REPORT TO CARE/MOZAMBIQUE
on its Farmer Field Schools and Conservation Agriculture work
April 9 - 28, 2016
By Roland Bunch

EXECUTIVE SUMMARY
This year’s Farmer Field School (FFS) experiments have provided us with enough information to start the scaling up process in both the Inhambane and Nampula areas. The combination of the bushy Canavalia (C. ensiformis), disease-resistant cassava, lablab beans and the 60-day determinant INIA 73 variety of cowpea can provide the basis for cropping systems in both Inhambane and Nampula that will withstand the worst of droughts (like the ones this last two years) and provide plenty of calories and good-quality proteins year-round so that families can eat well and avoid ever suffering a hunger season again. At the same time, the systems proposed, after the first year, will very likely be largely impervious to drought. Furthermore, these systems could well increase soil fertility to the point that maize yields, without fertilizer, could well double or triple in a period of six to eight years.

With this proven potential, it is time in both areas to start encouraging farmers to try out the recommended systems en masse on their own farms. This is all very good news.

This report will include a description of the cropping systems we will start using in Inhambane and Nampula, a list of specific activities that need to be carried out over the next six months in both areas, and the lay-out for the FFS in both areas for this coming year.

INTRODUCTION
The following report describes the findings and recommendations of a third 3-week consultancy carried out in both the Nampula and Inhambane areas of Mozambique. The report will describe some important successes achieved during this last year, and then will describe the program’s progress and future directions. It will, in so doing, repeat some of the information in the previous two reports so anyone reading only this report will understand most of the history and significance of what has been achieved.

The Program Objectives
The consultancies carried out over the last three years in Mozambique have had the objective of finding and spreading one or more farming systems that would succeed in achieving all of the following 10 objectives:

1. At least double or triple the per-hectare yields of those basic grains and tubers people most like to eat,
2. Increase soil fertility substantially over time while at the same time producing food,
3. Provide high-quality protein all 12 months out of each year, thereby reducing or eliminating the hunger season,
4. Significantly reduce women’s workloads,
5. Follow the tenets of Conservation Agriculture (CA),
6. Sequester significant quantities of the carbon from the air,
7. Increase resilience to climate change,
8. Increase farmer’s incomes,
9. And accomplish all this at an extremely low cost, so that other farmers would have no problem adopting the technology spontaneously after having observed these systems’ results.

This last year, we felt obliged to add an additional objective:
10. Use techniques throughout the systems that would survive and even prosper during severe droughts.

We will call these the program’s ten principles.

Furthermore, all these ten principles will be accomplished in two different parts of the country and on some of the most heavily degraded soils in all of Africa—so degraded that neither maize nor lablab beans could previously be grown anywhere except on termite mounds or next to people’s homes.

Most agronomists would claim that all this is impossible. In fact, most of them would say that just accomplishing both #1 and #8 have been shown, through experiments reported in peer-reviewed journals and in entire books, to be absolutely impossible, without even worrying about all the rest.

Nevertheless, we have researched a number of technological approaches and have selected the two most promising technological packages. We have done a good deal of research on them, finding out the best ways to handle them. We have proven that those technologies can accomplish all of the above objectives. We now have hundreds of farmers who have learned the technology and have given evidence that they definitely want to adopt it on their own farms by doing precisely that. And we’ve got these concrete examples, plus photos of them, to use in teaching other similar farmers. The CARE program is therefore eminently ready to engage whole-heartedly in the process of scaling up these technologies throughout the program areas.

These achievements, very frankly, have put CARE/Mozambique at the very cutting edge of the many NGOs that are promoting agroecology across Africa. I can say with some confidence that the number of organizations that have developed proven agroecological farming systems that can achieve all or most of the objectives listed above on extremely degraded smallholder farmer
soils, could be counted on the fingers of two hands. And even the most advanced of them are just beginning to scale up these systems.

What we have Learned to Date: A Series of Major Successes

I will list here what the program has learned to date:

1. Disease-resistant cassava

Two years ago, it was clear that the improved, disease-resistance varieties of cassava introduced by the program in both areas (before these consultancies started) represented a major success. They were successful in largely controlling both the brown streak virus and the mosaic virus, and farmers were so enthusiastic about the results that they were already planting out the new cassava varieties in their own fields as fast as the FFS plots could produce enough cuttings.

2. Sixty-day cowpeas

During last year’s consultancy, we observed a very similar phenomenon surrounding CARE’s introduction of two varieties of 60-day cowpeas (INIA 73 and IT 97 K). In Africa as a whole, cowpeas are the most widely grown legume. Furthermore, the leaves of the cowpea can be dried and stored for up to 12 months, thereby providing protein-rich food to smallholder farm families year-round. In Nampula and Inhambane Provinces, they are the second most important crop grown by smallholder farmers (after cassava) and very likely the most important single source of proteins of any kind for the population.

The 60-day cowpea varieties, fairly well known in Burkina Faso and Mali for over a decade, have been largely ignored in eastern and southern Africa. Their best known characteristic is that they produce dry beans about 20 to 30 days sooner than any of the traditional varieties in southern Africa. Since cowpeas are usually the first grains to mature after the rains start, this means that the people’s hunger season is cut short by close to a full month. This fact is especially important for women, because their most strenuous job—that of weeding extensive food crops like maize—comes at precisely the time of year when they are least able to feed themselves adequately. Furthermore, since the leaves of the cowpea are also edible and widely consumed, cowpeas easily supply the first fresh food of any kind in the new rainy season. And the leaves have a 25% protein content of very good quality (being high in the amino acids lysine and tryptophan). For these facts alone, the short-term cowpea can be a real boon to rural Mozambicans, especially women.

But cowpeas are important for two more very important reasons. First of all, for the last two years, Inhambane Province and parts of Nampula Province have suffered from major droughts. Each year, it failed to rain more than four times during the first three months of what is normally the rainy season. Farmers we interviewed agreed that these have been the worst droughts in the last ten years, and perhaps within their memories. Huge amounts of emergency food aid are being distributed in both areas. Yet in the FFS, the 60-day cowpeas have produced well both years. These experiments have confirmed the experience in the Sahel that if these cowpeas are planted immediately after one good rain, they will produce a fair crop of beans even if it doesn’t
rain again until after they are harvested! This is a level of food security that farmers working on
rain-fed fields in Mozambique have never before had with annual crops.

Photo 1. 60-day cowpeas after suffering serious drought (only two rains during their entire 70-day existence). Funhalouro, Inhambane

The second very important characteristic of the 60-day cowpeas is that they grow so fast that most other crops cannot climb over them before the cowpeas have matured. This means that in any system in which crops such as lablab beans, common beans or groundnuts are intercropped with maize, sorghum, millet or cassava, it is highly likely that 60-day cowpeas can be added to the mix without doing poorly themselves or reducing the growth of the other crops, because they will be harvested before the other crops need the space the cowpeas have occupied. Thus, the intercropping of cowpeas in other systems could easily increase total food productivity over most of Africa by 25%, and protein availability by around 50%, at very little added cost and with a higher over-all food security because of its drought-resistance. Such major, virtually free improvements that are widely appropriate across the continent are rare, indeed!

The 60-day cowpea, like the disease-resistant cassava before it, is now a proven technology. I would recommend that CARE get the word out to other NGOs and the Mozambican government about these two successes as quickly as possible. Such a publicity campaign would not only represent a major victory and source of good publicity for CARE, but a significant step in ensuring more food security for Africa’s smallholder farmers.
3. Ratooned pigeon pea

We now have a new, extremely drought-resistant way of not only improving very poor soils, but also of improving people’s diets and incomes, even in the droughtiest of areas. We already knew that pigeon peas could easily be intercropped with maize. But we now know that ratooning the pigeon pea (cutting off the stem at about 30 cm in height) each year just a week or ten days after planting the following season’s maize, the pigeon pea will produce seeds extremely well, and will produce a flush of new biomass capable of increasing crop yields significantly over time. In one experiment in Zambia, have tripled maize yields in just five years, due only to the use of pigeon peas as a gm/cc.

![Photo 2. These ratooned pigeon peas (shown in mid-March) are growing beautifully, in spite of their having suffered through an intense drought. The impact of the same drought on maize can be seen in the skinny, 2-foot maize plants at the immediate right of the pigeon peas.](image-url)
Furthermore, the pigeon pea is rapidly becoming one of the best-paying crops in some areas of Mozambique, given the huge and growing demand for it in India.

But even with these advantages, the pigeon pea’s usefulness may be eclipsed to a fair extent by a plant little used in Africa called canavalia.

4. The impact of canavalia

Several experiments this last year have confirmed that the bushy-type canavalia (*Canavalia ensiformis*) also has the potential to become a major factor in improving Mozambique’s soils. An extremely important trial in coastal Nampula showed that, compared with lablab beans, mucuna and mungbeans, the canavalia improved the soils by far the best. Furthermore, it will do this even when intercropped with cassava.

Equally interesting, in just one year, the canavalia increased the organic matter content of the soil so much that the resilience to drought of this year’s cassava was greatly increased. Where cassava followed a year of canavalia, not only did the above-ground growth of the cassava increase by about 40%, but the number of cuttings that died because of this year’s drought was reduced from about 30% to virtually none, as compared with a control plot where no canavalia had been grown the previous year.
5. The potential of lablab

Two experiments in Inhambane have confirmed the idea that with only one year of good growth of a perennial green manure/cover crop (gm/cc), the lablab bean can grow very well. We saw plots where the lablab was following other gm/ccs, and as a result, the lablab was climbing up maize stalks with the same vigor it would in almost any soil anywhere. Furthermore, in one village, where the women had learned to eat the lablab leaves, many of the women in the group we were visiting were more or less surreptitiously harvesting the tender leaves off the lablab plants even as we were talking about the plants’ impressive growth. In a number of instances where people in Mozambique and Malawi have learned to eat the lablab leaves, the women have reported that they prefer the flavor of the lablab leaves to those of the cowpea, even though they have eaten cowpea leaves for generations.

NEW GM/CC SYSTEMS FOR BOTH PROVINCES

Building on all this new, highly important information, plus the availability of the seeds of disease-resistant cassava, 60-day cowpea and bushy canavalia, which were obtained by Nicholas Dexter, we are now ready to describe two gm/cc systems that will be able to achieve every one of our ten principles. Furthermore, each of them will be able to do so in both of the program areas, and under conditions of major drought.

1. The cassava system

Description of the system. Being the mainstay of the diet in both areas, it is very important that cassava become a highly productive and totally reliable crop. CARE’s introduction of disease-resistant seeds is an important part of achieving this objective. But the droughts these last two years have shown that cassava production can be reduced considerably by drought if the soils continue in their present shape. On the other hand, some of this last year’s experiments showed conclusively that even during droughts that were this serious and came very early in the season, cassava could grow extremely well after just one year of soil improvement with a good gm/cc. Thus our road to a sustainable cassava system is quite clear.

Cassava can be very easily intercropped with the bushy varieties of canavalia. This combination of crops works very well together. After all, tens of thousands of Paraguayans have used this combination of crops for decades, at the same latitude as Mozambique.

The third crop in the system will be the 60-day cowpea. Since neither the cassava nor the canavalia come anywhere close to occupying the space in the first 60 days of their growth that they will later need, the 60-day cowpea can be grown together with them. By the time the larger plants require more space to develop, the 60-day cowpea will have been harvested.

The system’s management. The management of the cassava system will be extremely easy to learn and, if farmers wish, to modify. The cassava, canavalia and cowpea should all be planted together on the same day (assuming the cassava is planted in October, November or December). As soon as the farmers are sure that the rains have started, they would plant all three crops. The cassava would be planted in rows, just as we are presently doing in the FFS plots. With the experience the farmers already had with these plants, they can decide at what space the various
crops should be planted. The only condition they should keep in mind is that the canavalia will have to be planted at about three plants/sq mt in order to fertilize the soil well.

Within two months, the cowpea will be harvested and the cowpea biomass cut down to cover the soil and fertilize the cassava. The cassava will be harvested when it is always harvested. The canavalia will be allowed to continue growing, providing shade and cover to the soil until the rains come again in November/December.

The following year, if the farmer wishes, the plot with the cassava/canavalia/cowpea system can either be rotated into the maize/lablab/cowpea system, or the same cassava/canavalia/cowpea system can be repeated on the same land. Presumably, after the first two or three years, most of any farmer’s land will be in a rotation between the two systems.

In those areas of Inhambane where the cassava is planted traditionally in August or September, it is highly likely that it will do very well planted in November/December once the soil fertility has improved. If not, we may have to develop a special cassava system for this area.

The system’s advantages. The system will do a beautiful job of fulfilling every one of the CARE program’s ten principles:

1. Double or triple per-hectare yields. Canavalia has shown its ability to do this, even while intercropped with maize or cassava, in a number of countries around the world, from Paraguay and Brazil to Cambodia. Since the canavalia can fix up to 240 kgs of pure nitrogen/ha/year, it produces two or three times what mucuna or cowpeas can produce, and many times more than what the cassava will ever need. Our first year’s experience here with canavalia shows that the increase in yields under difficult Mozambican conditions is equal to or better than those after one year of canavalia elsewhere. I would expect average cassava yields here to double within two or three years and triple within five years.

2. Increase soil fertility substantially over time. This factor correlates quite well with the previous objective because most of the increase in yields achieved is because of the increase over time in natural soil fertility brought about by the increase in soil organic matter and nitrogen. Since canavalia can produce as much as 60 t/ha of biomass (green weight) which is still green in October, it is usually able to increase soil organic matter over time more than can any of the other gm/ccs we have tried in Mozambique. Of course, this continuing improvement in the soil’s fertility will only occur if we continue to plant the gm/cc every year.
Photo 4. Cassava grown in FFS plot in Nampula Province during the second droughty year.

Photo 5 (Next page). Cassava grown in another plot of the same FFS in Nampula, but in this plot the cassava was preceded by canavalia that had been planted there the year before. Note that in the first photo the cassava was about waste high at best, whereas in the second field is so high the photographer cannot see over the top of it. This difference is caused by the increased soil fertility brought by the canavalia. Also in the above photo, about 30% of the cassava plants died soon after planting because of the drought. In the field below, we saw no cassava plants that had died (although a few plants in the middle of the plot might have). This difference is caused by the increased drought resistance brought about by the increased soil organic matter produced by the canavalia.
3. Provide high-quality protein all year long. The 60-day cowpea will supply protein during the most-needed time in the annual cycle—the entire last month of the traditional hunger season. Furthermore, the high-protein cowpea leaves can be dried and stored for eating year-round.

4. Significantly reduce women’s workloads. In Paraguay, tens of thousands of farmers using this system (minus the 60-day cowpea) only have to weed their cassava once, instead of two or three times, because after the first weeding, the canavalia completely controls the weeds. This factor, in and of itself, will decrease women’s heaviest job by between 50 and 60%!

5. Follow the tenets of Conservation Agriculture (CA). Especially after the first year, the canavalia will grow twelve months out of the year, maintaining a good green cover right up to planting time, and a thick dead mulch for several months after that. The canavalia will also provide more biodiversity in the system. If this system is rotated with the maize system below, the combined systems will have five major crops, and probably a series of minor crops, during every two year rotation. Lastly, there is no need with this system to ever disturb the soil any more than what is required to harvest the cassava tubers.
6. Sequester significant quantities of the carbon from the air. Inasmuch as the canavalia alone will apply some 60 t/ha of biomass to the soil each year, the amount of carbon sequestered will be significant.

7. Increase resilience to climate change. We saw this year the incredible impact that canavalia had on the resistance of cassava to an early El Nino-caused drought: well over 90% of the sprouting cassava cuttings survived, as opposed to about 65% of them, after only one year of canavalia’s contribution to increased soil organic matter. Resilience to the droughts caused by climate change is achieved in three ways by the cassava system: it maintains soil cover (and green soil cover often does the best job), it increases the soil’s organic matter content, thereby increasing also its infiltration rate and water-holding capacity, and it includes the deeply penetrating roots of the canavalia, which allows more rainwater penetration, breaks up subsoil hardpans, and provides more food and paths through the soil for earthworms.

8. Increase farmers’ incomes. With a doubling or tripling of cassava production, virtually every family using this system will, for the first time in decades, produce enough food to feed themselves for a full twelve months of the year, with some cassava and cowpeas left over to sell. And after the first year, they will do so in good rainfall years and bad!

9. Accomplish all this at an extremely low cost. The total additional cost for a traditional farmer to adopt this system will consist of the value of a handful of canavalia seed and a handful of 60-day cowpea seed, minus a lot of weeding.

10. Prosper even during severe droughts. Even though the cassava and canavalia were both fairly heavily impacted last year by the drought, both of these crops looked excellent this year in fields that had had canavalia planted in them last year. That is, even if the canavalia does not stay green right up until November, it produces a significant impact on soil fertility. Thus, a temporary problem might exist the first year of adoption in the case of extreme drought, but after that, the sailing should be smooth, indeed.

The possible variations on the system. Farmers will likely want to modify this system as time goes by. Especially, as the soil becomes moister and more fertile, they will want to take advantage of these conditions to grow more crops, especially higher value ones. Furthermore, Mozambican farmers have a tradition of planting other crops opportunistically in their fields any time spaces have appeared in their fields. For instance, farmers will inevitably want to plant some sweet potatoes in among the three main crops, as well as the occasional maize plant. This is, in fact, a good idea, because over time, as the soil improves, farmers will discover that planting distances can be reduced, and more and more crops could be added to the system, either opportunistically or systematically. In other words, opportunistic planting can become a very good way for farmers to experiment as to how they can intensify their farming systems and make them more profitable.

Another possibility that can be tried is that of leaving some of the cassava plants standing after the harvest until October, so they can provide some dispersed shade for the canavalia, thereby helping the canavalia to stay greener longer during the dry season.
Some farmers in the Nampula area may want to try growing the mungbean in the place of the 60-day cowpeas. This would be a worthwhile variation to experiment with.

Two other very important possible variations to this system can also be used in the maize system, and will therefore be mentioned below: the addition of gliricidia-based dispersed shade and the planting of pigeon peas.

11. **The maize system**

A second equally valuable but more innovative system in the Mozambican context would be based on maize. Farmers throughout both program areas have expressed a strong desire to grow, and consume, more maize. They presently only grow it around their homes and on termite mounds, because the level of soil infertility in the rest of their fields doesn’t allow it to produce hardly anything at all. To a much lesser extent, the same goes for several other crops, including lablab beans. The following system will allow them to do so.

**Description of the system.** Once again, this system is very simple to understand and inexpensive to adopt. It merely consists of intercropping maize and lablab beans, with the addition of 60-day cowpeas. All three crops can be planted at the same time, as soon as the rains come in October-December. Again, the spacing should be decided on by the farmers, and they will very likely want to experiment with various spacings each year during the first few years. Nevertheless, they should be taught that the lablab can be planted right next to the maize because it will grow more slowly than the maize (except, perhaps, the first year, when the maize is still quite weak). Also, the cowpea can be planted fairly close to the lablab beans and maize, because it will have died by the time the other two crops have begun occupying the space around them.

Once the maize has been harvested, the maize stalks should be left standing in the fields, because the lablab beans will use them as tutors. The lablab bean will produce as much as 50% more beans and biomass if it is climbing, rather than growing along the ground. Furthermore, it will continue to grow throughout the dry season, maintaining an excellent cover of the soil and good weed control. And it will continue to produce a fair amount of beans right up until the rains come the following growing season. Then the plant can be cut down and laid on the ground right before the planting of crops for the following rainy season.

It is important to remember here that green manure/cover crops do not fertilize the field the same year they are planted and are growing. They only fertilize the field (to any substantial degree) when they have been pruned or cut down completely. Furthermore, in the hot tropical sun, they will often lose as much as 15% of their nitrogen every month, so after six months, they have virtually nothing left. Therefore, for these plants to do the best possible job of fertilizing the soil and crops, they must be cut down within a few weeks before the next crop is planted.

**The system’s advantages.** Once again, just as with the cassava system, this system will achieve every one of the ten principles:

1. **Double or triple per-hectare yields.** The increase in yields under this system, if the same system is used year after year on the same soils, will be a little slower than with the cassava system. A doubling of maize yields may take three or four years to occur, and a tripling six or eight years.
2. Increase soil fertility substantially over time. Again, this will occur, but a little more slowly than with the cassava system.

3. Provide high-quality protein all year long. The fact that the first two objectives will be achieved a little more slowly is more than compensated by the fact that the maize system will be producing a much better variety of food over a longer period. Not only will the 60-day cowpea be producing about the same amount of beans as it does in the cassava system, but the lablab beans will be producing a whole lot more protein, with the additional benefit that the lablab bean contains about 23% protein—far more than the cowpea. Even more important for a family’s nutritional well-being, the lablab bean, when it begins producing well, will be producing beans from about June clear through until October. The hunger season will largely be a thing of the past.

4. Significantly reduce women’s workloads. Furthermore, the lablab bean will do an even better job of controlling weeds than does the canavalia.

5. Follow the tenets of Conservation Agriculture (CA). The same is true of the maize system’s support of CA. The lablab beans will cover the soil faster and better than does the canavalia, and the maize harvest, unlike that of the cassava, requires no movement of the soil at all.

6. Sequester significant quantities of the carbon from the air. The lablab bean also usually produces a little more biomass than the canavalia.

7. Increase resilience to climate change. In this matter, the lablab will have much the same impact as will the canavalia.

8. Increase farmers’ incomes. This will depend on local market prices, but in general, this system, by producing lablab beans in addition to the main crop, will produce at least as much to eat, and more to sell, than will the cassava system.

9. Accomplish all this at an extremely low cost. Once again, the only expense required to adopt the maize system is a few handfuls of the right seed.

10. Prosper even during severe droughts. Both the maize and lablab beans are more sensitive to drought than are cassava and canavalia. This is another reason why the first year that a farmer adopts these systems, he/she should use the cassava system. By the next year, the soil will be more fertile and more able to absorb and hold moisture during droughts, so the maize and lablab beans should be able to produce fairly well even during a drought.

If we now take a broader look at where the program is, things are definitely looking good. We have identified two alternative systems that can do well in both Inhambane and Nampula. Both of these systems can achieve independently all of the very demanding ten principles. And farmers can easily rotate from one system to the other on the same piece of land, for decades, if they wish. Furthermore, between them, these two systems provide plentiful year-round proteins and both of the basic subsistence crops that farmers most want to consume: cassava and maize. And even those farmers with less than 0.75 hectares of land will, at least after the first year or
two, produce more than enough of these basic staples and legumes, during droughty years as well as normal ones, to take something to the market.

**The potential variations on the system.** The same can be said here that was said for the cassava system. Nevertheless, there are two modifications of these systems that should also be promoted by the program.

**Dispersed shade**, provided primarily by the gliricidia tree, should be added to all the plots, in the FFS or on farmers’ fields, where either the cassava or the maize system is being used. The trees are best planted at a spacing of 5 mt by 5 mt, across the field, or, at least, in a 5 mt by 10 mt pattern (in mt between the rows and 5 mt between the trees in each row). If some native trees already exist more or less in the rows, or if people want to plant three or four moringa trees, these trees can replace a few of the gliricidia trees.

The spread of gliricidia (*Gliricidia sepium*, sometimes called “mother of cacao” in English) should be a very high priority of the program for this coming year. It will provide many, many advantages for the area’s farmers:

1. The tree is very fast-growing. Even in fairly poor soils, if properly pruned, it will grow enough within three years to start providing a decent amount of shade (which should be between about 15 and 40%). Because the gliricidia is so fast-growing, it produces large amounts of firewood when it is full-grown.

2. Gliricidia leaves are wonderful fertilizer. Along with leucaena and piliostigma, they are the best tree leaves we know of for fertilizing the soil. In fact, 1 kg of fresh gliricidia leaves will increase maize harvests virtually the same as 1 kg. of fresh cow manure or 1 kg. of compost.

3. Once the trees are large enough, they will go a long way toward protecting future crops from drought. They will do this by greatly helping to maintain moisture levels in the soil. Both by reducing the ambient temperature and slowing down the wind, they reduce the rate of evaporation of water from the soil, keeping it more moist. That is, they keep the soil much more moist in the same reasons that the trees do in a forest.

4. The stem of the gliricidia can easily be cut at about 1.5 mt in height (whatever height is most comfortable for the farmer), and each year it can be pruned at that point (always leaving three or four branches so the termites will not attack the stem). In this manner, one can always prune the tree while standing on the ground, thereby easily controlling the amount of shade on one’s crops.

5. This simple process of pruning, combined with the fact that people’s fields are usually much closer to the home than are the village’s forests, means that the hours women spend collecting firewood will be greatly reduced.

6. As mentioned above, short-lived annual species of legumes such as cowpeas and mung beans are normally not of much use as gm/ccs in the lowland tropics because virtually all of the nitrogen they have fixed is burned off (or “volatilized”) by the hot sun during the dry season. But once the gliricidia is producing a decent shade, the cooler temperatures
in the fields caused by that shade will reduce the loss of nitrogen during six months from about 90% down to only about 40 to 50%, which means that a good portion of the nitrogen from cowpeas and mung beans will still be available for the following year’s crops.

7. The gliricidia’s leaves are a very high quality animal fodder, rich in proteins. Thus they can be fed to cattle in September and October, when virtually everything else the cattle normally eat is finished up. Furthermore, these leaves are not particularly tasty, so that once the rains come and the leaves need to be used to fertilize farmers’ crops, cattle will stop eating the gliricidia leaves because they prefer the fresh new grass. Thus, there is no competition between farmers’ animals and their crops for the use of the leaves.

8. The bark of the gliricidia can be used (with extreme caution) as a very effective rat killer, a fact much appreciated by many farm families.

9. The flowers are edible, and well-liked in Central America where the tree is native. I would guess that the easiest way for people to come to use them would be to add them to the sauces they make for pouring over other local dishes. (Research to look at ways local people like to eat the gliricidia flowers could also be done this year in preparation for cooking classes next year.) People will probably be somewhat reluctant to eat the gliricidia flowers once they know that the bark of the tree is poisonous. Usually, to overcome these doubts, it is sufficient to explain that many plants have poison in one part of the plant, but not in another part. Cassava roots, for instance, sometimes need to be processed to rid them of a poison called cyanide, but the cassava leaves can be eaten without any such processing.

10. Over time, the gliricidia will protect our fields from climate change. As the climate gets hotter, farmers will only need to prune fewer branches off the trees, and the temperatures under the trees, where their crops are, will remain the same as before.

To motivate farmers to take good care of the gliricidia trees, one of the first classes given to the farmers after the rains have started (assuming there are some gliricidia trees already in the village), is to have them bury two heaping handfuls of gliricidia leaves about 10 cm from each planting station where they have planted their maize seeds. This can be done on a test plot of perhaps 5 by 10 mts. Then the farmers can compare the growth and productivity of the maize so treated with that in the rest of their fields.

To make gliricidia trees and bushes as drought-resistant as possible the first year, the seedlings should be:

1. About 50 cm tall (above the ground level) at transplanting time. This means they will be larger than are most seedlings when we plant them, and therefore the nurseries will have to be established about a month sooner than usual.

2. Planted at the same time as people’s crops.

3. Planted into planting stations deep enough so their taproots go straight down,
4. Pruned of all leaves except those on the five or six top branches,

5. Fertilized by placing the pruned gliricidia leaves buried near the base of the trees.

6. Protected by making sure that the soil cover in the field is also protecting the soil right around the gliricidia trees and bushes,

The lower half of the horizontal branches on the gliricidia plants should be broken off right at the stem, so the trees will be putting most of their energy into growing upward.

For the time being, we should not use any direct seeding or cuttings, so that the gliricidia trees will have the best possible chance of making it through the droughts.

Those who have read the previous reports or have been working out in the fields will be wondering why no mention has been made yet in this report of the pigeon pea. There are several reasons for this. Most important, the tremendous demand for pigeon peas in India that has caused farm-gate pigeon pea prices to shoot up to as high as US $ 3.00/kg in parts of Malawi, Tanzania and Kenya, have just not reached the program areas of Mozambique as quickly as we had hoped. Furthermore, because of poor roads, these prices may never reach the program areas. Secondly, we had no access previously to the bushy-type canavalia, which can play much the same role as the ratooned pigeon pea would play in terms of getting the process of soil improvement going in spite of the droughts. Thirdly, and probably least important, fresh news from Zambia indicates that there are some doubts (though not very serious ones) as to the effectiveness of the ratooned pigeon pea under certain conditions.

Where pigeon pea is already being used by the farmers, it would be good for them to continue using it. They should continue to plant it in the FFS or on their own land just so they don’t lose the seed. If and when the price increases, or in the unlikely case that the canavalia fails to work well, they could then expand it. Where people do not have any pigeon peas yet, the program should probably not introduce them.

Where pigeon pea does exist, people should learn to ratoon part of it, so they will have at least some of it that will make it through any drought. To ratoon it, it should be allowed to continue growing after it is harvested, and then it should be cut off at about 40 cm in height 10 to 20 days after the cassava is planted. The pigeon pea organic matter thus applied to the soil will be enough to continue improving the soil over the long term. Furthermore, the canopy created eventually by the pigeon pea and cassava will reduce the volatilization of the cowpea residues, which will later be added to those of the pigeon pea.

A plant grown from seed has to struggle to grow a new root system every year while that very lack of a root system keeps it from getting the moisture it needs to do so. Ratooned crops, on the other hand, already have a deep root system, so they can dedicate all the moisture they can get, which is quite a bit, to growing new above-ground biomass. Furthermore, the soil strata close to the soil surface dries out much, much more quickly than do the deeper layers, so roots in these lower layers hardly suffer at all from the relatively short growing-season droughts. After all, trees that grow in Africa’s drought-prone areas don’t die every year there is a drought. Our trials of cutting off pigeon pea plants have shown that regrowth during droughts is much more vigorous when ratooned.
Just in the last few years, we have found out that lablab beans can also be ratooned, and there is no reason to think that lablab regrowth will not be equally vigorous and resistant to drought when it has been ratooned. Nevertheless, we don’t yet have enough experience to know how to best manage ratooned lablab beans, so this is something people can experiment with on a small scale until we know more.

We must admit that we don’t yet know for sure about the acceptability among farmers of either the cassava or the maize systems, and we will only know it with absolute certainty once the farmers are trying them out on their own land. Nevertheless, the systems’ profitability, lack of increased labor or expense, primary dependence on the traditional crops of the areas and structural similarity to their traditional systems (many crops being intercropped, with cassava and cowpeas being the main staples, and more susceptible crops being included) make them a very good bet for a very high level of acceptability. Therefore, it is now time to start encouraging farmers to try them out on their own farms, and on a larger scale.

ANALYSIS OF WHAT WE HAVE LEARNED TO DATE

Although there always exists the possibility that droughts even worse than those of the last two years will come along, if they don’t, the cassava and maize systems should work quite well. This would be true even the first year of adoption, which will be their most vulnerable time. We have good evidence of this because even though much of the lablab and canavalia did not grow through the entire dry season last year, their impact on this year’s crops was everything we could ask for. That is, even if the canavalia and lablab don’t stay green right up to the beginning of the rains in November, they do a very respectable job of fertilizing the following year’s crop.

Of all the gm/ccs we have seriously tried, only the mucuna seems largely useless. First of all, in Inhambane, the people do not consume it, and they clearly think it ridiculous to cook something five or six times before being able to eat it. Furthermore, our idea of planting mucuna as a relay in the maize or cassava has not worked—even plantings made as early as February looked pretty bad. And even though its cover of the soil impresses the villagers, it will not likely last past August even in fairly good years, which means it will not cover the soil during the critical months of September through February.

But most of all, we now have found other possibilities, such as the canavalia, lablab, and even the ratooned pigeon pea, that can produce very close to the same biomass as the mucuna. This means that at this point, the mucuna cannot provide us with any advantages that are not provided by other gm/ccs that are capable, in addition, of either producing edible beans or better drought resistance. If farmers want to continue trying the mucuna on the FFS plots in which they are making the decisions, that is fine, but I don’t think CARE should encourage its use any more. As a result, I think our idea of obtaining bushy-type mucuna from Ghana or elsewhere is no longer necessary.

FUTURE ACTIVITIES
Given the above analysis, there are a fairly large number of actions that need to be taken between now and September. They include the following, roughly in chronological order of implementation:

1. Organize and carry out as many exchange visits as possible of three to four leaders from villages presently with FFS to the plots of present or former FFS villages where there is good lablab or canavalia growth. It would be especially important that these exchange visits go to where the leaders can see the impact on this year’s crops of a good growth of lablab beans or canavalia from the previous year. During our trip, we saw one such plot with very good lablab in the Inhambane area, and two fields in Nampula on the coast with excellent cassava, maize and lablab following canavalia. Other such cases must be found to host exchange visits.

These exchange visits should not be seen as just one more detail we have to take care of. Now that we are in the scaling up phase of the program, they should be seen as one of the program’s two or three principle activities.

2. More seeds of the bushy canavalia need to be bought right away. If there are none within the country, Christian Thierfelder has plenty in Harare. Enough of these seeds should be bought so there are plenty for FFS plots and also so farmers can buy seed to plant in their own fields.

3. Enough 60-day cowpea seeds and lablab seeds also need to be bought so that, in addition to supplying the FFS plots with what they will need, the villagers can buy seed and plant out the cowpeas in their own fields to learn from their own trials.

4. Get nurseries established with plenty of gliricidia and moringa trees for dispersed shade in each of the FFS.

5. Get plenty of cassava cuttings just as soon as possible.

6. Ratoon about half of this year’s lablab plants in the FFS to see how well they grow during the 2015-16 season.

7. If not already done, recipes should be collected in preparation for cooking classes that include a) how to dry and store cowpea and lablab leaves and tasty ways to prepare both green and dry lablab beans. Among the recipes to be tried should be pigeon pea recipes from southern Malawi.

Lay-outs

Given that we now have two systems that will accomplish about all we could ever expect, we can now narrow down a good deal what we need to experiment with. Still, there are a number of new things we need to learn about future gm/cc possibilities. To do this, I would suggest the following lay-outs, in both Inhambane and Nampula:

1. The first priority is to establish a maize/lablab/60-day cowpea plot where the best canavalia or lablab plot was this past year, if there was any.
2. The second priority is to establish a cassava/canavalia/60-day cowpea plot where the second best canavalia or lablab plot was this past year, if there was any.

3. If a third plot had lablab or canavalia or mucuna in it this past year, try a second maize/lablab/60-day cowpea plot with a different spacing between plants to see which spacing best allows all the crops to do well.

4. The third priority is to establish a cassava/canavalia/60-day cowpea plot in addition to the one above, with a little different spacing. If the crops in the plot in #2 was spaced fairly far apart so the crops would do well during a drought, this one could be spaced a little closer together, with the hope that it would do well during a rainy year. If the plot in #2 was spaced fairly densely, hoping for a good year, this plot should be planted with a little larger spacing between the crops.

5. If there is a plot where the pigeon pea can be ratooned, plant maize together with the ratooned pigeon pea to see how resistant to drought the ratooned pigeon pea is.

6. In the case that #5 is done, plant a plot with maize and canavalia, with the maize planted with the same distance as in #5. In this way, we can compare the drought-resistance of the canavalia with that of the ratooned pigeon pea. This will be very important, because if and when the droughts get so bad that even the canavalia doesn’t grow well, maybe we can use the ratooned pigeon pea to get the whole system going (ie provide good green manuring the first year a farmer tries to adopt the system).

7. If there is any plot where the lablab is still alive in September or October, the lablab should be ratooned, to see how well it grows as a ratooned crop. To do this, the lablab should be ratooned this season (2016) before it dies. In fact, if one third of the lablab in this plot could be ratooned in July, another third in August, and another third in September (assuming it is still alive), that would be fabulous. Then it should be allowed to sprout next season (in about November 2016) and grow normally. Three plants/sq mt of lablab beans would be fine, or whatever the plant population was this last season.

8. This plot, and any others that are available because some of the first plots mentioned above were not possible, can be planted with farmer experiments.

All FFS plots should have gliricidia trees planted in them at 5 by 5 or 5 X 10 mt spacings. Where people wish, as many as three of the trees in an FFS plot can be of moringa instead of gliricidia. The moringa will not fix nitrogen, but its leaves are very valuable as food, and its shade and organic matter will also be valuable. The moringa will need to be managed (ie pruned yearly) just like the gliricidia.

The program should make available to individual participants small packets of 60-day cowpea seeds (1/4 kg?) that they can use in their own fields. These should not be given away, since that would dramatically slow down further farmer adoption (“I’ll wait until the program gives me some free seed, too.”) They should be sold at the market price. This will be very difficult this year because of the drought and people’s tremendous need for food, but if the seed is given
away, people will probably consume a high percentage of it, or next year may consume their seed, figuring more will be given out free.

**The Extension System**

The FFS system already in place can be used perfectly well as an extension system to start the dissemination process. But we should now gradually be moving into a process whereby the selection of the most promising technology is no longer so central, and scaling up the use of the already established technologies will become the central effort of the program. This will require a major change in the design of the program’s extension efforts. It will also mean that the program will be reaching a much larger population than it has during the period of developing and selecting technologies. Typically, in the new scaling-up period of the program, we should be able to reach two or three times as many people in each three-year period as we have in the past.

I also suggest we develop an updated FFS Curriculum for the fifth year FFS. Things have changed so much since our original curriculum was written that this is really important. I could at least participate, but it would be a major effort for which I would need to ask for some remuneration.

This report should be translated into Portuguese so all the field staff can read it. Furthermore, the technical parts of the report, which include a lot more technical information than usual (especially most of pp. 3 to 14), should be written up as a pamphlet to be distributed to all the field staff and lead farmers.