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How to Introduce Pigeon Peas or Lablab Beans

In areas of lowland, sub-Saharan Africa where smallholder farmers are already successfully using a green manure/cover crop, they should probably just keep on using the ones they are presently using. The best approach in such conditions would probably be that they try out these species described below in a small trial plot of, say, 20x20 mts, so they can see how well they work compared with the system they are already using. In this way, they can see if they would prefer to 1) adopt these new species in place of the ones they are already using, 2) use the new species on part of their land and the one they already know on another part of their land, or 3) continue using only the already known system.

In areas where the people have no successful past experience with gm/ccs, we should make sure they experiment with these new species before they introduce them into all of their fields. Also we should, if at all possible before they try these species out themselves, take the lead farmers to visit other farmers who have already been using one or another of these species. We should try to take both men and women on such trips, because the women will be especially interested in the savings of labor in soil preparation, weeding and firewood collection that the new gm/ccs offer.

On such trips to see established gm/cc use, we have found that farmers almost always have serious doubts about how much the soil can be improved. If they see a few fields where farmers no longer have problems with droughts, they often suspect

that these fields are being watered by hand. If they see fields where the soil fertility has improved impressively, they frequently suspect that these fields have been fertilized. The best solution we have found to convince the farmers of the value of the new gm/cc species during such visits is to use the “machete test,” or “panga test.” This consists of having one of the visiting farmers stab a machete absolutely as deep as he or she can in a nearby field that has had no gm/cc use. Normally, they can only stab the machete some 15 to 20 cm into the soil, at most. Then the same person should do the same thing in the field that has had gm/cc use for at least 4 years. In this case, the machete will usually penetrate the soil all the way down to the handle (60 to 80 cms or so). Then explain that where the machete can penetrate the soil, so can rainwater. If more of the visitors wish to try doing the same thing, encourage them to do it themselves. We have found this “machete test” to be far and away the most convincing proof to visitors that the droughts can be overcome.

Pigeon Peas and Lablab Beans

Pigeon peas (*Cajanus cajan*) and lablab beans (*Dolichos lablab* or *Lablab purpureus*), though unheard of in many parts of the world, are among the most widely consumed of all the world’s basic grains. They richly deserve this position because, if properly managed, they fertilize the soil extremely well, can easily be intercropped in the tropics with maize, and provide large amounts of highly nutritious food.

But perhaps most important of all, **pigeon peas and lablab beans (along with jack beans) are the two green manure/cover crops (gm/ccs) that can best overcome the “droughts” that are now destroying people’s food crops every second or third year across more than half of sub-Saharan Africa, as well as significant parts of Asia and Latin America**. And they both provide a lot of very nutritious food. It is because of these tremendous advantages that farmers across Africa are spontaneously spreading this technology to their neighbors and to other neighboring villages faster than any other gm/ccs, or any other technology of any kind—a sign of the tremendous popularity they have among the adopters of these gm/ccs.

Although most people think that these droughts are being caused by climate change, in fact, **at least 80% of the problem is being caused by the loss of organic matter in the soil, which makes clay soils almost as hard as a rock**. Gm/ccs are by far the best way to solve this devastating problem that otherwise could well result in the deaths of up to 60 million people in Africa within the next two decades, making it the worst famine in human history!

What These Gm/ccs Can Do for African Farmers

If you are working in an area above 1,500 mt in elevation, neither pigeon peas nor lablab beans will be of much use to you. At these higher elevations, you should probably be using scarlet runner beans or fava beans, along with alder trees. Also, if you are working on a field with a slope of more than 10 to 15%, and do not have an effective soil conservation technology in place (that is, there is water running downhill across the soil surface), then gm/ccs will not work well because most of the leaves will also be washed away soon after they are applied to the soil surface.

So what are the advantages of pigeon peas and lablab beans when they are properly managed? First, we will describe the tremendous advantages that these two species share with each other.

First of all, if properly managed, they both can fertilize the soil very effectively. For instance, the pigeon pea can fix up to 200 kg/ha/year of nitrogen (by far the soil nutrient that most reduces productivity in most African soils), and the lablab bean up to 140 kg/ha/year. This sounds like a major advantage for the pigeon pea, but both quantities are far higher than any basic grain, including maize, sorghum, or millet, will ever need under African conditions. In fact, the lablab will improve the soil somewhat better than pigeon peas, because it produces a lot more total organic matter per hectare than does the pigeon pea. But in either case, farmers who were producing about 1 t/ha of maize in years of good rainfall, will, within about five or six years, be producing 3 t/ha of maize in the good years, and their fields will continue very slowly to increase yields even further. If either of these species is accompanied by gliricidia trees (*Gliricidia sepium*), they should achieve this tripling of maize yields even a year or two sooner.

Secondly, and even more important, both pigeon peas and lablab beans will, in those same five to six years, dramatically reduce the impact of the droughts. This is because they both provide huge amounts of organic matter that will soften up the soil and allow the rainwater to penetrate the soil much more easily. Therefore, in those same six years, the percentage of rainwater that infiltrates into the soil will increase from just 10 or 20% up to 60% or more. Thus, farmers' maize yields in droughty years will typically increase from somewhere between 100 to 400 kg/ha, to about 2,500 kg/ha (equal to 2.5 tons/ha)! That is, within six years, farmers can expect that the droughts will only reduce their greatly improved yields of 3 t/ha in a good year down to 2.5 t/ha in a drought. Their yields in the droughty years will therefore be somewhere between 6 and 25 times what they were before using these species of gm/cc!

Furthermore, farmers in most of Africa who are growing sorghum, millet or cassava (which they are doing because maize can no longer grow in their degraded soils) and then start using gm/ccs correctly, find that by the second or third year of doing so, they are able once again to grow a good crop of maize every year, which they strongly prefer to eat over these other species.

A third advantage of both gm/ccs is that, by intercropping them, we are producing more organic matter and a more biodiverse organic matter that will become a permanent mulch. In tropical fields with gm/ccs, the crop roots, during the first three to six years, will gradually go deeper and deeper into the soil. Furthermore, where the mulch is well-established and permanent, crop roots will also grow upward into the mulch, feeding on the nutrients that the mulch gradually releases, before these nutrients totally decompose and fall through the mulch into the soil. Crop roots that can feed both deep down in the soil and up into the mulch obviously have very little need to grow horizontally, and therefore they do not compete very much with nearby crops. That is why we can intercrop so many plants in a small space of land without their competing with each for nutrients to any great extent.

The fourth advantage of both pigeon peas and lablab beans is that they do not die at the end of the growing season, but can perfectly well grow for a full 12 months right up until the following growing season starts. This is tremendously important because in the lowland tropics, any dead organic matter that is exposed to the heat of the tropical sun will lose about 15% of its nitrogen and some of its organic matter each month. Therefore, dead leaves that have spent six months sitting on the soil are almost useless for fertilizing the soil or ending the droughts. To fertilize the soil and end the droughts, plant leaves must stay on the living plant right up until a month or so before we plant our next food crop. This way, the impact of the legume on the soil will be maximized. This factor is the reason why nearly all the species used around the world as gm/ccs are perennials, rather than annuals.

The fifth advantage of these two gm/ccs is that they both greatly reduce the amount of work that farmers must do. By the third year of managing these gm/ccs correctly, plowing the soil or tilling it by hand will have become unnecessary. Nor will farmers have to make planting stations or ridges. The reason for this is that, very simply, the rainwater will infiltrate into the soil before it has a chance to start running across the surface. This means that women's labor in Africa is dramatically reduced.

Additional Advantages of Pigeon Peas

Each of these two gm/cc species also has a series of advantages the other one does not have.

The first important advantage that only the pigeon pea has is that, whereas the lablab bean eventually covers everything in the field, the pigeon pea allows quite a bit of sunlight to pass through its canopy all year long. This means that it does not control weeds at all, as lablab beans do, but it does allow farmers to grow an additional, low-growing food crop underneath the pigeon peas (except in this year when the drought will be so severe that we cannot grow a third crop in the field).

The second advantage of the pigeon pea over the lablab bean is that it does not die after its first year, unless we kill it. And that is the most important change farmers need to make to turn the pigeon pea into a wonderful fertilizer that will end the droughts. **The pigeon pea should not be killed right after it has been harvested.** Rather, it should be allowed to continue growing all through the dry season. Then, just before the maize, sorghum, or millet is planted again, the pigeon pea stem

should be cut off right about the level of an adult's lower ribs. This process is called "ratooning." All the top of the plant (except the larger woody pieces, which may be used as firewood) is then left on the ground, and most of the side branches are also cut off and left on the ground. All this plant material will then serve as fertilizer for the soon-to-be planted maize, sorghum or millet. And if the pigeon pea is growing vigorously and one wants to fertilize the soil even more, about 20 days to a month after the maize is planted, one can cut off all the new leaves once again and leave them on the soil as a "side-dressing." This process of ratooning can be repeated each year for the first three or four years, allowing the same pigeon pea plants to continue to grow for up to four years before being reseeded.

Ratooning the pigeon pea has a whole series of important advantages. First of all, the farmer does not have to use any additional seed the second, third and fourth years. This seed one would traditionally have planted can, instead, be eaten or sold. Secondly, when we plant a crop by seed, the roots look like little hairs, and they only become a few inches long during much of the growing season. But when we ratoon the pigeon pea, it already has, in its second, third, and fourth years, a well-developed root system that has penetrated quite deeply into the soil. The plants are therefore nearly as drought-resistant as the plants in a forest, which is never damaged by today's droughts. Often, the only food crop in an African farmer's unimproved fields that will nevertheless produce a decent harvest during a very bad drought are the ratooned pigeon peas that are in their 2nd, 3rd, and 4th years. Smallholder farmers who have already been using pigeon peas for several years will often begin staggering their plantings, so that each year only one quarter of their fields are planted from seed. As a result, 3/4 of their pigeon peas will always produce well even in a serious drought.

A third advantage of the pigeon pea over lablab beans is that lablab bean plants need to climb up the maize stalk. This cannot be done if the lablab is intercropped with sorghum or millet, because the sorghum and millet stalks are not strong enough to support the weight of the lablab plants. Therefore, lablab beans can only be used in sorghum or millet fields if one prunes the lablab halfway through the growing season, which constitutes an extra major job that must be carried out during the farmers' busiest time of the year. When the soil is still quite degraded, even maize plants can be pulled over if lablab beans are intercropped with them. However, pigeon peas have their own strong stem that supports them, so they will never pull over any other crop. As a result, pigeon peas can easily be intercropped with maize, sorghum, millet, or cassava, while lablab beans can only be used easily with maize. However, in most of Africa, this advantage only exists during the first year or two, because after that, virtually everyone who is growing sorghum or millet will very happily switch back to growing and eating maize.

The fourth advantage of pigeon peas is that they are also the only gm/cc we can easily use in vegetable gardens. In this case, one grows only one pigeon pea plant in each square meter of land. The pigeon pea will then not only produce fertilizer for the vegetables and food for people, but will provide a partial shade for all the vegetables. This can be especially important for sensitive vegetables like tomatoes in places where the extreme lowland tropical heat makes it difficult or even impossible to grow them during the hotter seasons.

If the pigeon pea does not stay alive until the end of the dry season, then it will have to be replanted when the rains fall again, but this will likely only happen the first year of using it, and then only if the farmer did not use jack beans the first year. After the first year of having pigeon peas, the soil should have improved enough that the pigeon pea will grow right through to the following rainy season.

Additional Advantages of Lablab Beans

Lablab beans do, of course, have some major advantages over pigeon peas. The first of these is that lablab beans do a very good job of controlling weeds. Usually, when lablab is being grown in a maize field, the farmer will have to do a first weeding, but the second weeding of the maize is completely eliminated by the lablab. This fact is especially important for African women, because the weeding of crops grown for home consumption is considered women's work. Furthermore, the second weeding is the most difficult of the two, and it occurs right in the middle of the hunger season, which means the women are out in the hot sun all day for a month or more doing hard labor after they have had very little or no breakfast. Some years it is necessary, even when the lablab is there, to walk through the field pulling out an occasional weed by hand, but that is nowhere near as hard as doing a major weeding. Of course, it is usually preferable to grow another food under one's gm/cc (as one can with pigeon peas) than it is to have no weeds, but also no food, growing under it.

A second major advantage of lablab beans is that their leaves are highly nutritious and very palatable for cattle, and they normally continue to grow throughout the dry season. This is especially important during the dry seasons following a poor rainy season, because in such years the people's cattle run out of forage in the middle of the dry season, and many of them die. In Mali, for instance, thousands of farmers now save the lives of their cattle because they have lablab plants in their fields. Farmers using lablab also never need to make hay or silage. In fact, probably the cheapest and easiest way to keep cattle well-fed during the dry season is to put them in a fenced field right after the lablab beans and maize have been harvested, and then lock the gate for the whole dry season. If the number of cattle is such that they will not finish the maize and lablab bean plants before the next rainy season comes, they will be very well fed and gain a good deal of weight, at virtually no cost, throughout the entire dry season. Scores of university-educated cattlemen in southern Honduras have been using this system for a couple of decades now.

Another advantage of lablab beans is that they are native to Africa, so they will not suffer in any major way from most of the plant diseases that are native to the continent.

But probably the most important advantage of lablab beans over pigeon peas (for which only the beans themselves are edible), is that almost every part of the lablab plant is edible for humans—the dry beans, the green peas, the pods, the tender flowers, and most amazingly, the tender leaves. And all these parts of the plant are

easy to prepare. Furthermore, the actual beans, which contain about 22% protein, have about 50% more protein in them than do the common beans (*Phaseolus vulgaris*) that are eaten in developed countries.

Nutritionally, the leaves are probably more important than any other part of the plant. They are edible, and they are produced in quantities as high as 30 to 40 t/ha/year, during 11 months of the year. Because these leaves are dark green, they have plentiful vitamins and minerals, in addition to having what for leaves is an incredible amount of proteins--well over 10%--making them a surprisingly well-balanced food. And they are a free by-product of producing the beans. In significant areas of Africa, during the serious droughts recently experienced, they have been the only food people have available from their fields during nearly the whole 6-month dry season. As a result, we have here a free food rich in proteins, vitamins, and minerals, that is available in large quantities in farmers' fields all year long—this is truly a nutritionist's dream come true.

Although quite susceptible to drought during their first three to four months if the soils are extremely degraded, after a year or two of jack beans the lablab beans can grow through the entire dry season, producing leaves and grain for up to 6 months with no rain at all.

It is also very simple to cook either the dry beans, the pods, or the fresh leaves. Recipes for each of these are given below.



Malawi, southern Africa. Here we can see how a field can eventually "imitate the forest." Notice that the maize is growing very well in spite of (or rather, *because* of) its very dense, biodiverse environment under the pruned gliricidia trees. One can see, toward the left of the photo, that even the maize growing three or four rows from the edge of the field is growing tall and dark green.

Once again, as was explained in the first of these papers, it may seem impossible that gm/ccs can have so many other benefits, but for 2,000 years forests provided all the same benefits.

How Can We Choose Which of these Species to Use in a Given Situation?

How can we choose whether to start working first with pigeon peas or lablab beans with a new group of farmers? First of all, if a community already grows and/or consumes either of these species, it is almost always best to work with the species they already know, can access, and like to eat. This way the process is much easier. Farmers will be much happier to use a known species as a gm/cc, and the costs of doing so will be less because they won't have to obtain seed from somewhere else. If farmers don't use either species and the seed of neither of these species is available locally, but one of them is available somewhere easily accessible nearby, then that would also tilt the scales in favor of using that species. Also, if many of the people in the area are growing sorghum or millet instead of maize, then the pigeon pea would be the species of choice, because it does not need to climb the stalk of some other plant.

If farmers in a given area are not familiar with either of these two species, and neither is available nearby, then it is important to review the advantages of each listed above, to see which species most interest the farmers. The program should always ensure that women farmers are included in these discussions. If knowing the advantages of each, farmers are still unsure which species to use, then the program may prefer one of them because it is easier to obtain elsewhere, perhaps within the same country. If this is still not a deciding factor, lablab beans would usually be the best choice, because of their guarantee of highly nutritious leaves all year long, and the reduction in weeding labor that they provide for women.

By the fourth or fifth year of using gm/ccs, farmers should probably learn to grow both of these species, each of them in a different part of their maize fields, so they have more biodiversity.

How Should we Manage Pigeon Peas to Maximize their Benefits?

Pigeon peas intercropped with maize, sorghum, or millet should be planted at about 2 plants/sq mt, or just 1 plant/sq mt if other crops like groundnuts or soybeans are going to be grown underneath them, which is almost always preferable.

Pigeon peas may not grow very well in soils that have been heavily degraded. If a farmer gets less than about 700 kg/ha of maize when not using chemical fertilizers, or is growing sorghum, millet, or cassava instead of maize, then the pigeon peas may not grow very well. In these situations, it is best to grow jack beans, intercropped with the maize, for one or two years before growing the pigeon peas. One cannot eat the jack bean without a huge amount of processing, but one only needs to grow it for one or two years, and then the farmer can switch to growing pigeon peas or lablab beans in an improved soil that will allow them to grow very well for 11 months each year.

It is far better to keep the leaves on top of the soil, and NOT to bury the pigeon pea leaves and plants when we ratoon the pigeon peas. First of all, burying the crop residues requires a major process of tillage, and tillage damages many tropical soils. It also dries them out. Even more important, this tillage requires a tremendous amount of labor, or the major expense of using a ripper or a plow. Furthermore, if we bury our organic matter, we are destroying our mulch. Soil cover is extremely important because it protects the soil from the hot sun, it helps keep the soil moist, and above all, it feeds our crops.

For pigeon peas to grow throughout the dry season, free-grazing cattle and goats will have to be kept out of the fields. Achieving this goal can be a very simple and cheap process. Using the monkey thorn tree (*Acacia galpinii*) one can easily plant a fence around one's field. This tree must be protected from the animals during its first year (with branches of thorn bushes), but after that, it will provide total protection from cattle, goats and sheep for up to 90 to 100 years. The monkey thorn seeds should be planted one seed each 30 cm along the edge of the field, but the seed is so small that if the field is not more than one hectare in size, it can be totally protected with just 1/2 kg of seed, which normally costs only about US $3.00. Unfortunately, seeds from this tree are presently available only in parts of southern Malawi and eastern South Africa, but this seed would grow well throughout virtually all lowland sub-Saharan Africa. The only other expense (involving only additional labor) is that the trees must be protected from fires during the whole 100 years. To do this, a 2- to 3-m wide space along the fence must be kept clear of vegetation during most of the dry season.

Even if a farmer is growing pigeon peas intercropped with maize, and has no desire to try out a full-fledged gm/cc system, he or she can ratoon the pigeon peas in these fields, as described above, and thereby save pigeon pea seed three out of every four years, while at the same time, achieving almost total drought resistance for the pigeon peas in the second, third and fourth years out of every four years. This alone would be a tremendous improvement over the normal pigeon pea system. Furthermore, such a system could also include other food crops beneath the pigeon peas.

Insect attacks can present problems for pigeon peas. The best protection against this possibility is that of planting the pigeon peas intercropped with maize and some other food crop under the pigeon peas. If insects still attack the pigeon peas severely, especially the seeds, some form of pest control will sometimes be necessary. If, however, the insects are only making little holes in the leaves, they are merely composting the nutrients in the leaves and dropping them on the soil—a benefit for the farmer rather than a problem.

How Should we Manage Lablab Beans to Maximize their Benefits?

Lablab beans produce much more grain and over-all biomass when they can climb, so farmers should almost always intercrop them with maize. However, if the maize is extremely weak from droughts or severely degraded land, the lablab bean may cause the maize stalks to fall over. In such a case, we use jack beans the first year or two to improve the soil before we plant the lablab beans. When intercropped with maize, the lablab beans should be planted with about 3 to 4 seeds/sq m, with four seeds being preferable if weed control is important. Unless one can obtain bushy types of lablab (which are not yet available in Africa, only in India), lablab beans should never be intercropped with sorghum or millet, because the stems of these crops are too weak to support the lablab's weight.

The most important rule in maximizing the benefits of the lablab bean is similar to that of the pigeon pea: **the lablab beans must continue growing until within a month of the following growing season**. That is, we let the maize stalks that are supporting the lablab beans continue to stand until a month before the next growing season. Then, we cut them both down and leave them on top of the soil to form, or add to, a mulch.

Insect attacks can present problems for lablab beans. Since people usually want to eat the beans, some form of pest control will often be necessary if the insects are attacking the grain. Nevertheless, if the problem is aphids, a very inexpensive solution will usually work. A lack of moisture kills aphids, so one can often control them by spraying the lablab plants with a powder made of cassava roots or wheat flour or something else that will dry out the surface of the pods. If the insects are only causing a few holes in the leaves, there is no reason to worry. We seldom can eat all the leaves of the lablab plant, so for eating, we can select those leaves that are not punctured.

In areas where cattle and goats are allowed to free-graze during the dry season, lablab beans, like the pigeon peas, will require a fence to protect them from these animals. And this is needed even more with lablab than most other gm/ccs, because grazing animals are especially attracted to the lablab. By far the cheapest solution we have found is to make live fences of the "monkey thorn" tree, as described above.

Recipes for Pigeon Peas and Lablab Beans

Pigeon peas can be eaten after just being soaked in water overnight and cooked like most any other bean. They can also be prepared with squash. In this case, the pigeon peas should be soaked in water for 8 to 24 hours, drained, and then boiled along with a little salt. Then this mixture should be reduced to a simmer until the pigeon peas are tender (about 2 to 3 hours). Then ½ of a squash that has been cubed and roasted until tender and golden, should be added to the peas. At the same time, one onion that has been cooked in oil is added to the mix, along with red peppers, if you like. The dish should then be served while still warm.

Lablab beans have a slight bitter taste to them, so we must almost always cook them together with something else. The simplest recipe is to soak them overnight, and then boil them together with whatever amount of peanut sauce one prefers. Another very simple recipe if coconut milk is locally available, is to soak ½ kg of lablab seeds overnight, then boil the seeds in water until they are tender. Then you add two mashed bananas, 1 cup of coconut milk, and some oil and salt, and continue to cook them for a while on a low fire, stirring occasionally, until they are served.

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