather induced variation in potential yields.

For Eldoret the average rains are nearly 1400 mm/yr but the bi-model pattern is not as clear. The annual variation is less but still higher than the ten to fifteen percent most people expect. The minimum variation is slightly over 40% with the maximum exceeding 200%. Again this is makes it very difficult to accurately plan any cropping activity and requires farmers to mostly respond to incident rains and hoping they will continue, perhaps accompanied by some prayers to the appropriate deity of choice.

The other climatic factor is temperature. This is basically the effect of altitude with cooler temperatures as the altitude increases. For the soybean value chain this can be critical as seed viability can be greatly reduced in the warmer temperatures of the lower elevation such as the area near Lake Victory or in the Rift Valley, to six months or less and have difficulty bridging the dry season. At higher elevation such as around Meru the seed viability is considerable lesser a problem. This could result in the need to maintain seed at higher

Table 4. Monthly Variation in Precipitation for Nairobi Airport, Kenya (mm)

Year/Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1987	20	9	7	7	93	79	1	17	9	0	64	21
1988	46	2	126	224	32	53	5	4	21	46	57	88
1989	108	30	71	217	162	1	343	18	16	50	103	
1990	27	31	179	117	55					61	166	
1991	10	6	46	55		31	2	7			72	96
1992		10	8	224	16	13	36	10	0	38	79	132
1993	211	520	170	8	51	50	0	4		70		83
1994			25	163	58	36	3	24	0	73	203	35
1995	59	66	133	71	86	47	18	18	32	21	30	32
1996	37	69	56		70	59	16		2		124	
1997		0		236	163	9	121		0	80	308	185
1998	367	125	74	110	323	70	31	6	19	0	74	6
1999	1	1	123	92	3	20	4	3		38	262	95
2000	13	0	19	72	22		1	2				
2001		11	159	61	38	14	19	14	4	34		16
2002	58	15	99	152	158	0	0		55	49	115	331
2003	204	10	26	155	230	7					120	25
2006		38	125	223	98	0	0	278				
Count	13	17	17	17	17	16	16	13	11	13	14	13
Sum	1161	943	1446	2187	1658	489	600	405	158	560	1777	1145
Ave.	89.31	55.47	85.06	128.65	97.53	30.56	37.50	31.15	14.36	43.08	126.93	88.08
Std. Dev	108.22	124.20	58.57	77.68	85.17	26.27	86.81	74.50	17.14	25.38	81.09	89.83
CV (%)	121.17	223.90	68.86	60.38	87.33	85.94	231.50	239.14	119.34	58.91	63.88	102.00
	Ave. Total Annual Rainfall					**828**						

Table 5. Monthly Variation in Precipitation for Eldoret, Kenya (mm)

Year/Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1987	61	67	72	118	273	150	61	155	20	39	130	3
1988	46	9	36	192	41	146	170	108	134	59	25	16
1989	15	46	121	159	152	101	207	126	110	59	41	116
1990	45	156	66	128	122	220	617		880	21	620	
1991	38		129		490	162		193				160
1992	30		13	178	87	100	180	245	96	128	39	12
1993	63	68		24	111	810	97	97	79	140	40	160
1994			96		10	142	23		25	140	100	50
1995	0	36	850	193	54	67	167	142	60	85	70	23
1996	27	55	180	59	77	145	247		70	9		
1997		0		285	25	152	175		1	157	177	65
1998	231	91	37	74	130	179	321	236	95	101	32	1
1999	38	0	183	109	57	68	192	129	33	197	39	293
2000	5	3	14	39								9
2001	126	2	79	154	77	143	147	234	234	106	65	0
2002	43	30	39	88	182	37	96		2	64		175
2003	3	2	47	238	170	103					8	42
2004		3							96	54		
2005				61							11	
2006		46	106	108	77	64	129	288	113			
Count	15	16	16	17	17	17	15	11	16	15	14	15
Sum	771	614	2068	2207	2135	2789	2829	1953	2048	1359	1397	1125
Ave.	51.40	38.38	129.25	129.82	125.59	164.06	188.60	177.55	128.00	90.60	99.79	75.00
Std. Dev	60.74	43.80	205.61	74.10	111.53	178.69	139.89	67.61	214.09	53.88	163.18	88.02
CV (%)	118.18	114.13	159.08	57.08	88.80	108.92	74.17	38.08	167.26	59.47	163.53	117.36
	Ave. Total Annual Rainfall					**1398**						

elevations and move it quickly to lower elevations just before the anticipated planting season. This would be a logistical challenge, but is what is done for 85% of Thailand's soybean crop, thus ultimately doable. It will require some extensive facilitation before becoming self sustainable. However, while getting soybeans established as crop in Kenya it might be best to concentrate the effort in areas above 1600 m. That should be high enough to eliminate the seed viability issue.

Soybean Value Chain

The soybean value chain analysis is a holistic evaluation of soybeans from the producer to the consumer or at least as far up that value chain as smallholder producers have any vested interest. This is usually only one or two steps up the value chain represented by clean cash sales, and not consigned sale. The intention is to increase the economic opportunity for the smallholder producer in terms of enhanced income from a cash crop or improved diet and a healthier lifestyle.

Soybeans

Soybeans are a major legume crop worldwide that has been grown for thousands of years originating in Asia. As a legume crop it has the potential for fixing nitrogen from the atmosphere but the rhizobium that fixes the nitrogen is normally specific to soybean and historically it has not cross inoculated with native rhizobium as other tropical legumes will. It does have the highest protein content of all legumes with close to 40% compared to about 20% for other legumes commonly grown in Kenya. Soybeans have less carbohydrate, but more total energy than other legumes commonly grown in Kenya, mostly as a result of the oil content. It also has the most balanced amino acids relative to the human diet needs (Table 6).

Table. 6. Comparison of Nutrition for Soybeans, Beans, Cowpeas and Pigeon Peas

Nutrient	Units	Value per 100 grams			
		Soybean	Beans	Cowpeas	Pigeon Peas
Proximates					
Water	g	8.54	11.75	11.95	10.59
Energy	kcal	446	333	336	343
Protein	g	36.49	23.58	23.52	21.70
Total lipid (fat)	g	19.94	0.83	1.26	1.49
Ash	g	4.87	3.83	3.24	3.45
Carbohydrate,	g	30.16	60.01	60.03	62.78
Fiber, total dietary	g	9.30	24.90	10.60	15.00
Sugars, total	g	7.33	2.23	6.90	
Minerals					
Calcium, Ca	mg	277	143	110	130
Iron, Fe	mg	15.70	8.20	8.27	5.23
Magnesium, Mg	mg	280	140	184	183
Phosphorus, P	mg	704	407	424	367
Potassium, K	mg	1797	1406	1112	1392
Sodium, Na	mg	2.00	24.00	16.00	17.00
Zinc, Zn	mg	4.89	2.79	3.37	2.76
Copper, Cu	mg	1.66	0.96	0.85	1.06

Table. 6. Comparison of Nutrition for Soybeans, Beans, Cowpeas and Pigeon Peas (Cont.)

Nutrient	Units	Value per 100 grams			
		Soybean	Beans	Cowpeas	Pigeon Peas
Manganese, Mn	mg	2.52	1.02	1.53	1.79
Selenium, Se	mcg	17.80	3.20	9.00	8.20
Vitamins					
Vitamin C,	mg	6.00	4.50	1.50	0.00
Thiamin	mg	0.87	0.53	0.85	0.64
Riboflavin	mg	0.87	0.22	0.23	0.19
Niacin	mg	1.62	2.06	2.08	2.97
Pantothenic acid	mg	0.79	0.78	1.50	1.27
Vitamin B-6	mg	0.38	0.40	0.36	0.28
Folate, total	mcg	375	394	633	456
Choline, total	mg	115.90		94.70	
Vitamin A, RAE	mcg_RAE	1.00	0.00	3.00	1.00
Carotene, beta	mcg	13.00	0.00	30.00	
Vitamin A, IU	IU	22.00	0.00	50.00	28.00
Vitamin E	mg	0.85	0.22	0.39	
Vitamin K)	mcg	47.00	19.00	5.00	
Lipids					
Fatty acids, total saturated	g	2.88	0.12	0.33	0.33
Fatty acids, total monounsaturated	g	4.40	0.06	0.11	0.01
Fatty acids, total polyunsaturated	g	11.26	0.46	0.54	0.81
Amino acids					
Tryptophan	g	0.59	0.28	0.29	0.21
Threonine	g	1.77	0.99	0.90	0.77
Isoleucine	g	1.97	1.04	0.96	0.79
Leucine	g	3.31	1.88	1.80	1.55
Lysine	g	2.71	1.62	1.59	1.52
Methionine	g	0.55	0.36	0.34	0.24
Cystine	g	0.66	0.26	0.26	0.25
Phenylalanine	g	2.12	1.28	1.37	1.86
Tyrosine	g	1.54	0.66	0.76	0.54
Valine	g	2.03	1.23	1.12	0.94
Arginine	g	3.15	1.46	1.63	1.30
Histidine	g	1.10	0.66	0.73	0.77
Alanine	g	1.92	0.99	1.07	0.97
Aspartic acid	g	5.11	2.85	2.84	2.15
Glutamic acid	g	7.87	3.60	4.45	5.03
Glycine	g	1.88	0.92	0.97	0.80
Proline	g	2.38	1.00	1.06	0.96

In addition soybeans contain only about 20% oil that can be extracted, and is often considered as an oil crop. However, since the physical extrusion of oil leaves 10% oil in the cake or 50% of the total, oil is normally not done by simple extruding. When oil is recovered it is usually done by a much more complicated hexane dissolution process. This requires a closed pressure chamber and the highly volatile hexane, this is chemically similar to propane, often used as a cooking gas, or octane that is usually associated with petrol. It is thus a fairly dangerous

process. In Kenya only BITCO has the facilities for hexane extraction of soybean oil, and they may have inherited the facility from Unilever when they took over their plant, rather than actually purchased and installed. As an oil, soy oil is fairly high quality with only 15% saturated fat, the undesirable form of oil (Table 7). This makes it not as good as sunflower but on par with corn and olive oil.

Table 7. The fat composition in different vegetable and animal oils

Type of Oil	Cholesterol, mg/10 ml	Saturated Fat, %	Poly-unsaturated Fat, %	Mono-unsaturated Fat, %
Vegetable Oil				
Soybean	**0**	15	61	24
Sunflower	0	11	69	20
Corn	0	14	61	25
Olive	0	14	9	77
Rice bran	0	18	45	34
Groundnut	0	18	34	48
Cottonseed	0	27	54	19
Palm	0	52	9	39
Coconut	0	92	2	6
Animal Oil				
Lard	13	41	12	47
Beef Tallow	15	52	4	44
Butterfat	36	66	4	30

Because of the problems in extracting oil from soybeans, most of the soybeans produced or imported in Kenya will be processed whole fat, and perhaps it should not really be considered an oil crop in Kenya, but definitely an industrial crop. When soybeans is defatted and the oil extracted it is more associated with the recovery of the protein than the oil, and the desire to extend the shelf life of the meal as the oil can become rancid and reduce the overall shelf life of the meal. In this case the soy oil is simply a by-product. This is true even for BITCO, although they are marketing soy oil and the only company doing so. However, they only extract the soy oil to manufacture the fully defatted soymeal for the feed industry. Currently the health conscious people in the USA are shying away from soy oil in favor of Safflower, Canola (rapeseed), or sunflower oil. A large percent of the soybean oil in the USA is going to bio-diesel instead of consumption. What soy oil is marketed to consumers as edible oil is marketed as generic vegetable oil at the lowest price.

Awkward Consumer Crop: Unfortunately, compared to other legume crops, soybeans is awkward crop for direct home consumption for rural smallholder communities in Kenya. It requires extra processing including the need for some cooking to deactivate the trypsin inhibitor enzyme[6], and an appreciation for new types of food. One problem repeated brought to the attention of the consultant was that soybeans will not soften when cooked like the other bean commonly grown and directly consumed in rural Kenya.

Industrial Crop: Thus the vast majority of soybean production worldwide goes for industrial use, mostly in the animal feed industry. This includes Kenya. There is some demand for

[6] Trypsin inhibitors are chemicals that reduce the availability of trypsin, an enzyme essential to nutrition of people as well as many animals.

soybean enriched ugali by the World Food Programs (WFP) for use in refugee camps, hospital, orphanages and school lunch programs. These are basically serving a captive audience. Apparently, with a 20% blend of soybean in enriched ugali, the texture is sufficiently modified to prevent the normal rolling into a ball between the fingers, but requires some utensils to consume. There is a little being used for blending with other grains mostly millets and sorghum for breakfast porridge, and there is some being heavily promoted for local consumption as milk and soy meat, but the promotion is more for soil enrichment from the potential for N-fixation, and the community based consumption business may need some substantial review and adjustments to become commercially viable and sustainable.

Soybean Products

Soybeans are used in several different products that can best be divided as industrial products and consumer products.

Industrial Products: The primary industrial products will be:

- The whole bean as the raw material.
- Soybean cake if the oil has been physically extruded leaving 10% oil in the cake. This could have a reduced shelf life due to the oil become rancid.
- Soybean meal if all the oil has been extruded, this will be more stable than soybean cake, with higher protein content.
- Soybean flour if it has been extruded and then ground into flour. Most often in Kenya this will be full fat, and again could have a limited shelf life due to rancidity.
- Soybean oil, which is marketable consumer product that is more by-product of the soybean meal process than a deliberate effort to manufacture editable vegetable oil.

Consumer Products: The consumer products normally associated with soybeans are:

- The whole bean for those wishing to process them for themselves including heating to deactivate the trypsin inhibitor.
- Milk derived from grinding and boiling the soybeans before removing the solid matter.
- Yogurt made from culturing the milk with selected bacteria.
- Tofu made by acidifying the soymilk with $CaSO_4$ or $MgSO_4$ or lime juice, and then letting the curd settle out under light pressure. This is not currently available in Kenya.
- Soymeat also known as texturized vegetable protein is just grinding and cooking or extruding the soybean without removing the fat.
- Roasted soybeans as a snack.
- Soybean Coffee

The nutritional values of these products are shown in Table 8 for those products for which nutritional data is available from the United States Department of Agriculture (USDA) nutritional website[7] and as the product is used in the USA. Of all of these, the only one not available in Kenya is tofu. This maybe something that should be considered, particularly by the vegetarian communities such as the Seventh Day Adventists (SDA). The nutritional information shows the concentration of protein in the beans, meal, and soymeat, although the soymeat in the USA appears to have considerable amount of water added, that most likely is not the case in the examples visited. The added water makes the soymeat consistent with ground beef which it considered to be substituting for. The milk, yogurt and tofu all show the impact of the water added after grinding, although the tofu shows some consolidation as the milk is partly dewatered in the tofu making process. The milk comes out with about half the fat of regular milk, a product marketed in the USA as 2% milk. There seems to be a lot of potassium in soybeans and all the products. The soy oil appears stripped of all nutrient values except the fat.

Table. 8. Comparison of Nutrition for Various Soybean Products

		Value per 100 grams							
Nutrient	**Units**	**Soybean**	**Meal**	**Roasted Soybean**	**Soy Meat**	**Oil**	**Soy-milk**	**Soy yogurt**	**Tofu**
Proximates									
Water	g	8.54	6.94	0.8	61.21	0	91.53	84.67	84.55
Energy	kcal	446	339	451	177	884	41	66	76
Protein	g	36.49	44.95	39.58	15.7	0	2.88	2.64	8.08
Total lipid (fat)	g	19.94	2.39	21.62	6.3	100	1.65	1.76	4.78
Ash	g	4.87	5.58	5.28	2.52	0	0.65	1.24	0.72
Carbohydrate	g	30.16	40.14	32.72	14.27	0	3.29	9.69	1.88
Fiber, total	g	9.3		8.1	4.9	0	0.4	0.4	0.3
Sugars, total	g	7.33			1.07	0	2.47	5.29	
Minerals									
Calcium, Ca	mg	277	244	140	136	0	123	132	350
Iron, Fe	mg	15.7	13.7	3.95	2.41	0.05	0.44		5.36
Magnesium, Mg	mg	280	306	228	56	0	16		30
Phosphorus, P	mg	704	701	649	206	0			97
Potassium, K	mg	1797	2490	1364	333	0	123		121
Sodium, Na	mg	2	3	2	569	0	49		7
Zinc, Zn	mg	4.89	5.06	4.77	1.26	0.01	0.25		0.8
Copper, Cu	mg	1.66	2	1.08	0.2	0			0.19
Manganese, Mn	mg	2.52	3.8	2.18	0.95	0			0.61
Selenium, Se	mcg	17.8	3.3	19.3	22.6	0	2.3		8.9
Vitamins									
Vitamin C	mg	6	0	4.6	4.5	0	0	13.2	0.1
Thiamin	mg	0.87	0.69	0.43	2.65	0			0.08
Riboflavin	mg	0.87	0.25	0.76	0.24	0	0.21		0.05
Niacin	mg	1.62	2.59	1.06	3.75	0			0.2
Pantothenic acid	mg	0.79	1.98	0.47	0.29	0			0.07
Vitamin B-6	mg	0.38	0.57	0.23	0.30	0			0.05
Folate, total	mcg	375	303	21	124	0	10		15
Choline, total	mg	115			19.4	0.2			
Vitamin A, RAE	mcg_RAE	1	2		6.1	0			
Carotene, beta	mcg	13	0		2.01	0			
Vitamin A, IU	IU	22	40	0	16	0	206	0	85

[7] *http://www.nal.usda.gov/fnic/foodcomp/search/*

Table. 8. Comparison of Nutrition for Various Soybean Products (Cont.)

Nutrient	Units	Value per 100 grams							
		Soybean	Meal	Roasted Soybean	Soy Meat	Oil	Soy-milk	Soy yogurt	Tofu
Vitamin E	mg	0.85			0	0			
Vitamin K	mcg	47		37	4.2				
Lipids									
Fatty acids, total saturated	g	2.88	0.27	3.13	1.44	15.65	0.21	0.22	0.69
Fatty acids, total mono-unsaturated	g	4.4	0.41	4.78	1.78	22.78	0		1.06
Fatty acids, total poly-unsaturated	g	11.26	1.05	12.21	2.02	57.74			2.7
Amino acids									
Tryptophan	g	0.59	0.65	0.58	0.16	0			0.13
Threonine	g	1.77	1.95	1.72	0.61	0			0.33
Isoleucine	g	1.97	2.18	1.9	0.78	0			0.4
Leucine	g	3.31	3.66	3.22	1.40	0			0.61
Lysine	g	2.71	2.99	2.63	1.00	0			0.53
Methionine	g	0.55	0.61	0.53	0.29	0			0.1
Cystine	g	0.66	0.72	0.64	0.26	0			0.11
Phenylalanine	g	2.12	2.35	2.07	0.89	0			0.39
Tyrosine	g	1.54	1.7	1.5	0.652	0			0.27
Valine	g	2.03	2.24	1.98	0.89	0			0.41
Arginine	g	3.15	3.49	3.07	1.05	0			0.54
Histidine	g	1.1	1.21	1.07	0.47	0			0.24
Alanine	g	1.92	2.12	1.87	0.73	0			0.33
Aspartic acid	g	5.11	5.65	4.98	1.55	0			0.89
Glutamic acid	g	7.87	8.71	7.67	4.09	0			1.4
Glycine	g	1.88	2.08	1.8	0.66	0			0.32
Proline	g	2.38	2.63	2.32	1.30	0			0.44
Serine	g	2.36	2.61	2.29	0.97	0			0.38

Consumption In The USA: One thing that may need to be considered in promoting the soybean value chain as a donor initiative is to compare the projected soybean use in Kenya with that in the USA to see if the donors are promoting and imposing on a developing country in excess of the use in the donor country. In the USA direct consumption of soybeans is mostly in the form of soymilk, which seems to be gaining in popularity. The next would be tofu. This may have initially been concentrated in the East Asian, but is slowly spreading to the entire society regardless of ethnic background. Soybean flour is available but only at specialty stores. The texturized vegetable protein is not very popular and is difficult to find in the market, it usually is referred to as veggie burgers emphasizing the substitution for ground beef. The roasted soybeans are reasonable available as a snack. However, the coffee is very difficult to find as are the whole beans. Groceries stores may be reluctant to carry unprocessed soybeans because of the problems with the trypsin inhibitors, etc., and the liability of any one getting sick. The relative costs of these products between Kenya and the USA is shown in Table 9. Again the price difference between Kenya and the USA is easily noted.

Table 9. Comparative Consumer Prices for Soybean Products (Kenya vs. USA)

Commodity	Kenya Price (KSh)		US Price		Adjusted to US$ & Common Unit			Compar-ison Ratio
	Price	Unit	Price	Unit	Kenya	US	Unit	Ke/US
Coffee	3,180	kg	9.98	lbs	43.27	21.96	Kg	1.97
SoyCoffee	545	kg	Not Available		7.41			
Soybean	65	kg	1.49	lbs	0.88	3.28	Kg	0.27
Soy flour			5.69	lbs		12.52		
Soy Meat			4.56	lbs				
Ground beef	240	kg	1.60	lb	3.27	3.53	kg	0.93
Tofu	Not available		2.27	lbs				
Milk (Fresh)	60	lit	2.19	gal	0.82	0.58	lit	1.41
Milk Soya	60	lit	2.5	qt				
Yogurt	146	lit	2.99	qt	1.99	2.81	lit	0.71
Soy Yogurt	40	lit	1.5	qt	0.54	1.41	lit	0.39

Most of the USA consumption is from a niche market of health conscious individuals trying to minimize the animal products they are consuming particularly cholesterol. This is in an economy and society in which the health concerns are mostly obesity and people are accumulating cholesterol and other undesirable elements in their diet. This could be in mark contrast to the economic and social conditions of Kenya were many people, particularly those in rural areas may not be getting enough energy to eat, and are going to digest many of the cholesterol and other concerns of the western over indulgences. In this case the soybean are mostly substituting for milk, yogurt and ground beef. Thus it might be desirable to make a quick nutritional comparison between the soy product and what it is replacing (Table 10). This quickly shows that in major nutrient terms the soymilk is very similar in terms of protein, fat, etc. to milk with half the butter fat removed. The same also goes from the soymeat compared with ground beef. In both cases there is little or no cholesterol in the soy products, a concern to the west that may be much less a concern to Africa. Also, since the soybean products are purely vegetable products that did not have to go through the rather inefficient conversion to animal products, they should be cheaper than comparative animal product, but unfortunately they appear not to be.

Demand for Soybeans in Kenya

In Kenya there is substantial demand for soybeans or soybean products that could amount to some 100,000 mt/year or more and at an optimistic estimated yield of 2/mt/ha represent some 50,000 ha or more of cultivated area or the intercropped equivalent. This is mostly for industrial use going into animal feeds, as well as institutional human consumption. There is some but limited demand on the open market, either for commercial processing in which soybeans are a minor component blended with other ingredients to make breakfast porridge or whole beans sales. Virtually all the demand is met with imported soybeans, mostly from Uganda where soybeans are stocked piled just across the border at Busia. Additional soybeans are coming from Malawi or imported all the way from Argentina and Brazil. The big consumers are Soy Africa Ltd., which has a demand of some 6000 mt/yr. They basically

Table 10. Nutritional Values for Soy Products and What They Substitute For

Nutrient	Units	Value/100g						
		Soy milk	Whole Milk	2% fat milk	Soy yogurt	Yogurt	Soy meat	Ground beef
Proximates								
Water	g	91.53	88.13	89.21	84.67	87.9	61.21	61.94
Energy	kcal	41	61	50	66	61	177	254
Protein	g	2.88	3.15	3.3	2.64	3.47	15.7	17.17
Total lipid (fat)	g	1.65	3.25	1.98	1.76	3.25	6.3	20
Ash	g	0.65	0.67	0.71	1.24	0.72	2.52	0.84
Carbohydrate,	g	3.29	4.8	4.8	9.69	4.66	14.27	0
Fiber, total dietary	g	0.4	0	0	0.4	0	4.9	0
Sugars, total	g	2.47	5.26	5.06	5.29	4.66	1.07	0
Minerals								
Calcium, Ca	mg	123	113	120	132	121	136	18
Iron, Fe	mg	0.44	0.03	0.02		0.05	2.41	1.94
Magnesium, Mg	mg	16	10	11		12	56	17
Phosphorus	mg		84	92		95	206	158
Potassium, K	mg	123	132	140		155	333	270
Sodium, Na	mg	49	43	47	13	46	569	67
Zinc, Zn	mg	0.25	0.37	0.48		0.59	1.26	4.18
Selenium, Se	mcg	2.3	3.7	2.5		2.2	22.6	15
Vitamins								
Vitamin C,	mg	0	0	0.2	13.2	0.5	4.5	0
Riboflavin	mg	0.21	0.17	0.19		0.14	0.24	0.148
Folate, total	mcg	10	5	5		7	124	7
Folate, food	mcg	10	5	0.53		7	124	7
Vitamin B-12	mcg	1.23	0.45	0		0.37	2.01	2.14
Vitamin A, IU	IU	206	162	102	0	99	16	0
Vitamin D (D2 + D3)	mcg	1.2	1.3	0	1.3	0.1	0	0.1
Vitamin D	IU	49	51	1	53	2	0	5
Lipids								
Fatty acids, total saturated	g	0.21	1.87	1.26	0.22	2.10	1.44	7.67
Cholesterol	mg	0	10	8	0	13	5	71

blend it with maize or other grains, and extrude the blend which provides enough heat to deactivate of the trypsin inhibitor (Fig. 3). They then grind the blend into flour. The maize-soybean blend (CSB[8]) is 80% maize and 20% soybean. This then goes into the relief program or school lunch programs via different NGOs including the WFP and United Nations Children's Fund (UNICEF). However, for UNICEF they add some additional sugar for the children. They also manufacture some other blends with soybeans that are openly marketed through the supermarkets. These are mostly blends with millet and sorghum and used for breakfast porridge (Fig. 4). Maize is not included in these blends. They also supply extruded soybean maize blend to Nestlé's for making a cornflake type breakfast cereal marketed under the name CereVita (Fig. 5). However, surprisingly Nestlé's does not market a baby formula containing soybean as they commonly do in other African countries.

[8] CSB means Corn Soy Blend using the American term corn for maize.

Soy Africa purchases their entire soybeans from brokers importing soybeans mostly from Uganda with some coming from Malawi. They need full truckloads with a minimum of 10 mt being delivered at any time, although a truck can be mixed between soybeans and maize or other commodities they need.

Fig. 3. Extruding a Blend of Soybeans and Maize, while also Generating Enough Heat to Deactivate the Trypsin Inhibitator

Fig. 4. Soy Africa's Commercial Products Containing Soybean Porridge Blends And Sold in Most Super Markets

Fig. 5. Nestlé's CereVita Cereal Made from a Blend of Maize and Soybeans

The WFP also has a major demand for the CSB. They need some 30,000 mt/yr of which about 50% is an in-kind contribution from the USA. They are willing to purchase the remaining 15,000 mt locally but are experiencing problems with the bid costs and it is cheaper for them to import from either Europe or South Africa. Hopefully they can work out the contract problems and can shortly buy more locally, but currently this will still be imported soybeans and not impact on the agriculture economy of Kenya. The WFP major use is for charity in terms of refugees, orphanages, hospitals and school lunch program. These are all captive audiences for whom the concern is improved nutrition at the cheapest cost, with little concern for favor or texture, or consumer preferences.

Another major user of soybean products is UNGA. They are the largest animal feed producer in the country with a capacity of some 8000 mt/mo of feed working 24 hr/day. This includes some 42 mt of soybean products each month. They use mostly soybean meal, which is the fully defatted soybean after the hexane oil extraction. This is mostly from India but do get some from BIDCO when it is available. They can also use soybean cake, which has been extruded with 50% of the oil removed and 50% remaining or 10% of the cake being oil. The problem with this much oil is the shelf life as oil can become rancid. They also use sunflower cake and cottonseed cake. Even if they remove all the oil, they then have to reintroduce some to bring the energy portion of the ration up to standard. They prefer protein derived from soybeans over other sources because the amino acid balance is almost as good as for

fishmeal. They do use fishmeal when possible but only in limited quantities as anything above 5% of the ration leaves a distinct and distasteful flavor in the final consumer product.

The only other potential major processor visited was BIDCO in Nukura. However, they were actually more interested in sunflower than soybeans, as sunflowers have more oil and of better quality than soybeans. Thus most of the discussion with BIDCO centered on sunflowers or became comingled with sunflowers so it was not always clear if the discussion was sunflowers or soybeans. They did process some soybeans imported from Uganda, but this was mostly to get the meal for sale to UNGA. There are other major soybean processors, but they were not visited.

One small to medium enterprise (SME) processor was visited. This was Nubian Food Industries in Meru. They were in the business of blending various grains into different porridges, used for breakfast. They did include soybeans in some of their products. This was mostly a blend of sorghum, finger millet, bulrush millet and soybeans (Fig. 6). Soybean was the minor component. They have a demand for only12 mt/year, which they purchased from brokers in town who brought the beans in from Nairobi, but most likely being imported from Uganda. They were unaware that some soybean was being produced not far from Meru that was in need of a market. This could be a very simple cell phone facilitation link. It may be desirable to take a closer look at these small processors as good initial market links while the production is increasing and there is not sufficient volume to meet the major processors needs for full lorries.

Fig.6. Soybean containing porridge flour produced by Nubian Food Industries in Meru.

In addition there is some limited open market sales of soybeans as unprocessed beans. In most markets visited the grain and bean commodity dealers were holding a bag of soybeans (Fig. 7) but they were the slowest moving of any commodity they were dealing with. Typically it would take up to two months to sell a 90 kg bag of soybeans. Most of these sales were in the quarter tin amounts which would be less than a kilogram. It was suspected that most of this went to consumers who were interested in roasting and grinding for coffee, or including in some form of homemade porridge.

Fig. 7. Commodity retail dealer holding a bag of soybeans that could take one or two months to sell.

Finally there might be what can best be called the promotional demand. This is a demand created by those promoting the production of soybeans for soil enrichment and then the direct processing and marketing within a community. Four locations were visited. The emphasis was mostly processing into milk, the by-products of the milk, roasted soybeans, and soybean meat, usually referred to as "texturized vegetable protein". At present it is really creating only a limited demand with some major concerns for the financial viability of the business models being used.

Producing Soybeans – Initial Consideration

From the perspective of the climate in Kenya there is nothing apparent that would prevent soybeans from being widely produced. It is grown in similar climates and neighboring countries with little difficulty. Thus while there are some substantial issues with the agronomic production of soybean these have been overcome in neighboring countries and could be overcome in Kenya. Thus the biggest problems with producing soybeans are more social and economic than agronomic.

Awkward Consumer Crop: Perhaps the biggest problem in producing soybeans is that it is an awkward crop for direct consumption particularly for potential producers. Yes, soybeans are a more nutritious bean crop than other beans such as plain beans, cowpeas, groundnuts and pigeon peas that are already well accepted by the smallholders, and much easier to include in the diet. Thus while they can easily substituted for land use, they are not as easily to substitute in the diet. This is primarily because they do not soften when cooked like other beans do and thus cannot be used in the ordinary way Kenyan farmers incorporate beans in their diet, and could be a source of most of the protein they consume. In contrast soybeans have to be roasted or ground up before consumption.

Substitution Crop: Also, since there are no provisions to enhance the resources farmers have to manage their lands producing soybeans can only be done as a substitution for a crop already being grown. These results in the net value of the value chain enterprise such as soybeans can only be the difference between the value chain crop and the one it is replacing, and needs to be accurately reported. It also means that value chain crop is replacing a well established crop, which, if that is a legume such as beans or groundnuts, you are asking the farmers to substitute an easy to consume crop with one that is awkward and accept the risk of not being able to use the crop. Also, soybeans are an internationally traded industrial crop, so Kenyan production has to compete with the imported soybeans that could be grown on large scale farms in countries like Brazil, Argentina and the USA. This could easily be imported into Kenya at a lower price then smallholder producers can afford to sell their soybeans. Currently the soybeans being imported from Uganda are only 50% of what the Kenya farmer want to sell for and what they can earn from beans and groundnuts. If that is the case, soybeans will have a difficult time competing just financially and as a cash crop that is the biggest determinant to the producers.

Also, if soybeans are promoted for the potential of enhancing soil fertility from the nitrogen fixation as TSBF is aggressively doing, but are replacing another legume then the effectiveness of soybeans to enhance soil fertility would be the difference in potential nitrogen fixation between soybeans and the legume it is replacing. If the soybeans are not inoculated with proper rhizobium, but relying on promiscuous lines that are only weakly fixing Nitrogen as may be indicated by the weak pink color in the nodules, the fertility enhancement could actually be negative. This really needs to be investigated in more detail.

Again, if the soybean are substituting for an already established crop, the wide spread acceptance of soybean as a cash crop could force the substituted crop into short supply and drive the price of it out of range of most consumers. In order to avoid putting other crops into short supply, it might be necessary to carefully look at how the enhance the resources farmers have available to manage their lands so they can expand the land they are cultivation and thus the soybeans can be a completely new or expanded enterprise, and not a substituted enterprise. This ultimately means making contract mechanization for land preparation readily available. This assumes that land is available within the community and the cultivation is restricted by the limited caloric energy of the farmers as discussed at the beginning of this article, and not by the availability of land to cultivate. It was noted that the farmer interviewed in-depth in Meru contracted a tractor for basic land preparation of most of his fields.

Mostly Cash Crop: Thus soybeans will most likely be strictly a cash crop flowing into the normal commodity marketing channel. However, since it most likely will have limited direct village level consumption, it will be more vulnerable to exploitation by brokers and traders than crops like maize, beans, and groundnuts that can be both a cash and subsistence crop. Thus to be successful as a cash crop it will be necessary to have a completely competitive marketing channel from the remote off-tarmac areas to the brokers who can bulk sufficient quantities to deliver full truck loads to the large scale processors. The same will be true for the sunflower value chain.

Producing Soybean – Variety and Seed Concerns

Improved Varieties: There are several basic production factors that need careful attention with promoting increased soybeans production. First is the availability of seed of appropriate varieties. The variety differences in soybeans are mostly associated with physiology and morphology in terms of height, maturity and shade tolerance. In addition for Kenya and other developing counties there is a concern for promiscuous of inoculums with native rhizobium. There is little concern with grain quality as there is not that much difference between varieties and the processors are not concern with the variety being delivered. This is considerable different from crops like rice where grain quality is a major concern to the consumers.

In Kenya there are several varieties recommended by KARI. These were mostly developed in collaboration with IITA and their Kenya outreach team. As an IARC collaborating with a

host country the IITA soybean breeders have to integrate the host countries needs with the IARC's primary interest. For IITA soybean program in Malawi the emphasis was largely of developing promiscuous lines with the assumption of early planting for full season growth. No concern for seed viability, early maturity that would allow maize to be planted prior or groundnuts, or shade tolerance to accommodate lower canopy intercropping or other physiological needs that may be needed for wide spread acceptance in Kenya under the specific growing techniques and other priorities of the multi commodity farmers.

Even so the collaborative program has recently released five varieties. Releasing five varieties of a crop at once is very rare and represents a backlog in the administrative process of formal variety release, and an indication of the financial constraints under which KARI and other government agriculture support services operate. More typically new varieties are released at a rate of one every five years or so. The question now arises as to what has become of the newly released varieties. Does KARI have the financial resources to undertake the necessary seed multiplication program that will make the seeds readily available to farmers? Unfortunately, inquires seeking this information was not conclusive, thus it was not possible during the consultancy to fully determine the status of the seed increase for these varieties. The default assumption is that the resources for increasing the seed are limited.

Thus it might be necessary for the organizations facilitating soybean production to by-pass KARI and go directly to the IITA's Kenya staff working on soybeans improvement, and obtain small quantities of seed, perhaps as little as 0.15 kg/line/location to distribute and carefully multiple within the smallholder communities with most of the seed being retain and distributed within the community. This will avoid importing large quantities each season and the costs associated with the logistics that will have to be paid by the farmers. This might easily be done by volunteering to participate in on-farm verification trials that are typically one of the final steps in the variety development process just before they are released. This is basically developing a genetic pump of potential lines, and letting the farmers sort through them, keeping what they like and fits into their production program, regardless if it intercropped or delayed monoculture, and quietly discarding those that do not fit. The process needs to be repeated about once every four or five years. This could result in some informal or premature release of some lines, but this may not be avoided given KARI possible financial limits and the need of farmers for new varieties.

Promiscuous Varieties: One concern with the variety development effort through IITA is the degree the soybeans are promiscuous. Historically, the rhizobium that fixes nitrogen in soybeans has been specific to soybeans. It is *Rhizobium japonica*. If this is not naturally available in the soil, soybeans cannot be inoculated and thus cannot fix nitrogen. Under these circumstances they become more a grain crop then legume crop. This is in sharp contrast to the other tropical legume crops beans, cowpeas, groundnuts and pigeon peas commonly grown in Kenya on smallholder farms. These all cross inoculate with the native soil rhizobium and readily fix nitrogen. In temperate areas and large scale farms inoculating soybeans with *Rhizobium japonica* is a common practice. However, in trying to transfer this to smallholder communities in developing countries the logistic has been overwhelming and

rarely has it been possible to marry the seed with viable inoculums at the farmers' field in time for planning. Thus there has been considerable emphasis, spearheaded by IITA, over the past 20 years or more to develop promiscuous soybean varieties that will actively nodulated with naturally occurring rhizobium and effectively fix nitrogen. Apparently this is beginning to have some success, as some of the new varieties are considered promiscuous, and most soybean fields visited were tested for the nodulation and fixing of nitrogen (Fig. 8). In most cases nodules were present and pinkish in color indicating active fixation. How active may still need to be determined as in all but one case the pink color was fairly weak, which may indicate only limited N-fixation. Only one case was the color a deeper red indicating more active fixation.

Fig. 8. Nodules on Soybean Plant needed for fixing N.

Seed Viability: As mentioned earlier one of the major problems with soybean production is retaining seed viability during the off season. For some reason, best known to crop physiologists, the viability of soybean seeds can deteriorate fairly rapidly after harvest. Since seed storage is usually at ambient temperatures instead of in climate controlled rooms, the viability time will be related to temperature during the off season when the seed has to be stored. The extreme example may be Thailand were viability in the low elevation near sea level that comprise much of Thailand's most productive land the seed viability of soybeans can be as brief as six weeks. In tropical countries like Kenya temperature is related to the elevation, with higher elevations providing cooler temperatures and longer viability. Thus, soybean seeds will remain more viable in Meru at 1600 m amsl than in near Lake Victoria at 1200 m amsl. In Kenya with most of the soybean productions expected in Western Kenya as part of the Rift Valley and near Lake Victory at 1200 m, soybean seed viability could be less than six months and not be able to bridge the dry season between harvest and next planting. This then becomes a major logistical problem. Either it will be necessary to facilitate some major annual seed movement from high elevations like Meru, or it will be necessary to facilitate some off-season multiplication within the community. The latter will be logistically and managerially be the easiest, but most likely will require at least some access to irrigation water.

Another option might be to initially promote soybean production mostly at higher elevations above 1600 msl. This is approximately the elevation of Meru and should be adequate for the temperatures to be cool enough in the off season for seeds to remain viable over the dry season. This is also the case for Malawi where soybeans are normally produced above the Rift Valley Escarpment and not along the lake shore or in the Lower Shire Valley. It is also consistent with the major soybean production area of Nigeria being around Jos. If the initial promotions for soybeans were concentrated above 1600 m the problem of seed viability should be removed from consideration. Once the production is well established above 1600

m, it can be encouraged at lower elevations and the logistics of providing viable seed undertaken. While many promoters, particularly those coming from the public sector, may claim the logistic problems of seed viability can be overcome, this is highly unlikely to be realized, and at least initially farmers are going to be very sensitive and if they lose a crop because of non germinating seeds, it will be years before they attempt to grow soybeans again. It is appreciated that The Lake Basin Development Authority (LBDA) and the SDA community might want to undertake some soybean work on their own. They certainly should be allowed to do so, and provided what support and facilitation they need, but other organizations should be discouraged at least until soybeans are well established as a cash crop in Kenya.

Seed Bulking: The problem with seed viability is immediately reflected in the problem of seed multiplication or seed bulking as the local term appears to be. This is particularly a concern for getting the five freshly released varieties distributed to the farmers interested in producing soybeans. Typically KARI is responsible for multiplying and distributing seed of new varieties. They tend to contract this out to private growers under their certified seed program, which may not have the financial resources to effectively implement a full scale seed certification program. Also, private seed companies tend to shy away from soybean because they are self-pollinated so that famers can use retained seed, reducing the amount of repeat business that companies depend upon. Seed companies prefer to work with hybrid seeds such as maize and sunflowers, for which the retained seed will start segregating and have lower yields.

Rather the seed viability problem, which could result in a need to obtain fresh seed each year similar to hybrid seeds, is enough to encourage seed companies to look into prospects for large scale soybean seed production is a question that needs to be investigated. The time limitation in dealing with declining seed viability could be considerable more sensitive and risky for seed companies, then producing and distributing hybrid seed, where seed can usually be stored for a year or more, and unsold seed kept as seed and not force sold as grain. However, such seeds will be considerable more expensive then locally retained seed both because of the additional cost in growing it and the transportation costs delivering it to farmers. This will impact of the farmers' bottom line for soybean production, and their willingness to produce soybeans as a major cash crop.

LBDA is interested in bulking soybean seed for a production of some 12,000 ha. This is mostly expected to go into their aquaculture program and thus be mostly a closed value chain and independent of the demand mentioned above. The LBDA is a government agency but with some independent funding, thus could easily be in a better position to bulk soybean seed than KARI. However, they are located near the elevation of Lake Victory and most likely will run into the problems of retain seed viability over the dry season, which they did not appear to be fully aware of. This could result in considerable bulking and some embarrassment, if the seed become non-viable. All efforts at bulking seed need to be fully aware of the variety identity they are working with even though it may not be reflected in grain quality. It will be reflected in the maturity and growth habit, and suitability for the

specific conditions under which it will be grown including lower canopy intercropping or delayed planting because as a monoculture maize and perhaps bean and groundnuts have higher priority as potentially subsistence crops than soybeans that is limited to being a cash crop.

Other Production Concerns

N- Fixation: The N-fixation process is actually a high energy consuming process as the chemical equation requires a substantial six electrons or valance changes for the N_2 to become a usable NH_3 as shown in the following equation.

$$\mathbf{N_2 + 6\ H^+ + 6\ e^- \rightarrow 2\ NH_3}$$

The only source for this energy is the photosynthesis accumulation by the plant. It has been estimated that it takes 10 kg of photosynthetic accumulation to fix one kilo of NH_3. This has to come from the dry matter accumulation and the bean yield. Thus it is always possible to obtain higher yields of a legume crops by fertilizing then relying on nitrogen fixation. However, when a legume receives Nitrogen fertilizer, the nodules will stop wasting energy on nitrogen fixation and enjoy the free supply. In doing so the rhizobium converts from a symbiotic relationship to a parasitic relationship, consuming energy but providing nothing in return. In addition, having spent all that energy to fix nitrogen the legume is not going to give it up readily. Thus, legumes will hoard the fixed N until they mature, die and decompose. Even then the nitrogen is still in the organic form and will still have to be mineralized to the ionic form before becoming available to other plants. Often this will be the following cropping season.

Table 11. Nitrogen Fixation by Different Grain Legumes

Species	Range of N fixed/yr (kg/ha)
Soybean	49-450
Common Bean	3 – 57
Groundnut	27 – 206
Black gram	119-140
Pigeon pea	4-200

Sources: Wani & Lee (1992), Peoples & Grasswell (1992)

Even so legumes can fix an appreciable amount of nitrogen (Table 11). However, most of the time the values will be in the lower range of what is shown rather than the upper range. Also, while soybeans are listed as one of the most effective N-fixing legumes, this is most likely based on the soybean specific rhizobium and not a promiscuous inoculation. How effective the promiscuous soybeans are compared to other legumes is a question for IITA and CIAT-TSBF programs to look at and report.

Production Techniques: While most of the research and production recommendations for soybeans are done for mono-culture (Fig. 9), much of the actual production in Kenya currently appears to be intercropping. This includes intercropping with a variety of crops the most common of which is maize and newly planted sugarcane. These are actually awkward intercrops as soybeans will be the shorter earlier maturing crop thus confined to the lower canopy and subject to shading by the taller longer maturing crop such as maize and sugarcane. This can greatly reduce the potential yield of the soybeans. It is usually better the

Fig. 9. Monoculture cropping of soybeans as recommended.

other way with the taller crop being the earlier maturing so it can be harvested and removed to allow the shorter crop full sun while maturing. In the case of Kenya the intercropping with maize in Meru resulted in the spreading of the maize rows to allow more sunlight to penetration to the soybean, although when observed, both were in the seedling stage prior to any shading (Fig 10). In other cases the intercropping uses standard maize rows (Fig. 11). In the case of sugarcane, this was a surprising intercrop as usually the

Fig. 10. Intercropping of maize and soybeans in Meru with the maize rows spread to allow better sunlight penetration to the soybeans.

Fig. 11. Intercropping of maize and soybean with norm row spacing of the maize.

Fig. 12. Intercropping of soybeans with newly planted sugarcane, with good solid pod set.

sugarcane canopy closes too fast and too dense for an intercrop to mature, but in this case is seems to be working at least with the initial planting of the sugarcane (Fig. 12). Apparently it does not work as well with the ratoon sugarcane. In both intercropping cases there could be a need to look closely at both early maturity and shade tolerance, things they may not be included in the IITA sponsored variety development effort. For the monoculture soybean planting has to be queued into the farmers' crop establishment priority with most likely places maize, the main subsistence crop, as well as bean and groundnut, the subsistence legumes, before soybeans, the cash crop. The delay could be three or four weeks or more after the initial rains that start the season. This could imply a major emphasis on early maturity, to assure the soybeans mature before the day season sets in. Also, there is

an expectation that some soybeans will be planted during the minor rains which can again emphasize early maturity

The degree farmers are adjusting and fine tuning their soybean or other crop production practices, is a good indication that smallholder farmers, despite some limited educations, are basically experiences practitioners in the art of agronomy and crop production, and can easily be depended upon to effectively adjust any crop management practices to their limited resource base. This has implication on the extent it is necessary to have extensive extension program to teach farmers the precise best management practices for soybeans or other crops with expensive demonstration plots, or simply provide them some general guidance and allow them to make the appropriate adjustments.

To often agronomic recommendations are based on small plot research and represent the best management practices for the physical environment, but overlook the limited resources the farmers have to manage the land, particularly the possibility the limited calories they may have access to could restrict the hours they can work, and prolong the time to complete different agronomic tasks like crop establishment and hand weeding. The delay will go well beyond the time when best management recommendations are effective. These limited energy and operational resources become a major drag on farmers' ability to expand small plot techniques to a full hectare or whole farm. The result is most extensions recommendations cannot be effectively implemented by the farmers, and extension demonstrations are largely ineffective in getting wide scale acceptance, yet because of the lack of acceptance, the extension program assumes the farmers have no fully learned the technology and repeat it again and again. For soybean in Kenya any extension efforts might best concentrate on distributing pamphlets on recommended practices, possible through the agro-dealer network, and assuring viable seeds are available and allow the farmers to adjust the management practices to suit their needs. There may be little need to waste valued time and money on extensive demonstration.

Marketing Soybeans

Perhaps the biggest challenge in developing the soybean value chain will be in facilitating sustainable profitable marketing channel between the producers and the industrial processors or consuming public. This really has to be integrated into the already established dry goods commodity marketing channel through which maize, beans, groundnuts, etc. pass, as well as integrated into the overall financial management strategy of the smallholder producers, that may based on retaining assets in-kind as long as possible and be inconsistent with many development projects expectations. At this point it might be desirable to combine the soybean value chain with the sunflower value chain, but with different emphasis depending on the area. This could also be an area where CNFA's network of agri-dealerships can make a major contribution, to both soybeans and sunflowers.

Commodity Marketing

The basic marketing channel for commodities in Kenya is very similar to that found in most developing countries in Africa and other developing areas. It is a highly fragmented marketing channel based on individual family enterprises. Apparently, there are some major managerial problems when enterprises grow beyond what an individual can manage. Perhaps, with wages so low the temptation to pilfer some goods, or try and add trash to a bag of commodity is just too much, and thus it is necessary for someone with direct vested interest in the company profits to supervise everything. That would invariability mean supervision by a family member. However, one problem with the fragmented marketing channel is that market volume for each family enterprise is so small that the mark-ups have to be larger so the traders can make a modest profit. This fragmentation can easily be seen as often the dealers in similar commodities will be lined up along a street in adjacent shops.

Market Channel: The basic commodity marketing channel for which soybeans and sunflowers will ultimately pass typically involves six steps.

1. It begins with the farmer who produces the crop.
2. The second person is the broker who buys from the farmer and transports the commodities to the accumulating wholesalers in the nearest town. This person often has the difficult and expensive task of off-tarmac transport. The off-tarmac transport cost can be triple the tarmac cost[9] and may be easily and transparently be justified. The justification is based on:

    a. The need for smaller vehicles to get into the remote areas (Fig. 13),
    b. The slower driving time increasing the transportation time that is reflected in additional labor costs,
    c. The higher fuel prices per ton per km for using a small vehicle that uses less fuel per km, but because of limited load requires extra trips thus more fuel per ton transported.
    d. Additional fuel cost to accommodate the extra acceleration and braking associated with working around the irregularities in off-tarmac travel.
    e. Additional repair cost also from the irregularities in the road
    f. Extra transshipment costs associated with delivery to accumulating wholesaler and reloading to next vehicle.

    Also, the only person who can pay the extra costs for remoteness is the remote farmer. In Meru the transportation costs of transporting a 90 kg bag from the remote areas to the town was quoted at 200 KSh (US$ 2.74)/bag. The distance was about 20 km. This converts to 2200 KSh (US$ 30.0)/mt or 110 KSh (US$ 1.50)/mt/km.
3. The next step would be the accumulating wholesaler who buys from the broker and then sells either to local processors or consumers or helps bulk the commodities into

[9] Estimate obtained some years ago in Zambia interviewing a business woman who was previously in the commodity transport business.

Fig. 13. Typical overloaded small vehicle used for off tarmac transport of both good and people.

large enough loads to justify a seven to ten ton lorry for transport to the cities or processors. These wholesalers usually are dealing in multiple commodities, and have a capacity for about 40 tons per enterprise.

4. After the accumulating wholesaler is the transporter who bulks up the commodities he needs and transports them to the processor or to the larger city like Nairobi. They will typically purchase the 10 tons of produce from several shops and could fill a lorry with a mixture of commodities depending on where they are going and who they plan to sell it to (Fig. 14). This tarmac transport costs could be as low as 6 KSh (US$ 0.08)/mt/km particularly if it is transported by large 22 wheel trucks that were primarily used to deliver containers to landlocked countries like Uganda and are returning to Kenya's primary seaport of Mombasa with empty containers, they are often willing to discount a return load, perhaps without informing the owners. This would include most of the soybeans being imported into Kenya. This discounted tarmac transport costs is only 7% of the off-tarmac costs.

Fig. 14. Large lorries used for on-tarmac transport between larger cities.

5. Ideally this will now go to a processor, but they typically accept only full lorries, although the lorry could be filled with different commodities they need like soybeans and maize or sunflower.

Fig. 15. Typical Multi-Commodity Dealer Selling Soybeans as One of Many Different Cereal and Bean Products.

6. Alternatively they will be delivered to the commodity market in the major cities, and distributed to different family enterprises that comprise the distributing wholesalers. They will then sell either directly to consumers or to the retailers. These retailers, many of whom are women, deal with the full range of grain commodities including most grains like maize, finger millet, sorghum and legumes such as beans, groundnuts as well as soybeans. (Fig. 15). They typically they want to sell approximately five bags of commodities per week. They also mention that soybeans are the slowest mover and it typically takes some six to eight weeks to sell a full 90 kg bag of soybeans. Most of the soybean sales

were for quarter tin, or about 250 g, while other commodities were more often sold by the full tin which was estimated to be a kilo.

This appears to be the typical value chain marketing channel in most African and developing countries. As complex and fragmented as it might appear it was developed by the private, profit conscious, traders and may thus have evolved into the optimal business efficient for the economy in which it is operating, where wages can barely provide the calories needed to do the work, which increases the temptation for many causal employees to look at opportunities to pilfer some of the goods resulting in the need for continuous close supervision.

Kenya – Malawi Comparison: In Kenya, however, the initial step does not appear to have the same competitive advantage for farmers as was noted in the soybean value chain analysis for Malawi. In Malawi many of the large processors had setup outlet shops in the rural areas to provide some consumer good, but also to purchase commodities directly from the farmers. These were joined during the main buying season by temporary buying points in even more remote communities. In addition these were joined by independent traders including some of the CNFA agro-dealers, even sharing the same building (Fig. 16). Most of these independent traders were long term members of the community, with vested interest in remaining in the community, and thus needing to maintain reasonable relations with the community including the farmers from whom they purchase commodities. Thus, during the main commodity buying season a farmer or spouse could have several traders competing for the business, and assuring the farmer a competitive return. In contrast the brokers working in Kenya do not appear to be resident of the rural community, but are summoned by cell phone when someone wants to sell some commodity, or sent by the large processors and then the broker proceeds into the area to pick-up the commodity requested as well as any other commodities to make certain he has a full load when returning to the town. This could then reduce the competition to the disadvantage of both the soybean and sunflower farmers. Both crops will be vastly more cash crops than consumer crops, thus if only offered a poor price do not have the option to consume rather than sell, and are forced to accept the lower price, but responding by not growing more soybeans or sunflowers in subsequent years.

Fig. 16. CNFA Agro-Dealer in Malawi Left) Sharing Building with Outlet of Major Processor (Right), both Purchasing Commodities from Smallholders.

Financial Management Strategy: The market value chain also has to consider what might be the overall financial management strategy of the rural impoverished smallholder producers. This could be that it is better to retain your assets in-kind rather than monetize them. This was first identified by the consultant while doing the soybean value chain analysis for Malawi in February 2009, when he interviewed a women proprietor of a CNFA agro-dealership. The interviewed initially indicated that most the people selling commodities were

women, but they were only marketing a relatively small about at a time. This was often what a women could carry in a basket on her head. Further evaluation indicated that in Malawi most of the cereal and legume crops are grown as rainfed crops with only a single rainy season each year from October to March. In this case the crop should be harvested by June or July and fully processed for sale by August at the latest. Yet the purchasing season extended from June to January, actually exceeding the start of the following rainy season and crop establishment. The initial interview was then confirmed with further interviews of dealers, both small and large, in Malawi as well as Nigeria, Ghana, and Kenya during the current three country trip. The best example in Kenya for soybeans was an individual who, three months after harvest, marketed a partial sack of 10 kg soybeans in Meru.

Thus the basic financial strategy appears to retain assets such as maize, rice, soybeans, groundnut, etc. in-kind as long as possible and only monetize them when cash is needed. This often resulted in stacks of bagged grains occupying a large percent of the home (Fig. 17), and resulted in the marketed volume at any one time being as little as 10 or 15 kgs of soybeans or other commodity, generally what a women could carry in a basket on her head. This is monetized, immediately spent, and the person returns home with the same minimum about of cash as when they left. The strategy effectively provides a hedge against inflation as well as taking advantage of any price increases that normally occurs with time after harvest and prior to the next harvest. It also may be a means of avoiding temptation of spending readily available cash. However, the farmer now has to absorb any post harvest losses from excessive moisture, rats, or grain weevils, etc.

Fig. 17. Stacks of Rice Being Held at Home in Madibira, Tanzania as Part of Financial Strategy of Retaining Assets In-Kind.

It makes it essential that when the grain is brought for sale, the farmer needs the cash immediately which goes against the typical development concept of consigning produce to a cooperative, so the cooperative can bulk it up to get a potentially more favorable price, but actually pay the farmer three to six weeks or more in the future, possible with some substantial but unreported overhead costs, that might consume all the bulk sale benefits. It also means it is essential that dealers, even cooperative dealers, handle the complete mix of commodities produced in the area. If commodity traders or cooperatives were only dealing with a single commodity such as soybeans, they would end up hiring full time staff, for some very limited total effort, as shortly after the harvest there could be a flush of soybeans being brought, but after that it could be a slow but steady trickling in of commodities over several months. During this time, if not involved in multiple commodities, the staff would not be fully employed while being required to be available and receiving full pay.

Agro-dealers: Within the marketing channel of the soybean and sunflower value chain there could be a major role for the CNFA sponsored agro-dealers, particularly those living and

operating from remote villages, with a vested interest in maintaining good community relations with its neighbors, etc. Such agro-dealers actually have more of a symbiotic relationship with the smallholder producers than the praetor-prey relationship often projected[10]. The agro-dealers could easily and effectively serve as the buying and bulking point for accumulating sufficient commodities such as maize, beans, groundnuts as well as soybeans and sunflowers to justify a cell phone call to a broker to buy a full small off tarmac lorry load. They could also have enough leverage to negotiate between several brokers to get the best possible price. This is basically the role some of the CNFA sponsored agro-dealers are filling in Malwai. It is also the role that was originally promoted by the Rural Enterprise and Agro-Business Project (REAP) project in Zambia some 10 years ago. REAP in Zambia was a USAID funded project implemented by CARE, Int.[11] Many of the agro-dealers under REAP actually continued for about two years after donor funding ended. The ultimate difficulty the agro-dealers had was maintaining the necessary buying float for purchasing commodities after harvest. It should be something addressed with micro-financing programs. It most likely will be a major concern with any CNFA sponsored agro-dealers that want to get into commodity purchases.

One of the concerns that may arise if CNFA sponsors agro-dealers to deal with soybeans and sunflowers as part of a commodity procurement business would be the desired density of dealerships distributed throughout the rural area. This becomes a factor of how the farmers will transport 90kg bags of goods. If it is by wheelbarrow, as indicated by one soybean processor, the individual would be hard pressed to cover a kilometer. However, if by motorcycle or bicycle the distance between dealers could be expanded. It is desired to have some overlap, so that an individual farmer or spouse would have a couple alternative places to market their goods and thus get a better price. Another concern would be for CNFA to undertake a detailed analysis of the overall commodity marketing including all costs and profit margins for each step outlined above. An example of the detail needed for an MSc thesis for marketing tomatoes in Nepal is attached as Appendix B. This should be possible using a local private sector consultant perhaps from a university, but with no or minimal ties to the government. This analysis is needed so farmers and local commodity dealers can understand and appreciate the complete marketing process and cost being incurred as that an accurate of the discount from the processors buying price can be accurately and transparency projected. The study needs to be redone at about five year intervals.

Financial Assistance Through KIVA: Another possibility for CNFA to assist the agro-dealers would be to team up with KIVA to assist agro-dealers obtain loans for commodity purchasing floats to buy the full range of commodities produced in their area including soybeans and sunflowers. This was the area were REAP Zambia ultimately had difficulty. KIVA is an NGO that specializes in microfinance by arranging loans between enterprises in countries like Kenya and individuals in developed like the USA or European Union. The operate through local partners for which there are at least eight assisting entrepreneurs in

[10] http://lamar.colostate.edu/~rtinsley/Symbiotic.htm
[11] http://lamar.colostate.edu/~rtinsley/SMC-RLT-Report.pdf

Kenya and for which CNFA should be able to become one, specializing in facilitating loans to their Agro-Dealers.

Clean Bags Of Commodity: Another role the agro-dealers could play would be removing trash in the form of chaff, sticks, mud and other field debris from the commodity and making certain any bag will be within the one percent trash tolerance desired by the processors. This actually is a major problem that was initially identified in Nigeria in September where a processor in Kano was discounting 15% to accommodate the anticipated trash in a bag of commodity. The problem was subsequently pursued and confirmed both in Ghana and Kenya. In the later the amount of effort retail dealers and processors undertake to remove the trash was noted (Fig. 18, 19, & 20). This involved both small dealers like the sunflower processor in Meru who was hosting a CNFA FtF volunteer and large processors like Soy Africa Also, a sample of beans taken from a full bag with a grain thief (spike) quickly showed an unacceptable amount of sand, grit and other contaminations (Fig. 21). In order to assist with the trash removal it might be useful to encourage the agro-dealers to invest in a simple manually operated mechanical winnower (Fig. 22). These are widely used in Egypt for a variety of crops including wheat and broadbeans, but were also noted in Ghana for rice.

Fig.18. Two Young Women Removing Trash from Bags for Groundnuts at 200 KSh/ Bag.

Fig.19. A Perforated Sorting Tray Designed By Previous FtF Volunteer for Cleaning Sunflowers Prior to Processing for Oil for CNFA FtF Host near Meru.

Fig. 20 Large Sorting Trays Used By Soy Africa to Clean Grains Before Extruding and Grinding.

Fig.21. Grain Thief (Spike) Used To Sample Grain Quality Including Amount of Trash Included With the Grain

Fig. 22. A simple Manual Mechanical Winnower for Cleaning Rice in Ghana but Could be Used by Agro-Dealers in Kenya to Market Clean Bags of Soybeans or Other Grains.

The idea might be to encourage value added as more in having a clean bag of commodity and receiving full value from the brokers and traders rather than trying to sell trash for commodity and risking the trader discounting in anticipation of certain percent trash contained within the bag as well as the cost that will be incurred in removing the trash. However, if CNFA promoted agro-dealers did become involved with promoting cleaner grain, they would have to make certain the clean bags were clearly marked so they would not get comingled with the more typical bags and the bonus earned for having clean bags disappears as the bags works their way up the value chain toward the ultimate processor accompanied by less clean bags that were discounted in anticipation of certain percent trash.

As agro-dealers become involved in commodity trading they might be wise to initially concentrate on the SMEs. During the consultancy only one such enterprise was visited. This was Nubian Food Industries in Meru. While they only need 12 mt/yr of soybeans, this is consistent with what is being produced in the area and the link to the farmers could be as simple as one cell phone call. Identifying such enterprises should not be too difficult. Interviewing the brokers or dealers and ask who is routinely buying more than a full bag of soybeans would be a good start. Emphasizing the SME processors would avoid the need to bulk up to 10 mt necessary to accommodate the needs of the larger processors.

Cooperative Business Model: In developing the market channel for either soybeans or sunflower, be extremely careful in using the cooperative business model. While this might be highly desirable from the social perspective and has been the development community's primary means of assisting smallholders, the model is usually too administrative cumbersome to be competitive against private traders or effective and sustainable without continuous external support and facilitation[12]. The persistence of the development community in promoting funneling assistance through cooperatives is often the result of some deceptive reporting the may be bordering on dishonest, and show a far greater commitment to the mechanism by which smallholders are to be assisted rather than to the effectiveness of the assistance. The most common means of deceptive reporting is the near universal failure to include the sustainable overhead costs in operating the cooperative. While during the initial start-up the overhead costs are often co-mingled with the facilitation costs, for honest reporting they should be disaggregated to determine how sustainable the cooperative will be once external support and facilitation are completed. One reason cooperatives loss their envisioned competitive advantage is their tendency to get involved in social issues that have to be funded from the overhead charges. This runs up the overhead costs and reduces the

[12] *http://lamar.colostate.edu/~rtinsley/Cooperatives.htm*

competitive advantage. Finally, it should be noted that the cooperative system in the USA has been in slow decline for several decades until the USDA, the government agency responsible to facilitate the cooperative system, no longer tracks the market share or number of members. The most recent data is now 10 years old and showed less than 30% market share for the cooperative system nationwide.

Cell Phones

A critical part of facilitating and developing a sustainable and profitable marketing channel for soybeans and sunflowers will the cell phones. They appear to be omnipresent all over the country including in some of the most remote rural areas where soybean and sunflower production will take place. The important thing is for farmers or rural agro-dealers to have easy access to several brokers who will be buying soybeans or sunflowers and moving them on to the processors or consumers. CNFA can enhance this process by collecting the broker and local dealers' cell phone numbers and distributing them to the farmers or local agro-dealers. This will allow a limited amount of negotiations when it comes to marketing soybeans. This does not have to be a formal marketing information service just a few local numbers that can be expanded upon as needed by the producers and brokers.

Consumer Promotions

TSBF-CIAT ongoing promotion of soybeans for soil improvement has a component promoting small scale consumption as a community enterprise. It is the opinion of this consultant that these enterprises should be very carefully reviewed to make certain they can be financially profitable and thus sustainable. If not they could quickly become financial losing operations that will ultimately the future of soybeans in the area they are being encouraged. They appeared to be based on the questionable premise that has guided smallholder development for decades, that there is surplus of rural labor that can be tapped for basically menial tasks and the people are actually happy doing hard menial labor. This overlooks the question raised at the beginning of this report regarding if members of rural communities have access to sufficient calories for the work they were expected to undertake. Thus the processing facilities are base on manual grinding soybeans with a modified bicycle grinder and wood stove to developing the steam pressure needed to cook the soybeans in making soymilk (Fig. 23, 24, 25 & 26) The latter providing some potential health hazards from possible CO buildup in the confined area it was being operated at least for the second and third units visit.

The emphasis is on soymilk, but they also produce roasted soybeans, soybean yogurt and some soymeat. They has a capacity of >50 kg/day. At that rate it is highly unlikely that any of this is in sufficient quantity to cover the overhead costs being incurred. Four of these were actually visited. The first one in Meru appeared to never have been used and when isolated from the group the one farmer interviewed acknowledges that he really did not retain any soybeans for home consumption. The second one was outside of Musambi. It was operating

but they claimed it was staffed by volunteers and had monthly sales of 3500 KSh (US$ 500). Unfortunately it is difficult of see how a business can survive for long operating with

Fig. 23. Small Storefront Housing A Small Soybean Processing Facility Of Questionable Financial Sustainability

Fig. 24. Bicycle Operated Grinder for Manually Grinding Soybeans for Making Soymilk.

Fig. 25. Wood Burning Steam Chest for Cooking Ground Soybean to Make Soymilk.

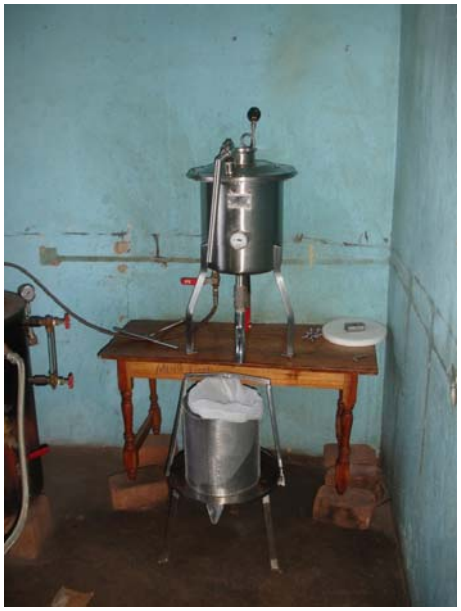

Fig. 26. Small Vat Used for Making Soymilk for Community Enterprise

volunteers, particularly in an impoverished society. There expectation would be for considerable personnel turnover. The third one was not far from the second and the leader of the endeavor was not available. The forth was near Migori. This one was also operating and with considerable enthusiasm. However, it has two full time people working in the production of soy products, and four full time people handing the administrative overhead. This included a chairman, financial officer, marketing officer and agronomist. If the maximum daily processing is 50 kg or less, it is highly unlikely that the sales will cover this level of administrative overhead. Also, several of these operations were promising the farmers substantially higher than the current commercial price of the major processors. This would be more than sufficient to encourage local production that would be greater than the

capacity of the small processing facilities. If this happens the surplus will ultimately have to be commercially marketed at a loss. Finally, the single outlet shops marketing the soybean were also marketing seeds that they contained in one kilo clear plastic bags that did not clearly identify the variety, nor was there any apparent awareness for long term seed viability (Fig. 27).

Fig. 27. Shelves in One of The Community Outlets With Unmarked Soybean Seeds.

For these businesses to be a financial success they will have to take a much closer look at their overall business model and see what volume then need to make a profit and how much overhead they can sustain. Most likely the four persons involved in administrative overhead will have to be reduced to one.

Vegetarian Community: Vegetarian communities such as the SDA offer a potential opportunity for promoting the direct consumption of soybeans, as they are committed to avoiding meat and looking for good sources of vegetable protein. In Kenya there is a substantial SDA community headquartered in and around Ranen in Western Kenya, near the Tanzania border. This is at a lower elevation where temperatures are likely to be warm enough for seed viability to be a major concern. However, because of the potential demand within the community, and the financial and technical resources most likely available through the community to resolve the challenges involved, it would be a good place to encourage direct soybean consumption and production. The community is large enough to justify some larger, commercial scale, production equipment including the more professional packaging for use both within and outside the SDA community. Outside the SDA community it might possible to look at the South Asia Hindu Community in Nairobi and other larger cities. While Hinduism is not as committed to vegetarianism as the SDA, it does encourage it among its members.

The individual at SDA headquarters interested in soybean production and utilization is highly enthusiastic, but is already overextended with other responsibilities of importance to the SDA community. However, she should be encouraged to look some additional personal to work with her at the processing of the full range of consumable soy products including Tofu. This should be fairly easy to initiate. Tofu is basically an acidification of soymilk with $CaSO_4$ (Gypsum) or $MgSO_4$ (Milk of Magnesium) or even lime juice. The instructions and kits are readily available off the Internet[13]. Like soymilk, tofu will require refrigeration for storage. Most likely if SDA community in and around Ranen initiate a commercial processing facility the farmers in the area will be willing to produce the soybeans. The SDA may initially have to facilitate the access to viable seed, but they should have the means to overcome the problem once they fully appreciated the problem and then it should not be too difficult. Also,

[13] *http://www.soymilkmaker.com/making_tofu.html; http://www.soymilkmaker.com/tofubox.html*

the SDA might be able to raise the funds needed to procure the necessary larger scale processing equipment through the Kiva organization (www.Kiva.org). Kiva is an NGO that specializes in loans to private enterprises in developing countries and solicits these loans from individuals in developed countries. However, the funding needs may exceed their maximum limit. For the SDA a quick request to the SDA community in the USA could result in rapidly fulfilling the requested funds. Dick Harwood, one of the original founders of the farming system initiative working out of IRRI, is a member of the SDA community and might be willing to assist in getting funds from the USA SDA community through KIVA.

Facilitating The Soybean Value Chain

The facilitation of the soybean value chain including the implementation of the recommendations included in this report will most likely require an initial five years of external facilitation. This will most likely mostly be coordinating the efforts of the various organizations working to promote soybeans, including CNFA. The effort will have to concentrate on developing the market links including and direct consumption through such organizations like the SDA community, but not the small micro enterprises processing less than 50 kg/day, and assuring the viability of seed. This initial effort should be concentrated outside the Rift Valley to avoid the high temperatures where the viability will become a greater problem.

The current primary facilitation is via the Kenya Soybean Farmers Association (KSFA). However, despite the Rev. George Kivandah, the KSFA chairman, enthusiasm it is highly unlike the KSFA is financially viable as currently organized and financed. The financing is primarily by “new” membership subscription and not annual membership dues. The registration fee is also only 100 KSh/member. This is most like barely enough cover the cost of collection, with very little funds to support the local chapter or national program activities. The KSFA urgently needs to develop a financial budget of what it wants to do and solicit annual dues to cover these costs. As it is there are more vested interests in soliciting new members than serving existing members. That just does not work. Also, any facilitation effort needs to include those providing support services as well as the producers. This would include the agro-dealers, who are providing inputs or marketing crops, as well as any one providing contract tillage services, etc. and respecting the symbiotic relationship between producers and service providers in the smallholder communities as well as the critical role the service providers will have in facilitating the success of the value chain.

In the meanwhile it might be necessary for some donor to finance a NGO to facilitate the soybean value chain or a combination of the soybean and sunflower value chains. The needs are really too much for only FtF facilitation, particularly in getting around the seed viability problems and market links. This would work through KSFA and the comparative association for Sunflowers to undertake the promotional activities including putting the Farmer Association on a financial sound footing to be sustainable. These associations should concentrate on overall facilitation of the respective commodity, using annual dues for funding and not get involved in business activities of actually handling the commodity. This should

be left to private dealers, etc. It should also undertake the periodic collection of new genetic material being developed by IITA and distribute this to different soybean production areas for producing and retaining or discarding depending on desire. Perhaps GTZ would be interested in making another effort at getting soybeans established in Kenya. They were involved before, but appear to have withdrawn. Perhaps this report will provide some information that will allow better success in the future.

Summary and Recommendations

The soybean value chain is being promoted in an overall economically suppressed environment in which consumer prices are only a fraction what they are in the USA, but wages are suppressed even more. This results in a highly efficient private sector business model that may be difficult to compete with. It also results in many people not having access, either by purchase or subsistence stocks, to enough calories to do the full day's work expected of them in implementing any value chain enterprises, including soybeans as well as other value chains. Typically many rural people, both farmers and casual laborers, have access to only 2000 cal/day when they need 5000 cal/day to implement value chain enterprises like soybeans in the agronomical timely manner necessary to take full advantage of the recommended and expected value chain technology. The result is most rural people only able to work three or four hours per day, crop establishment extends for months instead of weeks, and farmers are most likely cultivating all the land they have the energy or other resources to cultivate. Thus promoting soybeans can only be at the expense of already established crops. To have soybeans represent an increase in cultivated area will require enhancing the operational resources the farmers have to manage their lands, which mean facilitating access to contract private tractor mechanization for initial land preparation.

Also, the overall suppressed economy results in a limited tax base for the government to derive revenues. This in turn means that virtually all government revenues go for contract obligations to the governmental officers, with little if any funds remaining for operations, creating a state of financial stalled services. For the soybean and sunflower value chains this impacts on the variety development effort which is defaulted to the IARC's such as IITA and CIAT. It also impact on getting improved lines released and the seed multiplication and certification for distribution to farmers. In addition, it impact on the record keeping of soybeans being imported particularly those coming in from Uganda, for which the official records might indicate only five percent of what is actually imported.

In addition, there is concern for the high degree of rainfall variability that is going to make the yield of most rainfed crops, including soybeans, highly variable from year to year as normally occurring but unpredictable lulls in the rains cause substantial moisture stress most years. Furthermore, the temperature changes associated with elevation can be important as the cooler temperatures at higher elevations may be necessary to assure seed viability over the dry season between harvest and next planting. This could mean the initial promotion of soybeans should be above 1600 m.

In this overall physical and economic environment the desire is to promote soybean production. The reason is both nutritional as soybeans have the highest protein content of any bean as well as the best amino acid balance for the human diet. Also, as a legume, soybeans have the potential for fixing atmospheric nitrogen and enrich soil fertility. However, soybeans are an awkward crop for direct consumption, primarily because they will not soften when cooked as the other commonly consumed beans. The actually direct consumption takes some extra processing and adjustment in food consumption. Also, soybeans contain about 20% oil, but this is not really enough for simple physical extrusion and thus is normally extracted with a more complex hexane dissolution process, for which only one company in Kenya has the facilities. Thus for Kenya soybeans will most likely be used whole fat and essentially be an industrial cash crop mostly for animal feed with some going to processed foods. These processed foods will use soybeans as a minor component in blends of different grains for breakfast porridges or enriched ugali in food programs for refugees, hospitals, schools and orphanages. These are mostly a captive audience.

The total current demand for soybeans in Kenya is approximately 100,000 mt which at a optimistic average yield of 2 mt/ha represent the equivalent of 50,000 ha of cultivated land or more. Since there is no provision being considered to enhance the resource available to the farmers to expand the area cultivated, producing soybeans will have to replace existing crops. This could easily be other legumes such as beans and groundnuts and substantially reduce the supply of these legumes that are already an accepted part of the Kenyan diet and perhaps providing most of the protein needs of the rural population. Currently the demand for soybean and soybean products is being met with imports most of which are coming from Uganda.

However, there is no reason why soybeans cannot be produced in Kenya, but there are several challenges. These include the limited funding for variety development and seed multiplication that has resulted in most of the variety development being undertaken by IITA in collaboration with KARI. They appear to be making progress in developing promiscuous lines that can nodulate and fix nitrogen with native rhizobium. But there is concern about what other varietal qualities they may be selecting and how consistent this might be with farmers' interest in intercropping or delaying planting to accommodate higher priority more subsistence potential crops like maize, beans and groundnuts. However, the question remains if KARI has the resources to multiple and distributes the newly released varieties. Also, there is the problem of seed viability particularly at the warmer temperatures associated with lower elevation of the Rift Valley and Lake Victory. This might require that any additional promotional efforts be concentrated above 1600 m. where the temperatures in the off season should be cool enough to assure the seed viability is retain until the next planting. However, this is somewhat against the current emphasis at the lower elevations near Lake Victoria and the major sugar producing area of the country. Most of the crop appears intercropped with soybeans in the lower canopy subject to shading from maize or freshly planted sugarcane.

The biggest problem may be facilitating the market channel up the value chain from potential producers to processors, both small and large. This needs to be done through the existing grain commodity marketing system that emphasize small family enterprises and includes the need to transport soybeans from remote areas to the initial brokers for bulking into full 10 mt lorries for shipment to processors. The marketing process could be greatly assisted by CNFA through the network of agro-dealers they are promoting, particularly those operating from more remote areas. Also, at this point the value chain effort might best combine soybeans with sunflowers into an industrial crops value chain, as the marketing issues are essentially common to both crops.

Finally, the facilitation of soybean production and marketing may require some long term NGO involvement for approximately five years. This needs to work closely with the KSFA to assure that it is on a solid financial footing and not simply trying to operate on new membership registration. Then the project would concentrate on facilitating both the production and marketing of soybeans, but concentrating the effort on the high elevations to avoid the problem of seed viability. This effort should restrict its activities effort to overall facilitation and not get involved with any direct business activities, such as providing inputs or marketing crops. For a farmers' organization to get involved in such business, the business usually become to administratively cumbersome to be competitive, and ultimately alienates the membership, who take their business elsewhere. It should also facilitate the distribution of new lines with direct contact with the IITA program and allow the farm communities to do the final multiplication and distribution of seeds.

This should also avoid working with the micro business visited for providing direct consumption of soybean products in rural areas. They appear too poorly conceived to be financially viable. However, it should be possible to work with SDA and other vegetarian communities which to have the potential demand for larger scale more financially sound processing equipment, etc.

Recommendations

1. Encourage a donor to develop a program for facilitating the production of soybeans and sunflowers in smallholder communities and marketing to both small and large processors. Some of the specific tasks would be:
    a. Work with the KSFA to make it a financially viable association representing the soybean producers as well as the local support service enterprises
    b. Carefully, evaluate the crops soybeans may be substituting for and do the economic analysis to see what is the net benefit to soybeans in terms of finance and diet. Also, if soybeans are replacing an already established legume, continue the analysis to determine net benefit to soil fertility.
    c. Undertake a detail and quantitative evaluation of the private sector commodity marketing channel through which the value chains of both soybean and sunflower will have to flow.

   d. Facilitate the flow of new soybean lines directly between IITA's collaborative soybean variety improvement program and local farm communities, possible using the agro-dealerships as outlets.
   e. Identify and link some of the SME processors of soybeans or sunflowers with the producers or local agro-dealers working in remote areas to serve the producers.
   f. Work with the vegetarian communities like SDA to go into the processing of soybeans for their communities with surpluses into the regular markets, this would include looking at large scale equipment to accommodate a commercially viable volume.
2. Concentrate future soybean promotions above 1600 m to minimize the concern for seed viability.
3. Have CIAT-TSBF compare the nitrogen fixing potential of promiscuous soybeans lines and those of beans, groundnuts, cowpea, pigeon peas or other legumes currently widely grown by smallholder communities.

Appendix A

Activity Log & Notes

Fri. 6 Nov.	Arrived in Nairobi 5:30 am and was met as scheduled at the airport and check-in at Silver Spring Hotel. Since I had traveled all night I was given the day off to recover. I used the time to prepare account for ACDI/VOCA etc. Meet with Mercy who provided me with the cash advance in US$ for the time in Kenya.
Sat. 7 Nov.	Weekend, rested and started Ghana Report.
Sun. 8 Nov.	Still weekend so rested and continued Ghana Report
Mon. 9 Nov.	Program stated with review of schedule and any changes that might be needed. It looks very much as following the Malawi schedule. However, soybean production and utilization has weaker links, but more cottage processing and consumption.
Tue. 10 Nov.	Meet with People in Ministry Johnson Irungu Waitaka and Muamzali Shiribwa to discuss the soybean value chain and ministry position on it, the extent soybeans were imported while producers could not find market. Real need for improved marketing links. Soybeans not a scheduled crop like maize thus limited research and extension support. Second meeting was at ICAF with CIAT's Jonas Chiranu, an economist. They were mostly interested in soybeans potential for nitrogen fixation for soil improvement. Mentioned soybeans been in Kenya since 1904, but never developed. Did mention they had several promiscuous lines available that were as effective as inoculated lines. He had done a cost of production comparison between USA (KSh 12.75/kg) vs Kenya (KSh 13.00/kg). Much of the discussion was about seed, but not concerned with retained seed. Did mention seed viability a concern mentioning only six months, which is better than 6 weeks as reported in Thailand. After lunch we met with team at KARI. They presented different aspects of soybean issues. Did mention the possibility of complimentary seasons between the east and the west that could support a seed viability problem and allow a seed company to become interested. Also, mentioned problem of photoperiod sensitivity, and contribution of material from Zimbabwe. In all it was a lot of material to follow up on.

Wed. 11 Nov. After a delayed start to collect my laundry, Paul and I headed for Eastern Province. We stopped in Embu to meet with provincial agriculture office. This included Patrick Maina Musang, Emmy A. Wanjahi, and John N. Nyaga. They express same concerns as other ministry person except Emmy, the home economics officer, expressed reservation if soybeans could become a local consumer food, because would not soften when cooked as well as complexity of processing procedures. Farmers would prefer to continue with dry bean and other legumes already in the diet. After meeting proceeded to Maru arriving around 6 in the evening.

Thur. 12 Nov. Initial meeting was with the Government officials Emmanuel Kisebe and Imenti Nome. It was mostly the usual discussion. There was concern about seed and availability of newly released varieties. It may be necessary to intervene to make new varieties seed available to farmers. Later joined by Mary Mburugu agro-business officer and then by Catherine Ikiara of Jenga Kenya for the field trip.

We made field visit after rather extensive off tarmac road trip. The meeting started with large group meeting and some general questions, and good cup of soymilk. They had all the local processing equipment out on display, but it did not look like it was heavily used, just set out for the visit. Later we accompanied one farmer back to his farm for field visit, but we were accompanied by four “officials”. It was an interesting discussion. Soybeans were in emergence to three leaf stage. They were intercropped four rows between maize rows, with maize double wide rows. Farmer was unaware of variety, but only one had been offered so no final selection process for the farmers between different varieties. Farmer had mixture of other crops. Got the impression they really were not interested in soybeans for consumption, but possible for cash.

We returned to Maru to visit Nubian Food Industries that has a fairly brisk business of blending different grain for specialty porridges. He used soybeans in two products one a porridge blend with sorghum, finger millet, bulrush millet, and soybeans (5%). Also roasted and ground soybean for coffee. His demand was for 12 mt/yr or 3% of total commodity. Not really much, but did not know of local production. This could be good link to quickly establish with producing farmers.

Next visit was to broker who happened to have bought 10 kg of soybean the previous day, but not resold any. Really was not interested in that low volume, but was aware of Nubian's need for soybean. Could be part of link, but with quantities involved might just make it direct farmer to Nubian. Good overall discussion on marketing and broker/transporter relationship.

Fri. 13 Nov — Visited small sunflower oil processor struggling to get in business and was hosting another FtF volunteer. He had all the equipment he needed and got it off the shelf in Nairobi. Most came from China, with one unit from South Africa. He was concerned with the quality of sunflowers he was receiving and amount of clean up he had to do before processing. This was mostly a very interesting visit. No real prospects for using Soybeans.

We proceeded to return to Nairobi for weekend and arrived near 5:00 but in time for conference call from Washington.

Sat. 14 Nov. — Visited commodity markets to see how much soybeans was being traded. This was most interesting as there were more soybeans being traded than expected. Some may be going to some of the processors we will be visiting, particularly those involved in enriching maize flour. None had the volume of any major millers. The market was mostly slow. They did confirm that most traders were coming in with multiple commodities and that needs to be recognized and not try to isolate soybeans. We did talk to a couple transporters who seemed to negotiate between farmers, accumulating wholesalers and distributing wholesalers. Basically same value chain as noted in Nepal with farmer normally disposing of goods at farm gate to broker who had the off tarmac transport costs to the accumulator who then bulked up and mix to fill a load for transport to the destination where everything is disaggregated to new owners for sale to processors as whole bags or retail in small amounts. Each stage is a clean sale transaction on cash basis. All are based on family enterprises as the only way to supervise the process and make sure the commodities were as clean as possible and with a minimum of pillage.
We went to the supermarket to look for soy products. We did not see any. There were just some specialty items. No soybean in baby formula or cereals, nor was any in maize flour. This was actually very disappointing.

Sun. 15 Nov. — Rest day in hotel.

Mon. 16 Nov. Visited SoyAfric Ltd and meet with Kaburu Muguika, the general manager. SoyAfric was processing soybean into a 80/20 blend with maize for the WFP and other NGO relief agencies, mostly for areas to the north such as Sudan and Somalia. They went through some 500 mt/month or 6000 mt/yr. In addition to serving the NGO relief operations they made products for the open market and claimed 50% of their products were sold on the open market including several products with soy blends.

They also provided extruded soybean maize to Nestlé's for making breakfast cereal similar to cornflakes.
They obtained their soybeans mostly from Uganda, but suspected it was grown near the Congo border. They also received some from Malawi and Ethiopia. There was some complimentary seasons so Uganda was harvesting in August, Malawi April and May and Ethiopia in Feb and Mar.

They obtained soybeans in 40 mt batches associated with 22-wheel truck rigs. We did get an estimate of tarmac transportation costs based on transport from Mombasa to Nairobi at KSh 6.0/t/km. Now need the off-tarmac rate.

Second visit was with Nestles and Mr. Peter Aloo. However, they were mostly interested in obtaining extruded soybeans and not interested in whole bean. They used it in their Cerevita breakfast cereal. They were also concerned with quality control and tended to test all their incoming supplies to make certain they complied with the standards. They paid KSh 70 – 90/kg for extruded soybeans, about twice the price SoyAfric initially paid for the beans.

Tues. 17 Nov. We meet with UNGA Harrison Juma. UNGA is a subsidiary of Seaboard Corporation a USA company. They are the major animal feed industry in Kenya making a variety of feed products for dairy, poultry and pigs. The majority of their products go for poultry then dairy and finally pigs. They mostly blend maize for energy with soybean for protein. They don't use soybeans directly but purchase cake and meal after the oil has been extruded or extracted. Most of the meal comes from India but also from Europe on special request. The cake mostly comes locally but is far less reliable. Their capacity is some 8500 mt/month of feeds. They are concerned with balancing the heat of extruding to make certain the trypsin inhibitor is deactivated but not so hot the protein is denatured. Most of the local cake and meal were

suspected of coming from Uganda. They were mostly interested in full 30 mt truck loads and would find smaller amounts a major inconvenience.

Wed. 18 Nov. Much anticipated meeting with WFP. The meeting was with Arben Caslli, Head of Procurement. Most of the discussion centered on his not being able to purchase locally because the quoted price was substantially above the price out of Europe and South Africa. Also noted the price quickly dropped when questioned it, but still not good enough to contract. They were mostly interested in a CSB. This was use for school lunch programs as well as the refugee programs from Somalia and Sudan. They used about 30,000 mt per year with 50% coming from the US as in-kind contribution, most likely from PL 480. Also, they have a major concern for quality about as much as Nestlé's, and were continuously testing the procurement. They would hold the initial 200 mt of an order for up to 5 days to check quality with big concern for vitamins that had to be tested outside the country.

The rest of the day was for preparation of the large field trip.

Thu. 19 Nov. All day travel to Western Kenya, but stopped at BIDCO. This is an oil seed processing plant that took over a Unilever operation and inherited a hexane extraction facility which they have maintained. It is the only one I am familiar in Africa. We meet with Chandrakant Pareich. They deal mostly in sunflower but do process soybean. The soybean is mostly for defatted meal. Not really interested in the oil. They did mention that hybrid sunflowers had more oil than OPV, but that should be correctable. Did maintain and extension staff to promote sunflower and soybean production but acquired most of their soybeans from Uganda or South Africa.

Fri. 20 Nov. Three stops, first with John Cheruigot, Provincial Agriculture Officer for general chat on agriculture and soybeans.

Second was small soybean processing plant run on volunteer basis (???). They had several direct consuming products after processing. Nuts, crisp, porridge flour but not with maize, but mostly soymilk which they demonstrated with a lot of manual labor including bicycle operated equipment. It looked like some NGO's dream without a lot of business experience. It did not look like it had sufficient business to be economically viable, but it

appeared a reasonable demonstration. They did have some seed on the shelves in 1 kg bags, but unlabeled as to which variety. Ended visit with field visit to field on soybeans intercropped with sugar. It was more impressive than I would first image. One area was ready for harvest with all the leaves off, and with reasonable pod set.

Third visit was to Lake Basin Regional Development Authority. This is a government organization that appears to have some extra funding. They are interested in bulking sufficient seed to cultivate 1200 ha. That should be sufficient to get over the initial production hump. They had four varieties they were working with and it appeared independent of the presumed newly released varieties. This could be an initial startup effort for the region.

Sat. 21 Nov. Continued to Basria and the commercial border with Uganda. Talked to several of the small traders on Kenya side but got reference to other traders crossing over. One trader mentioned that she could only sell a 90kg bag of soybean in six months. That sounded too long. She also claimed she sold a bag of rice, groundnuts or green gram in one month and beans in two months. Perhaps she was confused between week and month. Also, saw rice from VN (15% broken) and rice from Tanzania.

Meet with a friend of Paul's to visit a soybean field, in which soybeans were intercropped with maize. Again it looked better than expected. Still filling with grain, but did have the most active nodules seen to date.

The two big traders mentioned that the soybeans were warehoused just across the border in the large market. It was again fragmented so they would have to go to several brokers to collect a full truck load, if needed. They also mentioned that everyone was dealing with multiple commodities and trucks could easily be carrying 600 bags broken down into several commodities. They did mention that to cross the border and deliver a kilo of commodity to Nairobi costs about KSh 4.00. Thus the market chain for soybeans from Uganda has an extra step to consolidate commodities at the border.

Finally, Hajji and his family came across for a very nice hour and half visit. It took him about two hours to come from Mbale to Barisa.

Sun. 22 Nov. Mostly day off after traveling to Kisumu. Caught up with log, etc.

Mon. 23 Nov. Our first stop was briefly at CNFA AGMART office the branch dealing with agro-dealers, but just a quick visit. Next to the ministry for normal chat, mostly repeat of other ministry visits. Next visit was with Chirasha Mathews of TSBF/CIAT that is promoting soybeans for enhancing soil fertility. He explained the program and then took us to look at some research trials mostly testing 100 lines, but some other work. The plants were nodulated but weakly fixing N.

Last visit was at another soybean processor less than 20 km from the first. It was an identical operation. We talked to the manager on the phone since she was in Nairobi headed for Arusha. She claimed she had 1000 farmers producing 0.25 ac each and she was paying KSh 80/kg for soybeans. That is more than double the regular commercial price for Uganda imported soybeans and she could get stuck with more soybeans then she can process and have to dump on market at a loss.

Tue. 24 Nov Spent the morning in the market collecting consumer price information, but including a solid chat with one dealer concerning the micro commodity retail business. She would collect 10 bags of commodities at a time closing her shop for day to do so, and arrange for independent transport to bring the goods home. This placed her market volume at 450 kg/wk. She did this once every two weeks depending on what she needed. She claimed soybean was a slower mover taking about two months to sell a 90 kg bag. She also mentioned soybean were sold mostly in quarter tins, and used from making porridge by blending with finger millet, bulrush millet, cassava, etc. but not maize. We collected most of the commodity information.

Afternoon travelled to Kisii for night.

Wed. 25 Nov. We started with the SDA community. The communications was messed up but ultimately meet with Roselyne Kyayo. Before being promoted to head three health related ministries she was activity involved promoting soybeans within the church community. She was interested in mostly working with community processed soybeans in the form of milk, “grits”, coffee, etc. She was interested in getting some better processing equipment, to which I would suggest she include Tofu in her selection. She had tried growing soybeans since 1994, but with

mixed results. She even got burned when she tried to market some, was placed in a credit group, and lost some of her crop to the credit defaulters even though she never had a loan. As a vegetarian community this is an ideal point of entry that can locally use and process soybeans, and pass any surplus off to the commodity market. But there can still be problems with seed, etc. Second visit was to the Uriri Soybean Cooperative producing soymilk and other products. It was identical to the other two. I just cannot see this working. They had 750 members out of a pool of 10,000, but only 300 currently producing soybeans in 0.25 ac fields. At 1.0 mt/ac and 188 ac they will produce some 188mt. They are paying KSh 50/kg, and expect to process all that is produced. This is unlikely as they can only process about 50 kg/day and have maximum capacity of 18mt/yr. But they had no real plans to deal with any surplus. They have six full time employees, two in processing and four administrative overhead as coordinator, extension, finance and marketing. That will be difficult to afford if they can only process 50 kg of soybean a day and not processing every day. They claim a 20% overhead cost plus 10% contingency for a total of 30%. That is 30% the farmers will not receive.

Final stop was late afternoon courtesy call on the district agriculture officer. Not really much more than the typical discussion.

We continued to Kenya Tanzania border stayed at a good very reasonable hotel.

Thur. 26 Nov. Main meeting was with Rev. George Kivandah the National Chairman of the Kenya Soybean Farmers Association. They claim 10,000 members scattered over the western part of the country, divided into districts, locations and sub-locations. This is all funded by new registration fees and not annual dues. No new members no new funds!!! Expecting most farmers to grow 0.5 to 1.0 ac of soybeans a large percent to be intercropped with maize, sugarcane or sorghum. He was not aware of the seed viability problem. He was expecting it to be from six months to a year. They were encouraging retained seed.

Much concern with marketing and mostly interested in facilitating links to brokers but still wanted to bulk independently, including building warehouses. This needs to be carefully thought through and look at possible community based agro-dealers to handle this.

We revisited the Uriri Cooperative to collect some soy-meat and visits field missed the day before but the person responsible was not available. Thus proceeded to Kakuru for two nights, but stopped at KARI in Kisii to see if they knew anything about the seed increase for the newly released varieties. They did not appear to have any solid idea.

Fri. 27 Nov. Tried to meet the DAO for Rift Valley but he was at a meeting in the hotel, but did meet with a friend of Paul's that enlightened us on the possible advantage Uganda and Tanzania had over Kenya because of Least Developed Country (LDC) Status. Thus depending on what the terms are it is possible for Brazil or Argentina soybeans to be landed in Mombasa, bonded across Kenya as "Transit Goods", be delivered to the market across the border in Uganda, and sold for right back to Kenya. Needs someone to look at!

Did make a couple farm visits to look at soybeans, mostly intercropped with other crops like maize but also coffee, in a real mix of cropping. Also were able to get some subsistence data and casual labor data.

Finally, we returned to the hotel to meet the DAO for lunch as his guest, and pleasant talk but nothing to noteworthy.

Sat. 28 Nov. Visited the Lake Kakuru National Park for four hours, saw several interesting animals including numerous white rhinos. Then we returned to Nairobi after stopping for a goat meat lunch.

Sun. 29 Nov. Day off at hotel in Nairobi, worked on report.

Mon. 30 Nov. Remained in hotel working on report and reviewed progress with Paul in the afternoon.

Tue. 1 Dec. Continued working on report from hotel
Wed. 2 Dec. Continued working on report in hotel.

Thur. 3 Dec. Continued working on report, but also visited with CNFA staff at hotel and meet with final soybean user at Java House

Fri. 4 Dec. Checked out of hotel, meet with CNFA staff for debriefing and final lunch prior to be dropped off at the airport to return to the USA.

End of Activity Log

Appendix B

Excerpt from:
Developing Smallholder Agriculture: A Global Perspective.
R.L. Tinsley
Chapter 4. Supporting Smallholders

Marketing of Tomatoes in Nepal

An example of how family enterprise (private sector) supports smallholders, is the marketing of tomatoes from the Sharlahi District of the Terai in Nepal to the capital Katmandu (Manandhar, 1996). In Sharlahi, tomatoes are grown from September to April as a winter crop in rotation with summer crops of rice and maize. Tomatoes are normally handled by the private sector, even in countries with extensive state involvement in agriculture. They are a popular vegetable with a high demand among the general public.

In the middle of the season, the price the farmer in Sharlahi receives in the "haat bazaar", a local bi-weekly farmers' market where buyers can purchase produce from farmers for shipment to distant locations, is only one third what the consumer pays in Katmandu. This situation is fairly common and looks like an excessive profit margin for the middlemen. However, detailed analysis of marketing systems indicates only modest profits.

The biggest problem is a highly fragmented marketing system with a multitude of competing family enterprises, each with a rather small market volume so that the dealers have to compensate with higher mark-ups than in more developed economies where large companies handle larger volumes, with smaller overheads.

The marketing system in Nepal is actually fairly efficient, capable of delivering tomatoes from the farmers' fields to the consumer in 48 to 60 hours. However, there are numerous steps in the marketing process, each with its handling costs and opportunity for spoilage losses. As in most Developing Countries' marketing operations, the entire wholesale process is done by volume or sight without any weight checks. Weights only became involved for the final sale to retailer, or from retailers to customer.

The Marketing Process of Tomatoes in Nepal: The general marketing process is:

1. Tomatoes are picked during the afternoon and transported from field to the homestead.
2. In the evening the tomatoes are sorted and packed into small tokaries, a round bamboo basket holding 20 - 30 kg each, or dokoes, a bamboo backpack type basket holding 50-60 kg.
3. Early the following morning, the tomatoes are transported from the homestead to the haat bazaar, a distance of up to 10 km. The haat bazaar is an open, muddy field with no facilities. Transportation is mostly by bullock cart

holding 40 small tokaries for a total of approximately 1,000 kg, but representing the marketed produce of 1-5 individual smallholders who must accompany the bullock cart, walking beside it. The alternative is using backpack dokoes.

4. Upon arrival in the bazaar, the tokaries and dokoes are placed on the ground for inspection by potential wholesale buyers (Photo 4.5).

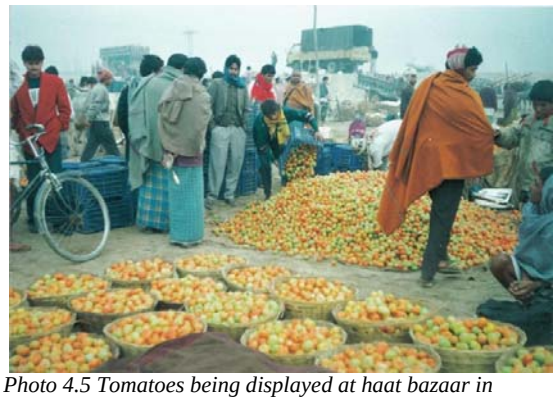

Photo 4.5 Tomatoes being displayed at haat bazaar in Nepal for auction by buyers. Photo Credit: S. Manandhar.

5. The buyers and growers haggle over the price until agreement is reached, normally for the full amount displayed by an individual grower. No weighing is done. The price depends on the number of wholesalers in the market and estimated demand based on phone calls from the one available public phone to the wholesaler's partner in the wholesale market in Katmandu, a one-sided communication system in favor of the buyers. However, it still translates into a fairly equitable system, as buying remains highly competitive among the traders ensuring the farmers a fair share as will be discussed below.
6. Once purchased, the tomatoes are dumped on ground clothes and the original containers are returned to the producer.
7. The buyers then consolidate their purchases, co-mingling the tomatoes of different producers. Because the cool temperatures in Katmandu retard ripening, those destined for Katmandu have to be riper, and are thus more susceptible to compression spoilage, than those going to warmer destinations where they would naturally ripen. For this reason they would be repacked into rigid, stackable, plastic crates holding approximate 28 kg. Those going elsewhere are repacked into larger tokaries with extended sides that hold 80 kg or more (Photo 4.6).

Photo 4.6 Repacking tomatoes in the haat bazaar of Nepal for shipment. Photo Credit: S. Manandhar.

8. All sales in the haat bazaar are completed by noon, less than 24 hours after picking, and by mid-afternoon all tomatoes are ready for shipment. Tomatoes going to small towns are then loaded on the tops of buses for transport, or specially partitioned trucks. Those going to Katmandu are loaded into 6-ton trucks holding 228 plastic crates.
9. As few wholesalers handle sufficient tomatoes for the entire truck, the loads are combined so that a truck can hold the produce of as many as 10 individual wholesalers, each handling 15-30 plastic crates, and representing the co-mingled produce of 20 or more individual smallholders.
10. The various transport vehicles leave the haat bazaar 24 hours after picking, for the 14-hour trip to Katmandu or elsewhere. The trip is made primarily during the cool of the night, which reduces heat build-up in the confined

unrefrigerated trucks and respiration losses associated with heat build-up. The arrival at the Katmandu wholesale market is early the following morning.

11. Upon arrival at the Katmandu wholesale market, approximately 36 hours after picking, the crates are disaggregated to the respective partners of the buyers in the Sarlahi. In most cases, the partnership is among relatives. Thus, each wholesale operation supports two families, the collector's family in Sharlahi and the distributor's family in Katmandu. The Katmandu wholesalers are mostly specialized in the few crops they handle and the source from which they obtain them. Occasionally, they will obtain produce brought to the market on consignment from a driver representing a wholesaler without a destination partner.
12. Like the haat bazaar in Sharlahi, the wholesale market in Katmandu is also an unpaved, muddy, open area on the outskirts of the city with no permanent facilities other than the market headquarters where wholesalers and truckers have to pay their usage fees.
13. Retailers come to the wholesale market to purchase and transfer tomatoes and other vegetables to their respective stalls distributed throughout the city. These retailers' purchases are frequently 5-10 kg of tomatoes and are consolidated with other vegetables. At this point, weighing is introduced into the system as an option.
14. Transferring the vegetables to retail stalls depends on the distance, and the volume involved. It can be on the back using large dokoes, by bicycle, motor tricycle, or pickup, depending on the volume involved.
15. Consumer sales commence as soon as the retailers return and open their stalls later in the morning and less than 48 hours after picking.
16. After a days rest, the transporter returns to Sharlahi with the empty crates from the previous trip. On the return trip the transporters serve as courier for cash and any messages back to the buyers. Typically, drivers carry some US $ 4,000 on their return trips, which represents a minor security risk from bandits. However, this is minimized by the daytime travel. The Nepal banking system, at the time (1996), did not allow for alternatives.

Analysis of the Nepal Marketing System: Throughout the marketing process in Nepal there are costs associated with handling the crop in each step, as well as opportunities for additional spoilage losses. Actually, the losses are very reasonable. For the tomatoes going to Katmandu the total losses were only 21%. This was broken down to 7% spoilage losses in the haat bazaar, 7% in the Katmandu wholesale market, and 7% in the retail outlet. Even though no weights were taken in the first two operations, these losses were well-known and accurately estimated by all concerned. In addition to the spoilage losses there was a 4.5% respiration loss associated with picked tomatoes still being live organisms that continue their biological metabolism even after picking. As there are no weight checks being made, and the water loss did not noticeably reduce the turgidity of the tomatoes, these losses are largely unnoticed. The total losses were considerably less than the 50% traditionally associated with handling vegetables in developing countries (APO, 1989). Much of the reduction in spoilage losses can be associated with the shift from bamboo baskets to rigid and stackable plastic crates, at least for shipments to Katmandu.

The result of these losses is that, in order to market 100 kg of tomatoes to the consumer, the wholesaler must purchase 126 kg from the farmer, which essentially, and

somewhat discreetly, increases the percentage of the consumer price the farmer actually receives.

Table 4.3. Marketing Cost Analysis for Delivering 100 Kilograms of Tomatoes to the Consumer in Kathmandu

Item	**Weight Needed (kg)**	**Unit Cost (US$)[a]**	**No. Units[b]**	**Cost/ 100 kg Delivered (US$)**
Purchase Price	126	12.54/ 100 kg	1.26	15.06
7% weight adjust-ment for damages at haat bazaar	117			
Shipping container (crate)	117	0.035/crate	4.18	0.146
Packing Material	117	0.016/crate	4.18	0.068
Packing labor	117	0.032/crate	4.18	0.135
Loading charge	117	0.032/crate	4.18	0.135
Marketing Tax	117	0.0485/crate	4.18	0.203
Transportation Cost	117	0.436/crate	4.18	1.823
Unloading in Katmandu	117	0.0485/crate	4.18	0.203
Market tax in Katmandu	117	0.0485/crate	4.18	0.203
Misc. charges for road taxes, overload fines, etc.	117	0.032/crate	4.18	0.135
Weight adjustment for respiration (4.8%) and damages (6%)	105			
Porter fees to retail stall	105	0.009/kg	105	0.945
Weight adjustment for losses at stall	100			
Total cost				945

[a] Based on Dec/Jan average prices. All dollar values were converted from Nepal Rupees at US$ = 55.0 Rupees

[b] Assumes a plastic crate will hold 28 kg.

The actual cost incurred in marketing tomatoes from wholesale buyer to consumer amounts to $4/100 kg (Table 4.3). This can all be broken down into various charges including market and road taxes.

The biggest charge is for transportation amounting to almost 50% of the total non-farm cost. Individually the rest are very minor, but add up to a considerable cost.

In Sarlahi, the marketing costs remain fairly uniform throughout the season, while the prices fluctuate with supply and demand based on what is available in the market, what is being provided from other sources, and what is available from the farmers.

Typically, prices will be high in the beginning of the season, will go down as the production peaks, and goes up as production tails off toward the end of the season, or, as in the case of Sarlahi, farmers have to shift to their main summer crops of rice or maize.

The seasonal price fluctuations reflects the percentage of the final consumer price received by the different people involved (Table 4.4).

With all the losses factored in, the farmers actually receive anywhere from 31-63 % of the consumer price, depending on when during the season the transaction occurred. This has to cover their cash cost estimated at US $4.13/100 kg with their profit margin representing returns to family labor.

This averages well above the 1/3 consumer price nominally claimed as their returns based on the apparent mid-season difference between haat bazaar and consumer prices. *The producer thus enjoys the highest profit margin.* Actually, most of the seasonal price fluctuation was accounted for in the fluctuations in the returns to the farmer.

The wholesalers, those normally considered exploitative of the smallholder, actually had the lowest profit margin in the study. Essentially they charge a near fixed price for the services they provide and are apparently not taking too much advantage of the seasonal price fluctuations.

The actual profit margin was only US $1.45/ crate to be divided between two families; the collecting wholesaler in Sarlahi, and the distributing wholesaler in Katmandu.

When the US $1.45/crate was multiplied by the typical number of crates being handled, an estimate of the wholesalers' income was obtained (Table 4.5).

This income was consistent with that of a mid level civil servant. It provides the wholesaler with a comfortable but not exorbitant living, with considerably more risk than the corresponding civil servant.

Table 4.4. Profit Margins for Marketing 100 kg of Tomatoes to Katmandu Consumers [a]

For the Producer							
Months	**Prod. Cost / 100 kg**	**Selling Price / 100 kg**	**kg Needed**	**Total Received**	**% of Consumer price**	**Profit Margin**	**% of consumer Price**
Oct./Nov.	4.13	32.58	126	41.05	63.54	35.85	55.50
Nov./Dec	4.13	19.00	126	23,94	45.22	18.74	35.40
Dec./Jan.	4.13	9.95	126	12.54	31.90	7.34	18.67
Jan./Feb.	4.13	10.41	126	13.12	43.81	7.92	26.77
Feb./Mar.	4.13	11.76	126	14.82	47.03	9.62	30.53
For the Wholesaler							
Months	**Purchase Price**	**Expenses incurred**	**Kg. Sold**	**Selling Price /100 kg**	**Total received**	**Profit Margin**	**% of Consumer price**
Oct./Nov.	41.05	4.00	105	52.33	54.93	9.90	15.33
Nov./Dec	23,94	4.00	105	35.13	36.89	8.96	16.91
Dec./Jan.	12.54	4.00	105	21.56	22.64	6.10	15.52
Jan./Feb.	13.12	4.00	105	23.86	25.05	7.93	26.80
Feb./Mar.	109,62	4.00	105	27.24	28.60	9.78	31.04
For the Retailer							
Months	**Purchase Price**	**Expenses**	**Selling price** [b]	**Profit Margin**	**% of Consumer Price**		
Oct./Nov.	54.95	0.94	64.60	8.71	13.48		
Nov./Dec	36.89	0.94	52.94	15.11	28.54		
Dec./Jan.	22.64	0.94	39.31	15.73	40.02		
Jan./Feb.	25.05	0.94	29.59	3.60	12.17		
Feb./Mar.	28.60	0.94	31.51	1.97	6.25		

[a] All monetary values are in US dollars converted from Nepalese Rupees at US$ = 55.0 Rupees
[b] This value is the basis for computing all % of consumer prices.
Shaded lines represent the values used in table 4.5

Table 4.5. Estimated Income for Wholesalers (US$)

No. Handled	**Income Per Unit**	**Daily Income**	**Monthly Income (8 trips)**	**Monthly Income per Family**	**No. Handled**	**Income Per Unit**	**Daily Income**	**Monthly Income (8 trips)**	**Monthly Income per Family**
Plastic Crates					**Tokari**				
20	1.45	29.00	232.00	116.00	7	7.84	54.88	439.04	219.52
30	1.45	43,50	348.00	174.00	10	7.84	78.40	627.20	313.60
40	1.45	58.00	464.00	232.00	14	7.84	109.76	878.08	439.04
50	1.45	72.50	580.00	290.00	17	7.84	133.28	1066.24	533,12