EDN ECHO Development Notes

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and Dawn Berkelaar

ECHO is a Christian non-profit organization whose vision is to bring glory to God and a blessing to mankind by using science and technology to help the poor.

Issue Highlights

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[From the Editors: In this issue of *EDN* we share some ideas about research and its importance for people doing agricultural development. First Mark MacLachlan, a member of our network working with SIM in Ethiopia, shares some thoughts about research and agricultural missions. Then Dr. Edward Berkelaar describes how to carry out a simple agricultural experiment, followed by an example experiment. You may find the second article difficult to follow. If so, it might be helpful to go through the information with someone local who is trained in planning and doing experiments. You might also find it helpful to first read through the example experiment at the end of the second article.]

ECHOES FROM OUR NETWORK: Towards More Fruitful Agricultural Experimentation

By Mark MacLachlan
SIM-Ethiopia

For many of us the idea of "research" is scary. We are not trained in it. We picture rigorous statistical analyses that we do not have any idea about. We have seen glossy scientific journals with technical words that we could not understand. Besides, isn't our goal to directly help small farmers? Why should we now do research? Who has time anyway?

Chances are that most of us are already involved in doing experiments at some level, but we just don't call it "research." We wish we had more information about some crop or agricultural technique, so we do a small variety trial or set up a demonstration to see if the idea works in our climate. How will this information be generated and distributed, if not by those of us in the field? And how will we know that we can safely implement or recommend some new method or plant unless we have done adequate experimentation?

Each of us has limited time and resources. But with a little thought, most of us can make the trials that we already do more useful. Anyone who has ever placed a seed into the soil and watched it grow can participate at some level in experimentation that is useful to all of us.

Imagine a missionary or extension agent who thinks that a certain plant might be useful in his area. He plants a small plot, though he does not record how much seed was used, the date it was planted, what the site conditions were or what method was used to plant it. After some time he finds that the plants did grow, and he ate the harvest. He can only guess how much was produced. All he learned was that the crop seemed to do well and that he liked the food it produced.

Is that kind of experimentation useful? Yes. He learned what he wanted to know. Gardeners around the world do this kind of trial all the time and accept the results of their trials as valid.

But the usefulness of his trial could easily have been increased. Chances are he will not keep the information to himself. At the very least, he will show it to the people around him, farmers and development workers alike. He may even send an email to ECHO, where the information will be tucked away in a plant file, to be discovered at a later date by an intern preparing a research note. And that very anecdotal information will have enriched in a small way the knowledge base of the ECHO network.

There is a temptation to avoid doing experiments because we are not trained to do research or we lack resources. But instead of giving up completely, we should do experimentation using the resources we do have. We may not have the skills to do statistics, but we can take an average of a group of numbers.

In planning any experiment, we should consider the target group. If our target group is university professors, we had better toe the line with our statistics. If our target group is uneducated farmers, we had better figure out what criteria they will accept to validate our trials, for the statistics are probably useless! I call this Resource Appropriate Experimentation.

There are many simple ways to make agricultural trials more useful. The first step is to **gather information**. This is referred to in the following article as literature review. For Resource Appropriate Experimentation, valuable information can be gathered locally. For example, it may be obvious to a local farmer why your trial will not work, because he or she has been around longer and has connections that you do not. You may learn that another missionary or development worker was in the area ten years ago and was trying all kinds of things. See if you can locate him or her. You may not have access to a university library, but the Internet is a very useful tool. Consult ECHO's book *Amaranth to Zai Holes*, if you have the book or can access ECHO's web site. You can also write to the ECHO staff to see if they have any information related to the trial you are considering.

Another step is to keep **written records**. Merely measuring the amount of seed planted, recording the length of time until germination, and recording the amount of harvest is valuable and gives more information than nothing at all. Ask at the start of your trial, “What information can I collect that will increase the value of this trial to me and to others?” These records (measured values) can then be used to calculate averages. You may decide later that more elaborate statistics are appropriate. But remember your target group or groups. Will the statistics help convince the people who most need to be convinced about the value of a method or plant?

The next step is to **document and share results**. University research results are usually published in journals. For Resource Appropriate Experimentation, there are other, simpler ways to get information into larger circles. You might include results in newsletters, send information to ECHO, write simple letters to others that are interested or post results on your own or another’s web site. The feedback can be encouraging. Our experience in Ethiopia has shown that appropriate experimentation is contagious. One of our joys in our work is the number of people who have come to us with new ideas they want to try. They saw that our research work about local trees was done simply but effectively, and they were encouraged to do the same.

Our results will be more convincing if we show similar results from more than one trial. (The academic community calls this replication.) A method may work or a plant may grow well this year, but what about next year? It worked on the east side of the farm, but what about the west side? It was fine on this end of the row, but what about the other end? When results are shared, others can duplicate what we have done, perhaps on a wider scale. This can help reveal limitations of a particular method or plant.

Do not let the rigors of formal publication scare you away from documenting and sharing the good information you have found. On the other hand, if you have the knowledge and experience to publish formally, go for it!

Another way to improve our experiments is to find **someone to review the research** and to give suggestions. This is referred to as peer review in the academic community. The purpose is to make our trials more accurate, and the information more usable. Who should be the experts who review our trials? Maybe this could be done by the farm families that we hope will utilize the results. Certainly other missionaries and development agents doing similar work should also be consulted. A professional researcher could give good suggestions if we intend to do more formal research. But the important thing is to get outside input from somebody, preferably on an ongoing basis.

Most of us have a vision that exceeds our own present circumstances. **Experimentation is a way to reach beyond our immediate situation**. Research catches the eye of government officials. Experimental results, when shared, can be useful in places where the missionary or development worker would otherwise not have influence.

I tended to think I was not doing real research because I was not participating in the “formal research” community. But when I looked at what we were doing, and evaluated it from the standpoint of different criteria, I found that my experimentation was a lot more advanced than I had thought. I also saw some ways to improve it.

Experimentation can be a bridge between highly educated people and the target groups in poverty. Anytime we can get a government official to see things from a farmer’s perspective, we are doing the farmer a favor. An experiment that is done well and is then shared with government officials is an opportunity to do just that.

For the educated, our experimentation serves as a model, and may lead to better ways to work with farm families. For the farmers, our experimentation can provide opportunities for them to share their expertise. For people like me who are foreigners in the areas where we work, it is an opportunity to be in a community as a learner, and the learner role is much more acceptable to most communities than a know-it-all attitude. An experiment that is done well also can serve to make our presence more valuable to the government of the countries where we work.

Can we do experiments to glorify God? Is research a valid path to bring Him glory? I believe so. God put Adam in the garden to work it and take care of it (Genesis 2:15). The “garden” still needs careful attention. Who is closer to working and caring for the garden than the farm families of the developing world? When we stand with them (through development work that is founded on **experimentation**) we are with them in caring for the garden, and we act in obedience to God. When we obey, He is glorified. If we encourage them to make changes using methods that are based on shoddy experiments or on none at all, we can expect that our care of His garden will be less than the best.

Formalizing Your Research: How to Carry Out an Agricultural Experiment

By Edward Berkelaar, Ph.D.

As you work in agricultural development, there may be times that you find yourself wondering about the answer to a specific question you have. For example, should plants be spaced 30 cm or 60 cm apart to achieve the highest yield? Which one of three tomato cultivars would grow best in a particular area? Would growing a cover crop in the off-season result in higher corn yields? Once you decide on a particular question that you want answered, several steps can (and should) be taken. These steps will make the best use of your time and efforts while giving you the most confidence in your outcome. This article will cover the important steps in planning and carrying out an experiment and then apply these steps to a sample experiment. In some cases we have used big words, but please do not let them turn you off. We have tried to define the words well, and we have highlighted them to make them more obvious.

Know your Question!

The first step is to know exactly what you are asking. The simpler and more specific the question, the better. For example, "Which tomato variety should I recommend in this area?" is a poorly worded question. It is vague and should be narrowed down as much as possible. Perhaps you are in a hot area and already know that you can discount any tomato varieties that were not developed or bred for tolerance to heat. A better question would be "Of the tomato varieties A, B, C, D, and E, which has the highest marketable yield?" The question you ask is closely related to your **research hypothesis**, which in this case would be: "One of the five cultivars A, B, C, D, and E yields better than the others"; or "Not all of the cultivars have similar marketable yields."

For statistical reasons, it is important to be able to come up with what is called a **null hypothesis**. This is the opposite of your research hypothesis. In this case, the null hypothesis would be "The tomato varieties A, B, C, D, and E have the same marketable yield." This kind of statement does not seem to make sense, but it is important because **use of statistics cannot prove a hypothesis, but it can provide information about a null hypothesis**. For example, if the statistical analysis of data suggests that the marketable yields of the different tomato varieties are NOT the same, then you can conclude that the varieties do not all produce the same marketable yield. A similar process can be used for comparing plant spacing, pruning techniques, rates of fertilizer application, etc.

Literature Search

Once you know your question, spend some time looking for information that has already been collected on the subject. Maybe a local research station has done variety trials and the information (or some of it) is already available. Perhaps a variety trial was done years ago or in another location, and you can see how some newly available varieties compare to some others that have been around for a while. You may find guidelines explaining how previous variety trials were done, even if they were for a different crop. Often, the result of a literature search is that you want to modify your question. In the process of doing a literature search, you will become better acquainted with your subject area and end up with a clearer question that you want answered.

Plan Your Experiment: Replicate, Randomize, and include a Control

The next step is to plan your experiment. First of all, what do you want to compare in your experiment? You might want to compare several varieties of a particular species of plant (this is called a 'variety trial'), or you might want to do an experiment that involves treating plants of the same variety in different ways (e.g. you space some 30 cm apart and space others 60 cm apart). In the latter case, each way that you treat the plants is referred to as a **treatment**.

When planning an experiment, there are three extremely important procedures to carry out: replication of treatments (or varieties), randomization, and having a control as one of your treatments.

<u>*Replication*</u>: **Replication** means that you apply each treatment to several different plants (or rows, or plots) instead of just one. Using two plants, rows, plots, etc. is replication, but is not enough—you should have at least three replicates for each variety or treatment. It is important to replicate within the different treatments because you want your results to be as accurate as possible.

For example, if you want to know if females and males in a population are the same height, the most accurate way to do this is to measure the height of <u>all</u> females and <u>all</u> males, take the average, and then compare them. Clearly, it is not realistic to try to measure the height of all those people. Instead, the population is sampled, and that sample is measured. If you only select one male and one female, you may have chosen a tall woman or a short man, without knowing that these individuals are not 'average.' By replicating (e.g. measuring the height of 8 males and 8 females), you are likely to get a more accurate idea of the average height of a female and a male. It is still possible, though much less likely, that you would choose 8 unusually tall women or unusually short men for your measurements. Replication also provides information about the uniformity of a population. For example, are most women similar in height, or do the heights vary widely?

As another example, assume you have a small field with 10 rows that are each 40 m long, and that you want to know the yield per given length of row of five tomato varieties. One option would be to fill each row with one of the five varieties (Figure 1a). This way you could plant each cultivar twice, and have two measurements (replicates) per cultivar. Alternatively, since 40 m rows are quite long, you could split them in half (20 m sections), or even quarters (10 m sections) (Figure 1 b and c). This would give you an opportunity to have four, or even better, eight replicates per variety. The only difference would be that instead of yield per 40 m, results would be in yield per 20 m or yield per 10 m. It would involve a little more work because you would need to mark off more sections and make more labels. You would need the same amount of land and the same number of plants. Statistically, you have increased the power of your experiment enormously. You cannot analyze your experiment using statistics if there are no replicates, e.g. if you plant only one row of each variety and measure the yield of each row. **The more replicates, the better off you are (try to do at least three), although generally, having more than 10 replicates is unnecessary in agricultural experiments**.

For some experiments (e.g. variety trials), it is also important to repeat them in different years to account for differences in growing conditions from one year to the next.

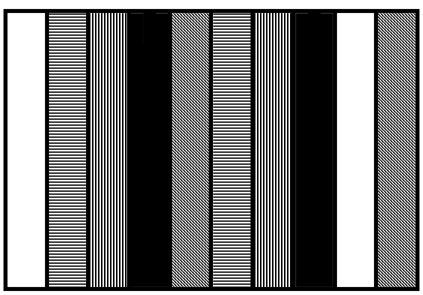

Figure 1a.

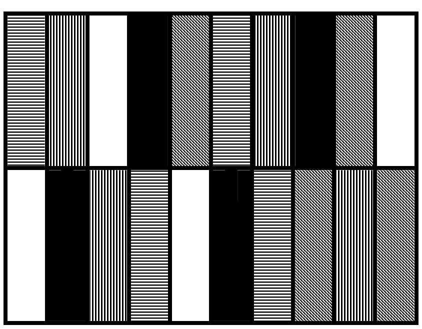

Figure 1b (above) and 1c (below).

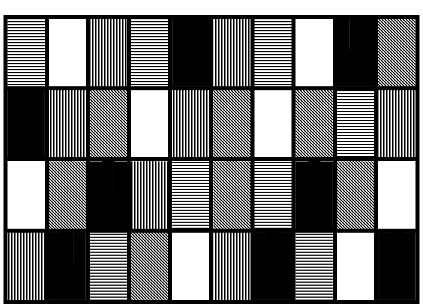

Figure 1. In 1a, ten rows are planted with five varieties (each represented by a different shade), giving two replicates per variety. In 1b, the rows are split in half so that four replicates can be planted per variety. In 1c, rows are split in four so that eight replicates of each variety are planted. 1b and 1c are stronger experimental designs.

<u>Randomization</u>: The second important concept is to **randomize** the location of your various treatments (varieties in this example). This ensures that the different varieties or experimental treatments are planted or distributed randomly, instead of having all of one kind in one place and all of another kind in another place. Randomization is necessary because the growing conditions (e.g. soil environment) in your plot may vary from one area to the next. Maybe a plant variety performed well in your experiment, not because it was a superior variety but because it was placed where it was more fertile (perhaps fertilizers were not applied evenly or the natural fertility of the soil differed from one area to another). Perhaps one area of the plot was a low point in the field, so that the soil there was wetter. Or maybe one edge of your plot was bordered by a row of trees and received a bit of shade during part of the day. The "magic" of statistical analysis is that it can give you confidence about whether the difference in crop performance you measured was actually due to a difference between treatments or to some other factor.

It is important that conditions be as uniform as possible throughout your entire research plot, but since conditions can never be made <u>exactly</u> the same, it is important to <u>randomly</u> spread differences in your plot among the different treatments.

Here is the easiest way to randomize if you want to plant a variety trial. First, mark out as many planting beds as you need (the number of varieties that you are testing multiplied by the number of replicates). Next, write the name of each variety on a small piece of paper. For each variety, you will need as many slips of paper as there are replicates. Next, put the slips of paper in a bag. Then go to your first planting bed and remove a paper—that is the variety you will plant first. Continue doing this until all the varieties are planted.

<u>Use a control</u>: A **control** is the variety or treatment to which others are compared. It is important to include a control as one of your treatments, and sometimes it is useful to include more than one. Imagine an experiment in which a new growing technique is tested and results in an excellent crop yield. Including the old growing technique as a control allows you to determine if the high crop yield was due to the change in growing technique or to another factor such as an optimal growing season. If you want to do a variety trial, it is always good to include at least one commonly grown local variety. Since controls are exposed to the same conditions (both good and bad) as your other treatments, they serve as an excellent point of comparison. Controls should be replicated and otherwise treated the same as your other treatments. **A control is essential**; it would not be acceptable to simply compare your results to data from yield of a previous year, or to compare your results to published data. (It is okay to compare data to published data, but not to do that instead of having a control.)

Record Observations & Data

A **written report** of your method and of the final results is important if you want to share this information with others—or even remember it yourself in future years. Others may try your technique, and it may not work. In such a case they will be very interested to know why not. What type of soil do you have? What were your weather conditions like? What time of year did you do your experiment and how long did it last? Did you fertilize your soil and, if so, when? With what kind of fertilizer, and how much of it was used? Did your plants suffer from any type of disease or from any pests? Information like this might explain why an experiment led to different results when it was done at a different time or in a different location. For example, if two tomato variety trials were done, it would be informative (but also a bit confusing) to know that in the first trial, Variety A did best and in the second trial, Variety D did best. It would be helpful to know that during the first variety trial, weather was ‘cool and damp’ while in the second variety trial conditions were ‘hot and dry.’

At the end of your experiment, **record your data**. The way you measure yield should be chosen carefully to ensure that it answers the question you are asking. Make sure you treat all of the plants in the experiment the same. Harvest everything at the same time if possible, or if this is not possible, try to harvest 25% of each treatment rather than everything from one treatment one day and everything from a second treatment the second day. If more than one person is harvesting, explain to everyone the standard used to decide whether fruit should be harvested, discarded, or left on the plants for future harvests. With more than one worker, it is also advisable to switch halfway through harvesting a treatment, so that one person doesn’t harvest treatments A and B only while the second person harvests C and D only. This can be another source of error when you are analyzing results; perhaps one person is a sloppy harvester, or has a different technique than the other.

Summarizing your Data: Statistics

Statistics is a way to summarize data. It is important to understand what statistics can and cannot do. Statistics relies on probabilities. It can allow you to know if the averages of two columns of numbers (treatment 1 and treatment 2, or variety 1 and variety 2) are different from one another. Statistics will give the answer to that question along with a probability. In agricultural experiments, that probability is set at 0.05 or 0.01, meaning that although you might conclude that the averages are different, there is a 5% or 1% chance that your conclusion will be wrong. This is a fairly small chance. In contrast, you would not have confidence in a conclusion that had a 25% chance of being wrong (a probability of 0.25).

For example, if you have two averages, 9.2 and 12.6, are they statistically the same or different? The answer to this question depends on two things; the difference between the two numbers (3.4 in this example), and the variability in the numbers the average came from. If 9.2 were the average of 8.2, 9.0, 9.7, and 9.9, while 12.6 was the average of 10.8, 11.7, 12.9, and 15.0 (i.e. in each case, the numbers were similar to the average), then we might conclude that the averages were not the same. On the other hand, if 9.2 were the average of 4.7, 5.8, 12.3, and 14.0, and 12.6 was the average of 3.9, 9.1, 16.5, and 20.9 (i.e. the numbers that make up each average vary widely), then we are faced with a different situation, and we could not conclude that 9.2 and 12.6 were statistically different from one another.

Write a Report

Once the data have been collected and analyzed and conclusions have been drawn, it is important to **write a brief report**. The report should contain several sections. In the *Introduction*, it is important to include the question you asked, why it was important, and any additional relevant information that you discovered while you were doing your literature search. The second section is called the *Materials and Methods* section, and should describe exactly how you carried out the experiment (the materials and methods you used to actually do the experiment). This section should be written in enough detail that someone could repeat your experiment using your description. The final section of the report is called the *Results and Discussion* section, and contains the data you collected along with conclusions you drew. Results from statistical analysis are typically included here, along with any ideas you might have regarding why the results came out the way they did. At the end of the report it is important to list any publications you referred to, so that others reading your report may also find and refer to them.

Example experiment

The data below are from an experiment that was actually done at ECHO, but we have simplified it by reporting results from only three varieties here.

<u>Question</u>: Which of three different tropical pumpkin (*Curcurbita moschata*) varieties ('La Primera', 'Butternut', and 'Acorn') has the highest yield?

<u>Research Hypothesis</u>: One of the three tropical pumpkin varieties ('La Primera', 'Butternut', and 'Acorn') has a higher yield than the others.

<u>Null Hypothesis</u>: The yields of the three tropical pumpkin varieties ('La Primera', 'Butternut', and 'Acorn') are the same.

<u>Experimental Design</u>:

<u>Number of Plants</u>: 54 (18 of each variety); 3 varieties replicated 3 times (each replicate was a bed of 6 plants)

<u>Treatments</u>: 3 different tropical pumpkin varieties; 'La Primera', 'Butternut', and Acorn. 'La Primera' was the control in this experiment, because it is a variety that is grown commercially in Florida.

<u>Randomization</u>: The experimental design was a completely randomized design (CRD). Other experimental designs exist and are useful in certain circumstances. The CRD is the simplest, most straightforward design. Following is a description of the easiest way to randomize this variety trial. First, make nine planting beds, each of sufficient size to contain six plants. Second, get nine slips of paper and write 'La Primera' on three of them, 'Butternut' on the next three, and 'Acorn' on the last three. Mix the papers in a hat or bowl

and draw them out one by one. The order in which the papers are drawn is the order in which the different varieties should be planted.

Data and Analysis: Data are shown in Table 1, below. Pumpkin yields (of six plants) are shown for each variety and each replicate. Yields of six plants averaged over all three replicates are also shown, and so is the standard error for each variety. Standard errors are a measurement of variability within a variety. For example, the three yields of 'La Primera' are quite similar, and its standard error is small, while the yields of 'Butternut' are not as similar, and its standard error is higher. The smaller the standard error, the more uniform the data.

Table 1. Yield data for tropical pumpkin variety trial.

	Yield of six plants in kg		
	'La Primera'	'Butternut'	'Acorn'
Replicate 1	21.1	4.42	15.2
Replicate 2	17.9	2.95	5.78
Replicate 3	21.2	12.8	13.1
Average	20.1	6.72	11.4
Standard error	1.08	3.07	2.86

The next step is to determine if, statistically speaking, the average yields of the different treatments are significantly different from one another. In our example, are the differences between the averages 20.1, 6.72 and 11.4 due to the fact that the different varieties actually yielded different amounts of pumpkins (i.e. are they 'significantly different'), or were the differences due to chance? A statistical analysis will indicate which explanation is most likely. An explanation of statistical analysis is beyond the scope of this article, but the outcome of a sample analysis is presented below. We are putting together additional information that will be helpful if you plan on doing statistical analysis of your data. We can mail or e-mail the information to you. We will also post it on our web site when it is ready.

A statistical analysis was done on the above data to test our null hypothesis that the yields of the three tropical pumpkin varieties ('La Primera', 'Butternut' and 'Acorn') are the same. The analysis can test whether or not the null hypothesis is true. A low probability or p-value ($p<0.05$) means that the null hypothesis is not true and that at least one of the varieties had a different yield than the others.

In this case, we compared each pair of varieties, resulting in the following p-values:
'La Primera' vs 'Butternut' p=0.015
'La Primera' vs 'Acorn' p=0.046
'Butternut' vs 'Acorn' p=0.33

Typically, the cutoff p-value is 0.05. This means that when the probability is higher than p=0.05 (5%, or 1 time in 20), we do not have the confidence to say that the averages are different. In this case, we can conclude the following: 1) The yield of 'La Primera' was different than that of 'Butternut' (p=0.015) and 'Acorn' (p=0.046); and 2) the yield of 'Butternut' and 'Acorn' did not differ. In the case of conclusion 1, there is less than a 1 in 20 chance we are wrong. Because the first comparison has a lower p-value (almost 1 in 100), we are more confident in it than the second comparison. Still, there is a very small chance that we are wrong–these kinds of analysis can never allow us to be absolutely sure. [Ed: scientists are sometimes the objects of jokes because they are so precise and hesitant to say much with certainty. Someone described a scientist as a person who, if asked what color a certain house is, would say, "The side facing me is yellow."] We cannot say that the yield of 'Butternut' and 'Acorn' differed because there is a very high probability (33%, or 1 in 3) that these averages are different due to chance. This is probably due to the relatively high amount of variability in the yield data of 'Butternut' and 'Acorn'.

Conclusions: We can reject our null hypothesis that "The yields of the three tropical pumpkin varieties ('La Primera', 'Butternut', and 'Acorn') are the same." Our statistical analysis showed that the yield of 'La Primera' was probably higher than the yield of the other two varieties. There was no significant difference in the yield of 'Butternut' and 'Acorn', despite the rather large numerical difference measured; there was a high probability (1 in 3) that the difference in these yields was due to chance.

In this case, the probability that the averages are all similar to one another is 0.0004 (p = 0.0004), or 4 in 10,000. We can confidently say that at least one of the treatments was different than the others.

Free Cyanide Testing Kits Available for Development Workers

By Dawn Berkelaar

When I was working on the article about chaya and leaf protein concentrate that appeared in the last issue of *EDN* (Issue 80), I learned about a cyanide testing kit developed by Dr. Howard Bradbury at the Australian National University in Canberra, Australia. The kit contains enough supplies to analyze 100 samples of root or flour. A separate kit measures urinary thiocyanate to give a measure of recent cyanide intake (when a food is eaten that releases cyanide, much of the cyanide is converted to thiocyanate and removed in the urine). The kits are available from Dr. Bradbury free of charge to health workers and agriculturalists in developing countries. So far, almost 250 kits have been supplied to workers in 35 countries.

The cyanide testing kits are compact and can be used by anyone with a high school education. Each kit contains a detailed instruction sheet (available in English, French, Portuguese and Bahasa Indonesia), 30 plastic vials, papers containing a buffer at pH 6, a balance to measure 100 mg of test material, two graduated 1 ml plastic pipettes, yellow picrate papers that darken in the presence of cyanide, and a color chart with 10 shades of color corresponding to 0 – 800 ppm of total cyanide. The darker yellow the picrate paper turns, the more cyanide is present (Figure 2). Figure 2 shows results from the tests I did to measure cyanide concentration in fresh chaya leaves and in leaf protein concentrate. Although the colors are not visible in the black-and-white picture, you can see the chart with its gradations of color that correspond to different concentrations of cyanide. You can see it in full color on our web site posting of this issue. **One important note is that you must have a freezer or at least a refrigerator to store the picrate papers, because they gradually darken at room temperature until they are eventually useless.**

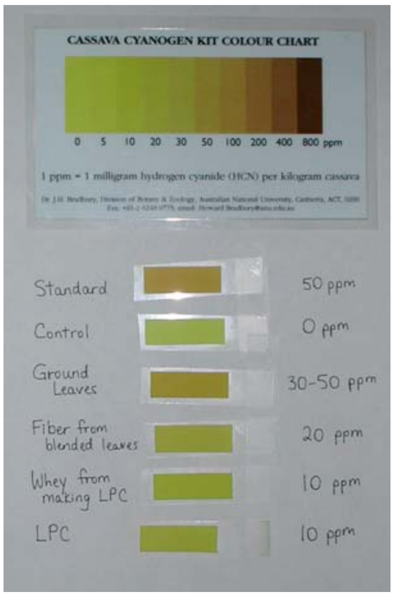

Figure 2. Results of a cyanide analysis, including the color chart that indicates how much cyanide is present.

If you are a health worker or agriculturalist working in a developing country and you would like to receive a free cyanide testing kit, please contact Dr. Howard Bradbury at the School of Botany and Zoology; Australian National University; Canberra, ACT 0200, Australia; phone: +61-2-6125-0775; fax: +61-2-6125-5573; e-mail: <Howard.Bradbury@anu.edu.au>. Include a brief description of what you would like to test, because Dr. Bradbury has slightly different kits to test for cassava roots (kit A), products such as flour and gari (kit B2), urinary thiocyanate (kit D1), and cyanogenic leaves (kit E). People who live in developed countries can purchase the kits for US$250 or AU$500.

Dr. Bradbury is also involved in a free network called the Cassava Cyanide Diseases Network (CCDN). He is starting a newsletter and encourages people to join if the topic is at all relevant to their work. The CCDN web site can be viewed at <http://www.anu.edu.au/BoZo/CCDN/six.html>. If you would like to join, e-mail or contact Dr. Bradbury at the above address.

By the way, in the past we wrote in *EDN* that after chaya has been boiled for several minutes, it no longer contains dangerous levels of cyanide or cyanide-producing substances. Thanks to Dr. Bradbury's test kit, we were able to test raw and cooked chaya and determine the levels of cyanide before and after cooking. Leaves of the plant that we tested contained 30 to 50 ppm before cooking, but only 5 ppm after they had been boiled for ten minutes. 5 ppm is a low enough level that it should not cause concern to eat cooked leaves containing that amount of cyanide.

BOOKS, WEB SITES & OTHER RESOURCES

New Moringa Web Site

We are pleased to inform you about a web site designed specifically for people and organizations that are interested in moringa species and their uses. The web site address is <www.moringanews.org>. Information on the site is available in both English and French.

The moringa web site was set up to facilitate a network of people interested in moringa. The importance of such a network was discussed at a conference called "Development Potential for Moringa Products" that took place in Tanzania in 2001. [Ed (MLP): I was fortunate to attend that conference.] The complete proceedings from the conference are available from the moringa web site. Also available is access to a mailing list. If you want to join, you need to sign up for the mailing list from the web site; messages that are submitted to the list are then sent to your e-mail address. Members of the mailing list have the option to add their name, organization name and e-mail address to a membership directory that can also be accessed online (currently 150 people are listed in the directory). Other helpful pages include a links page (with links to 52 related web sites) and a page where you can download some documents and find other references for literature related to moringa.

The moringa web site is maintained by several French NGOs that seek to promote sustainable development in the tropics and subtropics. Dr. Armelle de Saint Sauveur, the contact for the moringa web site, said that many people have registered for the mailing list. She is encouraged that, by all appearances, the web site seems to be meeting a need.

FROM ECHO'S SEEDBANK

Seven-Year Lima Bean

By Grace C. Ju, Ph.D.
ECHO Seedbank Manager

Seven-year lima (*Phaseolus lunatus*) is now available from ECHO. The seven-year lima is also called Madagascar Bean, Painted Lady or Tropical Lima. Our seeds originally came from the Asveldt Ranch in Mwenezi, Zimbabwe, where the seven-year lima is planted around houses and grows on top of roofs, away from foraging goats. The common name refers to its ability to remain productive for several years. A unique quality of this bean is its ability to smother and suppress weeds while providing continual forage for animals, beans for human consumption, a perennial dense cover crop for tropical dry regions and a green manure that adds nitrogen to the soil. The seven-year lima bean is characterized by vigorous vining growth that quickly develops into a thick mat about 2' high. The beans are white with a mix of deep burgundy.

The plant does best in a dry, frost-free growing season but if frosted, will die back and then regrow. Its growth is slowed down by cool weather. It is fairly drought-resistant and requires light, well-drained soil with a pH of 6 to 7. It is tolerant of a wide variety of soil types. The beans can be planted in mounds and trellised, or can be broadcast to produce a thick ground cover. Before the wet season, the vine should be pruned back to get a healthy flush of new growth to withstand the intense rains. The cuttings can be fed to animals as a mix with other forages.

Pods are produced continually throughout the life of the plant, providing multiple harvests. Dry beans are ready for picking after 3-5 months. The seeds are easy to collect and can be kept in cool, dry storage for many years. Seven-year lima bean is extremely hardy and vigorous. It is susceptible to root-knot nematodes, though it does continue to persist even with infected roots. When some other legumes on ECHO's farm were infested with leafhopper two summers ago, seven-year lima suffered the least damage and continued to produce, showing good vigor.

The beans can be eaten as a pulse. Beans should be soaked 4-6 hours before cooking, then boiled for 1 ½ hours. The water should be discarded before eating the beans. The beans and leaves should never be eaten raw because they contain a toxin, hydrocyanic acid, which is removed with soaking and cooking. The lima beans are a nice protein addition to soups, stews and casseroles. Cooked beans can be refrigerated and eaten cold.

Those working in missions or in some area of non-profit development in a developing country may request one sample packet of seven-year lima from ECHO free of charge. All others may purchase the seeds at $3.50 per packet plus $1.00 for shipping.

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Also note: the following types of seed are available in bulk from ECHO's seed bank. Contact ECHO to find out prices and quantities. Single trial packets are free to development workers.

Winged Bean (*Psophocarpus tetragonolobus*): This climbing rainforest legume thrives in hot, humid weather. It produces edible leaves, flowers, pods, green seeds and tuberous roots, all high in protein. Used as a Green Manure and intercropped with bananas, sugarcane and sweet potato.

Hairy Indigo *(Indigofera hirsuta*): Erect-growing legume used for grazing. Adapted to sandy soil and can grow in dry areas. Can be used as hay, silage and cover crop.

African Okra (*Abelmoschus esculentus*): Pods are still edible at a much larger size than is true for most okra varieties. In trials in Haiti we found that it continued to produce when the days became short and other varieties became less productive.

Tropical Velvet Bean (*Mucuna pruriens*): A hardy annual legume that is a vining cover crop and green manure. Usually intercropped with corn. Adds large amounts of nitrogen and organic matter to the soil. Good feed for cattle.

Uberlandia Carrot (*Daucus carota*): Unlike most carrots, this variety from Brazil will set seed in the tropics. Quality will be inferior but farmers can do their own selection to develop adapted local varieties from which farmers can save seed. See *EDN* 74-7 for one farmer's experience using techniques described in *Amaranth to Zai Holes* page 55 (both available on our web site).

Atemoya Seeds from ECHO

By Martin Price, Ph.D.

By the time you are reading this we will probably be enjoying my favorite tropical dessert fruit, atemoya. That means this is the time to request a packet of seed if atemoya is not already grown in your area. Though there are grafted varieties, it grows well from seed and produces good fruit in a few years.

Atemoya is a man-made cross between the high altitude cherimoya (*Annona cherimola*) and the lowland sugar apple (*A. squamosa*). It is in the annona family of fruits, other examples being soursop and custard apple. You can read about it on our web site, look at issue 54 of *EDN* or request that we mail or e-mail the article to you. Seeds are free to members of our overseas network, $3.50 per packet (plus $1.00 for shipping) for U.S. gardeners.