THE

BENSON INSTITUTE

SMALL-SCALE AGRICULTURE MODEL



BENSON AGRICULTURE AND FOOD INSTITUTE BRIGHAM YOUNG UNIVERSITY PROVO, UTAH REVISED MARCH 2003

Small-Scale Agriculture

<u>The Need</u>

Increasing available food through agricultural and rural development is key to reducing the number of the world's poverty stricken people. Current estimates indicate there are approximately 800 million people, or one in seven in the world do not have enough to eat. The inability of many small-scale farmers to meet the food maintenance needs of their families has resulted in a rapid increase in urban poverty as the rural poor have moved to the city in search of survival. These large masses of urban poor, in a real sense, pose a greater social and political problem for a country than do the poor in rural areas.

Many of the perennially hungry are children. Not infrequently they are born to malnourished mothers and are underweight at birth. Such children begin their lives with a handicap. Children who are not well nourished experience learning difficulties, and frequently fall well below their genetic intellectual and physical potential.

The development and application of technological approaches which improve life for the rural sector's small-scale farmers will dramatically improve a Third World Nation's economic and political health. Improved agricultural production by small-scale farmers can be an important means of breaking the vicious cycle of poverty which grips many developing nations.

During the past half century, in a spirit of cooperation and good will, many organizations and governmental agencies have used various approaches to alleviate the Third World hunger-poverty problem. Funds have been spent on infrastructure development, institution building, international research centers, etc. Others have gone directly to the people with emergency relief, disaster assistance, and food production systems. All approaches have been designed to improve the lot of the poor, and yet the problem of rural poverty is still very much present.

<u>The Ezra Taft Benson Agriculture and Food</u> <u>Institute Approach</u>

The mission of the Ezra Taft Benson Agriculture and Food Institute (Benson Institute) is to raise the quality of life through improved nutrition and enlightened agricultural practices. The science of the green revolution has not yet found application with many small-scale farmers in poor nations, and the adoption of agricultural practices which dramatically increase production of large scale or corporate farms are not practiced or adopted by small-scale farmers. Donated funding and assistance programs instituted to increase food production seldom are used for improving the small-scale farmer. These conditions act as barriers to finding a workable solution to the food problem of small farmers everywhere.

Many small-scale farmers attempt to feed their family with a land resource base of one to five hectares (approximately 2 to 12 acres). These farmers have neither capital for land acquisition nor for increased mechanization nor inputs such as improved seeds and fertilizer. Frequently they are trapped in a situation where they neither know of new technology nor have the means to adopt it. Each season is a struggle to survive. Given the high rates of maternal and infant mortality, children who survive the first five years of life are frequently without their mothers. Early marriage and early childbearing further compound the problem.

In the 1980's, scientists working at the Benson Institute recognized that if the cycle of poverty were to be broken, an approach to food production was required that recognized small-scale farmers could improve their economic circumstances if an integrated agricultural system were developed. That system has enabled them to maximize crop production from a more intensive utilization of their available land. A small food animal component has been included with the food crops resulting in a production system which could produce a greater abundance of high quality food than that which characterized the historic grain-bean production system. Food was needed that addressed calories, protein, vitamin A, calcium, phosphorus, iron, and the other minerals and vitamins required in the family diet.

The intensive small-scale animal production uses chickens (broilers and layers), rabbits, guinea pigs, small ruminants, or other appropriate animals which fit local dietary preferences, and which were produced with the resources available. Start-up funding was provided as an in-kind grant to initiate the program at the family level. Vegetables and fruit production were also included to improve the

diet of the small-farm family. On the Bolivian Altiplano small underground greenhouses were developed which enabled nine months of vegetable production in that rigorous environment.

Cooperating agencies were sought and relationships established. Frequently those agencies were in-country universities which had a responsibility to improve the circumstances of their people. Their students assisted in performing research on pressing problems and provided extension education to cooperating small-farm families. Not only was the small-farm family assisted under such an approach, but the local agency or university became more proficient in making a difference with their own people.

The Benson Institute approach is not a subsidy to subsistence farmers. It is an approach which enables small-scale farmers to achieve nutritional adequacy for their families, to produce a surplus for future reinvestment, and to improve the overall circumstances of the family. Its principal thrust is aimed at developing self-reliant families.

Benson Institute Family Self-Reliance Program

There are six components in the family self-reliance program (Figure 1):

- 1. Basic Human Needs Assessment
- 2. Small-scale Crop Production
- 3. Small-scale Animal Production
- 4. Appropriate Technology
- 5. Health and Nutrition
- 6. Literacy and Education

These modules may be integrated as a total program at a family or village level, or each may be utilized independently for any given situation.

The foundation of the family self-reliance program is the successful implemen-

• tation of the small-scale farming strategy.

The health and nutrition component may be implemented independently of other components. In reality, lasting improvement to health results through improved nutrition, which results from the quantity and improved critical

• nutrient levels in the food consumed by the family. The ability to improve a family's condition is heavily dependent on dietary ade-



FIGURE 1. BENSON INSTITUTE FAMILY SELF-RELIANCE PROGRAM MODULES

• quacy and food security.

The lack of adequate food makes teaching and adoption of new programs

- less efficient.
 Participation in family health programs can dramatically reduce days of ill-
- ness.
- Technological advancement is heavily dependent on improved income. Literacy and education or human capital development are important factors in improving the circumstances of individuals and families. Yet for millions of young people, especially in rural areas, the educational opportunity is lim-
- ited by lack of income, credit, and accessibility to educational programs.
- Family resources are a critical determinant.
 For sustained development, it becomes necessary to improve the family's circumstances.

Figure 2. depicts the interrelationships of the various components in the Self-Reliance Program.

Each program component meets a unique family need. Food availability at the family level undergirds everything else. The small-scale farming strategy is

given the greatest development emphasis because of the need to satisfy the family's nutritional requirements, thereby improving health and family income. While there are six modules in the family self-reliance program, only the smallscale crop and animal segments are described in this publication.

Small-Scale Agricultural Strategy

This strategy is directed toward improving economic and nutrition conditions of small-scale farmers. It is specifically designed for them, to more fully utilize the family's labor and limited land resources. It is a location and resource specific program.

Small-scale agriculture, as opposed to *subsistence farming* has family selfreliance as the goal. The variety, quantity and quality of foods produced, the nutrition provided for the family, and the products marketed or traded for family income are greater than that which results from subsistence farming. It operates on the principle of self-sufficiency with the goal of achieving nutritional adequacy for the family. Production in excess of that needed by the family is marketed. Where a farmer produces one or two crops which he attempts to market and use the income to buy needed food, he frequently encounters depressed prices or other difficulties which then leaves the family in greater financial and nutritional stress. Given rising expectations, available cash is frequently spent for non-essential items.

This small-scale agriculture program is based on research conducted at Brigham Young University's (BYU) Spanish Fork Agriculture Station, Utah and subsequently in several developing nations. After four years of experimentation it was field tested on nine different small-scale family farms in Ecuador. The field tests involved the integration of crop and small animal production to determine if it provided a family with an adequate and reliable food supply. The Benson Institute system is based upon a nutrition model. Consequently, a variety of crops are grown that satisfy both the nutritional needs of family members and of the small animals they grow. These animals in turn produce high quality protein, energy, vitamins, and minerals for family consumption. The small-scale farm can provide a source of income as excess animal and agricultural products which are then sold in the open market. This interrelationship is illustrated in Figure 2.

The success of any small-scale agricultural strategy is evaluated by the follow-

ing five criteria:

- 1. It must be simple and manageable. Complications result in discouragement and failure.
- 2. It must supply the family's minimal dietary requirements.
- 3. It must provide economic incentive, so that income will, at a minimum, meet the family's basic needs.
- 4. It must be labor intensive and provide meaningful employment and involvement for the farm family.
- 5. All components of the food production strategy must be complementary and integrated.

Specific methodologies are used to promote successful production and integra-



FIGURE 2. BENSON INSTITUTE SMALL-SCALE AGRICULTURAL STRATEGY

tion of

crops and small animals.

The small-scale agricultural program assumes the following:

- 1. Grain crops are the world's main food crops and form the caloric or energy base for both humans and animals. Grain crops may be corn, rice, wheat, or other satisfactory cereals common and adapted to the area.
- 2. Small animal components may include: poultry (broilers and laying chickens), rabbits, goats, fish, or other animals adapted to or present in the region.

Except for the goat, whose primary purpose is milk production, these animals are small enough to be consumed by the family in a single meal, thereby eliminating food preservation problems. The animals provide the family with a constant supply of quality protein, vitamin B_{12} , and other vitamins and available minerals. Small animals are nutritionally efficient and can be maintained on feed produced in the small-scale crop program.

- A food legume such as dry beans, chickpeas, cowpeas, lentils, etc., together with the animal products, provide the total protein base for the human diet. Soybeans and other high protein seeds, such as lupines, can provide the protein source for animals.
- 4. A garden with vegetables is grown to provide minerals and vitamins (particularly vitamins A and C).
- A revenue source, either food, non-food (flowers, etc.), or small animals, is raised solely for cash purposes. This creates some of the income for the family and becomes an economic driver for the small-scale agricultural program.

Nutritional adequacy requires that energy, protein, vitamins, and mineral requirements are met. The small farmer must produce plants and animals which, when properly prepared, meet those nutrient requirements. Crop and animal nutrition likewise must be considered. Additionally, there must be a sensitivity to family food preference. Crops that are highly nutritious, but culturally unacceptable, will not be utilized for food, even though they may be produced in abundance. Figure 3 depicts crops which can be used to meet various nutrient requirements.

Crop plant varieties vary from region to region. One should determine what is locally available, what can be successfully grown, what is well liked, and then produce crops that satisfy nutritional needs which may be unmet by locally consumed crops. Small animals grown by the family become the principal source of high quality protein.

The small-scale agricultural strategy is nutritionally driven. Consequently, the projected nutritional needs of the family and animals will determine the crops to be grown on the farm and the specific amount of land devoted to each crop each season. Standard nutrient requirement values and the crop yield of nutrients needed to satisfy family and animal needs are usually available in each community. The nutrient needs are determined by the number of persons in the family and their ages. Table 1 gives a general accounting of daily nutrient requirements



All elements must be present at the same time for proper nutrition, development, and growth to occur.

| Nutrient used by the body | Main use by the body | Common crops that supply the element | | |
|------------------------------|---|---|--|--|
| Carbohydrates | Energy for mainte- nance growth, activ- ity, and reproduction | Rice, wheat, maize, sorghum, millet, cassava, white and sweet potato, taro, quinoa, yam, ama- ranth (many other local crops) | | |
| Protein | Maintenance and muscle and tissue building | Soybeans, dry beans, ground nuts, lentils, chickpeas, cowpeas, fava beans, garden peas (many other local crops species) | | |
| Vitamins and Minerals | Body growth and metabolic function | All of the above crops, plus veg- etable crops such as tomatoes, peppers, chard, yellow fleshed squash, broccoli, onions (these crops provide good sources of vitamin A and C) | | |

FIGURE 3: NUTRIENTS, THEIR USES IN THE BODY, AND THEIR FOOD SOURCES

TABLE 1

Estimated Nutritional Requirements Per Person and the Number of Persons Supported from Two Potential Diets Designed from the Output of the Smallscale Agricultural Strategy

| | | Number of Persons Supported* From Food Product Sources | | |
|-------------------|---|---|--|--|
| Nutrition Item | Average Requirement per Person per Day Plant Product | Plant Product Alone | Combination of Plant and Animal Products | |
| Energy | 2000 kcal | 7.5 | 9.4 | |
| Protein | 50 g | 8.9 | 15.8 | |
| Calcium | 1000 mg | 2.2 | 5.8 | |
| Phosphorus | 1000 mg | 12.8 | 17.5 | |
| Iron | 18 mg | 8.4 | 9.6 | |
| Vitamin A | 1500 RE | 19.2 | 22.0 | |
| Thiamin | 1.5 mg | 11.6 13.0 | | |
| Riboflavin | 1.7 mg | 3.7 | 8.2 | |
| Niacin | 20 mg | 5.6 | 8.9 | |

per person and the number of people that can be supplied with the crop products alone, and the added number of people sustainable when animals are included in the system.

*Values represent the output from a 1.0 ha farm in a temperate zone. Continuous cropping where permitted by environment would approximately double the number of persons supported.

By including animals in the small-scale farm program, the number of people supported is almost doubled. Energy is the first limiting factor in these diets. When a person's diet comes from a variety of crops and animals, if the caloric needs are met, all other nutrients will generally be supplied.

Small-Scale Crop Production

Both the nutritional needs of the family and the animals they raise must be pro-

duced on the small farm. Therefore, it is necessary to allocate a specific percentage of the farm land to different crops designated to meet specific human and animal needs.

This program is more involved than growing a garden. In small-scale agriculture, the basic small farm production unit is one hectare (2.47 acres). Units smaller than one hectare require adjustments in the cropping pattern, so that the land is used to optimize nutritional and financial returns for the family. The additional land in production greater than one hectare may be planted with whatever crops or series of crops that may best utilize local market opportunities. In this strategy, the first hectare is always devoted to meeting the family's food requirement. The additional land can be used to grow crops with the greatest financial potential.

Crops may be marketed either directly, or indirectly by feeding them to the animals and then marketing the animals. That decision should be based on the net profit possibilities, recognizing that the situation changes from year to year and from commodity to commodity. Small-scale farmers will need to be taught this marketing reality. The crops which are appropriate to grow must be determined for each individual circumstance. The sequence of crops needed to ensure the family food supply must be carefully considered in single cropping as well as multiple cropping strategies. Benson Institute research at BYU, along with onsite projects, have resulted in defining possible schemes for allocating land to crops.

Three alternative schemes are illustrated in Figure 4, 5, and 6. Alternative 1 (Fig. 4) shows a possible crop selection and space allocation that might be chosen by a family that had only chickens. Alternative 1 (Fig. 4), with allocation for a forage crop, would be followed if goats and/or chickens were to be included. If growing conditions permitted, Alternative 3 (Fig. 6) could be followed in producing a second crop during the year. The increased production could be used either to feed more animals or as a cash crop. The family would decide which alternative would be the most appropriate for their circumstances. At this juncture, technical assistance or extension advice is often very helpful in making sound decisions. It is important to recognize with the major crops, the design recommends that year-to-year crop rotations occur. Rotation of grain crops with legumes enhances utilization of nitrogen fixed by the legumes. In addition, plant density and row spacing may be adjusted according to local available moisture conditions. Simple soil tests may be used to determine the kind and at least tehe minimum quantity of fertilizer needed to supply crop nutrient needs.

FIGURE 4. CROP ALLOCATION ON A ONE HECTARE FARM IN THE SMALL-SCALE AGRICUL-



TURE PROGRAM

Alternative 1: Possible crops grown during the usual cropping season (Goats and Chickens)



FIGURE 5. CROP ALLOCATION ON A ONE HECTARE FARM IN THE SMALL-SCALE AGRICUL-TURE PROGRAM

Alternative 2: Possible crops grown during the usual cropping sea-



son (Chicken Production)

FIGURE 6. CROP ALLOCATION ON A ONE HECTARE FARM IN THE SMALL-SCALE AGRICUL-TURE PROGRAM

Alternative 3: Possible sequence to main cropping pattern, as a second crop in the same year

Small-Scale Animal Production

Small animals are an integral part of the Small-Scale Agricultural Strategy. Animals can enable a more complete utilization of crops and crop residues. They convert many plants and plant byproducts which are unsuitable for direct human consumption, such as grass, leaves, and bran into highly desirable products such as meat, milk, eggs, as well as useful products such as wool, skins, and pelts. While some animals might serve draft and transportation functions, the primary role of animals in this strategy is food protein production. Many nutritional deficiencies which people experience in an all-plant diet can readily be corrected by eating animal products. By increasing the nutritional value of the family's diet, the quality of life is improved. By increasing total food production, additional persons can be supported (Table 1). Animals may improve the family's economic status by providing commercial production of live animals, eggs, milk, meat, or pelts. Animals best adapted to small-scale agriculture seem to be chickens, rabbits, and goats because:

- 1. Small animals are less likely to upset the crop balance established for meeting other basic family needs.
- 2. Small animals individually cost less and are therefore more affordable by small farmers.
- 3. The low individual cost and the short time to get animals into production reduce both the risk of loss and the time needed for return on investment.
- 4. The feed requirements for an individual small animal is minimal and fits well into the limited feed resources.
- 5. Small animals yield quantities of animal products more in keeping with the lack of refrigeration. The yield of eggs, milk or carcass meat match the daily needs of the family, and excesses can be marketed without requiring preservation.
- 6. Children can be safely involved in the care of small animals.
- 7. Feed required per unit of wieght gain is more efficient with rapidly growing small animals.
- 8. Small animals act as a living refrigerator.

The family must choose a type of animal which can be fed from on-farm produce and can thrive under the local environmental conditions. The family must also decide the kind and amount of the various animal products they want, then choose the animals which can best meet their expectations in keeping with their abilities and resources to produce such. The family will need to make the necessary schedule adjustments which will occur with an intense form of agricul-



tural production. This is especially so in the case of animal agriculture, in which more intense management is required for successful animal production.



A mix of animals suitable for many areas is:

1. 12 laying hens to provide 3,000 eggs per year and 24 pounds of meat when



birds are replaced.

- 2. 24 broilers replaced every two months to produce 440-474 pounds of meat from 150 birds yearly.
- 3. Two does and one buck goat to produce 300 gallons of milk and 50 pounds of meat per year.

Other species such as guinea pigs, sheep, swine, and/or fish can be used, depend-

ing on local conditions and the family's preferences.

The Benson Institute small-scale agricultural strategy takes into account the challenges involved in the introduction of small animals onto farms with limited resources. The following are factors which should be considered by small-scale farmers:

- Recognize that small animals are heavily dependent upon the family's care, and that they require more buildings and facilities and a higher level of management skills than do grazing animals. Profitable animal production depends on protecting them from harsh climatic conditions and caging them for sanitation and disease prevention. The penalty for failure to observe good husbandry practice is stiff and can be unforgiving.
- 2. Since small animals are especially susceptible to predators such as dogs, snakes, and birds, cages and fences must be provided. In some areas animals may need protection from theft.
- 3. An adequate supply of feed must be provided. Cropping systems have been developed that will meet the requirements for animal feed and at the same time not deprive the family of necessary food or cash crops. Harvesting and storing procedures must protect the feed value of the crop.
- 4. A program for improved animal health must be adopted. Such a program will prevent and/or control major animal diseases and parasites in the area. Included are practices such as quarantine, sanitation, vaccination, and breaking the cycle of internal parasites through the caging of chickens and rabbits to keep them off the ground. This caging, together with the tethering of goats, would also permit closer supervision and control of the animals (Fig. 7).
- 5. When using locally available animals, the farmer must determine which desirable traits can be improved by selection and breeding, and find means to introduce genetically superior stock.
- 6. A market for animal products produced in excess of family needs should be identified before production is begun.
- 7. The small-farm families must have a willingness to accept new technologies and to change some traditional practices. They must also be willing to invest capital and labor into improvements and practices essential for the effective production of food from animals.

Of all the factors to be overcome in the production of small animals for food, poor management as manifested by inadequate nutrition, the lack of control of



FIGURE 7. RABBIT HUTCHES AND CAGES FOR BROILERS OR LAYING HENS SHOULD BE SIMPLE, INEXPEN-SIVE, AND CONVENIENT, BUT THEY MUST PROTECT THE ANIMALS.

requiring educated attention. The proper selection and care of animals, coordinated with appropriate crops, can raise the quality of life while fulfilling the goal of self-sufficiency.

Pilot Project Implementation in Ecuador

The Benson Institute Small-scale Agriculture Strategy was implemented in the province of Manabi in Ecuador. Since then, it has been successfully adopted by small farm families in Guatemala, Mexico, Bolivia, and Ghana.

For the first cropping season, two pilot sites were selected. In the second season, the number was expanded to ten sites. It should be noted that the small-scale agriculture strategy was established directly on the land holdings of small farmers and not at experiment stations. Crops and animals produced in excess of that consumed by the families were sold at the local markets at local prices. The gross and net income data which follow are for the time and location of the proj-

| Product | Total Produced | Family Use | Animal Feed | Excess Sold | Family Income* |
|--------------------|-------------------|---------------|----------------|----------------|-------------------|
| Corn (lb.) | 7256 | 3110 | 4146 | 0 | 0 |
| Soybeans (lb.) | 1988 | 0 | 543 | 231 | \$69.30 |
| Dry Beans (lb.) | 243 | 243 | 0 | 0 | 0 |
| Vegetables (lb.) | 5383 | 2692 | 0 | 2692 | \$511.48 |
| Alfalfa Hay (lb.) | 2900 | 0 | 2900 | 0 | 0 |
| | | | | | |
| Broiler Meat (lb.) | 657 | 450 | 0 | 207 | \$269.10 |
| Goat Meat (lb.) | 50 | 50 | 0 | 0 | 0 |
| Eggs (Number) | 3000 | 3000 | 0 | 0 | 0 |
| Milk (Gallons) | 300 | 300 | 0 | 0 | 0 |
| Total | | | | | \$849.88 |

ect. It is recognized that yields and income will vary by location from year to year.

In considering the Ecuadorian experience and exploring other possible options, the yield and income data obtained in Ecuador over a two year period were averaged and some extrapolations made. The crop allocations of Alternative 1, as shown in Fig. 4, were used in generating the data for Table 2. Forty percent of the hectare was planted in corn to provide energy for both the family and animals. Beans were planted on 20% of the land to provide necessary protein for the family, the excess being sold for revenue. Vegetables were grown in a small garden, and alfalfa hay was grown as forage for the goats.

The yields which could be expected if the entire hectare were planted to one crop only were 6205 kg of corn, 2265 kg of soybeans and 3250 kg of dry beans. Corn produced the highest yield of dry matter per hectare, followed by dry beans.

Table 2 shows the yields of the crops grown on a single hectare of land as well as the meat, eggs, and milk produced when 150 broilers were grown and 12 laying hens and 2 lactating goats were maintained. The goats were fed crop residues and scavengered forage, though alfalfa hay was used as their major forage. Goats will not produce well if crop residue is the exclusive source of forage. The plant products not consumed by the family or their animals were sold to produce income.

TABLE 2

YIELD AND UTILIZATION OF FARM PRODUCTS INCLUDING 150 BROILERS, 12 LAYING CHICKENS, AND 2 GOATS *Income based on 1985 market prices.

<u>Conclusion</u>

The Benson Institute now has two decades of experience in implementing the small-scale farming program in a number of communities in various developing nations under a variety of environmental conditions. We state, with a high degree of confidence, the system works well when the following factors are effectively operative in the total small-scale farming process:

- 1. Local agricultural agencies and universities are taught the system and use it as a part of their extension and adaptive research efforts.
- 2. Village schools and local community leadership are involved in the introduction and adaptation process.
- 3. Mothers are taught how to use the products grown in school gardens and raised in animal facilities through such auspices as a village school-lunch program.
- 4. Initial micro-credit inputs such as seed, fertilizer, tools, chickens, feed, etc., are provided in-kind through a progressive system of grants for the first cycle.
- 5. Families are taught to save for future reinvestment toward the time when the NGO or other donor agency will not be present, that is local people are taught the principle of self-sufficiency.
- 6. Villages are helped to organize into cooperative units and local leadership is developed, so that larger projects which require community cooperation can be accomplished. This enables additional agricultural growth to occur, which growth will be needed as individual and family expectations rise.

Authors: Laren R. Robison, N. Paul Johnston, Allen C. Christensen, Luis V. Espinoza and Richard L. Brimhall.