

# A BEGINNER'S GUIDE TO SMALL-SCALE TROPICAL AGRICULTURE

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## ECHO TECHNICAL NOTE

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So you want to help people in the tropics. Beautiful! The tropics are waiting for you. No matter what your abilities, you can make life better for others in the tropics. Your concern for the physical and spiritual well being of people can be translated into fruitful service. Your first asset is your good will, your willingness to serve.

As you begin to get acquainted with the tropics, you will find that common problems are production and the use of food. Among the poor, those that most need your help, obtaining one's daily bread is a constant concern. This is not only a question of eating. It is first a matter of production, second of distribution and storage, and third of preparation of meals and balancing of the diet. It is highly probable that when you arrive in the tropics you will not have all the knowledge you need of food production and use in order to help tropical people with their priority needs. It does not matter what experience and training you may have had in your temperate homeland; you cannot be fully prepared in advance. Do not let this discourage you for it is normal. Frequently, however, to accomplish your purposes you will need to help others with their needs to produce and use food better.

The tropics are different from the temperate zones. While in theory it might be possible to produce food crops all year round, in reality a wide range of biological and social factors determine what crops are produced and during which seasons. The soils are formed by different processes than those of the Temperate Zone. They tend to be acidic and heavy, with low natural fertility; but there are numerous exceptions. Day length is short during part of the year, but never as short as in the Temperate Zone during the winter. Day lengths are longer 6 months later, but never as long as in the Temperate Zone during the summer. Many tropical plants are very sensitive to length of day, and flower in response to small differences.

Time and length of the rainy season vary. The most common weather pattern in the tropics is the monsoon, characterized by drought during short days and rain during long. However, tropical climates vary from almost dry all year to rainy almost all year.

The crops of the tropics are often very distinctive from the crops of the Temperate Zone; but when they are the same, the varieties are almost always different. The methods of producing them are highly varied and usually there are small-scale methods. Even the layout of the garden is different, often an irregular and undisciplined mixing of trees and vines with mostly perennial vegetables.

Add to these differences those due to local custom, food preferences, and personal preferences and you will quickly understand that the tropics are not like home.

This is a problem only if you make it so. If you try to teach in the tropics the patterns and customs that you are familiar with, you will almost always fail. Therefore, your task will be first to learn the techniques that local people are already using. In so doing your respect, understanding, knowledge and abilities will grow, and you will pave the way towards improvement of the local techniques. It can help you become a small scale food production expert.

## NATURE OF SMALL SCALE TROPICAL AGRICULTURE

The scale of agriculture in the tropics ranges from the small household farm to very large farms. Tropical agriculture is usually labor-intensive, seldom machinery-intensive. Large farms, sometimes called plantations, are often concerned with production of crops that can be exported. Large and medium sized farms are always concerned with sales and making a profit.

On the other hand, small-scale agriculture has a double purpose: subsistence (feeding the family) and marketing (cash or barter). Food that is produced on the subsistence farm is itself a savings in that income need not be expended. However, subsistence is more than just a way of life. It is often the only alternative that a family has. The food produced on the small farm is often not just a financial matter, but also a matter of life or death. This is the reason that small farmers follow traditions rigidly and dislike change. The price of a mistake is too high.

The crops that are grown on the small tropical farm are usually basic subsistence crops, grains, legumes, roots and tubers. These crops often are the best crops to grow to sell, for they are the crops used in great amounts by others. Oftentimes very little attention is paid to fruits and vegetables. Fruits are often neglected because they are so abundantly produced, at least during their season that they are available to most, and surpluses are difficult to sell. Their value in the diet, chiefly in terms of vitamins but sometimes carbohydrates and oils, is seldom appreciated. Vegetables, as known in the temperate zone, are produced even less than fruits, but there are many exceptions to this rule. European vegetables are often unadapted, but can be produced in the highlands, or during the cool season, or when varieties adapted to heat or other specific problems are available.

There are many tropical vegetables that are seldom if ever seen in the Temperate Zone. Because the newcomer to the tropics does not recognize them, he may wrongly assume that the local people do not grow vegetables. Many of these are the young and tender leaves of shrubs and trees. Some are wild but protected, and others are conscientiously planted. Any one of them is likely to be many times more nutritious than civilized lettuce. Some tropical vegetables have many edible parts including young leaves, shoot tips, flowers, tender pods, immature seeds, dried seeds, and roots or tubers. People often know the uses of other local vegetables. They may be ignorant of many uses of introduced plants.

When starting out, experimentation with very obscure tropical plants is not advisable. The properties of most plants that have a great deal of potential for the small farm are known and described somewhere (though often in publications which are difficult to get). The first place to start is always by learning from local people. Then look for plants that may be unknown in your location, but are important in other parts of the world.

You can learn about many of these plants in back issues of *ECHO Development Notes*; seeds for many of them are available from ECHO's seedbank. But remember, learning from local people is always the best way to start

Small-scale tropical agriculture is also characterized by small amounts of available resources, especially purchased inputs. While labor tends to be abundant, it might be committed to other tasks. Purchased fertilizer or pesticides might be out of the reach of the small farmer. Some small farmers may lack even the most elementary of hand

tools. Techniques you introduce should ideally be capable of reaching down to the lowest, and yet afford opportunity to those who can take advantage of advanced technology.

It is appropriate here to discuss what some consider a resource - credit. Indeed, there are many places where agriculture is deemed impossible without credit. As a general rule, the larger the farm the more easily credit can be obtained. Yet, credit implies an obligation. The farmer, small or large, assumes an obligation every time he accepts credit. The obligation is hard, absolute. Yet, his ability to pay is soft, full of risks. Small farmers are usually better off when they do not engage in the time-dishonored activity of borrowing. Without borrowing the farming risk is the same, or less, and the profit is the same or greater. You must decide whether credit is a resource or liability.

Tropical agriculture on a small scale is an adaptation. In many respects it is the result of an evolutionary process, the growth and change of the small farmer in response to the physical and social environment he faces. Change is a never-ending process. Agriculture may need to change rapidly sometimes, or not all at other times. The techniques of small-scale agriculture should not be considered primitive. They might be adaptations to reality. They should not be considered sacred and unchangeable either, because change is inevitable. Change represents opportunity: for innovation, for experimentation, for winning cooperation, and for bettering the life physically and spiritually.

Finally, small-scale tropical agriculture represents integration. In the sense used here, integration is the use of one resource to stimulate the production of an "unrelated" output. As simple examples, integration might be the use of crop residues to increase animal production, and the use of manures to increase crop production. Integration is a way of maximizing outputs (food for the family, farm products for sale, etc.) and minimizing inputs (purchase, labor). Integration on small tropical farms is often lacking even when possible. Integrating is one of the easiest ways to contribute to the welfare of the farm family, and may cost no more than some thought and discussion or demonstration. Some ideas of integrating activities are given below:

- Use of moveable cages where animals might feed on and destroy weeds, scratch the soil, and deposit manure in garden areas. This can be done with moveable cages on tethers.
- Restraining chickens from household gardens.
- Use of crop residues as litter in animal cages, and subsequent use as compost.
- Weed control with mulches that are later incorporated into the soil as compost.
- Off-season green manuring with appropriate species.
- Disposal of human waste in deep pits later planted to trees.
- Use of crop residues as fuel, as building material (roofing, etc.), and as clothes.
- Use of animal furs or skins as clothes and shoes.
- Location of small animal cages and outbuildings under fruit trees.
- Use of ashes as fertilizer and in soap making.
- Use of trees with edible products as fence posts. Rat control with poisonous seeds of fence trees (*Gliricidia sepium*).
- Uses of crop plants for a variety of compatible uses.
- Location of farming facilities to permit labor saving.
- Planting crops taking into account the amount of family labor that will be available later.

In most cases farmers have integrated many aspects of their operations. However, on almost all farms there are still-to-be-discovered opportunities.

Integration cannot be practiced until the non-integrated elements of the farmers' systems are understood!

## SOME COMMON PROBLEMS

### WATER

Water is almost always a problem with small-scale agriculture in the tropics. The availability of water will determine what crops can be grown and at what seasons. However, availability of water to the plant is conditioned

by many factors, especially the nature and treatment of the soil. The field of water management is complex, and therefore only generalities can be given in this publication.

Excess water can damage crops by flooding (excluding oxygen from the soil), loosening roots followed by lodging (falling over) of plants, leaching away nutrients, eroding soil, stimulating weed growth, and making work in the fields difficult. The first solution to excess water is to reduce its effects by providing better systems of drainage (ditches, furrows, or planting mounds).

Lack of water is a constant problem. One solution is to use irrigation. If this cannot be done, loss of water is partially controlled by plowing, terracing, use of pits to capture runoff, mulching, incorporating organic material in the soil, etc. Drought requires the use appropriate crops (millet is more drought resistant than sorghum; sorghum is more than corn). Some crops have drought resistant varieties.

Note that some soils retain water so well that some crops can be planted and grown to maturity after rain ceases, without addition of more water.

You can expect that small farms will need water management systems to maximize production.

### WEEDS

Weeds are a major problem on every tropical farm, large or small. As living plants they compete with crop plants for space, light, water and nutrients, and thus reduce yield. Furthermore, they usually produce their seeds before cultivated crops do, and thus assure their future. Seeds of many species live for years in the ground, and cultivation to destroy existing weeds brings previously buried seeds to the surface where they can germinate. Weed control is a major subject. A brief guide to weed control has been printed by ECHO and is available by request.

The major goal of weed control is to reduce the competition with the cultivated crops. The elimination of weeds from a field is impossible. Often when one pesky species is controlled, another arises to fill its niche. Practical control is achieved through one or a combination of methods, which might include reduction of germination, reducing the growth rate, or killing the weed during its growth.

It is almost always possible to improve weed control on the small farm. Better weed control will almost always improve yields. Yet, you should be aware that weeds can be tolerated in some situations. It may be uneconomical to control them, especially if they are few in number, not very competitive, or only present as the crop is maturing. A good rule for the time of control is as early as possible.

### SOIL FERTILITY

Problems with the fertility of the soil almost always occur on the small tropical farm. Only on those farms of exceedingly rich soil where primary or secondary forest is cut does one occasionally find fertility that cannot be improved. Soil fertility problems vary in terms of nutrients that are lacking. A soil analysis may be helpful, but is often not adequate. It will not measure other equally important factors such as the availability of nutrients that are present (this is determined in part by the form in which they are held), or the texture of the soil. It appears that the field is very complicated. And it is! The best analysis of the soil may be a small-scale trial of its ability to support crops.

Nevertheless, some very important generalities can be made. No matter what the nutrient problem of the soil, improvement can be made by the addition to the soil of organic material (any refuse from dead plants and animals). This material is best if first composted (rotted by fermentation, producing heat). This is feasible in the home garden, but may not be feasible on the farm. Useful results can be obtained when the organic material is mixed into the soil, or even when it is applied as a deep layer on top of the soil. For best results large amounts are

needed. It is difficult to apply too much. The most useful organic material is animal manure. Crop refuse often contains abundant carbon, but little nitrogen. Applying some nitrogen in the form of manure or as chemical fertilizer is desirable. Growing of a crop that can later serve as organic material (green manure crop) is often good practice. The best ones of such crops are legumes, including the vigorous velvet bean and the hyacinth or lablab bean.

Where sufficient organic material is not available, mineral fertilizer will almost always improve yields. When no guidelines are available, equal parts of nitrogen, phosphorus, and potassium can be used. The first 100 kg/hectar gives the most dramatic response. Since crop growth may be limited by factors other than fertility, very high rates (e.g. 1000 kg/hectar) are seldom economical on the small farm. Too high rates of mineral fertilizer, especially nitrogen, may even reduce crop yields. It will result in crops that are too soft, have too little roots or tubers, or are susceptible to drought.

#### APPROPRIATE SPECIES AND VARIETIES

It is often the case that a newcomer in a rural area tries to help local people by quickly introducing that which, through his previous experience, he knows is useful elsewhere. This is such a common error that each would-be reformer or teacher must be on guard for this mistake. Techniques developed elsewhere often do not work out when transferred to another area. New crops are often ill adapted or not culturally accepted. New varieties of an acceptable crop may fail for numerous reasons. Nevertheless, often the introduction of a better variety of an already commonly used crop will dramatically improve the welfare of the people. It is appropriate to look for innovations. Just remember that all innovations must be carefully tested in the immediate area.

The testing of a new variety can be very complicated or very simple. The simplest approach is to grow the new variety alongside the old, using the same techniques for both, and to harvest, eat, sell, and store both with the farmer. He will rapidly discover which is best. A more advanced approach is to become familiar with what other agencies are testing or developing, and test these materials first.

An even more complicated task is to describe the deficiencies of the existing varieties with the production systems, and to seek the advice of an expert. Often a newcomer will see a problem without understanding it. Low yields, for example, can be caused by a large number of factors. Very high yields are utopian, and may be achievable only when all growing conditions are maximized or all limiting factors are controlled. You may never achieve the maximum, but with improved techniques and better varieties you should be able to improve yields. What should you do? Proceed cautiously. Find out what has been attempted. Find the rationale behind existing varieties and techniques, and then proceed with caution. Look for new crop varieties first from the agricultural experiment stations and departments of agriculture in the region or country, and from your colleagues in similar situations.

Finally, crop adaptation is often very location- and technique-specific. Changes of area and of technique may change the variety desired. There is no end to the development of new techniques or the testing of new varieties. Don't expect to reach perfection, but strive for improvement.

#### PESTS AND DISEASES

Every crop plant has its pests and diseases. While the crops, their pests, and diseases may be different in the tropics, the principles of control are about the same. These are mentioned in ECHO's publication called "Control of Weeds, Insects and Diseases on the Small Farm or Home Garden", but will be reviewed in briefer form here. Pests and diseases may limit the production of a given crop in a particular region. When resistant varieties are available, their use is usually the most satisfactory and least expensive control. However, resistance cannot be obtained for many crops.

The use of chemical controls has many disadvantages, danger to the user and to others, possible contamination of the farm, killing of beneficial insects, and increased costs. Very often partial control can be achieved by changes in

the method of production or cultural practices. Usually farmers know something about these conditions, but may not have developed an integrated approach in which all knowledge available is incorporated into the system of control. There is great opportunity for progress on the small tropical farm through control of diseases and pests. Quite often the disease or pest problem occurs after harvest; thus special knowledge of appropriate harvesting and post-harvesting practices may be necessary.

#### INTERACTION OF AGRICULTURE AND HUMAN WELFARE

Often agriculture of the small tropical farm is intimately related to health of the farm families. Ignorance and custom, as well as lack of food or facilities may interact with farming plans, food produced and methods of use of food. Knowledge of good nutrition and good hygiene is desirable if farm families are to be helped. A newcomer who chooses to accept local customs uncritically can literally kill himself. By example and by teaching, farm families can be taught the basics of nutrition and hygiene.

#### *Nutrition*

Farm families often fall far short of eating balanced diets of the 4 basic food groups (meats and eggs, milk and milk products, breadstuffs, plus green and yellow vegetables, and fruits). In the third world, three kinds of malnutrition are evident, often combined: protein, carbohydrate, vitamin, and mineral. Ample information is available in this field and often is printed in the local language and is related to local custom. Publications are usually available from local government agencies.

Attacking only part of the nutritional problem is seldom the solution. An integrated approach is almost always necessary, including growing the right foods, producing animals, and using the foods rightly. Sometimes good nutrition involves introducing foods into the diet that are not customarily used. This is often difficult because people do not change their preferences easily. Sometimes the new food can be incorporated into traditional dishes. Sometimes acceptance begins first with the children.

Some of the crops or foods with great nutritional promise are high lysine corn (also called hard endosperm opaque-2 corn) which is useful for its balanced amino acids, leaves of many kinds for vitamins A and C, new legumes for their protein (including white in place of colored beans), soybeans for soybean milk, seeds of heavy seeding squashes and their relatives for protein and edible oil.

On the other hand, rural peoples of the third world often eat more than enough starches, and thus might consume too many calories as compared to oil, protein, vitamins, and minerals. This is often because such foods are readily available. These people need to learn new dietary habits.

#### *Hygiene*

The lifespan of rural people is often shortened due to poor hygiene. Dehydration of babies due to diarrhea is a major problem in the third world. Some of the basic problems in hygiene are the following: Pigs and chickens distribute their excrement throughout the yard, and thus parasites and intestinal infections are common. Personal hygiene (use of toilet or latrine, bathing, washing before eating) may be difficult, impossible, or neglected. Proper precautions are not used for preparation, storage, or consumption of food. Water for drinking and bathing may be contaminated. Disease-bearing pests may be present.

In advanced countries, the normal practices followed for good hygiene are so common that their essential nature is overlooked. It is dangerous to assume that rural conditions are equally valid alternatives. Good hygiene is always desirable and often will make a life-or-death difference.

### *Family Economy*

Farm families, like many others, need money. The lack of money often leads to poor nutrition. A pig on a small farm may be saved to sell when there is great need. The eggs are collected not to eat, but to sell. Crops are grown which have a market, not for their nutritional contributions.

A good farming system integrates crop production (food, feed, fuel), animal production, and making money, with preserving and improving health. (Growing vegetables for a cash crop can sometimes increase on-farm vegetable consumption because there are so many nutritious but not marketable culls.)

## **STEPS TOWARD IMPROVING SMALL-SCALE AGRICULTURE**

Like many good things in life, improvement of small-scale agriculture is not easy. Since every region (and every farm, to a lesser extent) is distinctive, there are no automatic solutions to improvement of agriculture on small farms. Nevertheless, from the experience of many persons, a few principles can be instilled as follows:

### INFORMATION

Agriculture requires information. Follow this document with other publications that teach principles. Be sure to obtain a free subscription to *ECHO Development Notes* and a set of back issues. (If you cannot afford the nominal charge for back issues, explain your situation - ECHO sometimes receives donations to cover this cost for special situations.) Enrich your library with publications of the country or region in which you will serve. Be cautious with information developed for other regions or countries with different soils, climates, and social-economic conditions. Do not believe that miracle solutions can be found or that any publication will solve your problems. Information is like a set of tools to be used judiciously.

### DIAGNOSIS

The first step in improvement of rural agriculture is to ask the right questions so as to arrive at a diagnosis. These may include the following and others: What land is available, and what are its limitations? What crops are grown, at what seasons, with what techniques, and with what results? How are the crops harvested, stored, transported, and used? What crop residues remain, and what is done with them? What animals are produced on the farm, and with what techniques? What is done with the animals and their by-products? What do people eat? How is food prepared and stored? What parts of the diet are inadequate? How does this change with time of year? How does animal production interact with human welfare? What do people buy, trade or share? Where do they get the money? What markets exist for new products? What purchased inputs are available (tools, mineral fertilizers, fungicides, etc.)? What is the health of the people? What are the social and economic factors influencing distribution and marketing? What are the infant mortality rate and the life expectancy? Does the diet appear balanced? From what diseases do people suffer? As the answers are compiled an impression will grow of the fundamental problems of the rural community. In addition to general problems faced by everyone, there will be idiosyncratic problems belonging to specific families or persons. Some decisions will need to be made of the most important problems to be attacked as well as their root causes. The fundamental problems may not be agricultural.

### SELECTION OF ALTERNATIVES

From this point, the discussion will concern only agriculture, the theme of this article. Other problems may be too numerous and complex to be discussed here, but they merit equal or perhaps greater concern.

From the diagnosis of the agricultural situation, several alternatives are planned. The closer the alternatives are to current practices, the more likely they are to be successful. Alternatives selected should be rational, based on knowledge and previous experience if possible. They may have experimental aspects to them (in the sense that one

can never be sure of the results). By organizing alternatives that are related to real problems, there is already a great chance of success. Some of the alternatives may be:

- A new crop, a new variety
- An improved system of preparation of soils
- A different season of planting
- A changed physical arrangement of the plants
- A better way of fertilizing
- A better nursery (if the crops are transplanted)
- A new way to control weeds or pests
- Improved harvest or storage
- Better ways of food preparation
- New uses of crop residues

Similarly, additional alternatives may be sought for the animal component of the farm.

#### TEST OF ALTERNATIVES

Selected alternatives can be tried first in plantings completely managed by the innovator. These plantings could be in schools, churches, backyard gardens or rented fields. Alternatives should be produced alongside plantings produced with the technology of the farmer. As soon as possible, farmers should be involved in testing alternatives alongside their own plantings. The same principles are applicable if the alternatives are storage or cooking techniques or any other aspect of production and use of food. Trials should be made for comparisons before new technology is introduced to farmers or farm wives. If the alternatives require new markets or marketing techniques, these should also be worked out before the alternatives are presented to the farmers.

In normal practice, a foreign innovator is closely watched. It is a serious error to introduce a technology that is not a significant improvement. (However, you should expect some disappointing results along with successes on your personal trial plots!) On the other hand, successful aspects of a technology (successful alternatives) will be watched and tried by others.

#### VERIFICATION IN FARMERS' SITUATIONS

Even when new alternatives have been demonstrated to be successful they must be verified in the hands of the farmers. The farmer will put them into use in his own way and will find strengths and weaknesses not obvious to the innovators. These verification trials accomplish a further purpose - a transfer of the technology to farmers. Usually the grassroots approach is the most useful in transfer of technology; but as acceptance becomes generalized, new doors may be opened for more formal training in agriculture, food processing, nutrition, and hygiene.

#### **SUMMARY: THE BEST WAYS TO HELP A SMALL FARM**

Become acquainted with what people do, diagnose first, select alternatives, try them out in small experiments - first under your control and then progressively with farmers. Promote that which proves to be better. Never give up, because improvement is always possible.

Doing agricultural missions is not an easy task. Many mission agencies with projects in evangelism, health, education, water, sanitation etc. hesitate to add agricultural projects to their program. Why? Because it is often much less clear what they should do to have a major impact in agriculture than it is in these other areas. It has been said that if you can provide clean drinking water and build latrines you take care of up to 80 % of a village's health

problems. Likewise, medicines already exist to treat most of the diseases in the developing world. But, if a community is "sick" because of poverty of farmers, it is much less clear what should be done.

Requirements for a satisfactory agricultural project include the following: It must involve no risk to local farmers who are already living on the edge. It must be something they are not already doing. It must make such a major difference that farmers will readily adapt the innovation. And, it must have a ready market (or be liked as food locally) if it involves sale of a product.

It's almost impossible to meet all of these criteria and some projects have failed miserably. But, there have been successes and more well-prepared agricultural missionaries are needed. The following are a few ideas to keep in mind in preparation for a successful agricultural project. We've not elaborated on them and they are not all inclusive, but they are points that come up over and over again:

Be committed to the people and the work. Effective change takes time. Get to know the people and their "felt needs". Live with them; learn their language and culture. Earn the right to help them. Go as a learner, see why they do things the way they do (There's usually a reason for everything, even if it seems foolish at first). Be flexible, you may become involved in more than you expected (ex: reforestation, sanitation and health).

Start small and be an experimenter. Identify naturally innovative farmers in the community and work with them. Keep things simple, pick a few important technologies and promote them until they are recognized as an improvement. Be patient.

The Nationals must own the project. If they are not involved in every aspect from start to finish, it won't work. Use local resources and appropriate technologies. As far as possible, they should provide the labor and materials needed. Teach folks to teach others and don't make yourself indispensable. You won't be there forever. All these help folks to keep their dignity, avoid dependency, and help assure sustainability. Whenever possible work with the government, not against it.

There are a lot of technologies that have already proven themselves in a particular cultural and climatic setting. These are well worth a trial in similar situations. But nearly everything will require some adaptations to the local situation.

Expect frustration. We once read that a farmer in the Philippines was able to multiply his cash income 15 times by planting disease-resistant tomatoes. But, he declined to plant them again because of social pressures from his less successful family and neighbors.