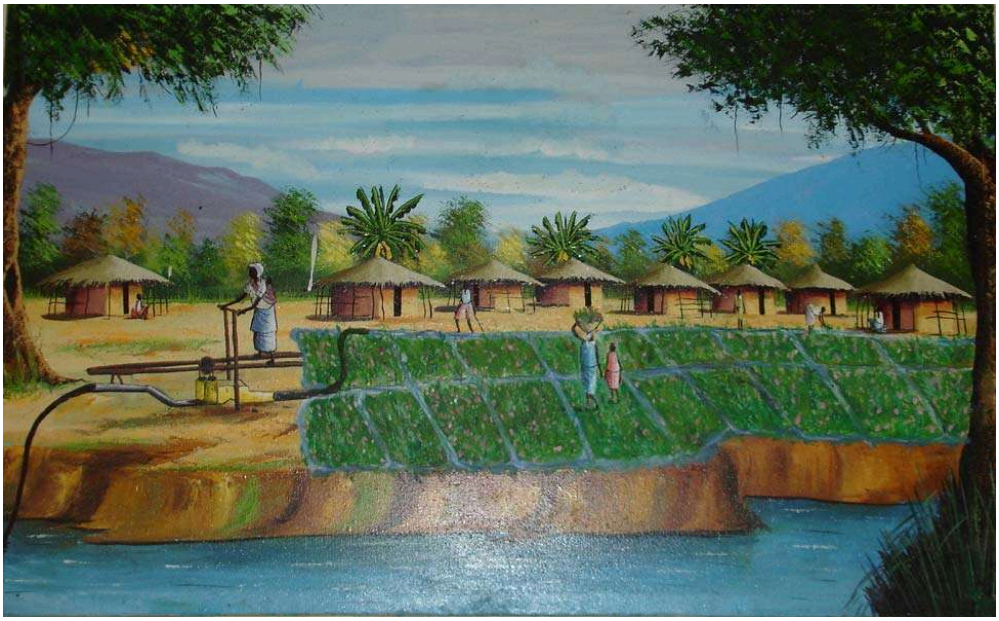
Winrock International
Farmer-to-Farmer Program

WINROCK INTERNATIONAL
Putting Ideas to Work

Smallholder Market Creation Project

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Declaimer

This report represents the insight of a short term volunteer consultant into the Smallholder Market Creation Project. As with all such consultations there was not enough time to meet with everyone involved or collaborating with the Project. The evaluation therefore has to be viewed in terms of the limited visits and interviews made and the information derived from them. This could result in some inaccurate statement, interpretations and excessive extrapolations. None of these are intended, but often can not be avoided. When this has occurred, please accept the consultant's apology and please advise him of any erroneous interpretations or omitted information. Also, the ideas and concepts expressed in this report are the author's who is solely responsible for the contents. The opinions are not necessarily those of IDE, SMC, Winrock International, or USAID.

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List of Acronyms

ADMARC	Agriculture Development and Marketing Company
AIT	Asian Institute of Technology
CARE	International Humanitarian NGO dedicated to fighting global poverty
CD	Compact Disc
CGA	Central Growers Association
CLUSA	Cooperative League of the United States of America
CPA	Certified Public Accountant
DED	German Development Service (English Translation)
DFID	Department for International Development (UK)
EPA	Environment Protection Agency
ET	Evapotranspiration
FAO	Food and Agriculture Organization of the UN
HIV/AIDS	Human Immunity Virus/Acquired Immunity Deficiency Syndrome
IDE	International Development Enterprises
NGO	Non Government Organization
OxFam	Another international NGO similar to CARE but based out of UK
PRISM	Poverty Reduction Through Irrigation and Marketing
REAP	Rural Enterprise and Agro-Business Project
SMC	Smallholder Market Creation (Project)
T&V	Training and Visit
US	United States
USAID	United States Agency for International Development
UV	Ultra violet light
ZK	Zambian Kwacha

Executive Summary

The four week volunteer consultancy looked at all aspect of the Smallholder Market Creation Project and accompanying IDE micro irrigation project. The emphasis was on micro irrigation using treadle pumps but also involved the problem of side-selling in the market structure, capacity building and finally the possible contribution of looking at smallholder communities as symbiotic associations of producers and service providers.

Micro-Irrigation: The micro-irrigation effort is based primarily on the treadle pump. This is a simple manually operated pump designed specifically for smallholders. In Zambia over 5000 have been manufactured or imported and distributed to smallholders. Most of these have been distributed via different NGOs as part of development projects. However, a substantial number have been sold on the open market. They do have a major heavy labor component that needs to be evaluated in term of dietary energy balance to assure the operators are consuming more calories then they are exerting. Also, what are the other opportunities for this labor in terms of improved crop husbandry that will lead to higher yield or higher produce quality? There is also a need to look at the hoses and other accessories being distributed as part of the treadle pump package. The current hard poly plastic pipe is really to stiff for effective use and is detracting from the overall effectiveness of the treadle pumps. In addition, farmers are quickly graduating to motor pumps so that over half the communities visited had farmers with motor pumps. All the motor pumps were self financed and represents the availability of liquefiable assets within smallholder communities. To a large extent the graduation to motor pumps represents the success of the project. Drip irrigation is under consideration. This is okay but needs to be done with care to make certain all the conditions necessary for introducing drip irrigation are met and all the extra managerial concerns are fully understood by those interested in trying.

The water management should concentrate in small level basins and mini-terraces that run along the contours so that water can enter one side of the basin and slowly work its way across the basin without causing any erosion. The irrigation scheduling is currently twice a week, which should be adequate.

Marketing Component: Like most development projects the marketing component emphasizes farmer cooperatives and is suffering from substantial side selling, often representing a substantial majority for the market share. There is a real need to, instead of blanket condemnation of side selling, recognize that it represents a loss of competitive advantage and understand why the anticipated competitive advantage was lost and how it can be recovered. The future of donor facilitated cooperative societies may actually depend on this analysis if the cooperatives are to be sustainable beyond donor assistance.

The loss of competitive advantage can be the result for direct financial returns as when the surcharges, handling fees and transportation costs are deducted from what the cooperatives receives, the benefits to the farmers could be close what to the side traders pay in cash. There is a need for more transparent accounting going the full distance from farm gate to final processor. There appears a tendency for the

accounting to stop at the cooperative. More important might be the convenience of immediate cash payment made by side traders compared to the six weeks to three month delay when consigned to cooperatives. It appears farmers are willing to accept a 20% deduction on cooperative listed price for the immediate cash payment. Additional competitive advantage is lost when marketing via a cooperative is used for leveraged loan repayment.

There were several marketing models identified during the consultancy, these all need a detailed analysis with full farm gate to producer accounting to determine which model actually provides the smallholders with the best return. It may be that by condemning the side traders you are condemning the persons who are providing the most cost effective and convenient service to the smallholder community.

Capacity Building: Normally capacity building has been considered to be extension education through workshops and demonstrations with the assumption that the farmers have the means to utilize the technology over their entire farms. This may be a historic oversight dating back some 40 years. The real constraint might be lack of means to implement technology and this may be the major reason for slow adoption by most smallholders. The most effective capacity building may thus be enhancing the means the farmers have to manage their land. This rapidly results in access to mechanization which in Zambia would be contract access to tractors. There already appears to be a demand that is being met to a limited degree. Thus, a future project might be to purchase used 65 hp tractors being traded in by large commercial farms, reconditioning them and selling them to individuals living in smallholder communities for contracting tillage and transport to smallholders. With the HIV/AIDS epidemic having an ever increasing detrimental impact on rural labor availability, this could easily be justified in terms of HIV/AIDS impact mitigation and may be the only means of preventing an HIV/AIDS induced famine.

With more traditional capacity building the need is to look carefully at the cost effectiveness of the effort and look for ways to make the effort more cost effective. Basically, how much can you rely on the inherent smallholders understanding of crop management, and only have to concentrate on details mostly associated with quality? Also to what extent is it necessary to maintain an administrative link to each smallholder and how much can be conveyed through the media including TV? Finally, how much detail is really necessary and how much fine tuning should be anticipated and appreciated by the farmers as they integrate the target crop into their overall crop management system which may give higher priority to food security crops?

Symbiotic communities: Finally, it is suggested that instead of concentrating on farmers look more at smallholder communities and consider them a symbiotic association of smallholder producers and service providers. As a symbiotic association it might be easier to assist them by enhancing the services available to them in terms of indigenous village base enterprises for supplying input and purchasing commodities, contract tillage providers, transporters and even grain mills. Working with the concept of service providers paying particular attention to services that will substantially reduce the overall drudgery.

INTRODUCTION

International Development Enterprise (IDE) – Winrock International's Smallholder Market Creation Project (SMC) is a United States Agency for International Development (USAID) funded project that seeks poverty alleviation for smallholder producers in Zambia by creating cash crop market opportunities by enhancing the resources available to smallholders in terms of micro-irrigation systems that will allow them to produce irrigated cash crops during the dry season. The project also works to establish viable sustainable links between the farmers and the agro-industry processors such as Cheetah Zambia Ltd. that processes and exports paprika, and Dunavant Zambia Ltd. that does similar things with cotton. In this relationship IDE concentrates on providing the micro-irrigation systems based on their trademark treadle pump, while Winrock International concentrates on market creation to accommodate the expected increased production of high valued cash crops. In so doing, it recognizes that markets are the most important determinant in selecting the actual crops produced, although usually market channels are well beyond the farmers' control. The project appears to be endorsed by the Government of Zambia, but operates autonomously. The autonomy from the government could be a major reason of its overall effectiveness in assisting smallholder communities.

The volunteer consultant was engaged for four weeks to review the program paying particular attention to the micro-irrigation systems, and crop management aspects using the micro-irrigation systems. This is consistent with his qualifications as an agronomist with extensive experience with smallholder irrigation schemes, although this is the first time he has been involved with micro-irrigation systems. This was expected to lead into the project's farmer capacity building efforts. In addition, the consultant's broader understanding of smallholder agriculture was utilized.

The consultancy took place over four weeks beginning 14 May and concluding on 10 June 2005. The consultancy consisted of extensive interviews with key organizations and individuals collaborating with the Project, visiting some of the farm communities involved with the project, reviewing their irrigation and crop management activities including marketing the crops, providing a closing seminar to project personnel and invited collaborators, and providing this written report.

IRRIGATION

Irrigation Overview

When water is available irrigation offers one of the few opportunities to enhance the physical environment available to smallholders and increase the overall crop production potential. It thus addresses what, in this consultant's opinion, is the largest constraint facing smallholders – the means to increase production. Irrigation provides additional flexibility to the crop management, extends the primary growing season, often allows for an additional growing season, and stabilizes yield at a relatively high level. When effectively organized, irrigation can provide very substantial return on the investment. However, irrigation remains just one of many crop production activities and has to operate within an overall farming system in which farmers make decisions. This often results in project endorsed crops such as paprika or cotton

getting a lower than desired priority. The higher priority is usually given to subsistence crops such as maize with its major impact on family food security. Such decisions by the farmers must be respected as part of their overall decision making in trying to ***maximize their total returns to all crop enterprises, rather than maximum yield of any individual enterprise***. This usually means maximizing the returns to their labor resources over returns to the land resource. The latter being the basis of most agronomic recommendations.

In the context of this project, irrigation is defined as micro-irrigation by which is meant individual farm irrigation. This is good as it requires no organizational interaction with neighbors or more distant users as is the case of large irrigation schemes including informal schemes that farmers construct themselves, but require sharing the water resource down a canal. However, it does limit the irrigation to those farmers with riparian (directly adjacent) access to water. This limits the total irrigation command area which could be well below the potential command area as determined by the available water. It also limits the number of community members that can directly benefit from the micro irrigation. Non riparian benefits would be limited to casual labor opportunities resulting from irrigated crop production or services provided to the riparian farmers. In addition water can come from groundwater via reasonable yielding wells including bore holes.

Micro-Irrigation Systems

Treadle Pump

The micro or individual farm irrigation system promoted by the project is basically the treadle pump. This is a manually foot operated pump in which the operator alternates stepping on two foot levers that activate a pair of cylinders (Fig. 1). These pumps are capable of lifting water a total of 10 to 12 meters with the intake limited to a maximum lift of eight meters, the normal limit of suction pumps as vacuum will break at one atmosphere of lift. The discharge can then be the balance between the intake lift and 12 meters which is the maximum a person can comfortably pull and push a two inch column of water.

The lift or head is the net lift between the static water level of the water source and discharge level from the end of the pipe. The depth of the intake pipe below the static water level is not counted, nor is peak height of any pipe having a U-turn and coming down the slope. The down slope section is convened by siphon action. However, the height the operator holds the pipe above the ground is part of the total lift and often represents unnecessary lift.

Using the treadle pump an individual can irrigate about one lima, the Zambian unit for land (0.25 ha), in about four hours. The expectation is the pumps will be used primarily in the dry season for additional cash crops. However, it does not preclude the use in the rainy season to provide supplemental irrigation during dry spells. That is to those fields sufficiently close to the water supply to be within command of treadle pumps. It must be recognized that substantial yield increases can be obtained for well timed supplemental water applications during lulls in the rains as was

demonstrated by an experiment conducted by IDE at the Cotton Development Trust in Mazabuka.



Fig. 1. Young women using a treadle pump to lift water from a well to irrigated vegetables.

Background of Treadle pumps: Treadle pumps were developed as a simple low cost easily operated pump and designed intentionally for use by smallholders. The expectation would be the cost could be kept sufficiently low that smallholders could easily afford them with the limited financial resources they are considered to have available, particularly when offered on credit through a development project such as IDE's. They appear to form the major worldwide effort of IDE development projects. They have promoted their use in many countries most noticeably in India and Bangladesh. There are many variations of the basic design including some done in Zambia. However, the fundamentals remain basically the same. There appears to have been several hundred thousand manufactured and distributed internationally. In Zambia, IDE is one of several NGOs promoting and distributing treadle pumps. Others include CARE, OxFam, PRISM, etc.

Distribution of Treadle Pumps: In Zambia the treadle pumps appear to be distributed primarily via IDE or other donor funded assistance projects. In their initial effort IDE established a supply chain of 16 retail shops throughout the five provinces they were involved with. This included some 20 manufactures that ultimately produced and distributed some 5000 units. The question is how many have been distributed through donor projects and how many were sold on the open market. The primary manufacturer in Lusaka, who over the past five years has made some 1500 units, has provided all units to IDE and claimed very few side sales or interest in side sales. While a large independent demand for treadle pumps would be a ringing endorsement

of the technology, the lack of such demand can only be taken as a neutral statement, but one of concern. The need is to distinguish if the treadle pump is the current donor fade or a durable sustainable technical innovation for the smallholders. It would be nice to see treadle pumps made more available through more commercial outlets to get a measure of the spontaneous demand. It was noticed in Kabwe that the local IDE office had provide a treadle pump to a commercial farm supplier for open sale. It had been on display for six weeks without a buyer. It is understood that earlier in the project there was extensive side-selling of pumps by manufactures at an estimated rate of 300 units per year. To some extent development projects are only as good as what they can spontaneously spin-off, and thus the need to continuously evaluate the extent of side selling to estimate the spontaneous demand for the technical innovation. There does seem to be a resale value, as farmers who have acquired more than one have easily sold the used ones. One farmer acknowledged have obtained a total of four treadle pumps and sold off two. In Lusaka several importers and distributors did acknowledge some side selling to individuals. However, a substantial majority were purchased by NGOs such as those listed above.

Labor Concern: One of the basic premises on which the treadle pumps were designed and distributed was that labor was readily available within a smallholder community. This consultant would like this revisited and confirmed. Underlying this concern is the basic premise that has guided donor efforts to assist smallholders over the past 40 years, and the limitations of research agronomists' efforts. The agronomists, including this consultant, working with small plot techniques effectively evaluate their technology advancements only against the physical environment, basically temperature, water, and soils. They do not develop an appreciation for the means required to extend the technology from a small plot to the entire farm. Instead, they basically assume the means are there. The failure to consider the availability of the means to extend technology from small plot to the entire farm could be a major reason for the slow adoption rate on many technologies intended for smallholder benefit, particularly those with a high labor component, as will be discussed later under capacity building.

The consultant's concern for labor shortages among smallholders is greatest for the main rainy season crops when farmers struggle to cultivate all possible land. It should be substantially less a problem for the dry season crops with the much reduced cultivation area as envisioned as the primary use of the treadle pump. However, it may still be something worth reconsidering in terms of the amount of drudgery involved in operating the treadle pump, and the other opportunities for this labor including an appreciation for the extensive time and effort that has to be committed to domestic tasks just to maintain the family.

While operating a treadle pump has some elements of drudgery, it may not be as severe as this consultant anticipated before arriving. However, it might be good to make a dietary energy balance analysis to make certain the operators are consuming as much caloric energy as they are exerting when pumping. If they are not, there could be some major weight loss or early fatigue necessitating early quitting. This could become a growing concern as the HIV/AID epidemic continues to adversely impact the rural labor supply. At this point it would require a nutritionist to complete the evaluation. One approach is to estimate what is the recovery time an individual

takes between irrigation days. Can workers operate a treadle pump for four hours on consecutive days, or do they require one or more days rest or lighter duties between successively operating the treadle pump?

The other labor issue is opportunity for more economically rewarding activities, which could represent a better economic return for the time and effort extended. It must be recognized that economic well being is based more on the returns to labor than the fact of labor. The question is would smallholders rather spend their time or hired labor's time manually pumping water, that has an opportunity for further mechanization, or expanding the area being cultivated and/or providing better management to their crops in terms of weed control, pruning excess vegetation, and other activities that can contribute to both yield and enhanced quality? Quality is often a major problem for smallholders producing high value crops such as paprika and fresh vegetables and competing with more commercial farmers. It was noticed in the communities visited that farmers who had graduated to motor pumps were able to nearly double the irrigated command area, expanding both up the slope and parallel to the slope. The increase was from one lima to two or more limas.

It should also be noted that farmers are often hiring laborers to operate the treadle pump. The prevailing rate quoted by one farmer is ZK 100,000 per month for each of two young men to manage the bi-weekly irrigation. They would switch off between operating the pump and distributing the water to the plants or small basins.

Accessories: When the pumps are distributed to the farmers the package includes hard poly plastic pipe attachments for the intake and discharge connections. It might be desirable to take another look at the pipes provided with the treadle pumps compared with other hoses and pipes that are available in Zambia or could be easily imported and made available. The poly plastic pipes being distributed are really too stiff requiring a large turning radius, approximately two meters or more. This makes it particularly difficult to lower them in well and make a reasonable connection to the pump. One farmer who had operated a treadle pump for four years converted the intake side of the pump to steel pipes with a solid elbow to make the turn from vertical to horizontal before attaching the pipe to the pump intake. This also resulted in this treadle pump being permanently fixed in one place. Also, on the discharge side the pipes are difficult to maneuver over the fields with the two meter U-turns in the pipe forcing the pipe to be dragged through basins and increasing the prospects of damaging the crops (Fig. 2). Alternatively, it results in numerous splices in the pipes and jerry rigged connections that result in considerable leakage and friction losses (Fig. 3- 6). This will require extra effort to pump more water and reduces the total distance up the slope the irrigated area can extend. Also, the final discharge is really too great for individual plant irrigation and needs to be conveniently divided into some units.

It might be desirable to review all the possible pipe and hoses available and bring a couple farmers in to review what they think would be the best combination. A couple farmers visited had already obtained other more flexible hoses that can U-turn without kinks in a 60 to 70 cm radius and easily be confined to normal field access paths. A visit to different shops and business in Lusaka found no more suitable pipes. Those available were nearly six times more expensive than the poly-pipe. Given the total

number of treadle pumps being distributed by NGOs in Zambia an external search is warranted to see what might be imported in sufficient quantity to justify the costs. If there are 5000 treadle pumps distributed and used in Zambia and each being distributed with 100 meters of hose, the total demand should be 500 km of pipe/hose. That should fill enough 40 foot containers to justify the import costs and get an improved hose commercially available in Zambia. In a following visit to a shop in Iringa, Tanzania the consultant did find a more flexible plastic two inch hose that could be used without kinking as much as the lay flat pipe. This should also be available from South Africa. In the meantime those distributing the pumps should advise the farmers of the options available for pipes and the costs associated with each option and allow the farmers the final decision. Meanwhile, the hard poly-plastic pipe is a distraction from the overall effectiveness of the treadle pumps.



Fig. 2. The hard poly plastic pipe looped into a crop basin and damaging crops as it is pulled down the path.



Fig. 3. Poly plastic pipe jerry-rigged into a steel pipe T-junction and then into smaller hoses for distribution to the plants.



Fig. 4. Rigid poly plastic pipe cut into two to three meter sections that have to be spliced together to get up the hill and disconnected as one irrigates down the hill.



Fig. 5. Lay flat plastic pipe also has difficulty in developing flow restricting kinks when cornering.

Farmer Innovations: In managing any innovation it is always good to keep track of the innovative manner farmers use the equipment. It is no different with the treadle pumps. The case in point is one farmer who mounted the pump on top of an above ground water storage tank (Fig. 7). He then pumps water from a well into the storage tank and irrigates from the tank. It does result in a precarious perch on top of the tank that may require some engineering adjustments to make it safer and easier to use. Other innovative uses can be expected and need to be noted and when appropriate design adjustments to accommodate them.



Fig 6. A better hose is a reinforced rubber hose that can make a U-turn in about 60 cm without kinking and fit into a normal field path.



Fig. 7. Treadle pump mounted on top of storage tank. The farmer then pumps water from the well in foreground into storage tank and irrigates from the tank to his fields.

Future of Treadle pumps: The future of treadle pumps in Zambia may be restricted to two major cases. The first would be areas where water is reasonably scarce such as shallow well that do not yield sufficient water to irrigate more than one lima without the drawdown in the water table exceeding the suction limits of the pump. These farmers would make the most continuous use of treadle pumps as noted by the farmer in the Lubombo in Southern Province who had been using a treadle pump for four years. It could also occur with dambo irrigation in which the water becomes progressively scarcer as the dry season advances and the number of farmers and irrigated

area expands so farmers can no longer irrigate enough land to justify a motor pump.

The other case would be the treadle pump as an initial pump replacing carrying bucket of water from dambo or wells to fields in areas where water appears to be plentiful (Fig 8). This would be the more typical case of dambo irrigation but also include high yielding wells such as those punched into gravel aquifers. In these cases the farmers will graduate to motor pumps as fast as possible, as did the neighboring farmer to that shown in Figure 8. Such graduations should be viewed as a positive impact of the project. The graduation to motor pumps can take place in as short as one year if the irrigated crop is plentiful and the farmer receives a good price. It could also be delayed to up to four or five years for those less fortunate or less careful in managing their assets. Once a motor pump is obtained the treadle pump is often retained as a backup in case there are mechanical problems with the motor pump or lack of fuel. The latter due to either, lack of funds, or lack of opportunity to get to town to make the fuel purchase.



Fig. 8. Lifting water with buckets from stream for application to vegetables. In this case the stream is waste water.

Motor Pumps

Smallholder Use of Motor Pumps: In most smallholder communities the consultant is familiar with, which require lifting irrigation water at the individual farm, the lifting is done with motor pumps. This includes virtually all of Egypt, where the government deliberately delivers water below the soil surface in rather erroneous expectation that by requiring farmers to lift water they will use less. While in Egypt lifting water was historically done by animal operated saquias, by 1991 virtually all farmers had converted to low the lift diesel pumps, such as the single cylinder Lister - Petter engines made in India.

Another, perhaps more relevant example for Zambia would be Dalat, Viet Nam (Fig. 9). This is high elevation temperate vegetable growing area that serves Ho Chi Minh City. As in Zambia most of the water is lifted from small streams with check structures and pumped to the respective fields. However, the lift is considerable more than can be managed with treadle pumps.



Fig. 9. Panoramic view of vegetable production in Dalat, Viet Nam that is irrigated by individual pumps from the stream in the center of the photo. The buildings along the stream are permanent pump houses.

Also, throughout much of Southeast Asia, where the water buffalo has been retired in favor of the rice power tiller, low lift irrigation pumping is usually done with a pump developed during the Viet Nam war based on reversing the propeller of the long shafted outboards used extensively in Thailand and Viet Nam. Most of these pumps are now powered by a belt drive to the power tillers (Fig. 10).



Fig. 10. A low lift pump in Thailand connected by belt drive to rice power tiller.

Implication for Zambia and IDE: Thus, for Zambia and the IDE project, the expectation has to be that when water is available in reasonable quantities for the entire dry season, the treadle pumps will give way to motor pumps as quickly as possible. This was readily observed during the field visits. In over 50% of the communities visited there was at least one farmer with a motor pump. The project can appropriately take credit for stimulating the initial irrigation that led to this advancement. It is a major indicator the project has addressed a critical concern of the farmers and the sustainable success of the project. The shift to motor pumps appears to allow the farmers to double their irrigated area from one to two or more lima. It also allows the labor used for pumping to be used for other crop husbandry activities that will enhance yield or quality, or if the pump operators were hired the labor costs will be saved. Perhaps, the conditions noted in the FAO report that advocated Zambia as the ideal place to promote treadle pumps in Africa, overlooked the same conditions would equally promote rapid graduation to motor pumps.

Available Pumps: During the field visits two types of motor pumps were found. The first was single cylinder Lister - Petter pump manufactured in India that was virtually identical to those used throughout the Nile Delta of Egypt (Fig 11) including the small trolley for moving them around. The major difference in the Zambia version was the centrifugal pump component was of smaller diameter reflecting the increase lifting required from 1.5 meters in Egypt to up to eight meters or more in Zambia. The unit observed was actually set in a trench that would lower it nearly one meter to access the well water without breaking the vacuum, implying the water table and pumping draw down approaching eight meter during most pumping. The water was then lifted to the storage tank shown in Figure 7. The farmer had purchased the pump from another farmer who said the diesel was too heavy for ease



Fig. 11. Diesel pump installed in a trench for lifting water from well to the storage tank shown in Figure 7.

movement. Something that was important for security reason. The purchasing farmer had a more secure placement near his home to install the pump with little need for moving.

By far the more common motor pumps seen were small gasoline pumps, for which Honda was the most common brand (Fig.12). However, cheaper Chinese manufactured pumps were becoming popular. Both of the gasoline pumps could easily be carried by one or two people from home to well or dambo as needed. They could easily irrigate two lima.



Fig. 12. Typical small gasoline engine motor pump replacing treadle pumps as funds become available.

Pump Finance: The big question with the motor pumps is how were the farmers able to finance them? It shows the prospects that there may be more capital assets within smallholder communities than normally considered, which raises the concept as to how essential are micro-credits projects. Apparently, Zambian farmers like their American compatriots can talk a cash poor game while holding liquefiable assets that can quickly be converted when needed. It might be interesting to conduct a small study to determine how farmers financed the pump purchases. It could simply be a quick purchase when flush with cash from sale of vegetables such as cabbages as one farmer claimed or by selling a bull as another farmer did. It may also be more complicated such as revolving credit clubs that are common in smallholder communities, borrowing from friends and relatives, the always available informal credit system, or other borrowing mechanisms. To some extent the graduation to motor pumps is what appears to be an impoverished community indicates “where there is a will there is often a way”. It might be worth noting that financing a motor pump is an order of magnitude easier than the Asian power tiller farmers purchased in the Tanzanian when the consultant returned to visit his previous project immediately following the consultancy. There, some 50 power tillers had been purchased by farmers during my four year absence with only 13 financed through institutional credit.

Drip Irrigation

Overview: The other form of micro irrigation being considered by the project is drip irrigation. Drip irrigation is normally not associated with smallholder irrigation. The exception the consultant is familiar with is Jordan and Iraq. In Iraq drip irrigation is common in the south near Basra for tomatoes that are established in temperatures exceeding 40 C˚ and water comes from dug wells sufficiently deep to require placing the pumps near the bottom of the well and considerably deeper than shown in Figure 11. Drip irrigation enjoys a tremendous ideological appeal from donors, governments and natural resource conservationists, etc. for the potential to reduce water use. This is correct and when properly used and under the correct situations drip can save 30% or more water relative to sprinkler systems and even more compared to surface irrigation. However, drip irrigation for water saving only becomes viable when the minimum water application of the alternative methods of irrigation such as surface or sprinkler is greater than the crop water needs. When this is not the case the water savings advantage of drip is lost. For this reason the advantage of drip is usually associated with incomplete canopy crops such as vegetables, fruit trees and vineyards. This is because the precision application to the individual plants eliminates the surface evaporation from soil surface where there is no transpiration demand. Drip quickly loses its water conservation advantage for full canopy crops, and often has difficulty keeping up with the total evapotranspiration demand of such crops, particularly during the periodic heat waves when the ET rates rapidly increase.

Drip irrigation can have some extra benefits in improved access to fields. Large vegetable farmers shifting to drip in response to high water costs appreciated the continuous access to the fields for frequent picking of cucumbers and other similar vegetables without having to wait a couple days for the fields to dry as is necessary with surface or sprinkler irrigation. Also, it can be easily used on undulating or sloping lands that can not easily be shaped for surface irrigation or accessed by self propelled sprinkler systems. It can also have added advantages for crops such as grapes that are sensitive to mildews and other diseases that are promoted by high canopy humidity. Finally for tree crops such as bananas the micro-sprinkler systems will allow farmers to irrigate under the canopy with applications similar to sprinkler applications.

Water users are also ideologically interested in drip irrigation to save water but they have the task of integrating the drip system into the rest of their overall crop management activities. This can result in their concern for water conservation becoming considerably less and perhaps far more local. Consistent with their overall outlook as individual entrepreneurs, their concern for water conservation really only extends to their immediate farm situation, with little interest in other farmers within the same dambo, let alone more remote water users and national water master plans. Farmers also have to be concerned with costs, time and effort to manage the system, as well as the extra care that may be required in working around the drip lines for weeding, harvesting and other field activities. This can make drip irrigation a difficult sell except under situation of immediate water shortages. This may have contributed to, with one exception, the only drip irrigation observed during the field visits was in demonstrations. The exception was a large farmer using micro-sprinklers for bananas near Ndola. He had a micro sprinkler between every square of

four banana plants. The main advantage was irrigating under the canopy. It might also be noted that major recent shifts in irrigation water saving in Colorado, going from siphon tubes to gated pipes, then center pivots, and now some buried drip was motivated more by labor savings than water saving. The water savings and opportunity to earn addition income by "renting" the surplus water was a nice by-product.

Available Equipment: There is drip equipment being manufactured and available in Zambia, and it appears to be appropriate. The emitters based on a design the manufacture obtained from his native India are basically very simple with an individual emitter adjustment by simply tightening the loop (Fig. 13). This could be a model for the US and other developed countries relying on more complex emitters for pressure compensation.



Fig. 13. Indian designed drip emitter being manufactured in Lusaka. By simply looping the tubing though the supporting stake it is possible to regulate the flow from individual emitters.

Using Drip Irrigation: For all the potential water savings drip irrigation offers, it has some additional management concerns that increases the operational costs and/or labor requirements, and reduces its overall competitiveness. The most important of these is water quality. Initially the biggest concern is sedimentation in the water plugging the emitters. This would be a major concern for water pumped from dambos that could contain fine sediments, algae or other suspended debris. It would be a lesser concern, but still something that needs consideration, for water pumped from wells. In normal commercial drip irrigation the sediment and other debris is removed by large sand filters which require changing every couple years, even when the water is good quality well water. In Zambia the small in-line filters being offered with the drip kits may not be adequate unless the water is exceptionally free of sediment. The life of these small filters can be enhances by pumping water from the source into some form of storage tank, allowing it to settle at least overnight to allow all the sand and silt to settle before irrigating. It would not allow for all the clay particles to settle, but they are too small to block the emitters. It was noticed that the

one farmer operating with a storage tank did have sediment free water at least as well as this could be visually observed after settling overnight. A settlement tank would not remove algae or other floating material that could plug emitters. These will have to be captured in the small filter and require the filter be cleaned after each use.

Once the sediment and other debris in the water has been taken care of, the next problem is algae developing around the emitter outlets and plugging them, particularly those laying on the surface and exposed to sunlight. This is developed from the algae normally found in the soil and is different from the algae in the dambo water plugging emitters. To remove the algae it is normally necessary to flush a surface drip system occasionally with chlorine to kill the algae. This can normally be done with Clorox or other readily available household bleach. The system then has to be flushed with plain water to leach the Cl^- from the soil.

Another problem would be calcification around the emitters that forms a crust and again plugs the emitters. Calcification is a major concern when the water source, particularly well water, contains large amounts of Ca^{+2} or Mg^{+2} bicarbonate that precipitate as oxides when exposed to air as it emerges from the emitter. This is the same material that accumulates on kettles, pots, pans and plumbing fixtures. This appears to have already been noticed in some parts of Zambia according to the comments during the seminar. In cases where calcification is occurring, it is necessary to periodically flush the system with acid to dissolve the crust and allows the Ca and Mg to move away from the emitters and ultimately contribute to soil fertility. In the US this is normally done with sulfuric acid. However, in Zambia it might be possible to simply add a bottle of vinegar to the settling tank periodically. It is important that this be done before the emitters become fully plugged as once plugged it will be very difficult for the vinegar to be effective.

In a similar manner drip irrigation, with its minimum precise applications, does not allow for sufficient leaching of salts contained in the irrigation water. Thus, depending on the conductivity of the water, salts in the soils can build up over time. This could become a problem with long term drip use, unless there is a substantial rainy season as there is in Zambia to leach out the salt accumulations.

Another problem with drip, particularly when exposed on the soil surface, is the plastic will interact with UV component of sunlight. This slowly changes the molecular structure of the plastic and makes it brittle. Typically, exposed drip lines have to be replaced on an annual or biannual basis. This can become expensive and reduce the overall competitiveness of drip irrigation. The life of a drip line can be prolonged by covering the line with banana leaves or other cover material that will shade it from the sun. This would also reduce some of the weed growth around the emitters. However, this is not commonly done. There can be considerable difference in the use life of drip equipment depending on the quality of the plastic used. In Iraq the locally manufactured drip material had to be replaced each year, while the imported materials would last two to three years. The frequent need to dispose of all the plastic drip lines and equipment creates a minor environment hazard as the plastic does not quickly bio-degrade and tends to become a eyesore in dump areas.

Finally, drip systems with all the emitters and lines over the field result in a more meticulous and time consuming effort for weeding and other field activities (Fig. 14). This is even more complicated by weeds normally concentrating around the emitters stimulated by the extra water. The larger the area the more the labor supply will be stretched which could lead to decreasing yields and or quality. The extra labor required to work around drip lines is actually an indirect cost that normally is not included in the labor costs of operating a drip system. However, it is a reoccurring cost that is repeated with each field activity. The need to work around drip lines will also reduce the potential for any kind of mechanization including animal mechanization and hand tractors. As an indirect cost the extra labor requirements are often overlooked except by the farmers who quickly recognize the problem. How these additional time and costs compare with the reduced drudgery of not having to pump as much water and the potential to expand the cultivated area is something only the farmers can sort out in their acceptance and continued use of drip systems.



Fig. 14. A precisely laid drip demonstration that requires meticulous and time consuming weeding, etc.

Future of Drip for Smallholder in Zambia: With the additional costs of purchasing and operating drip systems, drip systems in Zambia may have a limited niche market. It will most likely be restricted to areas with highly limited water supply such as in the Southern Province and similar areas where irrigation water comes from moderately yielding wells. It would then allow farmers to expand their irrigated areas from one to two limas. It would also require pumping water from wells to storage tanks, allowing it to settle overnight before being released to the crops. The storage tank representing an extra cost not normally considered in drip promotions and the kits supplied. In areas with higher yielding wells or irrigation from dambos the water most likely will not be scarce enough to justify the extra cost or time and effort needed for managing drip systems. Farmers might initially try them, but could shortly give them up simply by not replacing the system when exposure to UV light renders it too brittle for continued use. Ultimately, drip irrigation is worth considering, demonstrating, promoting and even providing credit, but it will require

full disclosure of all the extra direct and indirect costs. Farmers should also not be leveraged into agreeing to accept drip systems.

Water Resources

A Finite Resource

Irrigation is only possible to the extent the water resources are available. Thus any discussion on irrigation including micro irrigation has to include some discussion on water resources. In Zambia the water resources for micro irrigation is primarily surface water contained in dambos and ground water obtained from wells including bore holes. The important issue in looking at both these water resources is to remember that eventually water becomes very finite and in demand for different uses both locally and down stream. Thus, while it is hard to complain about an individual small water extraction, eventually the sum of many small extractions will amount to a considerable amount of water.

An example of how finite water can be and how difficult it is to supervise its use can be seen in the Usangu Plain in southern Tanzania, not far from the Zambia border. The Usangu Plain is in the upper catchment of the Ruaha River which is supposed to provide water to the Ruaha National Park for the wildlife and continue to a large reservoir for power generation and municipal use in the capital Dar Es Salaam some 800 km from the Usangu Plain. As the river seemed to be drying up earlier each year an international consulting firm was contracted to make a hydrological study of the Plain. The study quickly showed that in addition to the four public sector irrigation schemes totaling 12,000 ha, there were numerous smaller informal schemes totaling nearly 30,000 ha for a total of 42,000 ha of rice. Most were 100 ha or less. None were taking much water, but the total diversion was enough to dry the river. This represents an impossible administrative task to curtail with the limited resources available to the government. The small schemes are highly remote and outside the range most civil servants are willing to go as frequently as needed for successful enforcement. Also, it is hard to imagine a civil servant with much enthusiasm to curtail some poor farmers' efforts to improve their economic well being in order to protect the wildlife in a national park mostly enjoyed by foreign tourists. More likely the enforcement will provide the civil servants an opportunity to collect some informal unreceipted fines from the poor farmers with the expectation that as soon as the civil servants depart the water will be turned back on until the next visit.

In Zambia a quick idea of how much water is being removed by dambo irrigation would be to consider the potential evapotranspiration (ET) during a six month dry season to be one meter. Thus for each square meter of irrigated land it will require a net extraction of one cubic meter of water. Most likely considerably more water will be lifted, but the excess will ultimately return to the water source via underground seepage.

Dambos and Surface Water

It is expected that the most common water resource for micro irrigation will be dambos. These are wet lands, normally associated with streams. However, for

various reasons the dambos are usually enlarged streams more consistent with marshes or swamps than clearly defined streams. Although at the center it is possible to discern a slow moving stream, particularly when a road causeway has been built through a dambo and the water flow is restricted to culverts under the causeway. The dambos are typically full of reeds and other vegetation with little actual surface water visible (Fig. 15). The presence of reeds and other vegetation implies a water depth of only 50 cm or less. With the potential total ET for the dry season estimate at one meter the implication is that irrigated command area for a dambo would only be 50% of the area of the dambo. However, there should be some readily available additional water in the saturated soil just below the surface that could be easily accessed by shallow temporary wells and trenches dug into the dambo leading the water to the extraction point of the treadle or motor pump.



Fig. 15. Using a treadle pump to extract water from a dambo composed mostly of tall reeds with little visible surface water.

While at present the dambos appear to have enough water to support the current irrigation command areas, as irrigation expands the availability of water could become a major concern. Unfortunately, dambos represent a communal resource and as such will, as with other communal resources, become subjected to the "tragedy of the commons". This is a concept originally applied to communal grazing lands in which each farmer operating as an individual entrepreneur derives maximum benefit from the communal grazing land by crowding as many animals onto the area as possible without regards to the animals overall physical condition or impact on the long term carrying capacity of the communal lands. For dambo irrigation the implication is that those who grab the water first get the most water and most benefits. This will encourage expanding the command area and concentrating on early quick crops such as rape, to the determinant of longer season perhaps higher valued crops, but will risk running out of water at the end of the dry season.

Also, as dambo irrigation continues to expand it will eventually make a noticeable impact on national water supply. Thus there is a need for a national master planning as it would relate to reduction in water currently seeping out of dambos and being

used for other purposes. While such a water master plan is well outside the scope of this project, the situation needs to be carefully monitored by the appropriate government ministry and water planning agency. However, enforcing and curtailing dambo irrigation could be as challenging as curtailing the informal irrigation in Tanzania's Usangu Plain. While at present their appears plenty of water the Government of Zambia needs a master plan for water use and the amount of water available for irrigation relative to other needs.

Irrigating With Waste Water

Another source of surface irrigation water is waste water. Waste water was being used in one field visit. There are four concerns with using waste water that need to at least be thought about, but normally do not present a major problem. In Eastern Colorado 100% of the waste water is treated to an agriculture standard and released for irrigation use. This has been going on quietly for decades with no published harmful effects. In Eastern Colorado where the rivers are diverted to a dry stream bed multiple times into the irrigation system there is just no other place for the waste water to go. Colorado and the US Environment Protection Agency (EPA) have well defined standards that are easily obtainable. The Colorado standards are included on the CD resulting from this consultancy. It should also be noted that diverting waste water into the irrigation system tends to improve the quality of the return flow. This implies that more contaminants are removed through the irrigation application than being added, which is in contrast to conventional wisdom that blames agricultural runoff for much of the stream contamination.

The four major concerns to think about are:

1. the nutrient load,
2. the toxin load,
3. the human pathogens, and
4. direct contact with pathogens by the operators

The nutrient load is the extra plant nutrients in the waste water compared to natural stream water. These include virtually all the major and intermediate plant nutrients including Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Sulfur. These are all beneficial to most crops and represent potential savings in fertilizer costs. Of particularly note would be Phosphorus, which is often used in detergents and released into the waste water in relatively larger quantities compared to other nutrient elements.

The toxin load is those elements that in high concentration are toxic to plants. They can normally be divided into light elements and heavy metals. The light elements would be mostly Sodium and Chlorine. They come from the salt people apply to their food and the preservatives used in processed food. The chlorine as an anion is usually leached out so it is rarely a major problem. The sodium can be a bigger problem in large quantities as it potentially could lead to sodic conditions developing in the soil. However, usually the soil can adsorb many years of sodium applications at the levels contained in waste water before becoming sufficiently saturated to approach sodic conditions. Sodium represents a concern that needs monitoring, but is not normally

restrictive, unless the soils already have a high pH and sodium content. The heavy metals are normally a result of industrial waste more then domestic or municipal waste. However, most of them will be accumulate in the soil. The exception is Mercury, which can accumulate in water and sediments at the bottom of the dambos. It is possible to develop a toxic metal load capacity for soils and there are environment standards established for this, but usually this is many years away. In both cases this is a concern that needs to be monitored but not be a cause for panic.

Human pathogens are also normally not a problem to the crop. Plants take up nutrients only in the ionic form and not molecular form. Thus most human pathogens in waste water will quickly die once applied to the soil with irrigation or remain inactive in the soil. There is some concern for human pathogens remaining on the harvest crop particularly for tuber crops, but this will be only on the surface and readily removed with normal washing, and certainly cooking. In all, from the irrigation - plant concerns, using waste water is normally not a major problem and is widely, if not quietly, done in many areas.

A bigger concern in Zambia in contrast to the US would be irrigation workers becoming exposed to typhoid and perhaps cholera from contact with waste water. This could be a major concern and when such diseases are reported in the area additional cautions may need to be taken such as wearing protective clothing including gloves and face masks, etc. However, these are rarely used by most smallholders even when available. For this reason it might be desirable to encourage some form of pump irrigation rather than bucket irrigation when waste water is used. It might also be desirable to return to the area currently using waste water for some detailed questioning about health issues and sanitation related diseases.

Using waste water does have one major advantage in that the flow is normally more stable throughout the dry season than stream and dambo water (Fig. 9). In the field visit the estimated 100 l/s was expected to remain steady and available throughout the dry season, unlike other areas where the water supply continuously declines over the dry season.

Groundwater

The other primary source of irrigation water is well water from either dug wells or tube wells. The availability of this water is highly dependent on the depth to the static water level, the drawdown curve as the water is pumped out, and the overall yield of the well. The big concern is that the water level by the end of the dry season will have dropped below the level from which suction pumps, either treadle or motor, can effectively lift water. If this happens, a trench might have to be dug to lower the pump and bring the water table back to a relative level from which water can be obtained. This is shown in Fig. 11 for the only diesel motor pump observed during the field visits. This is most likely an exceptional case in which the well has punched a gravel aquifer and has sufficiently high yield to make effective use of the motor pump.

More typically, the yield of the wells will limit the pumping to treadle pumps and require several hours pumping before the well is pumped dry to the limit of the

suction capacity of the treadle pump. At this point, pumping will have to pause while the water level recovers. This will normally take a few hours and limit the number of irrigation to at most two per day.

Another major concern would be an estimate of the total drop in water level over the dry season. Again, if a farmer is irrigating one lima from a well and the season's potential ET is one meter and there are 50% soil voids in the aquifer, a season decline of about two meters could be expected. Thus, if the static level at the beginning of the season is more than six meters the areas irrigated should be restricted. Again this would have to be done on a case-by-case basis based on previous experience on irrigated area and end of season water levels.

Water Management

Conceptual Overview

Water management is not rocket science, and no attempt should ever be made to make it rocket science. Efforts to do so have resulted in my normal opening and acknowledged provocative statement about irrigation that:

> ***More money, time, and effort has been spent by engineers, agronomists, economists and sociologists for less acceptance by users than any other crop management activity, smallholder and large alike.***

During my recently completed irrigation class I can confirm that this applies to the smallholder micro irrigators in Zambia as well as the turf managers with unlimited budgets maintaining the heavily used hybrid natural/artificial turf used for professional football fields such as Invesco Field in Denver. It is the home field for the Denver Broncos, American Football team and the Denver Rapids, the international football team in Denver.

Similarly, in an internet inquiry some years ago seeking detailed crop coefficient information I sent an inquiry asking if the person had an irrigation system that could respond to the detailed information sought. This provoked the following reply from another subscriber:

> "***Measure it with a micrometer, mark it with a grease pencil, and cut it with a chainsaw"***

Again, it is possible to compute irrigation needs far more precisely than most irrigation systems can effectively respond to. The important thing is that these statements do not necessarily reflect the limited knowledge or understanding of the water user. They have more to do with the limited flexibility different systems allow, the overall economics in which the cost of water is factored in to total farm production economics, and just plain convenience of management. In the end water management is more associated with practical experience of the user than sophisticated applications of science and engineering. This is normally about as efficient as can be expected.

Water Management for Micro-Irrigation

As the principles of water management are applied to the use of micro-irrigation in Zambia it will have to be adjusted on virtually a case-by-case basis as needed to compensate for the different topology and parcel configurations of each farm. Thus, the discussion can only be in general terms and appreciation given to an expected multitude of adjustments and fine tuning by the users. As observed during the field visits there are three main concerns with water applications. They are:

1. Field layout,
2. Available water flow and application, and
3. Scheduling.

Field Layout: There are normally three ways to apply surface irrigation water to plants. They are individual plants, furrows, and basins. All can be used, but my preference would be for small basins of approximately one to two meters wide running parallel to the contours and up to 30 meter or more in length starting in the middle of the field and stretching to the edges. The idea being that water will can enter the basin from a path in the middle of the field and flow slowly through the basin in about 10 to 15 minutes.

Developing such basins will require some micro land development to assure the basins are level or graded slightly toward the edges of the field. The need is to assure the flow of water within the basin remains laminar and does not become turbulent and erosive. This usually requires a slope of less than one percent which is difficult for most people to discern without survey instruments. Thus, basin development will require some time and may require a couple attempts. That is doing the best that can be done with the eye. Then making a trial irrigation to see how well the water flows and making some final adjustments so it will flow smoothly. Such small basins should support two or three rows of plants depending on the size of the plant and desired plant spacing. Once made, such basins are permanent and only require minor adjustment to compensate for normal soil movement associated with crop management.

It would also imply some micro terracing to level the fields from front to back (Fig. 16). Again, the important thing is that water can move smoothly over the field with no ripples or others signs of turbulence that will cause erosion. The ideal for getting from one basin to the next is to have a flexible enough hose that can U-turn in the path and move back down the slope from one basin to the next alternating across the path (Fig. 6). Alternatively, it would be possible to put a small delivery ditch down the hill that would convey water to each basin. However, this really requires an overall slope of < 1%. Slopes > 1% would normally have sufficient turbulence to cause soil erosion (Fig.17). Most farmers are already recognizing the benefits of this layout and moving in this direction. They should be encouraged to continue doing so.

Available Flow and Applications: The discharge available from both treadle pumps and motor pumps it too much for individual plant applications as some farmers wish to do. It is also too much to try to increase the pressure for crude sprinkler

application along a basin or furrow (Fig. 18). The drop size and uniformity is just to big to avoid damaging the plants, the discharge tends to spurt with the changing pressure as the pump operator shift between the two cylinders, and the uniformity of application is severely restricted with high potential for the furthest plants receiving insufficient water while those closer receive too much water. This also requires extra head to compensate for holding the hose at arm level as well as extra head to generate the sprinkler pressure. All of this requires extra exertion by the pump operator.



Fig. 16. Farmer with nicely leveled mini-terraced basins over which water can flow smoothly down the basin from one end to the next.



Fig. 17. Farmer using small conveyance ditch to supply water to individual furrows. However, the slope is just marginal with some potential for soil erosion that could lead to a substantial gulley.



Fig. 18. An attempt to restrict the flow from the discharge hose in order to generate extra pressure and sprinkle irrigate the crop with large damaging water drops.

It also would be better to avoid pumping into buckets and then distributing to individual plants (Fig 19). However, in the figure the use of buckets at the end of the pipe could be a result of limited flexibility of the poly plastic pipe as discussed earlier.



Fig. 19. Irrigating individual plants with alternating buckets at the end of the pipe from the treadle pump in Figure 1. The process requires extra exertion on the part of the person distributing the water.

It is much better to lay the pipe along the ground so water can enter and flow smoothly over the basin (Fig. 20). When the basins are properly level, this will provide a more uniform application with less damage to the plants.



Fig. 20. A more effective means of applying water by keeping the hose low and allowing the water to flow by gravity across the basins or furrows.

Irrigation Scheduling: While the science of irrigation scheduling can be highly sophisticated with all kinds of ways to measure soil moisture and evapotranspiration, few systems have sufficient flexibility to effectively utilize this detail of information. Most farmers visited are irrigating their gardens twice weekly. That is probably as good as can be expected. With what is basically a surface irrigation system you will automatically apply more water than the soil water deficit. From the consultant's experience in Egypt, where detailed analysis were made of many irrigations, it was noticed that is was nearly impossible to apply less then 10 cm of water and still get the wetting front across the field. This was done when the soil water deficit was only about seven to eight centimeters. However, it was also consistent with when the plants began showing some water stress. Since substantially more yield loss is associated with moisture stress than excess water, for non-ponded applications, farmers are fully justified to moderately over irrigate. For the micro irrigation systems utilized in this project applying excess water will have little adverse impact. The excess water will simply return to the water source via ground water movement and effectively leach any salts that might build up. The only adverse impact will be the extra effort exerted in pumping the water, and some minor leaching of mobile nutrients such as nitrate nitrogen.

It would be helpful to those applying the water to apply as little as possible during each irrigation. That can be done by observing the advancing wetting front and anticipate when it will completely advance over the basin on its own without additional water being applied. At that point move the hose to the next basin and allow the wetting front to equilibrate on it own. It will take a couple tries to master this technique.

MARKETING COMPONENT

Overview

The marketing channels probably represent the single most important determinant of a smallholder farming system. It is the primary factor selecting from the crops that are permitted by the physical environment those that are actually produced. Unfortunately, the farmers, particularly smallholders, rarely have any control over their markets. The project's attempt to develop and promote sustainable links between smallholders and markets is a noble one. The question remains, what is the most cost effective link that will assure the smallholder producers the best returns on their efforts? In the development community over the past 20 years or more the resounding answer has been farmer organizations. This consultant has severe reservations with this approach and the field visits have only served to reinforce these reservations. The reservations are based on his experience with the very limited times donor promoted farmer organizations have been able to remain active and viable beyond the period of donor funding and facilitation.

Farmer Organizations

Farmer organizations have a tremendous ideology appeal from the donors and expatriate facilitators assisting the implementation of development projects. I actually share this ideology appeal. However, farmer organizations may make more political sense then business sense as when they become involved in economic support activities they appear to lose whatever competitive advantage they may conceptually offer to side traders.

American Model

Perhaps in evaluating farmer organizations it might be good to carefully look at the American experience and compare Farmer Associations with Farmer Cooperatives. In the US virtually every farmer no matter how large or small is a member of at least one farmer association, depending on the farm enterprises. These are normally enterprise related and would include the wheat growers' association, the organic farmers' associations, the cattlemen's association, etc. These are mostly information sharing activities centered on newsletters, magazines, and annual meetings. They also undertake political activities in representing their members to state and federal governments responsible for legislation and regulations that impact their members. They do not normally get directly involved in economic support services. Members are charged a membership fee that might be related to the volume of business they do, but that would not be associated with business funneled through the association.

The farmer cooperatives are farmer owned business organizations that do provide economic support services. Some of these are fairly large and command nation wide brand recognition. This includes Land O' Lakes the dairy product cooperative headquartered in Minnesota and Ocean Spray that deals in Cranberries with headquarters in Massachusetts. However, these tend to be the exception as cooperatives in the US command less than 30% of the agriculture market share for both produce and inputs with only the dairy cooperatives commanding the majority

share of its sector (Fig. 21). Furthermore, the long term trend for cooperatives is a declining market share and declining membership. The latter may be more associated with the overall decline in the number of farmers. Finally it should be noted that Farmland, a conglomeration of cooperatives and thus the largest cooperative entity in the country, filed for Chapter 11 Bankruptcy protection three years ago and has since been force to dissolve. Not really the best endorsement to base a development program on.

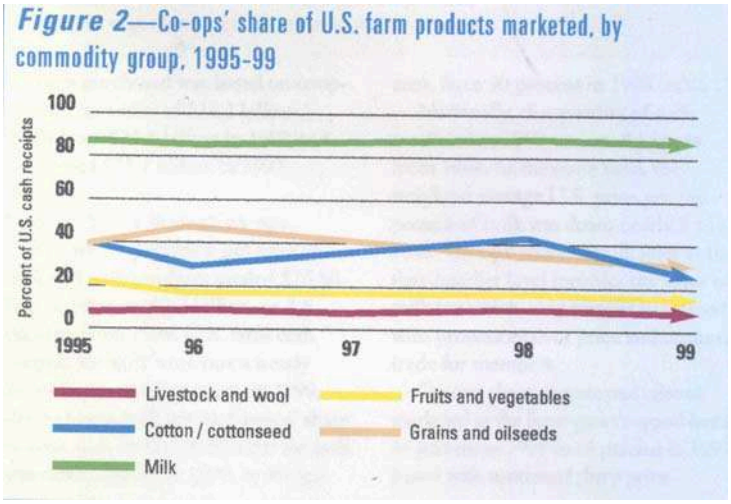


Fig. 21. Market share for cooperatives in the US

Apparently, there is something inherent in the business model of cooperatives that make them less cost effective than non-cooperative business models. Perhaps it has to do with the extra administrative processing needed for maintaining individual members account and the largely hidden costs implied by this.

It is known that in the US the cooperatives and the private companies enjoy a congenial working relationship as noted in Wray, Colorado where the local cooperative and Cargills are located directly across the street from each other and often the managers will join each other over lunch at the town's main café and discuss their mutual interest in the business of agriculture.

Critical Contribution of Cooperatives

Despite all the problems cooperatives appear to have in the developing countries and limited market share in the US, there may be one critical contribution cooperatives can make in both cases that goes back to the very origins of the cooperative movement. That role is the regulatory effect cooperatives can have on the private sector. By providing an alternative, how-be-it cumbersome, business channel cooperatives can put a check on "excessive" profits, if they exist, by the private sector, or at least an appreciation for the costs of doing business. This does not require a major market share. Perhaps as little as 15 to 20% market share is sufficient for a regulatory impact.

My best example for this comes from Malawi and interaction of a private trader with the colossal parastatal ADMARC. Perhaps on the surface does not appear to be a valid comparison, but it is this consultant's opinion that farmer cooperatives, as they operate in developing countries, are managerially closer to parastatals than private traders. The private trader could buy produce from the farmers at one tambala (0.01 Malawi Kawcha) above ADMARC's buying price and sell to millers or other agro-business including export traders at one tambala below ADMARC's selling price. In operating just outside ADMARC's buying and selling differential he could corner the market and move commodities from Chitipa in the extreme northwest near the Tanzanian and Zambia borders to Blantyre his headquarters in the South. ADMARC for all its cumbersome operations was effectively dictating the buying and selling prices of the private trader.

Application to Zambia

For Zambia as well as most developing countries it might be well to look at the American model in terms of both farmer associations and farmer cooperatives. In so doing it might be desirable to concentrate the farmer organizations on the farmer associations or, as will be discussed later, community associations, dealing mostly with information sharing and political empowerment, and leave most of the economic support services to the private traders. They are actually the ones who even now are handling most of the commodities in support of smallholders, and are the default system if the cooperatives fail.

Private Traders – Side Dealers

Fundamental to this concept is a major reconciliation with the private traders. They are normally maligned as being unscrupulous price gougers such as the following comment I received relative to this project:

> ***"… increased market opportunities to enable farmers to improve their produce (both in quality and quantity/variety) and prices by eluding unethical middlemen dictating exploitative prices to farmers will provide a conducive environment for sustained farmer participation and growth".***

An in depth analysis may show such comments are unfounded and in reality the private traders may be simply having reasonable mark-up for the services provided in what is a highly fragmented business environment in an overall financially suppressed economy. The market volume may actually be so small that even with the substantial mark-ups many private traders may be living below the international standards for poverty. Unfortunately, fragmentation is expensive and this cost ultimately rest on the smallholders. Equally unfortunate is that while many like to condemn private traders, none appears to have conducted the detailed analysis that would support the condemnation. This was well illustrated last year when between April and June 2004 a DFID sponsored E-Forum on Agriculture Development with over 500 subscribers and up to 30 years, equaling full careers of experienced professional, failed to produce one reference to inquiries requesting a cost of business comparison between the condemned private trader and the alternative donor funded farmer operated initiatives.

Bryan Cole, an earlier volunteer to the project, while not actually having time to make the analysis, did detail the various items that would need to be looked at in such a study. If would be nice to follow up on his report. A case study undertaken in Nepal by one of my AIT MSc students followed the marketing of tomatoes from the Tarai to Kathmandu. In the study the nominal tripling of the farm gate price to the consumer was mostly justified by the costs within the system with the middle men receiving an income equivalent of a mid-level civil servant, and most of the seasonal variation going to the farmers.

Lose of Competitive Advantage

Instead of general condemnation of private traders and the side trading they undertake with goods committed to cooperatives and farmer organizations, it might be better to recognize that side trading represents a loss of expected competitive advantage by the farmer organization, and the farmers exercising their options to work with the marketing channel that provide them what they consider the best competitive advantage. This could then lead to an understanding of why the competitive advantage is lost and what might be done to recover it. In reality, the long term sustainability of project promoted farmer organizations beyond donor funding and facilitation will depend on such organizations obtaining and maintaining a competitive edge over their private trader competition. If not, then the side traders will simply take over when the project ends, if not before, as they have done for decades. Competitive advantage can come in several ways, including direct financial advantage, convenience, trust, leveraged loan repayments, etc.

Direct Financial Advantage: A side trader can obtain a direct financial advantage over a farmer organization by simply offering more money such as side-buyers of paprika offering ZK 3600/kg regardless of grade compared to Cheetah's offer of ZK 34,000 for grade A with declining prices for lower grades. They can also obtain a direct financial advantage by side-stepping some of the administrative charges. Again, using Cheetah as an example, the ZK 2000 / bag transport charge and the one kilogram per bag handling charge actually gives a side seller a ZK 5000 / bag opportunity to handle the paprika and get it to the main depot with the same returns to the farmer. The ZK 5000 represents the ZK 2000 for transport and ZK 3000 as the average price per kilogram between grade A and grade B. It should also be noted that the transport charge is transparent, but the handling charge is buried in what a good CPA would consider creative accounting. That is when they openly weigh the bags then record one kilogram less. That is a bag weighing 22 kg will be recorded as weighing only 21 kg. Thus during the field tour to the buying site the recorded total purchased was 198 kg, while the real total was closer to 225 kg (Fig. 22). I am fairly certain the farmers were well aware of the financial losses credited to them and there is no need to bury this.

Similarly, the Central Growers Association (CGA) in Kabwe charging farmers 25 to 30% of their gross sales to cover overhead costs including their 13 employee's salaries and maintenance on there processing and storage facilities, is an open invitation to side selling. In this case CGA can prevent side selling for tobacco because they have monopolistic control over the selling floor in the region. However,

their other commodities may be substantially leaking to side traders. They may be better off to have membership fees independent of marketing activities.



Fig. 22. Cheetah buyer checking the grade of Papirka before weighing it for sale.

There is a need to look very carefully at the overhead costs, handling fees, and surcharges charged by farmer organizations and provide more transparent accounting of what the farmers actually receive for their goods with all these charges factored in and not stop the accounting with what the organization receives as often appears to be the case. Failing to do so would indicate the accounting is more promotional to promote the cooperative system than objective seeking the best deal for the farmer beneficiaries.

Convenience: Perhaps the biggest opportunity for side buyers is convenience. Convenience is intangible in that it is difficult to quantify, but can be of considerable importance to smallholders. In the project's market creation effort convenience is the difference between cash on delivery vs. consignment selling with delayed payment. There seems to be a nearly uniform 20% deduction by side sellers from cooperative quoted prices for an immediate cash payment. The 20% also does not include the cooperative handling fees which, when factored in, will further reduce the difference. The rather uniform 20% discount may actually be an indication of the regulatory impact of cooperatives on private traders. The payment delays are projected to be three weeks but can stretch to six weeks or even three months. This may sound too long but could represent the legitimate time it takes for the different financial transactions in Zambia in getting payments from the receiving agro-industry back through the different intermediaries and to the smallholder producer. Each transaction

may take three business days for the money to clear so the recipients can access the funds to make their payments.

The net result is that the CLUSA office in Lusaka estimated approximately 60% side selling, while the CLUSA office in Kitwe estimated that farmers only deliver an estimate of the amount of commodity needed to cover their loans and side sell the balance. It really has to be recognized that smallholders really need their cash payments. They are operating on the very margins of their cash flow and have bills to pay and perhaps informal credit accounts at 100%+ interest to settle in kind. If smallholder farmer organizations are ever going to be sustainable without donor facilitation this issue has to be addressed across the developing community, not just Zambia.

Another aspect of consignment selling is trust. Unfortunately, in smallholder communities trust is a commodity in very short supply. Smallholders have endured too many previous poor experiences with both private traders stealing crops and cooperatives with financial mismanagement.

Repayment Avoidance: Another mechanism for side buyers to obtain a competitive advantage is when cooperatives are leveraging loan repayments and link this to a specific crop to be marketed via the cooperative. I tend to have sympathy on both sides. I appreciate the need for the loan repayments, but am offended by the leveraged manner in which it is done. It has elements of distrust for the farmers and questions their inherent integrity. There may be many reasons why farmers may not want to repay their loan with the sale of the targeted crop. They may have other short term needs for the money and wish to repay their loans later from the proceeds of another crop or enterprise. It must be recognized that most smallholders are involved in multiple farm enterprises and will receive cash from other sources than the preferential crop that will allow them to make payments later. Often this could be the sale of some animals, etc. I would prefer to continue to hold farmers liable for their repayments, but provide whatever flexibility they need to make that repayment in the time frame agreed upon.

Urgent Needs

Ultimately, the project, along with all projects working with farmer organizations, needs to take a very close and detailed look at the business operations of the side buyers to make certain they are not condemning the most cost effective and convenient service providers to the smallholders. This would allow the donors to fully appreciate the services side sellers are providing, the legitimacy of their markups, and ways that they can adjust the business plan of the cooperatives to obtain the competitive edge needed for the cooperative organizations to remain sustainable beyond donor funding and facilitation. This would include getting some kind of financial estimate for the intangible of convenience for cash payments and thus the tolerance for consignment purchases with delayed payments. As mentioned previously the analysis needs to go all the way from farm gate to agro-business processor, factoring in all handling fees, surcharges, etc.

Out Grower Programs

When the consultant last visited Zambia in September 2001 there were four agro-industrial companies working with smallholders via company sponsored out-grower programs. There were AgriFlora, Amanita, Cheetah and Dunavant. All of them worked via farmer organizations rather then individual farmers. All of them also experimented in production credit for seeds and other inputs, and subsequently backed out of production credit except for seed. Of the four, AgriFlora with its high risk sensitive program of marketing specialty vegetables crops via pre-contracted air-freight to Europe has gone bankrupt. One of their problems was the high quality requirements such as baby corn that would go from immature to over ripe in one day and resulted in substantial discards that could not be determined prior to delivery to the packing shed and cause much concern with smallholders who felt they were not getting a fair return on their crops. In this case high value meant high risk and not necessarily high profit.

Amanita, working with less quality sensitive oil crops such as soybean and sunflower, were withdrawing from their out-grower program in 2001, and have now completely withdrawn. They were concerned with side selling and loan recovery. They are probably continuing to receive produce from smallholders but are doing so via ethnic Greek and Middle East traders, in essence the side sellers. They have no mechanism for tracking what may be coming from smallholders other then a general knowledge that some of the traders delivering produce are not producers and are based in areas with a large smallholder presence. Are they exploiting the smallholders?

Cheetah that deals in the quality sensitive but less perishable paprika for export continues with the most time and effort commitment to the out grower effort but it has been costly for them. They have a costly network of extension agents conducting field demonstration and training programs as well as managing buying points. To assist in the overall management of its out grower program Cheetah as obtained the services of some DED volunteers. DED is a German volunteer organization similar to the Peace Corps. This effectively provides them a management subside for their out grower program. They are also discounting the price they offer the out grower producers to assist in recovering the extension overhead costs. This increases the flexibility the side buyers have in buying Paprika. The extent of this discount could not be determined. However, the side selling remains a problem. There appears to be several price structures used by Cheetah depending on the volume, and proximity to the main facility.

Dunavant also maintains it's out grower program, but not as extensive as Cheetah mostly in terms of the extension education effort. This may result from cotton being produced in Zambia some eight years more than Paprika, and thus the quality factors are better known and less education extension effort needed. Also, cotton may not have as severe quality concerns as paprika. Dunavant's out grower program emphasizes identifying a local distributor in an area and empowering him to buy cotton with cash including loan collections. The distributor receives a commission based mostly on loan recovery rather than overall cotton purchases. The Dunavant system appears similar to Cheetah but simpler. It is also similar to my experience in

private traders in Malawi and Tanzania. With their modification they have reduced the side trading to an acceptable eight to ten percent.

Ultimately, it has to be recognized that large agro-businesses have been willing to work with smallholders, but it has been costly. All have pulled back from their original involvement with production credit and restricted their credit efforts to providing seed of their preferred varieties. Half have totally withdrawn including one going bankrupt. Those remaining are having problems recovering their costs without encouraging side trading.

Marketing Models

During the consultancy several marketing models were identified that may need a complete economic evaluation. These are:

- The normal marketing channel typified by the Sweto wholesale system in Lusaka
- The farmer organization system promoted by donors as providing the farmers a better return on their produce but seem to result in substantial side selling and thus may not have the competitive advantage expected when all factors are considered particularly convenience and direct cash payments.
- Commodity traders, who operate in rural areas from municipalities, wander into villages to purchase commodities with transport in hand. This is the means Amanita appears to utilize. They may actually be the side sellers interfering with the cooperative programs. They appear similar to the marketing mechanism used by a private trader in Malawi competing with ADMARC and those traders that appeared out of the bush and scooped up all the rice from the irrigation project I worked with in Tanzania.
- Out grower programs like Cheetah and Dunavant. Their models are similar but with some minor differences that need to be looked at.
- CARE International's REAP program that empowered Business Agents indigenous to rural communities and already doing kiosk style selling of household goods to expand into input and purchasing agriculture support services. This seems successful but the follow-up project has become bogged down in politics. The biggest problem it encountered was obtaining and maintaining the purchasing float for buying produce with cash at harvest.

All of these marketing models need a comprehensive detailed evaluation that goes all the way from what the farmer actually received to delivery of goods to the consumer or agro-industry processor. This could follow the previous volunteer consulting report of Bruce Cole or the Nepal study contained in my book, two copies of which are available to the Project. It needs to detail all the steps in each model, the costs associated with each step, and the incomes of the people involved. It needs to start with true farm gate prices factoring in any handling fees such as the transport charges and one kilogram per sack handling fee Cheetah charges, or surcharges imposed by cooperatives such as the 25 to 30% imposed by CGA. The bottom line is to see which model provides the best return for the smallholders and who, if anyone, is making an excessive profit, or is it mostly the underlying true cost of doing business in a highly

fragmented business environment. An environment in which a retailer attempts to makes her living from the markup of two 25 kg boxes of tomatoes (Fig. 23). She expects to pay ZK 45,000 per box and sell them for ZK 55,000 which when factoring other expenses will give her a days profit of ZK 15,000 or $3.50. If her income supports three or more people she would meet the international standards for poverty. It should be recognized that those models not associated with development efforts were constructed over time by businessmen with a profit motive, a large portion of which is reducing costs.



Fig. 23. Retailer in Sweto market planning to buy two boxes of tomatoes for resale from her shop in the main market.

CAPACITY BUILDING

One of the important expectations from this consultancy is input into the Project's capacity building effort. Traditionally, capacity building has meant knowledge via technology transfer using extension education programs including field demonstrations and financial capacity via institutional loans. I would like to expand that and suggest another source of capacity building that could be the most critical of all. That would be the **means** the farmers have to manage their lands. It is the opinion of this consultant that this has been overlooked by the development community for nearly 40 years and is largely responsible for the slow adoption rates of technology intended to benefit smallholders throughout the developing world.

The Means to Farm More Intensively

Means in this context are the resources the farmers need to manage their lands. This would mostly include their labor and labor substitutes such as work animals or ultimately contract access to 4-wheel tractors. While addressing this is outside the scope of the present IDE/Winrock Project it might be something worth serious consideration for future projects. It would appear to be appropriate for IDE's mandate following their emphasis on introducing treadle pumps. The treadle pump is a prime example of enhancing the farmers' means to manage their land.

Historic Oversight

As alluded to earlier with the discussion on labor, it is the opinion of this consultant that there has been a historic oversight and misdiagnosis in the development effort for smallholders dating back 40 years and persists to date. It is anchored in the way both agronomists and economists approach their specific task. In essence, the agronomists accurately observed delayed crop establishment and assumed this represented deliberate risk aversion, waiting for more assured rains, or making certain that not all the crops were affected in case of mid-season dry spells. The economists reinforced this by averaging the range of crop establishment times and concurred it was one month after the onset of the season. This led to the assumption that has guided development efforts including this project, that a substantial increase in smallholders' well being could be accomplished with the resources already available to the farmer. This could be done with an extensive extension education effort largely based on promoting earlier crop establishment. It was assumed the farmers had the means to do so.

An example would be how long it takes for the Sri Lankan couple (Fig. 24) working with hoes, similar to an African or Zambian smallholder couple, to establish 1.5 ha of paddy, although it could just as easily be maize. Most people, particularly the expatriates coming to assist with development projects and doing most of the conceptualization on how best to assist smallholders, will assume three or at most four weeks. As did those attending seminar held at the end of this consultancy. In virtually all the farming communities I have analyzed, the answer has been closer to eight weeks, and it is a continuous process from the first opportunity. Anything less, seriously risks not completing the task and substantially jeopardizing the farmer's food security for the year. This extends well after the recommended deadline for follow-up field activities or optimal yields, and resulting in returning to the earliest established fields with a severe eight week weed infestation that will have already reduced yields. Rather then being risk aversive, smallholders are mandatory risk takers, at least regarding crop establishment as their only chance at food security. Some of the longer than anticipated time for basic crop establishment could be attributed to a negative dietary energy balance in which people are consuming less calories than they are exerting with the manual land preparation resulting in weight loss or early fatigue forcing them to return home to recover early in the day while there is still ample amount of work needing urgent attention. The late morning return from the fields with fatigue also coincides with when most visiting civil servants will arrive and note the lazy, poorly motivated farmers loafing around the village. Now is

this laziness or hunger? Given the known yield loses with delayed crop establishment and the potential for this to jeopardize food security, which is more logical?



Fig. 24. Sri Lanka couple preparing their paddies with only hoes.

To carry the analysis a bit further, if you observe the paddy track (Fig. 25) you will see rice in many different stages from the field just being plowed with water buffalo, to nurseries, to transplanting, to already established transplants in the tillering stage. In total, an eight week spread in rice agronomy.



Fig. 25. Rain fed rice paddy track showing an eight week spread in crop activities.

The question is, to what extent does the early crop establishment represent:

a. A few farmers completing all their lands in the timely manner, or
b. Most farmers completing only part of their lands?

From the photo it is impossible to determine which case prevails. What is the implication of the answer in terms of extension education capacity building or facilitating enhancing the means available for the farmers to manage their lands? In

the first case, it might be necessary to have an extension education program to teach the late farmers the importance of getting things done on time. In the second case there would be no need, as the farmers already have the knowledge. The problem is they lack the means to extend it over their entire holdings. In this case, in order to assist the community it is necessary to facilitate enhancing the means to get the job done. Given the importance of food security to each family, which would be more likely?

Finally, allow me to look at the standard adoption curve (Fig. 26). To what extent does this imply adoption is discretionary on the part of the farmer?

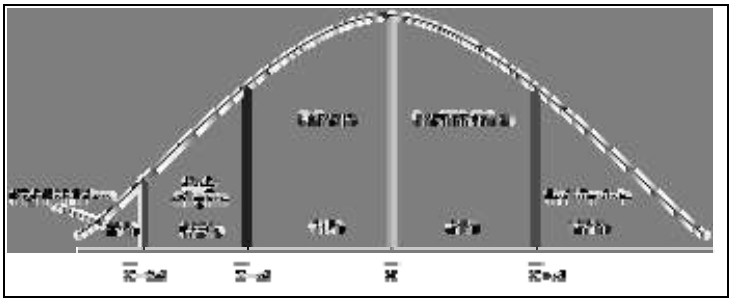


Fig. 26. Standard bell shaped distribution curve for adoption of technology, agronomy or otherwise.

Thus the question is, how would you separate those who as implied by the categories in Figure 26 are taking a wait and see attitude looking for more confirming data and seeing how their neighbors do, from those who:

a. Are interested but to not have the means to adopt the technology
b. Are interested but only have the means to adopt on a limited part of their fields,
c. Are interested in and activity trying to find the means to adopt?

Again, the answer to these questions would determine the amount of traditional extension education and demonstrations you undertake versus some effort to facilitate providing the farmers the means to adopt.

Prime Example Of Means Enhancement

My prime example of how enhancing the means farmers have to manage their land has had a positive impact on economic well being of smallholder rice producers is the retirement of water buffalo in Thailand and most of Southeast Asia in favor of the paddy power tiller (Fig 27). This has reduced the crop establishment period in half, allowed for possible expansion of operational holdings and allowed diversification to more intensive agriculture activities such as fish ponds with poultry or pig production suspended over the ponds so the dropping from the animals become feed for the fish (Fig. 28). It has enhanced the material wellbeing of Thai farmers so many now enjoy refrigerators, TV's and VCRs, motor cycles if not pick-up trucks and the inevitable cell phone. To the best of my knowledge the shift to power tillers has all taken place through the private sector under the radar screen of the development community. The

task was completed 15 years ago. The inclusion of the fish ponds and poultry did have some strong promotion by the King, but could not have happened without first converting to the power tiller. It was also noted in the return to Tanzania after the consultancy the rice farmers in Madibira had obtained some 50 similar power tillers to assist in their rice cultivation. Again this was mostly a farmer initiative with only 13 of the 50 purchased with institutional credit and the rest self financed.



Fig. 27. Rice power tiller now commonly used in Asia replacing the water buffalo.



Fig. 28. Fish pond with poultry production on top. An intensification made possible by retiring the water buffalo in favor of rice power tiller.

Suggestions for Zambia

The resource enhancement that I think would be most effective in providing the smallholder of Zambia and much of Africa the means to greatly improve their farming practices would be contract mechanization based on 4-wheel 65 hp tractors.

Is there really any other effective means to substantially reduce the prolonged eight week crop establishment period and allow farmers to bring their timing more in line with recommendations? This is already taking place. During the field visits two farmers mentioned getting contract tillage at ZK 100,000 per hour. This allowed them to cultivate two to three lima which is very consistent in both cost and area cultivated with other areas such as Egypt, Pakistan, and Iraq where the vast majority of basic cultivation for smallholders is by privately owned contract tractors.

I can thus see and recommend IDE look at a future project of obtaining used tractors being traded in by large farmers, reconditioning them and making them available to individual members of smallholder communities for contracting to farmers. It does not necessarily have to be a farmer, and being a farmer would actually be a conflict of interest. In Egypt with its fully irrigated subtropical climate and two mutually exclusive annual crop season, winter and summer, I once estimated the work days for contract tilling at over 200 days per year, equal to a typical professional work year. This excluded transport opportunities. Basically, when you add transport opportunities, contract tractor operating can be a full time service to the community. Again, when I returned to Madibira I noticed an increase in the number of tractors available in the villages along with the previously mentioned power tillers (Fig. 25). In Zambia and much of Africa where the HIV/AIDS epidemic is having a major impact on rural farm labor a project like this could be easily justified as part of an HIV/AIDS mitigation effort. This consultant would contend that it might be the only means to effectively prevent an HIV/AIDS induced famine.



Fig. 29. A tractor and power tiller purchased by farmers in the past four years and used for both individual and contract tillage or transport

More Traditional Capacity Building

Limited Knowledge or Limited Means

Looking at the more traditional capacity building education extension effort, the knowledge for producing the targeted crops appears well known and in a brief

consultancy I do not have the time nor experience to sort out the technical details of specific crop recommendations. I will, however, assume that the recommendations are based on solid small plot trials and demonstrations. They are thus an accurate evaluation of the physical potential base on the target crop be it cotton, paprika or vegetables being the highest priority of the farmers and not necessarily considering the means available to the farmers to implement the recommendations or a likely priority for other crops such as maize needed for food security. Since I can not address the specifics of the crop production, I will concentrate more on some over lying issues.

The biggest concern I have based on the previous discussion is differentiating between limited knowledge and limited means. Limited knowledge is a lot easier to address and too often the failure of smallholders to accept recommendations is attributed to limited knowledge when in really it is limited means. Making this mistake can result in considerable effort with little success.

Cost of Capacity Building

Another issue is the cost of extension capacity building. As much as we love the workshops and training programs, and one often wonders how much of this is the transfer of information vs. the opportunity for supplemental income in the form of honorariums for instructors and per diem for participants, they can be expensive and difficult to sustain without the external support of donor funded assistance projects. The experience of Cheetah's out grower program is a prime example. Running the program has cost Cheetah dearly and has resulted in their obtaining external assistance in the form of DED volunteers to assist with the overall management and have discounted the price they offer smallholders to cover their costs. Fair enough, but it has also contributed to the opportunity for side trading. Cheetah really needs to look at more economical means of conveying the educational needs so they can concentrate on marketing, reducing the overall cost of their out grower scheme, and allow them to offer the farmers a better price.

Thus there is a need to look at all the alternatives for conveying technical information to the farmers. Traditionally, it has been deemed essential for extension programs to have a traceable administrative link to all members as promoted by the T&V, (Training and Visit) extension program originally imposed by the World Bank and continuing today with the emphasis on contact farmers. Is this really necessary? Is it affordable with non-donor funding? Also, how much really has to be physically demonstrated versus conveyed by brochures and other publications including the mass media? Even TV should not be overlooked as many smallholders have access to TV, even when they can not afford to own one. Another surprise in the return to Madibira was the number of TV available in the bars, etc. where they can be a major business attraction (Fig. 30). This is some 70 km away from the nearest electric grid, but with small generators and satellite dishes TV is readily available as well as VCR, etc. and thus an opportunity for conveying extension information.



Fig. 30. Bar in Madibira that has recently acquired a TV system with generator on the floor beside the beer case and VCR below the TV.

Inherent Knowledge of Smallholders

The next issue is how knowledgeable are smallholders and to what extent can they be depended upon to *fine tune* recommendations to fit their particular needs including fitting the target crop into their overall crop enterprise system that may give priority to other enterprises. It is this consultant's opinion that smallholders may have limited educations, but this is mostly due to lack of educational opportunity, and does not reflect on inherent intelligence. They are thus experienced skilled practitioners in the art of crop production and tend to make adjustments from recommendations moving from the maximum yield, as most recommendations attempt, to the more practical economic optimal. The field visits only confirmed this as most farmers could engage in wide ranging discussions of both crop management and market conditions. The crop management often showed more in-depth fine tuning knowledge then we had, such as the use of bags to cover bananas for cold protection. My usual expression for this fine tuning compromise is substituting extent for quality. Such fine tuning needs to be accepted and basically appreciated. It normally represents some good economic rationale with a primary interest in returns to labor. The typical example I use is with a given finite amount of labor a farmer can plant one lima of sunflowers at full recommended plant density or two lima at half recommended plant density. Which will give him the highest total return for this effort? In most cases the typical sigmoid agronomic production function will favor the more extensive two lima at half density over the one lima at full density (Fig 31).

Thus capacity building needs to be careful not to package too many details, with little tolerance for any divergence from those details. The farmers will accurately fine tune them anyway. Is it really necessary to assume farmers have zero knowledge of a particular crop? Instead, concentrate on the more critical issues particularly those that pertain to quality concerns such as with Paprika and cotton, and not general crop production procedures. Would this reduce the overall costs of extension programs and allow the available funds to reach more people? Can you really afford a more comprehensive program without continued donor assistance? Now, how much of this

requires detailed workshops and demonstrations and how much can be done with published materials? What can really be afforded with sustainable funds? Cheetah really needs to take a close look at this as it effects the cost of their out grower program and the discount they impose of farmers to cover that cost.

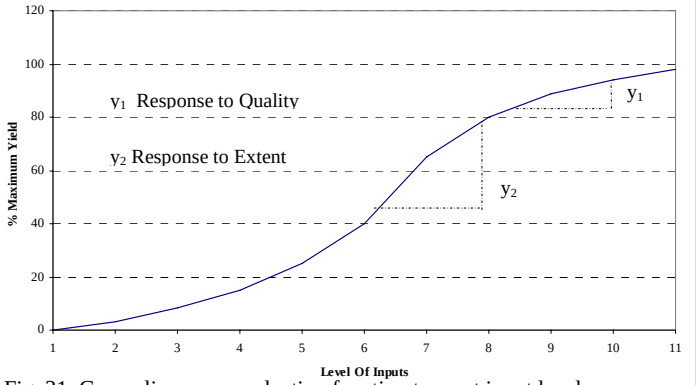


Fig. 31. Generalize crop production function to most input levels

Financial Capacity Building

The other aspect of capacity building is financial which is normally interpreted as institutional loans to smallholders via donor promoted farmer organizations. While this is not my major specialty there is little I can comment on other than point out that most such efforts can not survive donor assistance and thus have little long term sustainability. It is also worth noting that there are farm surveys that do not list capital and credit as high on the priority list as donors tend to place it. It may be more a problem the donors find easy to address, than a major smallholder concern. In the absence of institutional credit there are other forms of finance available including the notorious informal credit which is often quoted at 100+% seasonal interest rates. For some reason, smallholders often seem to prefer it to the administrative hassles of institutional credit. However, there are many games played between borrower and lender in the informal credit system that effectively reduces the interest rate, which ultimately may reflect the overall administrative costs including defaults than the highly exploitive interest rates quoted. Some games include poor quality of in-kind payments in which a bag of rice contain 15 to 20% chaff, unfilled grain, pebbles, mud clods, etc. all of which require extra effort to sort out as well as the volume reduction in interest rate; delayed payments; tremendous running around to collect payments; and in-kind discounts for those who provide on time good quality payments. An example of the latter from Zambia is giving a borrower 10 kg of maize seed for a clean on time payment as an incentive of others to honor their debts. It must also be noted that all the motor pumps in Zambia and most of the power tillers in Tanzania were self financed without institutional or other recognized credit assistance.

SMALLHOLDER COMMUNITIES – A SYMBIOTIC ASSOCIATION

Historically the effort to assist smallholder producers has focused on the smallholder farmers and their families. However, smallholders can not operate totally

independently and as noted throughout this report require support services. Thus, it might be better to look beyond smallholders as individual and view them as members of a community. The community consisting of the smallholder producers and those providing support services. Furthermore, it might be best to view the relationship between the producers and service providers as being largely symbiotic and not exploitive, with the service providers exploiting the smallholders. The reality of a financially suppressed economy actually prohibits such exploitation.

If this is a symbiotic association then any assistance to one will automatically assist the other. Thus, as implied earlier on the discussion of lack of means, if the farmers are effectively maxed out and operating at the peak capacity their total resource base will allow with the limited means being a major drag on the agronomic potential, then it might be more effective to assist them indirectly by enhancing the support services available to them.

What are the support services? They would include the indigenous village businesses that sell various household commodities. They are basically single family owned village enterprises. These are the people CARE envisioned to be empowered and supported to provide production inputs and buy produce. Could they also distribute the extension information and have a vested interest in doing so as it would mean an increase in market volume? This is an idea well worth reviewing and considering. During the field visits while we were actively engaged in observing and assisting Cheetah's buyer and very concerned in sorting out transport, a ten ton lorry pulled up in front a small village shop > 50 m from where we were (Fig 32 & 33). It apparently had sorted out the transport problem. What would it take to assist them to become major buyers of Paprika and Cotton for the community? This is similar but more multi-purposed than the Distributor used by Dunavant. Don't most of the private traders and side-buyers deal with multiple commodities and not just one? Doesn't this represent an increase in business efficiency, particularly transport efficiency with the substantial surcharges required for transporters to operate off the tarmac? Off tarmac transport is typically slowed by at least 50% incurring extra time and fuel costs that easily justifies the surcharges.



Fig. 32. Small village shop near Kabwe dealing with an assortment of household supplies but with a store room full of agriculture commodities.



Fig. 33. Lorry parked in front of shop in Fig. 30 not 50 meters from where we were assisting Cheetah purchase paprika and concerned with how to transport it.

Another example comes from Madibira where this shop is a full service shop providing both household goods, contract tractor services, purchasing of crops and informal credit and has done so for many years (Fig. 34).



Fig. 34. Full service shop in Madibira handling household goods, contract tillage, transport, buying produce and providing informal credit.

More important service providers would be those that reduce the drudgery within the community. An example might be the use of grain mills to replace manual pounding of maize (Fig. 35 & 36). The latter as now mostly disappeared from rural Africa and preserved only in the souvenir shops. What is the agronomic impact of tossing aside

the mortar and pestle in favor of paying a neighbor to mill the maize? Does it not make major reduction in the domestic drudgery, allowing women more leisure in the evening, etc.? Will it also allow them to work longer in the fields or go to the fields more refreshed the next day? Will this enhance the care given to crops resulting in higher yield or better quality? Are these millers exploiting the smallholders or rendering them a valued service? Would it also apply to charcoal making, thus reducing the time and effort women spend collecting firewood?



Fig. 35. Young women pounding maize is now all but a relic of times passed.

Of course my favorite of all is the contract tractor operator. Smallholders can not normally afford a 4-wheel tractor nor is there any real justification for them based on the amount of land they manage. This has to be done by contract as it is in other countries, most noticeably Egypt, Pakistan and Iraq. During the field visit a demand for such services were expressed and they were used when available. In Tanzania about half the land preparation in the irrigation scheme was done by non-project tractors (Fig. 29), some funded by the informal credit system. In Thailand this has now extended to combine harvesting (Fig. 37) with small combines that can operate in a one rai field ($1/6^{th}$ hectare). This has been a major contributor to Thai farmers now managing five crops in two years compared to government projects and irrigation management expecting on two crops per year. It should also be noted that tractors, like all mechanical equipment, have to be under individual ownership and any public sector or joint ownership has universally failed. As primarily a private effort it has quietly been done under the development community's radar screen.

Finally there is a need to recognize the potential impact of cell phones penetrating into rural areas even when there is no apparent means of recharging the batteries (Fig.

38). Cell phones can be particularly useful to village support enterprises providing inputs and buying produce from the smallholder producers. They can help keep track of prices, availability of inputs, and arrange essential transport. This could prevent a lot of wasted energy running around and assure more favorable prices to farmers.

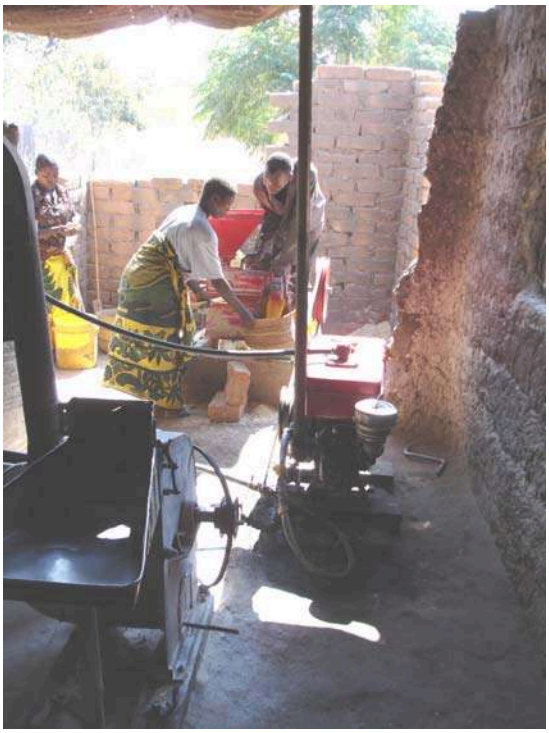


Fig. 36. The grain mill has effectively replaced grain pounding. This operator has both a rice mill running in the background and a maize mill in front, shifting the belt drive from one to the other as needed. This mill is also new in the last four years.



Fig. 37. Small combine available on contract to smallholder rice farmers in Thailand.



Fig. 38. Farm woman using a cell phone in rural area.

RECOMMENDATIONS

Irrigation

1. Document the side selling of treadle pumps as a measure of treadle pumps being a sustainable innovation as opposed to current donor fade?

2. Make a dietary energy balance on the treadle pump to assure operators are not exerting more calories than they are consuming.
3. Continue looking for more flexible hoses for the treadle and motor pumps including outside Zambia, the number of treadle pumps being distributed and the 500 km of hose required would justify facilitating someone to import and make availability more flexible hose.
4. Keep track of the innovative way farmers use treadle pumps and other adaptations they make, as it contributes to future design changes.
5. Make a brief study on how farmers are financing the motor pumps. This appears to be mostly on their own.
6. Consider assisting farmers with purchase of motor pumps to expedite their graduation from the treadle pumps.
7. Promote drip irrigation with care. Under most circumstances, it may not be the best fit for most micro irrigation situations in Zambia.
8. Monitor any water master plan development work undertaken by the government as it would impact on the water resources available for dambo irrigation.
9. Don't attempt to become over sophisticated with water management as it is largely based on experience.

10. Encourage farmers to develop small level irrigation basins parallel to the contour and irrigated basin by basin.

Marketing Component

1. Carefully review the American model of farmer organization and separate the farmer associations with their emphasis on information sharing from farmer cooperatives as a business support service.
2. Make a detailed analysis of the costs of doing business for all the different marketing models at work in Zambia and see which provides the best return to the farmers. This could be a task for a locally hired consultant firm and require some three or four months. It is also the most critical need for development programs across the developing world.
3. Based on the result of the study above work with Cheetah and Dunavant etc. to develop the most cost effective out grower program including consolidating some of their depot activities when both commodities are grown in the same community.

Capacity Building

1. Consider if the means to produce high yield and high quality crops is not more limiting than knowledge of how to produce them.
2. For future projects consider how to provide smallholders increased access to contract tractors. This may be the only effective means of expediting their crop establishment to come closer to research extension recommendation. Also, with the increased impact of the HIV/AIDS epidemic on rural areas this could be justified as means to mitigate the impact of HIV/AIDS on rural labor, and may be the only way to prevent an HIV/AIDS induced famine.
3. Work closely with smallholder to understand their priorities and limitations as it has impact on the acceptance, rejection, and modification of recommendations.
4. Do not package recommendations in too much detail, but allow as much flexibility as the farmers need to integrate the specific crop into their overall crop enterprise system.
5. Look carefully at the costs of extension and what might be a more cost effective means of communicating information to smallholder including use of the mass media such as TV.
6. Work particularly with Cheetah to assist them in developing a more cost effective out grower program so they can reduce side selling and provide the farmers a better return.

Symbiotic Community

1. Look beyond farmers to the community and see if it is easier to assist farmers indirectly by enhancing the support services available to them.

APPENDIX

A. Consultant Itinerary

B. Consultant Bio-Profile

C. Developing Smallholder Agriculture: A Global Perspective

International Development Enterprises (IDE) and Winrock International

Smallholder Market Creation Project – Zambia

Volunteer Consultancy for Agronomy, Irrigation, & Smallholder Agriculture

Daily Itinerary

14 May	- Arrived Lusaka from USA
15 May	- Rest and Jet lag recovery
16 May	- Introduction meeting with Larry Rudgers, IDE Country Director - Initial briefing with Peter Manda, Director of Programs - Planning briefing with Kenneth Chelemu, Output Market Development Coordinator and Anna Mwamba Agronomist - Visit with Wynner Makombe IDE Commercial Manager - Visit to Duram manufacturer of treadle pumps and drip lines - Interview with Reuben Banda, Cooperative League of USA (CLUSA)
17 May	- Interview with Harry Ngoma, Agriculture Support Project (ASP) - Field visit to Dunavant Distributor for cotton and a farmer irrigating from wells - Visit to Chikupi Farmer also irrigating from a well
18 May	- Interview with Patrick Nyumbu, Dunavant Cotton - Visit to Ngwerere Arameri farmers irrigating with waste water - Visit to Katuba farm irrigation from dambo behind check dam
19 May	- Traveled to Kabwe - Briefing by IDE field staff Friday Phiri, team leader; Peter Tembo, output marketing officer; and Benard Sikatunga, supply officer and irrigation layout - Visited farmer using both treadle pump and motor pump
20 May	- Interview with Joseph Banda and Berrywick Mungabo of Central Growers association dealing with tobacco, cotton, groundnut etc. - Visit Chibombo for Cheetah paprika buying - Visited Chibombo with windmill pump - Visited local office of ASP in Chibombo discussed with Victor Makaba
21 May	- Traveled to Kitwe
22 May	- Off day started report

23 May	- Briefing by field team Sunday Mwelwa, team leader, and Nancy Phiri Chileshe, output market officer - Visited farmer group in Mwekera - Visited farmer group in Dag Harmajsoeld - Visited the memorial site of Dag Harmajsoeld plane crash
24 May	- Visited Sustainable Agriculture Program, Mbenza Mwanza, and Macdonut Kayana - Visited CLUSA and interview with Kenny Silwimba - Visited Farmer group in Twapya - Visited Farmer group in Chiwala
25 May	- Returned to Lusaka - Visited drip demonstration outside of Kabwe
26 May	- In office to catch up - Visit Cheetah meeting with Bettina Schoop, DED (German) volunteer
27 May	- Visited farmer in southern province - Visited Cotton Development Trust in Mazabuka meeting with West Chita and Patrick Nyumbu
28 & 29 May	- Weekend rest and report drafting
30 May	- In office catching up and report drafting - Visited Amanita Premier Oils Ltd. and discussion with Oda Friend
31 May	- Remained in office working on report and discussion prospects
1 June	- Visited business areas seeking alternatives to treadle pump hoses, including Alex Chama at SARO AGRI Equipment Ltd. and A. Shankar at Aquagro Ltd.
2 June	- Visited CARE International for discussion with Douglan Mwasi on the former REAP – Rural Enterprise A
3 June	- Worked in office drafting report - Visited Ministry of Agriculture Planning and Co-operatives Department to obtain cooperative by-laws outline from Justin Mwansa.
4 June	- Visited SWETO vegetable wholesale market - Continued drafting report at hotel
5 June	- Remained at Hotel and finished drafting report
6 June	- Started Reviewing Report - Made field visit to two field sites in Katuba

7 June - Remained at hotel to prepare PowerPoint presentation

8 June - Made presentation at one day workshop

9 June - Wrap-up and prepare to depart

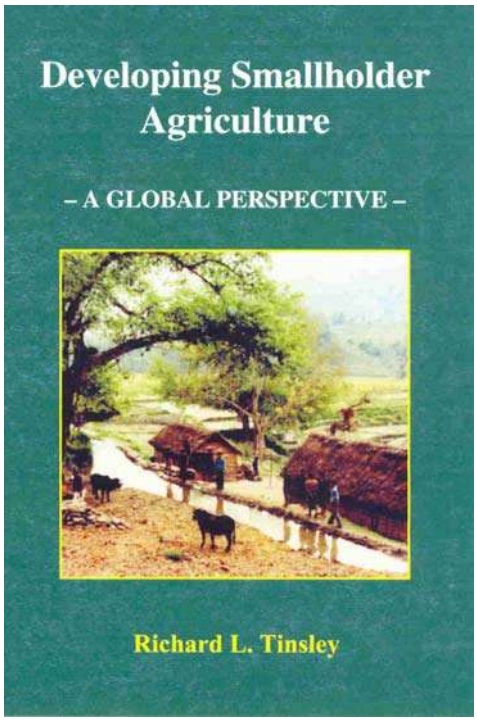
10 June - Departed Zambia for Tanzania and Uganda



Consultant's Bio-Profile

Richard (Dick) Tinsley is professor emeritus in the Soil and Crop Science Department at Colorado State University. He has over 30 years of experience assisting smallholder producers and their communities. He has worked in Asia, Africa and the Middle East. He is the author of Developing Smallholder Agriculture: A Global Perspective, published by AgBe Publishing in Brussels, Belgium. Two copies of the book are available at the project office in Lusaka. He also manages the Website: www.smallholderagriculture.com. This is a website committed to promoting the understanding and development of smallholder agriculture as it occurs in developing countries. He can be reached by email at: Richard.Tinsley@ColoState.edu, or by mail at:

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Developing Smallholder Agriculture

– A GLOBAL PERSPECTIVE –

By Richard L. Tinsley
AgBé ; 2004 440 pages, 24 Tables, 30 Figures, 30 Graphs, 70 Photos, 25 Boxes. US $ 49.

This book presents a synthesis of nearly three decades of work with smallholder producers and their communities. It takes the farming systems work of the 1980s and 1990s a step further, and pays particular attention to those factors and issues that have proven to constrain agricultural development in developing economies.

Developing Smallholder Agriculture is thus a very practical book. As a synthesis of experience from countries in Asia, Africa and the Middle East, the book is not specific to any country. However, most readers should be able to quickly relate the subjects to their country. The photographs and other illustrations, which give examples from many different countries, help this.

Much of the information contained in this book is derived from unpublished project reports. In many ways the book presents lessons learned from farming systems programs as they developed and evolved over the last three decades. The book carefully reviews the hypotheses on which most assistance to smallholders has been based; that is smallholders' failure to fully exploit their physical environment was the result of limited motivation, and a desire to minimize risks by delaying crop establishment until more assured climatic conditions prevailed. It replaces this notion with an appreciation for the limited resources smallholders have at their disposal to manage their land which often results in a six to eight week extended crop establishment and low yields.

For this reason the book concentrates less on the agronomy and soil science of the author's professional background, but more on the various factors that impinge on the farmers' ability to implement more productive crop husbandry. In so doing, the book promotes looking beyond technology and development. Dissemination concentrates on the supporting services that smallholders need to enable them to enhance their crop management. It emphasizes the importance of village-level, private micro-enterprises as a cost-effective means of assisting smallholders, and questions the potential of governments and public sector institutions in providing these support services.

The book's perspective is that of a technical assistance advisor working through host country clients, for the ultimate benefit of the smallholder producer. As such, it addresses many of the stereotype ideas that advisors confront when working with host institutions.

Developing Smallholder Agriculture is one of the few books that directly addresses practical problems in the overall context of the socio-economic, political and technical environment of

the smallholder. Forging links between different subjects and disciplines creates a holistic approach. The book uses both a scientific *and* a practical approach, and a specialized *and* a general point of view.

The book is aimed at a wide readership: depending on the background and interests of the reader, different chapters can be used as a textbook for students, a handbook for extension workers and consultants, and a resource book for development practitioners, researchers and policy makers. It is sufficiently technical for the agricultural scientist as well as being sufficiently general for decision-makers and specialists in related fields.

CONTENTS

1. Characteristics of Smallholder Producers

This Chapter introduces smallholders as individual entrepreneurs, who despite limited education, are skilled practitioners of agronomy. They are usually constrained by circumstances outside their control and have limited resources such as labor. This results in prolonged crop establishment that limits their prospects for adopting time sensitive innovations. The Chapter develops the concept of financially-suppressed economies, and how this impacts on farm management.

2. Determinants of Smallholder Systems

This Chapter reviews the physical, economic, social and biological determinants of farming systems; how they interact, in terms of what can be produced; what is produced; how well it is produced; and who has control over the different determinants. It ends with a discussion of rainfall variability and the extent it can be used as a planning tool. A case study of rain-fed rice in the Philippines is given.

3. The Role of Land Tenure

This Chapter evaluates land tenure including ownership, cash rent, share rent, customary, communal, landlessness, etc, and how this impacts on crop production and prospects for long-term investments in protecting natural resources. The Chapter also examines the relative well-being of estate workers and independent smallholders.

4. Support for Smallholders

A major Chapter that looks at both private and public sector support services. It contents that the private sector is more effective, while big parastatal companies and corporative societies are usually detrimental to smallholder production, because of high overheads. The Chapter divides the private sector into small, family-based village enterprises that are in direct contact with the farmers, and large corporate enterprises that eventually process and distribute the produce. Case studies are from Malawi for the public sector and from Nepal for the private sector.

5. Technology Transfer

This Chapter contents that extension efforts are now more an instrument of government policy aimed at supporting a suppressed price policy than a program to promote farmers' well-being. The Chapter looks at how much information is actually flowing through informal channels and how this can be enhanced. A discussion of integration, and how both innovations and the farming environment can be adjusted to make the innovations more acceptable to farmers, is offered.

6. Sustainability of Smallholders Systems

This Chapter takes a developing world definition of sustainability as "the need to balance food security with environmental protection". The chapter reviews the trade-offs between the power required to protect the natural resources and the fossil energy based inputs to assure a commercial yield. A next section looks at the issues surrounding nutrient cycling, composting, etc. It evaluates the ratio of the land from which nutrients must be collected to that on which they need to be applied to obtain sustainable yields. The final section looks at the use and abuse of insecticides. Examples are from India, Vietnam, and Thailand.

7. The Role of Mechanization

This Chapter emphasizes the importance of mechanization in providing farmers with the necessary resources to cultivate enough land in a timely manner. The emphasis is on privately owned contract mechanization versus public ownership. Also discussed is how the smallholder environment reduces the equipment's efficiency because of difficulty in accessing small fields and excessive turning once in the small fields. Private contract mechanization is discussed for land preparation in Egypt, Pakistan, and Iraq.

8. Irrigation Development

This Chapter looks at how irrigation can be provided to smallholders through large schemes: Egypt and Pakistan are the main example. It looks at pragmatic issues such as the minimum amounts of water needed to push a wetting front across a field; at water depletion; and the substantial period between crops in which little irrigation water is used. The emphasis is on bottom-up planning as an effective management tool.

9. Practicalities of Smallholder Farming

A Chapter discussing various concerns for those assisting smallholders. Items discussed are: casual crop management, certified and hybrid seed versus retained seed, soybeans, intercropping, soil testing, impact of HIV/AIDS, etc.

10. Assisting Smallholders

A summarizing Chapter that looks at the impact of various factors on developing projects aimed at assisting smallholders. It focuses on smallholders as individual entrepreneurs that are more restricted by labor and other shortages than knowledge or motivation. The Chapter reviews how projects might concentrate more on off-farm support services than on technology development and promotion, and the mechanism to effectively do so.

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