Best Management Practices For Grains – Koffele, Ethiopia

F2F Assignment ET 09

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List of Acronyms

ADP	Agriculture Development Project (Program)
CRS	Catholic Relief Services
DAP	Diammonium Phosphate
FCU	Farmers' Cooperative Union
FtF	Farmer-to-Farmer
IFSE	Innovative Fund For Improving Food Security in Ethiopia
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
NGO	Non-Government Organization
SDCOR	Social Development Coordinating Office of Robe
SME	Small & Medium Enterprises
USA	United States of America
USAID	United States Agency for International Development
WFP	World Food Program

Executive Summary

The F2F volunteer consultancy was undertaken to assist in the extension of best management practices for wheat and barley production in Koffele, Ethiopia with an emphasis on crop establishment and row seeding. The assignment was divided into four parts. First was some *ad hoc* preliminary visits with various agriculture support programs, this was followed by two days of extensive PowerPoint lectures for agriculture professionals, and four days of farmer meetings with four different groups of farmers consisting of 20 invited farmers plus any walk-ins that wished to join. The farmer meetings were mostly a group discussions to review current crop management practices and what was needed to enhance crop management and bring it more in compliance with recommendations. Then finally some debriefing back in Addis Ababa and review of potential future F2F assignments completely unrelated to this assignment and based on a side trip to Robe.

The PowerPoint lectures focused on looking beyond limited knowledge and need for extensive extension training programs to explain why farmers failed to comply with extension recommendations for the best management practices. This concentrated on limited operational resources available to manage land, and to a lesser degree the limited logistical support for quality seed, fertilizer and other inputs.

The operational limitations were followed-up and substantially reinforced during the farmers' discussions as they quickly demonstrated only limited time for crop production field work each day. This was due in part to limited dietary energy as the subsistence stocks of three quintal of potatoes and 1.5 quintal of maize per adult would only provide a daily diet of 2054 kcals. This would be sufficient for basic metabolism, but was only half the 4000 kcals/day needed to diligently work all day in crop production. This very much restricted the hours famers could be expected to work, plus the diligence at which they could exerted themselves without exhausting the limited calories they had access to.

The other limitation was the management of animals. This may result a double drag on crop management and national food security. The first major concern was time spend in caring for the animals. The farmers stated they spent two hours in the morning and another two hours in the afternoon caring for the animals for a total of four hours per day with only 12 hours of daylight. The net result of this and limited energy was the agronomic work day was limited to about four hours, with a question on how diligently they would be committed and the extent this would extend the time it took to complete various agronomic tasks including basic crop establishment and the normal declining potential yield as crop establishment was delayed.

The other concern for the animals was the amount of land required to maintain them, much of which could easily be converted to crop land as one farmer mentioned. Thus there may be a serious need for Ethiopia, perhaps with the assistance of some donors or NGOs, to reevaluate the commitment to having the largest per capital animal populations in Africa in terms of its impact on crop production and national food security. The alternative that may need considerable evaluation is looking at how to effectively enhance access to contract tillage for basic land preparation etc. This is slowly taking place in Ethiopia and across Africa, but needs to be done

with care and avoid business models that were discredited some 40 years ago. At present their appears to be a European NGO trying this but most likely using the communal owner/operator that was previously discredited.

As for basic knowledge of crop management the farmers appeared well aware of recommendations and were able to give detailed commentary on the use of row seeding including its importance in increasing yield, but also the need for extra land preparation, extra labor to establish the crop, as well as the reduction in labor for weeding. Thus the decision to row seed or not is an individual rational decision considering both the agronomic potential and operational requirements including any delays in getting the crop established against declining yield potential.

Another major concern mentioned by the farmers was the massive crop loss from threshing by animal trampling. The estimate was a 30% crop loss plus additional market value loss from contamination with urine and feces. There are alternatives to animal trampling that need to be considered. There appears to be a European NGO promoting combines. However, this may not be the best means of addressing the issue at this time, as the combines appear too big and cumbersome to work in the small fields typically only a fraction of a hectare, and the business model appears one that was discredited over 40 years ago, as well as the possibility of some informal access fees being demanded by the operators.

The other alternative is the IRRI style axle-flow thresher being manufactured by Salem Children Village. This may have better prospects for Ethiopia at this time and should be given a careful evaluation particularly as a SME village based family enterprise to serve the immediate smallholder community.

Other concerns discussed was one of getting quality market seed available within smallholder communities, being careful in the promotion of both composting and bio-char. Both represent ideas that may be easy to demonstrate but difficult to extend. Just inventory how available the material is for the entire community, and if the material does not have better use such as feeding the composting material to the animals and allow them to do the composting or using the char material for cooking firewood.

Preface

Before getting into the main technical report for this F2F assignment, it might be desirable to reflect briefly on what are realistic expectations for a F2F volunteers that bring Farmers or other agriculture professionals from the USA to Ethiopia or similar host countries. The biggest concern is the economic operating environment between the USA and host countries is very different. In the USA virtually all full time farmers are multi-millionaires and have to be just to capitalize their operations. For example it would be very difficult for a full time farmer in the USA not to have a million dollars in both buildings and machinery as well as several millions in land, with additional prospects of for multi-millions in water rights, if involved in irrigated agriculture in the western portions the USA such as Colorado[1]. Such farmers either directly own or can easily contract for all the equipment they need to smooth their land for easy mechanization and then mechanically manage their land with limited manual effort. This is considerable different from Ethiopian smallholder farmers operating in an financially suppressed economy and limited to manual farming assisted by a couple bullock teams for preparing the land[2]. This could make it difficult for a F2F volunteer farmers to fully relate or appreciate the operational limits of their smallholder beneficiaries that could take years of full time commitment to fully appreciate. This could easily and often results in excellent recommendations that are well beyond the host farmers' ability to effectively take advantage of.

Similarly, faculty members coming from USA universities, including the Land Grant Universities that represent most of the Colleges of Agriculture, could have a very good sincere personal interest in international agriculture development, and very much want to assist in the poverty alleviation of smallholder farmers, but their primary commitment has to remain with their university and the research work they are contracted to perform. Most of this will be to serve the multi-millionaire farmers mentioned above, whose tax dollars are paying their salary and research grants. Thus regardless of personal desire these faculty experts can really only spend limited time in host countries, which will normally not be sufficient to fully understand the conditions that have trapped the beneficiary farmers in poverty. This can and often does result in well intended recommendations that are beyond the host capacity to accept.

Finally, it has to be appreciated that most F2F volunteers, particularly those from universities, come from the professionals who are the developers and promoters of technical innovation, rather than end-users. Thus, they could easily imply a considerable higher level of acceptance in the USA than reality. A couple examples would be the use of Certified Seed in self-pollinated crops like wheat. The impression might be that all USA farmers sow certified seed each year, but the reality is that only 25 to 30% of the wheat land is states like Colorado or Kansas is planted to certified seed with the rest planted to retained or "market seed". Most farmers only resort to certified seed when they are interested in shifting varieties. Also, if one visits a USA supermarket, less than 1% of the good on display will represent the consumer terminus of a

[1] I once estimated that a person with enough water rights to irrigate on section of land (290 ha) from North Pouder Irrigation Company represent $14,000,000 in equity.

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

farmer controlled value chain, which is the current primary emphasis for most externally funded rural development projects.

In the end the volunteer usually learns more than the host farmers, and then conveys a better understanding for the plight of smallholder producer to the USA general population and inspires continued support for the USAID assistance program, then providing recommendations with substantial sustainable impact for the host country. This maybe one reason USAID is so interested in volunteers promoting their experience once the return.

Best Management Practices For Grains – Koffele, Ethiopia

RL Tinsley

Introduction



Fig. 3. SDCOR headquarters

The F2F assignment, ET-09, was implemented between June 19 and July 9. The objective was to provide "farmer training" on the best management practices for grains and legumes in Koffele, Ethiopia. Koffele is located some 215 km South of Addis Ababa at an elevation of some 2,656 meters. This makes for a cool temperate temperature regime ideal for growing temperate grains and vegetables. For this reason the staple crops appear to be potatoes, wheat and barley. The official host was the Social Development Coordinating Office of Robe (SDCOR) (Fig. 1) which was part of the Robe Catholic Secretariat with accommodations being provided through the Secretariat guest house. However, the predominate religion in the area is Islamic. The Secretariat appears to provide social services to the total community mostly in the more traditional Church sponsored forms of education and health services. Its involvement in agriculture and food security for the community appears to be new endeavor that is just getting started and in need of some direction. Hopefully this assignment can provide some guidance into how it could best assist the food security of the area.

The assignment was divided into four components as follows:

1. Preliminary visits to various officials and public sector agriculture service providers,
2. Two days of formal presentations to a group of 27 mostly government officials,
3. Four days of facilitated group discussions with 20 invited farmers plus some additional walk-in farmers, and
4. Final few days to wrap up, provide a debriefing to CRS staff in Addis Ababa, review possible additional consultancies, and begin drafting this report.

Preliminary Visits

The preliminary visits were unfortunately very brief and appeared more *ad hoc* than fully organized, with limited opportunity for in-depth interviewing of key personnel. They started with a brief visit from a couple local agriculture officers to coordinate the whole program. They became the primary contact between the hosts and invited participating farmers. This was followed the next day by visits to the agriculture office, the cooperative union, the seed company, and the open market. This was then followed by field visits to the various locations where the farmer meetings would take place. Finally there was a visit to the research area that was directly across the road from the SDCOR.

Agriculture Office

The visit to the agriculture office was fairly chaotic as officers were all busy in what was explained as arranging for pesticide applications. This appears to be a service provided by the government, but may only have enough stock of pesticide to accommodate about half the requests.

Farmers' Cooperative Union

The visit to the "Farmers' Cooperative Union" (FCU) was next door to the agriculture office, however when we got there it was lunch time and the offices and warehouses were closed. However, numerous farmers were seen picking up their supply of certified wheat seed (Fig. 2) and arranging transport back home. It appears that the FCUs has monopoly control on the distribution of certified seed and fertilizer for the farmers, at least to smallholder farmers, but the supply is limited so that most farmers, particularly the smallholders are left to plant "market" seed. Also, with limited supply the question of who get access come a concern, and if access may require a gratuity payment? This would result in priority going to large farmers as was noted in the field visit when we passed a large farm ready to plant his crop in a well prepared mechanically graded 74 ha field using cyclone broadcaster (Fig.3). It was also possible the dependence of the farmers on the FCU for seed and fertilizer was due to accepting institutional credit packages for these inputs that mandated they accept the whole package. This is often the case in other countries similar to Ethiopia.



Fig. 2. Farmers Collecting Certified Seed from Farmers Cooperative Union



Fig. 3. Large Farm Receiving A Whole Truck Load of Certified Seed Directly From the Seed Company for Broadcasting on 74 ha Field

The final opinion of the FCU was that while there may be some nominal farmer involvement in the oversight of management, for all practical purposes it was a government parastatal corporation with all officers appointed by the government. Such organizations, particularly when they have monopoly control of such things as seed and fertilizer, have a reputation of being administratively cumbersome and thus inefficient with little motivation to become more efficient resulting in high uncontrolled overhead costs that have to be passed on to the members in order to balance the books and minimize government subsidizes. This ultimately causes concern with the farmers. In Ethiopia this might be more noticed on the marketing side where the coffee cooperative in Oromia Coffee FCU in Jimma

only marketed some 8 kg/member[3], and the Sidama Elto Cooperative[4] grain cooperative in Hawassa only marketed about 1/4th of the farmers' marketed maize production, and that was not delivered to the Ethiopian consumers, but diverted to the World Food Program (WFP) for relief and other institutional uses as the only organization willing to pay a bonus for working with the cooperative and cover the overhead costs. Ethiopia may need to take a closer look at its reliance on FCUs for assisting smallholder farmers. They may be better served by open market private service providers competing for their business.

Seed Company

The visit to the seed company, which was a government parastatal, appeared to be a fairly well equipped facility that could process and store quality seed (Fig. 4). The place was open for business and we were allowed to freely wonder around the facility. It had several warehouses that held incoming seed separate from processed seed, good cleaning, bagging and labeling equipment and good clean storage facilities. In stock were seed for wheat, barley, hybrid maize and teff. It was not possible to determine if the seed was produced on government farms or under contract to seed farmers. Nor was it possible to determine if the quantity of seed was able to meet all the demand, but it was understood the capacity was well below the demand so many farmers would have to rely on "market seed". It did appear that some of the large farmers were able to purchase seed directly from the company, while smaller farmer had to get seed from the FCU. It would be interesting to see the price difference between direct purchases by large farmers and through the FCU assuming that most of the difference would represent the overhead costs of the FCU.



Fig.4. Seed Processing Equipment at Seed Company

Open Market

As usual the open market was buzzing with activity. However, of concern were the two adjacent shops. One was the FCU's fertilizer outlet and the second was private seed seller selling "market" seed. As for the fertilizer the only thing available was DAP (Fig. 5). Urea would be available later in the season. However, in contrast to other countries Ethiopia appeared to emphasizing DAP instead of Urea. This would typically provide an excess amount of Phosphorus to the soil, which would simply be banked in the



Fig. 5. Farmers' Cooperative Union Fertilizer Outlet Stor for DAP at Open Market

[3] http://lamar.colostate.edu/~rtinsley/DeceptiveReporting.html
[4] http://lamar.colostate.edu/~rtinsley/EthiopiaValueChainWorkshop.pdf

soil and not lost. However, there were no solid soil test to indicate the Phosphorus was that urgently needed. Most countries emphasis Urea as Nitrogen is usually the nutrient in greatest need.



Fig. 6. Private Seed dealers with bags of "market" seed.

The seed seller had numerous bags of seed that he claimed represented pure varieties (Fig. 6). This might easily be true as even for hulled wheat and barley, the seed of different varieties can be easily determined by the trained eye. Thus the concern for "market" seed being of mixed varieties may be over stated as knowledgeable farmers could easily tell if it was mixed and avoid it or demand a substantial discount. In the poorly lite building I could not discern the differences, but others could.

Farmer Meeting Venues



Fig. 7 Ministry Standard Meeting Building, but Located the In Middle of Open Field or Communal Grazing Area Instead of Cropped Area

The field visits to the designated locations for the farmers' meeting were already establish extension demonstration training facilities. These were located on land that was readily available to the government, but not necessarily convenient to the farmers or the farmers' fields (Fig. 7). They were often isolated from the community and surrounded by extensive communal grazing lands. Also, while there may have been some recent field demonstration activity for the most part the facilities appeared to have received only limited use. Thus there was little opportunity to compare any training ideas to what farmers were actually doing. The facilities consisted of fenced off compound with a main building but without electricity, so no lights or fans. The building contained a main class room with multi-person desks and chairs, a chalk board, and an instructor's table, but limited shuttered windows that when open only allowed for limited light. One meeting was actually outside. The building also had some storage and potential office space for the village extenstion officers.

Research Plots

The research area was immediately across the street from SDCOR. However, it appeared to be mostly a substation of a larger research program. There were no professional staff available, nor office facilities to accommodate them. Just some casual laborers. There were a couple variety improvement plots being cultivated for barley and potatoes and a large area being prepared for possible personal production (Fig. 8). The understanding was the researchers' were at a larger facility and came out here on occasion to review the plots.

Overall Impression – Preliminary Meetings



Fig. 8. Research Plots in Substation Area Across From SDCOR Headquarters

The overall impression of this part of the assignment was that it was rushed through without a lot of appreciation for its overall importance for adjusting any training programs. There was no effective opportunity to meet with farmers on an individual basis or visit farmers' field. Likewise no in-depth discussion with research or extension personnel that would highlight their concern with what the farmers were expected to do. The only reference to this was to row seeding instead of broadcasting wheat. For future F2F programs CRS might want to make certain the volunteers are more fully briefed on the state of agriculture in Ethiopia.

Overall Impressions of Ethiopian Agriculture

Based on these limited initial visits, discussions with farmers, and information acquired in my previous visit to Ethiopia, my impression of Agriculture in Ethiopia is one of complete poverty with an over reliance on animals for general draft, including both farm operations and transport. Ethiopia priding itself on having the largest farm animal population per capitol than any other country in Africa. This when many other countries in Africa are slowly shifting to more mechanized operations, resulted in visible being more economically well-off. I fear the reliance on animal for work may be deceptively expensive in terms of the daily time and effort to care for them as well as the land requirements for grazing on unimproved communal lands (Fig. 9) often consuming lands that appear well suited for crop cultivation, while crop production appears on the more erodible sloping lands. The farmers acknowledged that tending to their animals took 4 hrs./day out of the 12 hrs. of daylight. The communal lands usually have a potential for substantial improvement that could increase the carrying capacity several fold, but this is invariably tried up in the "Tragedy of the Commons[5]" in which the disadvantages are shared but advantages are individually retained. Resulting in the individual farmer's best economic practice is to put as many animals as possible into the system, regardless of the quality or quantity of available and resulting poor overall conditions of the animals, a practice that would cause a person to be arrested and jailed in the USA for felony animal cruelty. This essentially daily requirement for caring for the draft animals, distracts from crop management and animal husbandry for marketable animal products. Ethiopia may be well advised to take a closer look at the farm animal populations and see if it



Fig. 9. Large Tracks of What Appears to be Prime Land being Devoted to Communal Grazing Lands with Crop Land on Far Slopes

[5] http://www.wisegeek.org/what-is-the-tragedy-of-the-commons.htm#didyouknowout

would be better off by reducing its reliance on animals for draft. Would this free substantial amount of land for cultivation, enhance overall crop management, and improve national food security? Does the degree a country is relying on animal draft power become an index to extent of entrenched poverty?

"Training" Activities

The "Training" component of the assignment consisted of two days of intensive PowerPoint presentations for government agricultural officers followed by four days of farmer meetings. The formal presentations were held in the SDCOR headquarters meeting room and were attended by 27 professional agriculture personnel from the agriculture department and the FCU (Fig. 10). These included three women from the FCU. The material presented was from two 60 slide PowerPoint presentation[6]. The content was a basic review of the volunteer's perspective of smallholder agriculture as it applies across the developing world including Ethiopia. This is based on the need to review the basic premise on which agriculture development has been based for the past 40 years to include focus on the operational limitations smallholder confront in attempting to implement recommendation over an entire farm or community[7]. Much of the material comes directly from the volunteer's text ***Developing Smallholder Agriculture: A Global Perspective*** or the ***www.smallholderagriculture.com*** website the volunteer manages. Thus, where possible, the commentary in this report will be brief and footnote references made to specific webpages. The general outline was to provide a conceptual overview, and then relate this to the various crop management activities as the seasons for wheat, barley and potatoes unfolds in Ethiopia.



Fig. 10. Formal Training Program.

The farmer meetings were set up for 20 invited farmers as arranged by the village extension workers (Fig. 11). This allowed for the invited participants to be biased toward the farmers better known to the extension officers and could be more representative of the "progressive" farmers than the general smallholder farmer population. In addition to the invited farmers other farmers just showed up and were encouraged to fully participate. In one case the meeting coincided with the end of women program meeting, and these women were also encouraged to join the



Fig. 11. Group Meeting with Farmers

[6] Handout copies of the PowerPoint Presentations are in Appendix 2 along with the PowerPoint presentation used for the debriefing in Addis Ababa.

[7] http://lamar.colostate.edu/~rtinsley/BasicPremise.htm

group which substantially increased the numbers of participants to over 50. In a couple case it thought that some "party" officials were sitting in on the meeting to make certain the discussions remained politically correct.

The meetings took the form of facilitated group discussions that basically followed the cropping activity from land preparation to harvest and marketing. In essence the meetings consisted of **two facilitator "trainees**" and over **one hundred participant "trainers"**. It was from these discussions came most of the commentary and recommendations on how to best assist the smallholder farmers of Ethiopia to alleviate their poverty and provide a better quality of life. For this purpose Mr. Habtamu Tola proved to be an exceptionally able translator/facilitator and did his best to maximize the number of participants actively participating and minimize the extent a few people dominated the discussions, as so often happens in large group meetings.

Commentary

Operational Limitations

The conceptual overview of the volunteer is that, in contrast to the basic premise of limited knowledge and risk avoidance, most smallholder are more restricted by the limited operational resources available to manage their lands, than the knowledge of best management practices. The operational resource being the labor, draft animals, tractor access needed to extend a small plot research/demonstration result across an entire smallholder field, farm or community.

Administrative Void: This is really the oversight of agronomy, which does an excellent job of determining the physically potential of an area, while saying nothing about what is required to extend the results beyond the demonstration area. The unfortunate assumption is that it is not a problem and the farmers have or can get access to an infinite supply of labor, draft animals or motorized tractors when needed. This is really an administrative void in the rural development process as no one appears interested in or willing to take responsibility for:

- Determining the labor, draft or other operational requirements to extend demonstration over the rest of the field, farm, or smallholder community,
- How available these resources are within a smallholder community,
- Or, given what is available how will it impact on the implementation of recommended best management practices.

The agronomists, who have done a good job in determining the physical potential, as applied biological scientists, are uncomfortable in analyzing what is more of a social science input than a biological science input. Over the past 40+ years no other discipline as stepped forward to address the issue. The best effort has been the economists who can often tell you the operational needs, plus what they will cost, as part of their need to estimate the production costs or cost benefit analysis, of recommendation packages. However, they will usually stop short of determining the availability of these essential operational resources within a smallholder community or the drag the limited amounts will have on the recommendations, in terms of the compromises the farmers make to the recommendations as crop establishment is delayed and potential yields decline. I fear that until someone steps forward to address the operational

limitations of smallholder farming, we are destined to continuing the endless cycle of making beautiful demonstration of the physical potential and repeatedly teaching, or perhaps badgering would be more accurate, farmers with what they already have a reasonable good idea about, but not the means to take advantage of.

Conceptual Questions: Thus when smallholder farmers are not operating in full compliance with the recommendations developed and promoted for their benefit, the conceptual questions are what percent of the problem should be attributed to:

1. ***Lack of knowledge*** requiring yet another round of extension demonstration/educational effort,
2. ***Lack of operational means*** requiring facilitating access to labor, mechanization or draft animals to expedite the farming operations that will bring crop management in closer compliance with recommendations, or
3. ***Lack of logistics*** requiring facilitating sufficient supplies of quality seed, fertilizer and other inputs available at the community level to provide the entire community's needs.

Unfortunately, the normal assumption is to emphasis # 1, lack of knowledge. However, this may actually be a minor concern at approximately 10% of the problem. Instead the emphasis might best be place on #2 lack of operational representing about 70%, with the 20% balance attributed to #3 logistic concerns limited supply of inputs. The result of all this could easily be that what is observed as ***smallholder farmers failing to comply with recommended best management practices, might be an optimization of those same best management practices to the limited operational resource base the farmers have access to***. Note that most of the observed differences between farmer practices and recommended practice require a substantial increase in labor, etc. While this may not be the accepted approach to assisting smallholders, there was nothing seen during the visit or mentioned by the farmers that would contradict this but instead only reinforced the concept.

Caloric Energy Balance[8]

One way to develop an appreciation for the limited operational resources available to farmers is to examine the caloric energy balance for smallholder farmers comparing the calories they have access to, to the calories required to undertake the expected full day of manual agricultural labor. Typically smallholder farmers have access to about 2000 kcal which is barely enough for basic metabolism. If they are expected to diligently work all day the dietary requirements are in excess of 4000 kcal[9]. This was conceptually illustrated for Ethiopia by a food scientist participant as part of a value chain workshop during the volunteer's previous F2F assignment based on an assumption of daily casual labor wages and consumer prices in Addis Ababa[10]. The estimated dietary calories was approximately 3000 kcal per adult. A diet of 3000 kcal would allow a person to work reasonably diligently work about 4.5 hrs./day. However, this represents the upper limit

[8] http://c.ymcdn.com/sites/www.echocommunity.org/resource/collection/62026577-227A-4FB0-8B25-B0838484CED7/Issue121.pdf
[9] http://lamar.colostate.edu/~rtinsley/DietPoster.pdf
[10] http://lamar.colostate.edu/~rtinsley/EthiopiaDiet.html

of published caloric energy available to smallholders. The limited diet relative to labor needs was reconfirmed from the farmer meetings in Koffele during this assignment. In this case the consensus of subsistence food stock retained by the farmers was stated as three quintals of potatoes and 1.5 quintals of maize per adult. This would provide a basic diet of some 2054 kcals. Determined as follows:

- Energy from potatoes:
    - 300 kg/365 day = 0.82 kg/day (820 g)
    - If 100 g of uncooked potatoes provides 69 kcals then 69 x 8.2 = 566 kcals.
- Energy from maize
    - 150 kg/365 days = 0.41 kg/day (410 g)
    - If 100 g of uncooked maize provides 363 kcals than 363 x 4.1 = 1488 kcals
- Total is 566 + 1488 = 2054 kcal.

This would only cover basic metabolism, but not allow any major hours of diligent agriculture labor that would consume up to 300 kcal/hr. While farmers most likely are also consuming beans and other food, the potato and maize stock will represent well over half their caloric intake. Thus most likely the most calories they could consume would be about 2500 kcal which would allow them to diligently work for 2 hrs/day, perhaps longer by pacing the work load, but then taking longer to complete the task.

Work Day

Since Ethiopia is in the tropics with nearly continuous year round 12 hrs of daylight and 12 hours of darkness, the work day can be reasonable consistent all year. During the day the need to care for animals will have priority over crop management, as they need to be watered and feed or taken to where they can graze for the day, then later returned to the homestead for the night. These animal chores cannot be avoided or substantially postponed, as easily as they can for crop management. Thus the farmer were asked how much time they spent taking care of their animals. The consensus reply was two hours in the morning and another two hours in the afternoon for a total of four of the 12 hours of daylight. This most likely represent a lot of time, but not a lot of caloric exertion, as occurs with agronomic field work. Thus while there might be eight additional hours for potential agronomic field work, the farmers claimed they only worked about 4 to 4.5 hrs./day. This would go from approximately 9:00 after getting the animals settled for the day, until 1:00 or 1:30. This 4 hrs. also represents the limited energy the draft animals may have for hard pulling in land preparation with only the marginal rations associated with communal grazing lands, and crop residue fodders, and without any supplemental grain or other feed concentrates. Also, given the limited diet, this human output is most likely not at full diligence, but represent some degree of pacing their available energy to extend the workday. This can also be fairly clearly seen in casual driving through rural areas of Ethiopia. In this case in the morning starting around 9:00 you can see a lot of field activity, but after about 2:00 in the afternoon most of what you see are farmers slowly leading their animals back home, and setting them to feed on straw stacks, while substantial agronomic field work opportunities clearly remain uncompleted. Thus a typical workday would look something like:

1. Daylight begins around 6:00 am;
2. 6:00 to 8:00 am, Morning care for animals;
3. 8:00 to 9:00 am, Return home from caring for animals, breakfast and walking to Agronomic field for the day;
4. 9:00 am to 1:30 pm, agronomic field work depending on crop or land needs;
5. 1:30 to 4:00 pm, return home for lunch and some well-earned rest;
6. 4:00 to 6:00 pm, afternoon care for animals; and
7. 6:00 pm, darkness descends and the day ends.

Impact on Timing of Crop Management Activities

If farmers are operationally limited with insufficient calories for a full day of work, how will this impact on agriculture production and compliance with extension recommendations? If farmers are confined to traditional manual land preparation and can only work 4 hrs. and it takes 300 person hours to manually cultivate a hectare of land, this will require some 80 days (12 weeks) to complete initial land preparation and crop establishment. This is well beyond the time limits needed to take fully advantage of any recommendations that typically expect crop establishment to be completed in two or at most three weeks. It might be possible for farmers to be assisted by their spouse, but this will be a secondary priority to the daily domestic requirement of fetching water and fuel wood, cooking, child care, etc. All of which could easily consume all her caloric energy. Thus spousal assistance might be possible, but not as a major reducer in the time required. An adolescent child might be better able to provide an additional 4 hrs./day, but that will only reduce the time by half and still exceed the unstated time limits for complying with recommendations. However, from a development effort perspective, the long term national priority should be to have adolescents in school rather than working on the land.



Fig. 12. Two Pairs of Draft Animals Doing Land Preparation.

However, in Ethiopia most of the land preparation is done by teams of two draft animals (Fig 12). This will probably substantially reduce the time for land preparation and crop establishment compared to manual operations, but will it be enough to comply with recommendations. The estimate time required for animal cultivation is listed as 0.25 ha/day. However, this probably refers to a well maintained team receiving supplemental feeds rather than animals surviving on communal grazing and crop residues. A more realistic time for more typically maintained animals grazed on unimproved pasture, possible emerging from the dry season in which they lost weight and conditioning, and without any supplemental grains, would be $1/6^{th}$ ha/day. In this case it will take a week for each cultivation. Thus, if it takes four cultivations for a minimum quality for broadcasting grains, with an additional cultivation for the quality needed to row seed, then it will take at least a month from when cultivation begins to start actually planting a crop. This will still leave a fairly ununiformed field compared to the large farm seen broadcasting wheat seed with a cyclone applicator that

appears to have at least been graded with a land-plane on a 74 ha field (Fig. 13). I think that is longer than accepted according to most "best management practice" expectation. If this is outside the recommended time frame, it has to be considered as operational and involuntary limitation, and not lack of knowledge. Also, this would support the contention that what is observed in the field represents the farmers optimizing the recommendations over their limited operational resource base. However, it is consistent with the volunteer's personal observation from many smallholder communities in Ethiopia or elsewhere in Africa and beyond, that crop establishment tends to extend from the recommended time as the earliest up until as much as eight weeks past the recommended time. At no time were any smallholder fields actually sown during the assignment, even though the assignment was designed to cover most of the crop establishment activities. The only sowing and subsequent germination observed was from this large farm.



Fig. 13. Large 74 Ha Well Graded Field for Cyclone Broadcasting on Time Not Far From Koffele

Access to Mechanization

If smallholder farmers in Ethiopia, be that Koffele or other locations in Ethiopia or elsewhere in Africa, are more limited by lack of the operational resources to manage their land in as timely a manner as desired to comply with "best Management Practices" recommendations, then the most effective way of assisting them is to facilitate an enhancement of the operations resources needed to manage their lands. This very quickly become the need to look at access to contract mechanization. This is slowly taking place both in Ethiopia and the rest of Sub-Saharan Africa, but largely below the radar screen of the rural development effort (Fig. 14). This lack of interest in mechanization is part of the over sight in not considering operational limitations, and the assumption that the delay in crop establishment is largely a risk averse concern, resulting in the assumption there is a labor surplus in smallholder communities. Hopefully this report has indicated this is unlikely.



Fig. 14. A Contract Tractor on The Road to Robe Available for Contracting to Smallholder Farmers.

However, contract mechanization has to be done carefully to be effective. The important thing is to recognize that successful mechanization has to be individual private owner/operators. There is a tendency to emphasize either public sector mechanization units or joint ownership through some form of farmer organization. This type of organized mechanization was discredited some 40 years ago and should not be attempted again. Under any form of joint ownership tractor will be surveyed out of service with less than half the designed 10,000 operating hours, often for

minor repairs that, for reasons unknown, cannot be effectively organized. This can be clearly seen by the line-up of non-operating tractor outside any Agriculture Development Project (ADP) in Nigeria (Fig. 15). Also such communal tractors are often diverted away from the intended smallholders to serve larger more influential farmers, perhaps with the payment of an "access" gratuity. However, when individually owned tractors will usually get considerable more operation hours than the designed 10,000 hours. This is common throughout most of the Middle East from including Egypt, Iran, Iraq, Pakistan and Afghanistan, where most basic cultivation for smallholder farmers is by individually owned and operated private contract tractors. The exception being in terraced areas inaccessible to tractors and animals or manual is the only alternative. An example is the famous "World Heritage" 2000 year old Banaue Rice terraces in the Philippines. The terraces have been mostly abandoned because they could only be manually cultivated and can no longer compete with the more mechanized rice cultivation of Central Luzon (Fig. 16).



Fig.15. Typical Line of Surveyed Out of Operations Tractors With Less Then Half The Designed Operating Hours Outside any ADP In Nigeria.

During the farmer meetings, famers were familiar with tractors and their potential to expedite their field operations. However, the available tractors had to come from a long way and would only be available for brief periods. This was after the barley crop was planted, but still in time for the wheat crop. However, of greater concern was the statement the farmers made that in addition to the quoted price of Birr 800/ha they were also being charged another Birr 400 facilitation fee to get access to the tractors. This left the impression, which needs to be confirmed, that there was a NGO, most likely from Europe as the tractors and combines are largely CLAAS manufactured in Germany, in the region organizing contract mechanization for smallholders but using the cooperative or public sector model, mentioned above to be avoided. This then allowed the drivers and facilitators to quietly impose the extra charge on the farmers. This can quickly diverted the access to tractors away from the intended smallholder beneficiaries to those more affluent. Unfortunately, this is all too common when joint ownership of equipment is done and represents a highly desired informal income opportunity for the operators at the expense of the intended beneficiaries[11]. This also means there can be tremendous vested interest in keeping the number of tractors very low. It is doubtful that the NGO advisors are aware of these informal payments. The underlying problem is that there are just not enough tractors in the area and the



Fig. 16. Mostly Abandoned 2000 Year Old Rice Terraces in Banaue Phillippines Because they Could Only Be Manually Cultivated.

[11] http://lamar.colostate.edu/~rtinsley/InformalIncome.htm

tractor density needs to be substantially increased. This could be a task for CRS perhaps following the model for importing used tractor to be reconditioned as part of an Auto/Diesel mechanics vocational training program such as those run by Don Basco, and then selling the tractors into smallholder communities[12]. The more ties to the specific communities the higher the likelihood of success.

Expanding the access to contract tillage with appropriately organized and managed tractors may need to be carefully considered. One of the farmers mentioned that if he had reliable access to tractors, he would get rid of some of his animals and expand the land he was cropping. If this was widely done, it could have a major impact on assuring food security for Ethiopia. It must also be appreciated the unrecognized role of mechanization in the success of the "green revolution" in Asia. How much of this is the result of new IRRI developed technology of short stature, high yielding, fertilizer responsive varieties and how much the concurrent self-financed shift from draft animals, mostly water buffalo, to rice power tillers. Since this was done by farmers without assistance from the development community, it goes mostly unrecognized by development community. However, how much land can be cultivated in the timely manner needed to take full advantage of the green revolution technology if left with the water buffalo compare to use of power tillers. Such power tillers are also slowing becoming available in rice schemes of Africa (Fig. 17).



Fig. 27. Rice Power Tiller Being Used In Rice Scheme of Ghana.

It should also be noted that an interview with a smallholder rice farmer in NE Thailand acknowledge that the shift from water buffalo to power tiller reduced his rainfed crop establishment period from four month to two months, expanded the area he was able to cultivate and allowed him to diversify into such intensive value chains as poultry suspended over fish (Fig. 18). The same should be expected of Ethiopian and other Sub-Sahara African farmers once they have access to the operational resources that will assure the food security for their staple food stocks.

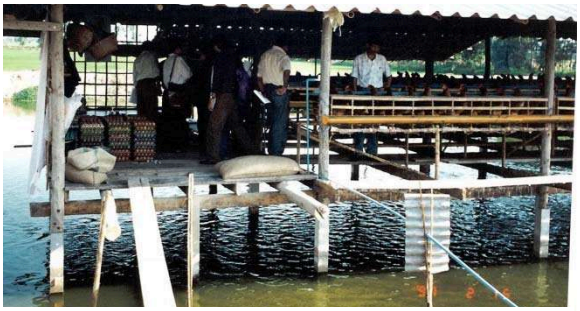


Fig. 18. An Intensive Poultry Farm Enterprise Suspended Over Fish Pond in Thailand Made Possible by Shift From Water Buffalo to Power Tiller for Rice Cultivation.

It is hard for this volunteer to anticipate Ethiopia making substantial gains in crop production and food security until these operational constraints are effectively addressed, either by the development effort or by the farm communities alone.

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

Seed Quality

There is always some concern about seed quality. There appears to be a viable parastatal seed industry in Ethiopia that deals with most of the staple crops like wheat, barely, teff, and maize. It is not certain if it also deals with seed potato which is a major staple crop in Koffele, but can be difficult to multiply except by farmers selecting and retaining "seed" potatoes. However, the seed supply tends to be limited and may be disproportionally available to larger farmers buying directly from the seed company, while smallholders appear obliged to obtain seed from FCU. In general there is not enough seed to meet the full demand, thus most of the certified seed is provided to the "progressive" farmers, leaving the remainder of the smallholders to rely on market seed.

While "market seed" is generally widely condemned by those in authority, for self-pollenated crops it may actually be fairly good quality and represent one of the area in which the advisory effort has conveyed the impression of greater reliance on the annual use of "certified seed" in countries like the USA then is actual. For example only between 25 and 30% of the wheat crop in Colorado is planted to certified seed with the remainder planted with retain seed or "market" seed. That is because for self-pollenated crops the genetic purity will be retained with minimum outcrossing for several generations. In the farmers' meetings one farmer mentioned market seed could be used up to seven generations before becoming too contaminated and needing to be replaced.

There three primary concerns with market seed all of which can be easily overcome. The big concern is variety mixing. This may not be as big a problem in Ethiopia as seen in other countries. In the farmers meetings the farmers were well aware of varietal differences and recognized different varieties of wheat and barley, clearing knowing which barley varieties were preferred for brewing, and which wheat varieties were best suited for bread vs. pasta. Also, it appears that just closely examining the seed they could determine which varieties were present and degree of mixing as shown by one participant providing examples of three varieties of barley (Fig. 19). This may be mostly related to grain size but could require a discerning eye. As with the tractor access, the limited supply of certified seed could represent an informal income opportunity for those insisting on its use, as the village extension worker noted when they requested 300 kg of seed be provided to the local FCU, but only received 50 kgs., and defined the "progressive" farmers as those using the certified seed.



Fig. 19 Three Varieties of Wheat Seed That Can be Easily Distinguished by Farmers with Discerning Eye and Knowledge of Varieties Available in the Area.

The second concern is germination. This is really a storage problem and may require some training in how best to store seed to preserve the germination over the off season from harvest to planting. However, since the farmers appear to be able to provide reasonable amounts of market

seed, the knowledge of acceptable seed storage my already been reasoned out. The germination can be easily tested for with simple "rag doll" germination techniques[13].

The third concern is cleanliness of the seed from foreign material. In this case the biggest problem is including weed seed that will then germinate and have to be weeded out. This can easily minimized with some simple grain/seed cleaners.

Market seed can become a major problem for open pollenated crops such as maize and sunflower. In this case it is critical to avoid hybrids and concentrate on using composite lines that have already been selected for uniform morphology.



Fig. 20. Nigerian Farmer Obliged to Grow Low Yielding 3 M High Sorghum for Lack Of Improved Varieties in His Community

Here is an area where CRS working with SDCOR or other organizations, perhaps through the Church, could assist smallholder communities to facilitate the access to market seed of reasonable quality in terms of genetic purity and germination with minimal foreign material. This could follow the example of the **Genetic Pump**[14], however the idea was developed for more adverse condition in which all variety identity had become completely lost and farmers were using market seed that had not been updated for decades, resulting in growing three meter high sorghum when improved higher yielding varieties were less than two meters (Fig. 20).

Crop Establishment – Row Planting

There was considerable interest in promoting row seeding of wheat and barley as a means of increasing yields (Fig. 21). Again this was based on the physical prospects without concern for the additional operational requirements that might be needed. This was discussed at great detail with the farmers during the farmer meetings. They appeared to be well informed about row seeding, clearly stating the yields could be higher, but also the row seeding did require an extra animal based cultivation to adequately prepare the land, and thus require approximately an extra week per hectare for land preparation. They also noted the extra labor required claiming it would take about 15% more time than broadcasting, but would substantially reduce the time for weeding. The 15% extra labor is similar to the 20% extra labor for row transplanting rice, and results in most farmers opting to continue random transplanting to expedite the total transplanting



Fig. 21. Demonstration of Row Seeding of Wheat

[13] http://utah.agclassroom.org/files/uploads/training/ragdoll.pdf
[14] http://c.ymcdn.com/sites/www.echocommunity.org/resource/collection/F6FFA3BF-02EF-4FE3-B180-F391C063E31A/The_Crop_Genetic_Pump.pdf

process. Thus the decision to row seed vs. broadcast has to be considered a knowledgeable decision by the farmers after considering all the factors. It would thus be expected that row seeding might be concentrated among the smaller farmers, who are not being as pressured to get larger areas cultivated, or among the early planted fields. As the season advances and farmers are delayed in their crop establishment with potential yields declining, the farmers will opt for the more expeditious broadcasting. It is interesting to note the large farmer observed outside of Koffele was using a cyclone broadcast seeder, when for the same equipment cost could have obtained a grain drill (Fig. 22). The field was certainly smooth enough for drilling. This raises the question, "with all the operational resources available and timing being correct, why they opted for broadcasting"?



Fig. 22. Large Cyclone Broadcast Seeder Used On Large Farm with No Apparent Concern for Row Seeding.

I n the Philippines on an exceptionally well drained and aggregated volcanic ash soil, readily accessible immediately after heavy rains, upland rice farmer have an animal drawn implement called a latheo that will take broadcasted seed and move them into rows where they can again be cultivated with the same implement (Fig. 23). This might be worth trying and the implement or at least a detailed diagram should be obtainable from IRRI headquarters in the Philippines. However, the soils in Ethiopia might not be friable enough for the latheo to be effective and not accessible for a couple days after a heavy rain.



Fig. 23. The Latheo Used In the Philippines for Forcing Broadcasted Rice Into Rows for Easier Cultivation.

The time of planting seems slightly delayed from recommendation, as the timing of the assignment was geared toward crop establishment with the idea that this could be observed and addressed with the farmers. However, the operational limitation usually result in crop establishment being spread out over several weeks starting with the recommended time then extending well past that, perhaps as much as eight weeks past recommendations. This is typical over most farming communities, but is a greater problem for smallholder communities. Facilitating the enhancement of the operational resources for expediting crop establishment is frequently one of the more effective innovations for smallholder farmers although often over looked by the development effort.

Soil Fertility

Soil fertility is always a problem. In Ethiopia fertilizer appears readily available but for smallholders this is virtually exclusively through the FCU. The available fertilizer is both DAP (Diammonium Phosphate) and Urea. At the time of the assignment the only thing available was DAP with the expectation the Urea would be available later when needed for top-dressing. There was interest in other forms of mixed fertilizer but they were not currently available.

There was also interest in establishing soil testing laboratories. However, this needs to proceed with caution. Normally, it is possible to establish a soil testing lab and get donor assistance in funding it. This would include providing all the necessary equipment, training staff, and even providing the initial supply of reagents and materials. However, once the initial donor assistance ends, does Ethiopia have a sufficient tax base to sustain a lab with replacement reagents, and other supplies? In most developing countries this is not possible and the lab quickly falls in disuse without external assistance. Also, will the turnaround time to acceptable? Typically in the USA the soil test results are available within 24 hours, while in most countries like Ethiopia the turnaround will be months after submission and thus not available for the current season.

Also, will a soil test be cost effective? This is again unlikely for smallholder farmers. The cost of a soil test, either to the smallholder farmer or the government, if it is a government sponsored and financed program, is typically comparable to the cost of a 50 kg bag of fertilizer such as Urea or DAP. Thus a soil test needs to make the difference in a bag of fertilizer to be cost effective. Since with fields of only 0.25 to 0.5 ha for which the total fertilizer recommendation would be only two to four bags with most of that Urea Nitrogen, it will be difficult for a soil test to make the difference in a whole bag of fertilizer. Thus it would be better to operate from standard fertilizer recommendations based on 100% Nitrogen needs, and recognizing the over application of other nutrients will mostly be banked in the soil and not leached out.

There is an alternative that will accomplish much of what a soil test will accomplish, particularly if results are typically not available for the current crop season. That is to conduct soil fertility surveys of the area. This would be basically following a grid sample, or perhaps a grid modified to accommodate different soil type as identified in a comprehensive soil survey, if available. This would sample perhaps 100 ha at a time, and look for regional trends in soil deficiency or toxicity and make adjustments in fertilizer recommendations for the effected regions. The nutrients or greatest concern would be the non-nitrogen major nutrients of P, K Mg, Ca, and S plus some of the critical micro-nutrients like Fe, Cu, Mn, B, and Zn. In addition the pH would be important as it controls the availability of many minor nutrients, and indicate the need for either lime or gypsum to either raise or lower the pH, respectively. Such surveys would only have to be repeated once in about 10 years. It should also be noted that applying extra nutrients in excess of what the plants need usually result in the nutrient being banked in the soil and not lost from the soil. That is for the elements listed above.

Composting and Nutrient Recycling

There is usually an interest in promoting nutrient recovery and recycling, often with an emphasis on composting. Governments tend to like this and endorse it as a means for reducing expensive

fertilizer import that will consume substantial foreign exchange. However, it needs to be undertaken with care to make certain there is sufficient organic material to fertilize the entire community or recommendation domain[15]. This is rarely the case, as most plant nutrients are removed with the grain and exported from the area with the grain sales. The results are, if relying on grain straw, the ratio of land over which organic material needs to be accumulated compared with that over which it can be applied to provide the fertility of a commercial crop necessary for promoting food security is about 3:1 for the community while contributing to national food security. Such accumulating areas are normally not available with in a smallholder community, s most land is already being cultivated.

Second the labor requirements to accumulate composting material, mix it up during the several months of decomposition, and later redistribute the compost back over the land, can be considerable in what early was mentioned as a labor short environment. During the farmer meetings one farmer mentioned the labor needs for composting and was shying away from getting involved. As mentioned earlier, there is also a concern for the manual energy exerted in preparing compost and if that energy can be recovered through increased yields. It is estimated that if you are exerting 300 kcal/hr. preparing compost, you will need to increase the grain yield, in rice, wheat or maize by some 77 g/hr. worked. I am not certain that is possible and not healthy for people with limited diet to exert more energy than they will eventually recover, even if the recovery is several months in the future, at the next harvest. Thus compost making may be something that can be fairly easily demonstrated, but has little potential for extensive acceptance, and should not be considered as a 100% replacement for chemical fertilizers.

Animal Composters



Fig. 24. Goats Effectively "Composting" Crop Residues in the Field.

Considering the time and energy required for using compost for nutrient recovery, it might be much easier and more effective to, where and when possible, rely on the herbivore farm animals, cattle, goats, sheep, even horse and donkey although the latter two are not really ruminants, to do the composting (Fig. 24, 25). At the very basic level it is virtually the same process. It is a microbial biochemical process of reducing the carbon and thus the volume while increasing the concentration of nutrients. For compost this is slowly done by the soil microbes, while in the animals it is more rapidly done by the ruminant bacteria aided by the extra body heat of the animals that expedite the biochemical process. Perhaps these herbivore animals should be considered portable composters, as they can be taken to the field to graze on crop residues thus effectively doing much of the collecting, process the material in place, and redistribute most of finished product i.e. manure back where it will do the most good. Effectively, the animals are taking materials that are normally burned because they cannot be manually or with animal power

[15] http://lamar.colostate.edu/~rtinsley/OrganicNutrients.htm

be effectively plowed into the ground in a timely manner, and converting it to a material that can be easily plowed under.



Fig. 25. Herbivore Farm Animals Happily Making Compost (Manure) from Straw Piles.

Furthermore, instead of having to exert energy in making the compost, the animals will actually derive energy from the process. This could have considerable value as in a recent agriculture forum based in Laos, discussing the new role of water buffalo now they are not used extensively of heavy draft with farmers shifting to the power tiller for rice preparation, it was eventually determined that the live weight of the animals was valued at US$2.00/kg. Thus feeding straw and other crop residues to the animals will have a financial value of US$2.00/kg of weight gain, or kg of weight retained, if during the dry season when animals often lose weight and draft conditioning. Thus feeding the animals will be a higher priority than making compost for most farmers particularly in Ethiopia which has the largest animal to people ration in all of Africa. This can easily be seen by the animals brought back to the homestead at night are left to munch on piles of straw, etc. (Fig. 25). It should also be noted that straw is not really a quality fodder and should be supplemented with grains or other feed concentrates, although this is most likely rarely done in smallholder communities and animal husbandry. Please also note that neither manure or compost represent a new fertilizer source to the community, but more a movement of nutrient around the community in what is ultimately a zero sum effort.

Bio-Char



Fig. 26. Demonstration of Bio-Char Showing Lumps of Charcoal.

There is a current fad in the rural development effort to encourage applying bio-char to the soil with the expectation of improving soil moisture content and nutrient retention, this in addition to removing excess CO_2 from the atmosphere as a greenhouse gas, possibly expecting countries like Ethiopia to compensate the environment for the excessive use of fossil fuel by countries like the USA. However, this needs to proceed with extreme caution (Fig. 26). As with composting there it is unlike to have enough charable material for an entire smallholder community or other recommendation domain, and most of the material may have a higher priority in the community such as firewood for cooking. This is really promoted from some rather questionable research studies in which only the highest application level showed a significantly measurable but not necessarily substantial difference. The result is an application recommendation of some 10 t/ha of char, which, because in making char 70% of the material is volatilized, requires 30 t/ha

of burnable material. Is that available without doing some major deforestation and consuming considerable firewood needed for cooking and other domestic requirements? Thus while it is possible to make demonstration plots it cannot be realistically extended across a smallholder community, and could be environmentally detrimental.

Bio-char is also considered as an additional source of soil organic matter. However, this also needs to be carefully reviewed. While, yes, bio-char retains many of the carbon ring structure associated with soil organic compounds, it is more a mineral form of carbon than an organic form and does not have all the exchange sites true soil organic matter contains nor does it decompose and mineralize as normal soil organic matter does. Instead is simply sits inertly in the soil for potentially a couple millenniums. This is the same material archeologists use for carbon dating of ancient sites. Again proceed with considerable care and hopefully the fad will shortly fade away.

Plant Protection

The concern for plant protection from weeds and insects was not a major discussion point during the assignment. It seems most of the weeding was manual with some herbicide use, with is unusual for smallholders and if using simple backpack sprayers to apply would be difficult to get the necessary uniform coverage needed to control weeds without damaging the crop. It was noted that row seeding made the weeding much easier, while broadcasting did the opposite. Herbicides were available through the FCU as were insecticides. How reliable the supply was somewhat left up in the air.

Harvesting & Threshing

Most of the harvesting remains done by hand, with the cut grain often stacked for up to two months before threshing. The threshing remains mostly done by animal trampling, which leave up to 30% of the crop on the ground and contaminates the remainder with urine and feces that could reduce the market value (Fig. 27). This is a major area that innovations might be possible to improve the grain recovery and reduce the drudgery.



Fig. 27. Threshing Grains & Pulses By Animal Trampling, Leaving 30% of Crop Behind

Combining: There are some combines available through what appears to be a European NGO as they are CLASS machines with headquarters in Germany the same as the tractors and could represent a single project (Fig. 28). The combines were also based a couple hundred kilometer away and were only available for brief periods of time, and thus could not be relied upon for combining all crops. It also looks like they are using the joint/operator business model that was discredited over 40 years ago, as noted in driving past compounds containing several combines during the trip to Robe. It is thus unlikely they will be sustainable for more than about one third the manufactures anticipated service life, before repair problems will sideline them. These machines are designed for the



Fig. 28. CLAAS Combine Now Available in Ethiopia, Most Likely From European Based NGO

larger fields of Europe and may not be the best suited combines for smallholders' fields of half hectare or less particularly on sloping lands. Too much lost efficiency turning around and backing into corners. The running efficiency could be reduced by 20% or more. More suitable would be combines coming from Asia and designed to work in small rice paddies of one rai ($1/6^{th}$ hectare) (Fig. 29). They are designed with only a two or three meter head. While these are all tracked combines for working the wet but drained paddy fields it should not take too much effort to convert them to pneumatic tires for dryer conditions. Perhaps they could become available through JICA, the Japanese aid program. The introduction of combines into the fully irrigated rice areas of Thailand increased the crop intensity from two crops per year to five crops in two years.



Fig. 29. Asian Combine that Might be Better Suited for Ethioia than the German Combines

CLAAS is an internationally well-known high quality manufacture of farm machinery. Thus these combines should be easily capable of providing a high quality combining service with grain already complying with the international standards of >1% foreign. Thus it was a great concern when farmers complained about the quality of the grain coming from the threshers. The complaint was that too much trash was included in the bagged grain, thus doubling the number of bags the operators claimed to have combined. Since the farmers were being charged by the number of bags harvested they felt they were paying double the amount they should have paid. This should not happen with this quality combine. Thus when given a chance to examine one and look in from the back at the straw discharge area, it was noted the possibility a couple screens might be missing (Fig. 30). These screens would safely carry the straw over the drop area where the grain falls into the auger (Fig. 31). As it appears the straw could leave the threshing area and fall directly into the auger to contaminate the bags of grain. This would explain the famers complaints on quality of combined grain, unless the screen were removed for security purposes when the combine is parked in a poorly secured area, as this one was.



Fig. 30 View Inside the Straw Discharge Section of the CLAAS Combine Where Some Screens Carrying the Straw Past the Grain Augers May be Missing.

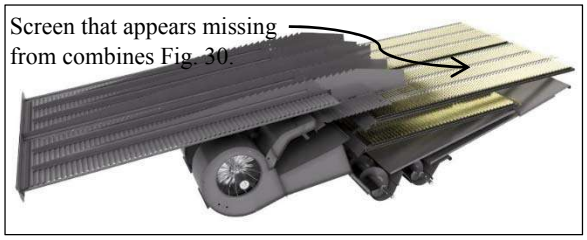


Fig. 31. Internet Picture of Claas Combine Showing a Screen Across the Grain Auger That Appears Missing in the One Above.

One thing that might be worth considering is shifting the charges from per bag of combined grain to a percent of the crop, say 15%. That would put the vested interest of both the farmer and combine operator the same at maximum recovery of clean grain, instead of cranking out as many bags as possible in the shortest possible time. This would be similar to the Philippines where the manual harvesting and threshing was worth 20% of the crop. Given the potential extra grain recovery is 20 to 30% this would be a reasonable charge and paid for by the increased recovery compared to animal trampling making the farmer better off even after paying for the combine.

Farmers also had another serious complaint about the combines, similar to that made about tractors. The claimed they again had to pay a Birr 400 access fee to the operator or facilitator for the combine to come and work their fields. This sounds more like someone extorting informal income from the farmers unbeknown to the NGO or whoever was providing the combines. Unfortunately, I think this is typical of what happens with jointly owned and operated equipment and needs to be carefully evaluated to make certain it is an acceptable charge by those managing the combines.

Looking at the total combining operations currently in Ethiopia I would voice some reservation and think the program may need to be carefully reviewed.

Mechanical Threshing: The actual use of combines is very rare, as there just aren't enough available in country. An alternative that appears to be slowly becoming available in Ethiopia is the mechanical threshers modeled after the IRRI axle-flow thresher. These are currently being manufactured by Selem Children's village as part of their vocational training for adolescent residents (Fig. 32). Perhaps other organizations are or could manufacture similar thresher. Since the thresher was developed by IRRI with international funding, the blueprints are public domain and freely available directly from IRRI. While the original design was developed nearly 40 years ago for rice, it has been adopted and adjusted for different crops. It also appears to work reasonably well on teff, perhaps the world's smallest grain, for which one would expect considerable grain to be blown out with the straw (Fig. 33). Thus it might be desirable as a follow-up on this assignment to look at ways to make these threshers available in smallholder communities. At this point Ethiopia might be better off emphasizing the axle-flow thresher instead of the combines for enhancing the harvesting and processing of grains. They are independent of field size, less expensive and will be easier to



Fig. 32. Axle-Flow Thresher Being Manufactured at Selem Children's Villaae

distribute to private community based family enterprises living and working within the smallholder communities.



Fig. 33. Axle-Flow Thresher Being Used With Teff

While the axle-flow can do a g ood job of threshing the grain leaving little grain left with the straw, it may not be capable of winnowing to the international standard of > 1% foreign matter. Also, it is unlikely that the normal wind winnowing can achieve this level of clean grain, particularly if done on a communal drying floor where the tails from one winnowing pile simply contaminate the next downwind pile, only to have to be re-winnowed until eventually being blown off the drying floor from the most downwind pile (Fig. 34). Thus there may be the need to look at some simple mechanical winnowing machines that could bring the quality to international standards. Selem Children's Village also makes grain/seed cleaners that could be used after threshing (Fig. 35). Such winnowing machine might best fit into smallholder communities with the private trades who purchase most of the grain sold by the farmers. That is where the vested interest in a clean bag of grain is most appreciated. Thus when a farmer or perhaps a spouse brings some grain to market it can be quickly run through the cleaner. A clean bag of grain should command at least a 10% primum price over normal grain. This reflects the need for the buyer to remove the foreign material and represents both the amount of material removed shrinking the amount marketed and the costs for removing it.



Fig. 44. Communal Drying and Winnowing Floor in Ghana With Tailing From on Pile Simply Contaminating The Next Downwind Pile, Making Clean Winnowing Difficult.



Fig. 35. Grain/Seed Cleaner Manufactured by Selem Children's Village.

Marketing & Home Storage

Most of the farmers marketed the grain they sold through private traders operating within the village. The marketing period would often extend up to 10 months after harvest and represents the common financial management strategy of smallholder to retain most of their assists, crop and animal alike, in-kind as long as possible and only market what is necessary to meet immediate cash requirements[16]. Apparently, cash presents a greater security risk than post-harvest grain loses. Thus household storage could be a major problem

[16] http://lamar.colostate.edu/~rtinsley/FinancialStrategy.htm

that may have a fairly simple solution. Purdue University has recently developed a triple bagging technique for air tight storage that will prevent insects from surviving. The claim is it will allow farmers to store grain for up to a year free of at least insect damage, but no mention of rats (Fig. 36)[17]. The emphasis is on cowpeas and other pulses but still should be something worth evaluating in Koffele for wheat, barley, teff as well as various pulses. The woven outer bag is for strength and two polyetheleine inter bags are for air tightness. All of these should be readily available in most open markets or could be made available through organizations like SDCOR and farmers instructed in how to assemble and use them. There should be no problem with fabricating these bags and no patient infringement.

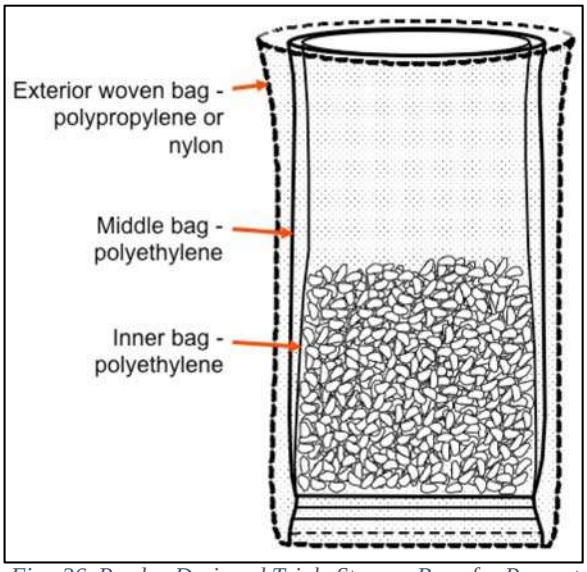


Fig. 36. Purdue Designed Triple Storage Bags for Prevent Insect Damage During Storage.

Rainfall Variability

One issue I frequently get involved with during training programs that did not become a major portion of this assignment is rainfall variability. However, in preparation for the assignment I did make an analysis of the data available from the USA government's NOAA climatic data site[18]. This amounted to 10 sites for which the closest to Koffele was Robe. The main idea behind the analysis is to illustrate the high level of natural yearly variation in monthly rainfall and the extent that variation is considerable higher than most people would accept for an accurate agronomic planning tool. The data for Robe is presented in the Table 1and reaffirms the variability as noted in the last line CV (Coefficient of Variation). The table shows basically a bimodal rainfall distribution, but for which no months does the average rainfall exceed 200 mm which is the base level for crop evapotranspiration in tropical climates with uniform day length throughout the year. Thus the area would be considered fairly dry and most crops would be suffering some moisture stress during their growing season. This would impact on the potential yield, but not necessarily any specific agronomic practice. Typical of other tropical areas, the variation of mid-season rainfall from 30 to 50% while that for on-setting and decline, the critical periods for crop establishment and harvest is around 70%, and the dry season well over 100%. This is substantially greater than the 20% variability as the upper limit of what most people would tolerate as a planning tool, and farmers and agriculture professional need to respond to the incident precipitation and not make detailed plans in anticipation of the rains. Also, before one blames poor agronomic performance on poor rainfall, they should check to make certain it was outside the CV limits. If not, then is the normal variation that needs to be taken into account. Similarly be careful on attributing variation in rainfall to climatic change unless it is reoccurring

[17] http://extension.entm.purdue.edu/publications/E-262.pdf
[18] http://www7.ncdc.noaa.gov/CDO/cdo

on a regular basis and identified in long term rolling averages. While I agree that the climatic must be undergoing some substantial man induced changes, I don't think it can be clearly identified from individual anomalies in rainfall. Although the information was not a major part of the assignment, having been tabulated I have included it in the Appendix 3 as a reference. It should also be noted the available data was fairly limited. Normally you would like at least 20 entries for each month. You can still expect reasonable results with only 10 entries, but would have to be careful when fewer than 10 entries as is the case with several of the data sets from Ethiopia.

Table 1. Rainfall Data For Robe Bale

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Sum	Adjusted
1980	0.76	39.88	46.99	114.05	52.32	77.22	50.29	69.85	135.64	77.47	42.16	0.51	707.14	707.14
1981	0.00	23.88	99.06	242.82	91.19	23.88	81.79	142.24	133.10	42.93	29.72	12.70	923.29	923.29
1982	17.78	44.45	76.71	194.31	121.41	45.72	64.01	123.19	53.59	147.83	57.40	74.42	1020.83	1020.83
1983	40.39	29.72	16.76	184.91	123.44	54.86	121.16	191.26	186.94	119.89	50.04	7.11	1126.49	1126.49
1984	0.00	11.43	11.18	102.36	138.43	24.64	38.10	86.11	153.42				565.66	687.67
1985	26.92	0.00	68.83	132.33	87.88	13.46	79.25	44.45	138.94	52.07	20.57	0.00	664.72	664.72
1986	0.00	36.32	38.61	165.86	112.01	65.02	51.05	52.83	99.82	46.48	10.67	0.25	678.94	678.94
1987	8.13	22.61	141.99	204.98	169.93	43.69	22.61	81.28	108.46	53.85	12.19	0.25	869.95	869.95
1988	2.54	9.65	25.15	146.81	12.45	51.82	184.15	184.15	140.72	116.33	0.00	1.27	875.03	875.03
Count	9	9	9	9	9	9	9	9	9	8	8	8		
Sum	96.52	217.93	525.27	1488.44	909.07	400.30	692.40	975.36	1150.62	656.84	222.76	96.52		7554.06
Ave	10.72	24.21	58.36	165.38	101.01	44.48	76.93	108.37	127.85	82.11	27.84	12.07		839.34
Std.Dev	14.62	14.98	42.83	45.86	47.00	20.73	49.35	54.62	37.41	40.43	20.50	25.60		166.34
CV	136.33	61.88	73.38	27.73	46.53	46.61	64.15	50.40	29.26	49.25	73.64	212.19		19.82

Farmers' Cooperative Unions & Development Cooperatives

One concern I always have in countries like Ethiopia is the heavy reliance on cooperatives to provide business services such as procurement of inputs and marketing of produce to smallholders. The problem is that most of the time the cooperative business model is too administratively cumbersome and too inconvenient for smallholders to rely upon them, unless absolutely necessary, such as monopoly control of seeds and fertilizer. Thus while they may be socially desirable, and they can arrange discounts for bulk purchases and bonus for bulk selling, most if not all of these financial advantages are consumed by the extra overhead costs associated with operating a cooperative, particularly if they are assuming that because they are farmer managed, they automatically have a competitive advantage and are not actively closely paying attention to reducing overhead costs. Thus, they rarely are competitive and farmers are both financially better off as well as more conveniently served by private service providers. Unfortunately they are heavily promoted by the development community with some extensive spin reporting that is more intended to appease the donors than sincerely assist the smallholder farmers. Two of my best examples come from Ethiopia. One is from the Oromia Coffee FCU which in a published article boasts of representing 21,891 members, but only marketed 181 tons of coffee or 8.3 kg/member providing net benefit of perhaps US$ 5.00 and representing less than 5% of the estimated production and 1% of farm income, and thus having a negligible impact on poverty alleviation[19]. The second is the Sidama Elto Cooperative[20] that appeared to only market

[19] http://lamar.colostate.edu/~rtinsley/DeceptiveReporting.html

[20] http://lamar.colostate.edu/~rtinsley/EthiopiaValueChainWorkshop.pdf

about 1/4th the members' marketed maize production. They in turn did not sell this to the Ethiopian consumers, but to the WFP for use in relief efforts including school lunches. The WFP being the only organization willing to cover their overhead costs. With this limited amount of market participation one wonders if the only production the farmers are consigning to the cooperative is what is needed to repay any production loans and side selling the rest to the private service providers. Something that was pointed out to my a few years ago but senior local hired staff of CLUSA in Zambia[21].

In Ethiopia it appears that farmers are obliged to belong to the Farmer Union Cooperatives, which than appear to have monopoly control over fertilizer and certified seed available to the smallholder farmers. However, the marketing is more open and at that time farmers overwhelming side-sell their production to private service providers. Thus, one can only wonder if the fertilizer and seed was available on the open market would the farmers be able to purchase it as a substantial discount. One often can easily list how cooperatives can lose their envisioned competitive advantage[22].

Summary & Recommendation

The F2F assignment was requested to provide a training program on best management practices for grain production in the Koffele area of Ethiopia. However, it was modified to first determine if extension/demonstration education was the limiting factor in farmers' non-compliance with recommendations or were they more restricted by limited operational resources to manage their lands, or limited logistical support to obtain recommended inputs. The assignment was divided into four parts. Some preliminary visits, two days of formal lectures to agriculture officers that mostly introduced the concept of operational and logistic limitations to compliance with recommendations, four days of farmer discussions, and a couple days for debriefing to CRS headquarters and consultation on possible future F2F assignments.

The farmer discussions confirmed, at least to the volunteer, that the farmers are fairly knowledgeable about their crop husbandry, and their lack of compliance with recommended best management practices is more likely the result of the not having the means to complete most agronomic tasks in the expected time frame. This includes the heavy emphasized row seeding of wheat and barley. The farmers showed a good understanding of the impact on yield as well as the extra time required to do it with animal tillage, and the reduced time it took for weeding.

The discussions also identified two major drags on farmers' ability to comply with recommendations. The first was limited diet and the second the large animal populations. As for the limited diet, the farmers' subsistence stocks were estimated at three quintals of potatoes and 1.5 quintals of maize per adult. This would provide a daily diet of only 2054 kcal/adult, which corresponds to basic metabolism and provide no energy for extensive manual labor required for non-mechanized agriculture. Thus the workday for crop production maybe reduces to four or 4.5 hrs. and of questionable diligence. To allow a person to work diligently all day requires a diet in

[21] http://lamar.colostate.edu/~rtinsley/SMC-RLT-Report.pdf

[22] http://lamar.colostate.edu/~rtinsley/LossCompetitiveAdvantage.html

excess of 4000 kcal/day. This limited work day can be readily seen as after two o'clock most of the field are empty of workers; and what is seen is farmer slowly bring their animals back to the home.

The animals may provide a double drag on crop production and national food security. First the caring for their animals consumes two hours in the morning and another two hours in the afternoon, for a total of four hours when there is only 12 hours of daylight. The care of animals is a daily need that cannot be avoided and directly diverts time and effort from crop husbandry. The second drag is the amount of land the animals require that could also be used for crop production. Thus Ethiopia should be encouraged to reevaluate its commitment to having the largest number of animals per population as it might be adversely impacting on national food security.

A third major concern and one that might be easiest addressed is the 30% lose in yield of grain and pulse crop do to threshing by trampling with animals.

Thus assisting the smallholders may require working within the smallholder communities to facilitate and enhancement of the operational resources available to them so they can get various crop husbandry tasks completed on time, than continue extension /demonstration/education efforts. Thus the key to improving the crop husbandry and recover would be improved access to mechanization. There appears to be some tractors and combines being introduced, most likely by a European NGO, as the tractors and combines are high quality CLAAS machines. They are quality machines with headquarters in Germany. However, there are really too few machines to make an impact at present and there may be some questionable practices with a Birr 400 access fee being required in addition to the stated charges. The combines may also be too large to conveniently work in some of the smaller fields where they will have to spend considerable time turning around or backing into corners. There are smaller combines available in Asia designed to work in 1.6th ha fields. These might be worth considering for future efforts. There are also some mechanical threshing machines based on the IRRI axle-flow thresher developed nearly 40 years ago for rice. They are small enough to be carried by two people or placed in a donkey cart. They also appear to do good job of threshing the very small grained teff. Getting three or four of these threshers to private services providers within smallholder communities could make a major difference in grain recovery, enhance food security for farm households, increase the calories in the diet and allow more diligent pursuit of future field work.

Concern was also expressed with the effort at preparing compost to replace chemical fertilizer and use of bio-char as a soil amendment. Both can be easily demonstrated but would be difficult to extend across any smallholder community. There is just not enough compostable material or charable material to do this to say nothing about extensive labor requirement in making compost. For compost when possible the material should be fed to the animals as mobile composters.

Recommendations:

1. The official host was SDCOR and the initial recommendations should be addressed to them, however, it did not appear they were in a position to move into any major agriculture efforts to assist smallholder farmers. Their social activities were following the

typical church social services of education and health care, and they were doing a commendable job of that serving the entire community regardless of religious affiliation. Agriculture development would be an additional effort for them. Also at present they do not have any real connection with any smallholder communities. Thus what they appear to be doing is mostly assisting the local agriculture officials. They do have at least one community about a half hours drive from the secretariat where they provide a weekly Sunday mass. Perhaps that could be a starting point for getting involved with a smallholder community. However, the budget appears limited thus they might consider getting involved with such things as:

   a. Evaluating the need for multiplying and maintaining quality seed of recommended varieties within the community and reduce the reliance on certified seed that typically is in short supply.
   b. Look at how to get some of the IRRI style axle-flow threshers into communities that will allow farmers to avoid animal trampling threshing and both increase the recovery of grain and the quality of that grain.
   c. Look at some of the Purdue storage bag idea to see if it will work for storing wheat, barley and maize at the farmers homes.

2. If the real need is to enhance the operational resources available to smallholders and this is more a national need that a local Koffele regional need, than the CSR country program may be in a better position to follow-up on this consultancy. That is if they have budget for activities not being contracted through some donor like USAID. Such things they could consider:
   a. Review their nutrition program to see if the base diet needs to be increased from 2000 kcal/day to 4000 kcal/day. As the nutritionist attended the CRS debriefing and appreciated the Dietary Energy Balance analysis this might already be being considered.
   b. Take a closer look at the role animals are playing in Ethiopian Agriculture to see if they are more of a drag on national and community food security than an aid to it. Perhaps this would make a good future F2Fassignment directly hosted by CRS.
   c. The next would be looking at enhancing access to mechanization. While normally the emphasis would be on tractors for land preparation, because of the heavy threshing loses with the current animal trampling the priority might be for getting the IRRI style threshers into smallholder communities with enough unit to handle most of the threshing needs, taking into consideration the farmer stack the unthreshed grain for up to two months, most likely given the stagger between crops maturing there could be up to four months of annual opportunity for mechanical threshing within individual villages an no need to provide a migratory service. It should be possible to develop this through individual owner/operators indigenous to the villages. It might be possible to get funding for this from such opportunities as the recent USAID Mission initiated IFSE effort. Given the potential 30% grain recovery it might be a real challenge to design a project with greater potential return for the amount of invested funds. This might be a good

future F2F assignment to develop a detailed SME business model for getting threshers to private service providers indigenous to smallholder communities.

d. I would avoid concentrating on combines at this time, but if so they should be based on the smaller Asian combines, perhaps something could be worked out jointly with JICA, the Japanese aid program.
e. As for tractors these again have to be individual owned/operated. Thus you might consider basing a project on importing used tractors for Maryland received under a charity donation to the local Church for reconditioning in Ethiopia as part of a vocational training program such as with Don Basco, a well-established Catholic NGO similar to Boy's Town in Nebraska and working throughout Africa[23]. CSR with it contacts both in the USA and Ethiopia may be uniquely situated to follow-up on this recommendation.
f. If CRS should get involved in enhancing access to mechanization, it might have to substantially revise the micro-finance system into a two-tiered system with a major concern for downstream benefits within the smallholder communities. The first tier would be for initially assistance with the capital purchase of machine, but for which the machines could serve as collateral, and later at least for the tractors, operational loans so operators can do contract land preparation and receive a delayed payment, perhaps in-kind payment, after harvest some 5 months later. This would be similar to some informal credit provided land preparation experienced in Madibira, Tanzania.

3. Avoid excessive farmer training programs, unless initiate with some good informal interviews to make certain the farmers are not already well aware of what the training is about, and have made some rational decisions to modify the recommendations as appears to be the case of row planting of wheat, etc.

[23] http://lamar.colostate.edu/~rtinsley/UsedTractors.htm