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A Strategy for Jamaican Hillside Agricultural Development

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SUMMARY AND RECOMMENDATIONS

The hillside area of Jamaica is important because it:

- Contains most of the land area;
- Is the area of residence and employment of at least 25 percent of the population;
- Provides most of the domestic food supply;
- Produces important export crops, including coffee, cacao, pimento, citrus, ginger, and yams;
- Provides the country's forest products;
- Is the watershed that supplies the cities, industry, and irrigated agriculture of the coastal plains; and
- Is where the bauxite mining industry is located.

Small farms of less than 5 acres, engaged in mixed cropping and livestock production, dominate hillside agriculture. These farms primarily produce annual food crops for both family consumption and the market, but perennial crops and livestock also play an important role. Productivity -- return on capital, labor, and land -- is low:

- Soils are generally shallow, on steep slopes, low in nutrients, and heavily eroded;
- Traditional handtools are used because the slopes permit little mechanization;
- The level of technology is low, lacking in improved varieties, fertilization, disease and pest management, and erosion control;
- The marketing system is not well organized; and
- Credit is difficult to obtain because farmers do not have title to their land to offer as collateral.

Soil erosion is heavy, primarily because farmers cultivate annual crops on the slopes without taking measures to control erosion. This is a serious problem with the following consequences:

- Topsoil is lost and the agricultural potential of the area is decreased;
- Water runoff is accelerating, reducing absorption by the soil, increasing gully erosion, and causing flooding;

- Erosion causes siltation in waterways and reservoirs that supply the cities, industry, and irrigation projects; and

- Siltation has postponed the implementation of dam construction projects.

The government strategy for development of the hillsides emphasizes small-scale farmer production and erosion control, and includes:

- Improvement of the general infrastructure: roads, water supply, electricity, housing, public health, education, and physical development of rural communities;

- Provision of extension services for crop and livestock production;

- Foreign donor-supported projects based on land settlement and subsidized structural works for soil conservation;

- Provision of credit and marketing services; and

- Reforestation and structural erosion control, and water channeling on public lands.

Although infrastructure development and reforestation have been successful, the government strategy has not succeeded in increasing agricultural productivity. Moreover, small-scale farmer incomes have not risen significantly, and a high percentage of young people have left the farms for employment elsewhere. Soil erosion has not been appreciably reduced. While the markets for export crops produced on the hillsides have been good, growth in production has been slow. With current conditions and strategies, projections for the future are grim. Improved technology and management practices will inevitably be applied widely in food crop production on the coastal plains as one of the replacements for the unprofitable sugar industry. When this happens, hillside farmers on poor land with traditional technologies will no longer be able to compete for the domestic food market.

A new strategy for hillside agriculture is required that serves the following national objectives for agricultural development:

- Increase farm income, rural employment, food production, export crop production, and foreign exchange earnings; and

- Decrease soil erosion, siltation, and foreign exchange expenditures for agricultural imports.

The new strategy should:

- Be long-term in orientation;
- Focus on high-return farm enterprises;
- Emphasize bottom-up, participatory planning;
- Integrate programs;
- Be led by the Jamaican government, not donors;
- Exhibit flexibility to changing circumstances; and
- Respond to the diversity in hillside conditions.

A new strategy must be based on the facts that the farmers manage the watershed and produce the crops, and that their needs must be addressed first. The strategy must increase total production and not reduce annual food crop production in the process. Measures that control soil erosion must be affordable by both the farmer and the national budget.

Using the above objectives, characteristics, and criteria, an analysis of four potential scenarios (each encompassing a different set of assumptions) was conducted to identify an appropriate strategy. What evolved is a scenario, based in part on natural events and in part on policy implementation:

- Agricultural production in the hillsides will shift to heavy emphasis on permanent tree crops and an improved pasture/livestock system. Annual crops for the most part will shift to the coastal plains;
- Hillside population will decline slightly and stabilize;
- Soil erosion will decline significantly under a permanent tree crop and pasture system;
- Employment and incomes will increase with use of improved technologies for tree and livestock production; and
- Land use will be rationalized with higher utilization and larger, more cost-effective units for hillsides and subdivision of large holdings on flatlands.

The major components of the proposed strategy are:

- A program of technology generation and dissemination that is based in large part on a farming systems approach to research and extension;

- A soil and water conservation program emphasizing on-farm practices developed in conjunction with the crop and livestock production techniques emerging from the farming systems research and extension program;

- A land-titling program for hillside small farmers;

- An increase in the production campaigns of the commodity boards handling hillside export crops, including coffee, cacao, and bananas;

- A program to strengthen the Peoples Cooperative Banks and to develop methods for effective group lending;

- A program to strengthen the higgler marketing system; and

- The development of farmer organizations, such as producer associations, for major crops.

The proposed strategy should become national policy with the full support of the Prime Minister and Parliament. Coordination mechanisms will be required for effective implementation. A number of discrete projects can be identified for donor support.

CHAPTER ONE

INTRODUCTION

This study was conducted by Development Alternatives Inc., (DAI), under contract to the United States Agency for International Development mission in Jamaica. DAI was initially asked to review the Integrated Rural Development Project II (IRDP II) and make recommendations on its redesign and extension. An interim report was submitted by the DAI study team to AID and the Jamaican Ministry of Agriculture in October 1982. The report concluded that the development approach used in IRDP II was weak in production technology, and employed inappropriate and excessively expensive soil erosion control practices. The study team presented several options for dealing with IRDP II, but recommended as a first priority that AID and the Ministry of Agriculture design a more viable strategy for hillside agricultural development and erosion control. The ministry and AID decided not to extend or redesign IRDP II, but to let it terminate on schedule on February 28, 1983. The Minister of Agriculture and the AID director agreed to undertake a review of the hillside development strategy and asked DAI to conduct a study and recommend for a new approach.

This report contains the findings, conclusions, and recommendations of the DAI study team. It should be noted here that no attempt was made to outline all of the aspects of a comprehensive development strategy. Instead, the report describes the major issues relevant to agriculture and the natural resource base in the hillside areas, explores alternative

approaches, and recommends a new strategy. This report is to provide the basis for discussion of the issues and a consensus on the principal components of a new strategy. In addition, recommendations are made on the implementation of the major components of the proposed strategy. Most of the questions on tactics and program actions are left for a later time, to those who will be managing the new strategy once it is adopted. Where this report does venture into tactics and management, it is primarily for illustrative purposes or to give more substance to the treatment of a strategic element.

Following the review of this report in draft, DAI will produce it in final form, incorporating any changes requested by AID and the Ministry of Agriculture and outlining subsequent actions to be taken, based on decisions made during the review process.

Strategic issues are never easy to analyze. The complexities of agriculture on the Jamaican hillsides make them particularly difficult in this case. Agricultural production patterns change throughout the island as soils, climate, elevation, market demand, and local custom change. This diversity makes generalizations difficult and risky. Nevertheless, national strategy analysis requires a certain level of aggregation and generalization in order to deal with the major issues. This report attempts to do that, without fully qualifying all of the assertions or listing the exceptions, in the belief that it is the major issues and policies that are important in a strategy.

CHAPTER TWO

THE ANALYTIC BASIS FOR A HILLSIDE DEVELOPMENT STRATEGY

DESCRIPTION OF JAMAICAN HILLSIDE AGRICULTURE

Jamaican hillside agriculture is dominated by small diversified farms containing less than 5 acres of sloping land. The soils are generally of low fertility, shallow, and already heavily eroded. Only 13 percent of the island's 2.7 million acres is in high potential Land Classes I and II, and very little of this land is in the hillsides. Class III soils, suitable for intensive cultivation only with major erosion control measures, and Class IV soils, suitable for tree crops and pastures, are used for annual food crop production. Farming under these conditions with hand-tools is both unproductive and destructive of the soil. On the basis of land classification, the hillsides should be used for tree crops, pastures, and forestry. Yet the bulk of domestically produced food is grown on the hills, with the coastal plains and inland valleys reserved for export crops.

Jamaica's maritime tropical climate is suitable for farming year-round, but numerous microclimates determine which crops can be grown in specific locations. Different regional rainfall averages (40-300 inches, coming primarily between May and October) and elevation ranges (sea level to 7,400 feet) dictate the farmers' choices in a locality. Jamaica can produce a wide range of crops and livestock; some form of agriculture or forestry is possible nearly everywhere.

Given the small size of most farms, a high unemployment rate, and the strong market demand for agricultural produce, it is suprising to find a utilization rate for agricultural land of only 44 percent. This situation appears to have several explanations. On the small farms, available family labor is a major constraint, and hired labor costs are high relative to the return in small hillside farm enterprises. On larger farms, there is apparently a preference for extensive production systems even on better soils, for instance, grazing on Class I and II land. This choice may also be based on cost and return calculations on farm labor or on the absence of improved technologies and trained management. The perceived opportunity cost of investment capital is also a probable cause. Whatever the reasons, shortage of land is not constraining higher levels of agricultural production in Jamaica.

Farmland ownership is skewed, but this fact has little to do with the productivity of hillside farms. Given current production practices, small farmers are limited in how much land they can farm with hand-tools and family labor. For example, if all the farmland in Jamaica were equally divided among all the farmers, other factors being equal, there is no evidence to suggest that either productivity per acre or total national production would rise. Improved technology and management are needed on both large and small farms, on the flatlands and the hillsides alike. The 5-acre and under category represents 74 percent of all farm units and accounts for 16 percent of the

country's total farmland, mostly in the hillsides. Given topography, production cannot be easily mechanized without first installing expensive bench terraces.

The overall trends in ownership and farm size indicate a declining number of total farms, a decline in the 5-acre and under category, an increase in the 5-25 acre category, constancy in 25-50 acre holdings, and a decline in the 50-acre and over group. Change in the latter category is attributed primarily to government programs, but the decline in small farms is consistent with the general decline in population from rural areas, particularly hillsides, owing to the low incomes that can be earned on small farms. The increase in the number of farms in the middle groups suggests a trend toward a more viable size of family farm units, not an unhealthy sign.

The small farmers in the hillside areas rely on off-farm income sources to a significant degree. As many as 20 percent of the hillside farmers, by some estimates, have very small (less than 0.5 acre) holdings and use them only for subsistence production. Over 50 percent of the small farmers on the hillsides report income from other sources that exceeds their farm income. Employment in the industrial, service, or public sectors and remittances from relatives contribute to household incomes. Outside employment opportunities represent important opportunity costs to a farmer considering intensifying farm production. Income from the ganja trade is also reported to contribute significantly to household income in certain areas.

While the majority of hillside farms are operated by their owners, most of them do not have a clear title. Many of these farms have been in a family for several generations, but application for title has never been made. In some cases ownership may be in dispute, or would be if title were sought. The inheritance law, which provides that all surviving offspring share equally in the estate, creates a situation where farms must be subdivided into uneconomic units, or alternatively, where the operator of the farm shares ownership with siblings or cousins. An application for a title may take several years and considerable expense to complete. A single challenge to a title application can tie it up in such expensive litigation that most farmers do not bother to pursue it.

Agricultural credit is in most cases given only to those farmers who can provide a clear title to their land as collateral. Loans can be obtained if a borrower can find someone with sufficient collateral, usually a land title, to co-sign a note as guarantor of repayment. This turns out to be impossible in most cases. While there are a number of channels for credit, both public and private, they are relatively ineffective for the small hillside farmer.

Production inputs, while available in the main market centers, do not reach the small farmers located farther away. The general shortage of foreign exchange has placed a constraint on importing farm supplies. Essential items are often not available when needed, even if farmers have the money to buy them.

The much maligned higgler marketing system receives a large share of the blame for the lack of development in hillside agriculture. While the system no doubt contains many inefficiencies, higglers still manage to move the produce from farmers to consumers, at costs that are much higher than those in other, comparable countries. The higglers provide an important economic service at a financial risk. They are often farmers or farmers' wives, and the income earned contributes significantly to household finances. Government programs in marketing have not succeeded in providing a viable alternative. The export crops, handled by the monopolistic boards, move to market fairly efficiently. It is with the domestic food crops that marketing problems emerge.

Existing System of Farming

Previous reports have adequately described crops, livestock, production practices, and all aspects of the erosion problem in Jamaica (including Henry, 1978; Posner & McPherson, 1981; Payne, 1976; Sheng et.al.; and IBRD Project Paper; DAI interim report). Instead, the following section discusses those important aspects that relate to the strategy discussion in later sections of this report.

The farming system throughout the hillside areas varies, but one important factor characterizes the island: lack of improved technology. Traditional practices apply for yams, vegetables, coffee, and bananas alike. Farmers use a diversified, minimal risk, low input system, which is not much different from that used 100 years ago. While this system works for subsistence purposes, it will not suffice for increasing production, raising

incomes, or expanding employment. In the absence of effective erosion control practices in most places, the most basic resource of agriculture is being depleted.

At lower elevations along the coast, permanent crops tend to dominate, including many types of fruit trees and pastures on shallow soils overlying limestone rock. Along higher ridges on deeper clay soils, yams and other annual crops predominate in rotation with relatively large areas of grass and brush fallow, minimally used for livestock grazing and replenishment of soil nutrients. The field cultivation pattern for annual crops tends to be vertical rather than horizontal on the slope as a result of the inheritance law. In the production of annual crops, soils remain largely unprotected from raindrop impact during the cropping cycle. Yam production in particular, with the dragging down of soil for mounds, leaves the soil overexposed.

The Smithfield Research Station has addressed this problem for many years. At Smithfield, erosion control practices using bench terraces, hillside ditches and individual hills or continuous mounds, individual basins with orchard terraces, and convertible terraces are evident. Results of interplanting one peanut crop or two red-pea crops during the early stages of yam development to help protect the soil and provide extra cash income appear particularly promising. The technologies used at Smithfield work well under the experimental station's close management. But adoption by farmers has been disappointing, for several reasons discussed in other parts of this report.

CONSTRAINTS AND ASSETS IN THE CONTEXT OF HILLSIDE DEVELOPMENT

Development of the hillsides poses a serious challenge to Jamaica's farmers, their government, and the donors. The natural resource base in the hillsides constrains economic productivity, and the complementary resources of financial and human capital are severely limited as well.

For this discussion, the resources available have classified into constraints and assets. While this classification is somewhat arbitrary, it is useful as an indicator of where development opportunities are most likely to be found. The constraints are ranked with respect to how tractable they are, that is, the degree to which they can be ameliorated or eventually removed by development programs and the actions of farmers and rural residents themselves. This ranking is shown in the following chart:

Constraints			
Intractable <==========> Tractable			
Slope	Accessibility Soils Rural age structure Govt. financial resources Effective demand	Rural labor supply Marketing system	Credit system Tenure system Availability of technologies

Constraints

- **Slope**

  Relatively little of the cultivable land in Jamaica lies within slope classifications permitting it to be culivated without significant efforts to control erosion.

Yet Jamaica's small size makes it impossible to leave these lands unused, despite the difficulty of achieving high production without endangering the resource base. Mechanization is limited without bench terracing.

- Soils

The majority of the soils are shallow, highly erodable, and low in essential plant nutrients. The country's poor soil endowment not only makes it necessary to undertake substantial investments in erosion control and fertilization, but also limits the productivity of much of the agricultural land, even with good management.

- Accessibility

As a result of Jamaica's mountainous terrain, much of the land area requires a high-cost investment in roads and other infrastructure to link the hillsides effectively with the national economy. While Jamaica has an excellent road network, many farms still are not reached by roads that would permit farmers to transport their goods to market and purchase necessary inputs quickly and efficiently.

- Rural Age Structure

The continued outmigration of young adults in search of employment and a better life in Kingston and overseas has resulted in an imbalanced rural age structure, with a high dependency ratio, an average head of household age of 55, and comparatively few farmers in the prime years for work and investment (20-45 years old).

- Government Financial Resources

Given the current strictures on government expenditure in Jamaica, it is not realistic to expect substantially increased expenditures for hillside development (such as a doubling of personnel in the extension service or a nationwide program of terrace construction). Expenditure-related weaknesses in the public sector operation (notably the inability to compete with the private sector for highly qualified staff) are likely to continue in the medium term at least.

- Market for High-Value Fresh Produce

Jamaica's domestic market is limited by the country's small population and low per capita income. There is substantial (but not unlimited) scope for expansion in the supply of fresh produce to hotels. Although the possibilities for expanding fresh produce exports to supply North American and European winter markets are encouraging, the high cost structure of Jamaican

agriculture and the intense competition for these markets constrain Jamaica's ability to sell produce in these markets.

- Rural Labor Supply

Despite the unfavorable age structure of the hillside population, there is some scope for expanding the agricultural supply in response to profitable opportunities in the sector, in view of the high proportion of rural labor devoted to off-farm employment. In general, however, labor is arguably the key constraint in hillside agriculture; the scarcity of on-farm labor and the relative high cost of hired labor limit farmers' willingness to employ labor-using erosion control practices or to intensify operations through planting of tree crops and permanent pastures on fallow lands.

- Marketing System

In the higgler network, Jamaica has the elements of an efficient and effective marketing system. To realize this potential, however, considerable inputs will be necessary in the areas of management, organization, infrastructure, and standardization.

- Credit System

The reorganization of the agricultural credit banks promises to strengthen this critical system considerably. At the same time, the system as currently structured will not meet the needs of the small farmers, particularly in the area of medium- and long-term credit. Most government farm credit programs have fostered a prevailing attitude among farmers that government loans are really grants.

- Tenure

The development of the hillsides, and of the agricultural sector as a whole, is constrained by the lack of secure legal title for most small parcels of land and the mismatch between the structure of farm sizes and the optimal intensity of the use of land with respect to its capability.

- Availability of Technologies

At present, effective and economically profitable technologies for the sustainable cultivation of hillside soils do not exist for Jamaica. While considerable work has been done on the export tree crops and on pasture crops (primarily for lowland conditions in the latter case), very little effort has been made to find technologies that will improve the small farmer's operation under the difficult hillside conditions. As a result, the large

and well-developed extension system does not offer the information the farmers need to raise their productivity and incomes without further damaging the hillside resource base.

Assets

An evaluation of prospects for the hillsides reveals several opportunities for development, as well as several areas of strength where existing resources could be tapped with greater effectiveness than at present. These assets suggest some of the areas where the strategy should place more emphasis, in order to capitalize on resources and capabilities available. The study team considers the following to be the major assets that should be counted in designing a revised strategy for the hillsides:

- Physical Resources

  Climate (year-round growing season, adequate rainfall in many areas, variety of crops that can be produced), and underutilized lands, in the lowlands and the uplands alike.

- Human Resources

  Skilled and committed personnel at all levels of the institutional structure serving agriculture, a core of well-educated and skilled farmers oriented toward the market, and increasing interest in agriculture among the urban entrepreneurial group.

- Financial Resources

  The revitalized Agricultural Credit Bank/People's Credit Bank system; underutilized private investment resources, including those of the farmers themselves; and continuing readiness of the donors to finance worthwhile projects, particularly in the areas of small farmer development and environmental management.

- Institutional Resources

  A well-organized marketing structure for many export crops, with potential for expansion to other crops; a sound organizational structure in the Ministry of Agriculture, with appropriate strengthening programs (for example, training-visiting-monitoring method and

regionalization) under way; institutional capacity in the commodity bourds, the Jamaican Agricultural Society, and other ancillary organizations in the agricultural sector; and a well-developed road network, port facilities, and air and sea transport system for export markets.

- Market Resoures

  Strong (but highly competitive) North American markets for products that can be grown and processed in Jamaica; and growing (but limited) domestic markets for high-value produce, including both the tourist trade and the urban market.

MAJOR TRENDS AND THEIR IMPLICATIONS FOR HILLSIDE DEVELOPMENT

Agricultural Production Trends

Traditional food crops -- yams, beans, and vegetables -- continue to be grown on the hillsides as they have been for decades. There is a significant trend toward increased vegetable production. Cropping patterns tend to fluctuate with price changes directly related to the quantity of imports in a given season. Export crop production -- including coffee, cocoa, bananas, and pimento -- is in a slow growth pattern resulting from the lack of investment capital and of confidence in the markets. Weakness in the sugar industry will eventually bring about a shift to production of other crops on the traditional sugar lands. Food crops will be produced with modern technologies, irrigation, mechanization, fertilizers, and improved varieties on the better soils at much lower per unit costs than small farmers can produce them on the hillsides. The domestic food markets and certain export markets will be captured by the farms on the coastal plains. Hillside production of traditional food crops will decline to a subsistence level, and

hillside farmers will be forced to change their cash crops to those that give them a competitive advantage, such as crops that do not do well on the coastal plains.

Social Trends

The current trend of declining population in the hillside areas will continue as soils continue to erode and become unproductive, as food crop production shifts to the plains. The age profile will continue to shift to the older age brackets. The trend toward more medium-size farms will continue as the better farmers employ improved technologies on crops suitable to the hillsides. Jamaica will continue to urbanize, and the hillsides will become areas for extensive agriculture (grazing, tree crops, and forestry), recreation, and retirement residences.

Soil and Water Conservation Trends

The geomorphology of Jamaica's upland areas is characteristic of high natural or geologic erosion. This erosion is a natural consequence of the region's geology, climate, and soils, and forms the base rate on which the effects of man's occupation of the island have been superimposed. There is little that man can do to reduce it; it is in the nature of mountains to produce the soil elements that are then carried downhill to form the soils in the valleys below. It is worth noting, therefore, what this geologic rate might be. De Graaff in Table 26 shows erosion rates for various cover conditions and slopes. For Bushland Forest on Slope Categories 4,5, and 6 (which account for most of the upland area and erosion), when converted from inches to tons per acre (tpa) per acre-inch, the rates range from 12 tpa to 18 tpa. While this is the only estimate available, it is consistent

with the ASCE Manual 54, Sedimentation Engineering and the work of the Soil Conservation Unit. Thus the base-line geologic erosion rate in the upland areas is about 15 tpa per year.

In addition to this natural erosion, farming and forestry activities on the hillsides have increased average basin-wide erosion rates to about 50 tpa. Accelerated erosion on smaller areas within a catchment commonly reaches two to three times this rate. In time of topsoil losses, this average rate translates to about 0.33 inch per year, while the natural soil regeneration rate is about 0.03 inch per year. Clearly if this great imbalance continues unchecked, the hillsides of Jamaica will be denuded of topsoil in just a few decades.

De Graaff, in Tables 28, 29, and 30, shows basin-wide rates ranging from 40 to 60 tpa for the Hope River, Upper Yallahs, and Lower Yallahs/Cane River/Bull Bay catchments.

Current production trends will cause erosion rates to continue, but as lowland farms force the hillside farmers out of annual crop production, erosion will decline. Rivers and reservoirs will continue to be heavily silted for the foreseeable future, making the construction of irrigation systems infeasible.

CHAPTER THREE

THE CURRENT STRATEGY

POLICIES AND STRATEGY

Policies

Jamaican government policies with regard to hillside agricultural development are not stated in a particular place. A considerable body of general development policy exists that applies to hillside agriculture and soil conservation. The government is committed to supporting small farmers with rural infrastructure, agricultural extension and credit, and health and education programs. Protection of the watershed and reduction of siltation in the waterways are policy objectives of major importance. Although the approach of the government to the agricultural sector is based on a free enterprise system, it does own a considerable amount of farmland and a number of agro-industrial firms, very few of which operate at a profit. The current administration has implemented a policy of divestiture of commercial enterprises, but so far the policy has not been broadly implemented.

The government has attempted at various times to protect domestic producers with import restrictions on agricultural products and tariffs. At present, however, the policy is to encourage free trade as much as possible. Foreign exchange control policies have limited the import of fertilizer and other agricultural inputs in the past, but that is apparently not the case under current guidelines.

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Increasing agricultural exports is a major policy direction that has broad ramifications for small farmers. Foreign investment in export agricultural enterprises is being strongly supported by the government.

Strategies

There is no stated strategy for hillside development. There are a number of sub-strategies for various components, which in the aggregate amount to a de facto strategy. The overall strategy has two parts: ongoing government programs and donor-supported projects. The Ministry of Agriculture's strategy for the hillsides includes an effort to improve technology through research and extension. It also involves soil conservation efforts that emphasize the construction of on-farm structures with subsidies to farmers and supervision by ministry staff.

Off-farm soil conservation strategy, carried out primarily by the Natural Resources Conservation Department (NRCD) of the Ministry of Mines and Natural Resources, focuses on structural works on the major waterways in watersheds with high erosion rates. Both public and private lands with extreme slopes are targeted for forestry.

Much of the investment in hillside development occurs in the donor-supported projects, including the integrated rural development projects and various technical assistance projects in the subsectors.

The principal export crops for hillside farmers -- bananas, coffee, cacao, citrus, and pimento -- are managed by autonomous marketing boards. The programs of these boards vary with respect to promoting and supporting production by small hillside farmers,

but none of them has aggressive expansion programs. While the government strategy is to promote exports on the one hand, and to increase small farmer productivity on the other, the operational strategies of those organizations that deal with small farmer export crops do not appear to reflect a high priority. The land title problem and the lack of capital for investment in export crops are no doubt important constraints, but the boards are not developing and teaching the technologies and management practices that would increase the productivity of small farmers and provide more attractive incentives to expand.

PROGRAMS AND PROJECTS

Research and Extension

An expanding agricultural sector requires a dynamic and scientifically advanced research and extension program as the driving force behind increased production and profitability of the farm enterprise. Indeed, numerous studies demonstrate the high rate of return to investment in agricultural research and extension in both developed and less developed countries (including Schuh, Grilliches, and Ruttan). In addition to generating new technology, a strong cadre of agricultural professionals can provide the government with important policy advice on a broad range of agriculture-related issues.

In Jamaica, the Research and Development Department of the Ministry of Agriculture has the primary role in mounting agricultural research. The department is composed of several divisions: crops and soils, livestock, and plant protection, each led by a

principal research officer. Research personnel at the Bachelor of Science level or above numbered 35 in 1982, down from 56 four years earlier.

Research trials are conducted at numerous stations and sites throughout the country. Results are published in an annual publication, Investigations, which is then used by extension personnel for formulating recommendations. In fact, very little research data are available for crops grown in the hillside areas of Jamaica.

Several of the commodity boards, including sugar, banana, and coconut, maintain their own research programs. Furthermore, the ministry collaborates with several international organizations in agricultural research, including the Caribbean Agricultural Research Development Institute and the Institute for International Cooperation in Agriculture.

The Production and Extension Department of the ministry is responsible for training farmers and administering a wide array of development programs, such as subsidies and credit, and a farm housing scheme. The department is organized into four levels -- national, regional, parish, and district -- and maintains about 400 area extension officers at the district level. The service is currently introducing the training-visiting-monitoring (TVM) method, which organizes farmers into groups around a contact farmer and establishes field demonstrations. Several of the commodity boards also maintain their own extension services.

The Ministry of Agriculture is currently decentralizing its research structure and plans to establish a research station in each region. This change should facilitate interaction between

research and extension personnel at the regional level. The linkage has been further strengthened by the creation of a new position, development officer (DO). The DOs assist in planning research projects and transferring new technologies to farmers. Commodity research committees are also being established to plan research programs. The committees are composed of representatives of research, extension, the farm community, and other organizations involved in agricultural development.

Watershed Management

There are six separate programs in as many agencies working on watershed management. There is no central coordination or planning of watershed management programs, and no overall watershed management strategy. Instead, watershed management involves activities in areas such as forestry, stream channeling, and structural works. The Ministry of Agriculture's principal effort in the last 15 years has been to promote bench terracing, hillside ditches, and the other techniques developed at the Smithfield Research Station. The IRDP projects have been the main vehicle for implementing these technologies. This approach has had very little success in arresting erosion.

Tenure and Other Rural Institutions

Jamaican agricultural policy has long recognized the undesirability of a situation where a large portion of the better lands are held in a limited number of underexploited holdings, while the vast majority of farmers work small holdings precariously situated on the steep and unproductive hillsides. This situation limits agricultural production, since the most

intensively cultivated lands are precisely those that are least productive and least tolerant of intensive cultural practices. Moreover, it promotes socioeconomic inequality and fuels political unrest.

Tenure

Since 1895, the government has pursued programs and projects designed to break up the most underutilized of the large holdings and settle small farmers on these lands. It is estimated that between 1929 and 1971, 174,000 acres redistributed to 39,400 farmers (IICA, Land Settlement in Jamaica, 1977). Since 1971 additional land has been redistributed under Land Lease and other programs. These programs have varied with the government in power and with increasing experience in the implementation of land settlement. The most recent such shift is a return to the emphasis on freehold rather than leasehold as the basic pattern of tenure in the land settlement areas.

The land settlement program has constituted the government's main vehicle for redressing the imbalanced tenure situation. It has recently been buttressed by the Idle Lands Act. This act empowers the government to survey holdings over 50 acres, identify underutilized lands, and if the owner does not agree to develop them, certify these lands as idle and purchase them for distribution. Relatively few properties have actually been acquired under this authority, since owners of usable properties rarely allow the process to reach the point of certification. The degree to which the program has actually led to significantly increased utilization of land on the larger holdings is unknown,

but many of the larger holdings continue to be exploited as extensive cattle ranches or in other comparatively low-intensity patterns of land use.

Despite nearly a century of land settlement programs, the distribution of land in Jamaica remains highly unequal. Of the 150,000 farms, about 14,000 landowners (9 percent) hold 69.3 percent of the farmland, while 111,000 farmers (73.8 percent) hold only 15.5 percent of the land in holdings of less than 5 acres. If one excludes the 40,000 who hold less than 1 acre (many of large kitchen gardens and rely almost exclusively on off-farm income), farmers in the 1-5 acre class constitute 14.3 percent of the total farmers but hold only 14.3 percent of the land.

Although few data are available, there is widespread agreement that most farmers (and perhaps as many as 80 percent of the small farmers with holdings under 10 acres) do not have clear legal title to their land. The vast majority of these untitled farmers own their land (or hold shares in family land), rather than renting it or squatting illegally. At present there is no program to assist these individuals to gain title and thus access to credit and a broader market should they wish to sell, although all farmers are eligible to apply to register their land under the Facilities for Title Act. For farmers operating family land, this requires the cooperation of all co-heirs. Even for those owning the land as individuals, the process can be very costly and take months (if not years) to complete. The Peoples

Cooperative Banks (PCB) will provide limited assistance to farmers wishing to secure their title in order to use the land as collateral for a PCB loan.

Landless labor is a major factor in the lowlands (especially in areas adjoining the sugar estates), but is not significant in the hillsides. Rental of lands is common in the hillsides, but most farmers own their land, and those who do rent appear to rent primarily from other small farmers at reasonable rates.

Credit

The government's agricultural development programs take cognizance of the major role of credit in enabling farmers to increase their production and incomes. Agricultural credit programs have generally been channeled through a government-financed bank that provided subsidized (below-market interest) loans to farmers, either directly or through the extensive network of PCBs.

Little regulation has been directed at the commercial banks, which generally make funds available only to the larger farmers at commercial terms. The informal credit market, which constitutes an important source of capital for small farmers, has not been touched by governmental policy. One estimate of the role of such interpersonal lending (Ohio State University, 1980) suggests that informal credit reaches three times as many farmers as formal credit, although formal credit constitutes the majority of the total loan value. The informal system appears to operate smoothly in providing short-term credit in comparatively small amounts. Very little of this loan activity is tied to marketing

arrangements, and most of it at no interest or at very low interest rates, indicating that exploitation of the borrower by the lender is not likely to be a serious problem in Jamaica.

Following the failure of the main agricultural bank in 1981, the government reorganized the bank as the Agricultural Credit Bank (ACB), with the assistance of the Inter-American Development Bank (IDB), and the International Fund for Agricultural Development. Under the reorganized structure, management of the PCBs will be more closely monitored, loans will be made at a significantly higher (but still below market) rate, and collateral requirements will again be tightened up. Credit will be available up to five years.

Marketing and Other Institutions

Prior to the current government, the main initiative in the marketing area was through the government-owned Agricultural Marketing Corporation (AMC). The experience of the AMC was typical of marketing boards in the Caribbean, that is, it handled a very small portion of the produce marketed (less than 5 percent), and generally operated in the red. The commodity boards continued to play the central role they had played prior to independence in the marketing of major export commodities. Their operations, while not without fault, have generally been effective in bringing crops to market (with the noteworthy exception of small farmer bananas).

At present, the main programs center around the buildup of private sector marketing activities through reconstruction of parish markets and establishment of central grading and packing

facilities. Both activities receive support from a range of donors, including the World Bank, IDB, and AID.

Input supply channels are primarily in the private sector, with the Jamaican Agricultural Society stores and small itinerant traders supplementing the activities of a limited number of large scale distributors. The system works comparatively well, although periodic shortages occur, tied to foreign exchange restrictions, and small farmers in remote areas must pay relatively high prices for bulky inputs such as fertilizer. At this time, there are no major government programs in this area.

CRITIQUE OF THE CURRENT STRATEGY

Research and Extension

The agricultural research and extension services in Jamaica have achieved some notable successes in contributing to the development of the island's agriculture (University of Kentucky, 1979). However, these advances have been most relevant for larger farmers and those in lowland areas. Several important obstacles limit the effectiveness of Jamaica's agricultural research and extension network, particularly with regard to developing hillside areas.

Inadequate Governmental Support of Agricultural Research

There appears to be little understanding within the ministry of the crucial role that research plays in contributing to agricultural development. Many staff consider extension to be the weak link and maintain that sufficient research has already been conducted. However, these critics fail to realize the importance of a sustained research effort, and the fact that

investment in research is necessary now to generate new technologies 5 or 10 years in the future. They also fail to realize that some of the problems of extension are due to inadequate emphasis on research: "Extension presupposes the knowledge to extend....Research [on yams] has failed to provide the essential knowledge in a manner in which it can be utilized or transformed into such action that would be reflected in increased productivity" (Paine, 1976). The result is a downward spiral, a self-fulfilling prophecy of failure. Research is accorded low priority, thus researchers are unable to perform effectively. As a result, research is accorded even lower priority.

An important factor inhibiting researchers' effectiveness is the low salaries paid to personnel. Moreover, they lack adequate support not only for maintaining current station experiments, but also for initiating new experiments on or off-station. Principal problems include lack of transport, spare parts, and funds for hiring casual laborers and purchasing inputs. As a result, researchers become frustrated and leave the ministry at a rapid pace, practically paralyzing the research program nationwide. For example, the chief station for the hillsides, Orange River, has only one resident researcher, whose time is spent mostly on administrative duties.

Inappropriate Research Perspective for Approaching Hillsides Problems

The current structure and perspective of research make it difficult for researchers to focus on addressing the problems of small hillside farmers.

First, research tends to be top-down and prescriptive. Maximizing yield or minimizing soil erosion are often the objectives of experiments, without any regard for the priorities of small farmers. For example, the researchers' attitude that cocoa research must be carried out only on monocropped cocoa neglects the fact that nearly all small farmers intercrop their cocoa. Whereas the cocoa researcher is interested in maximizing cocoa production, the small farmer has other objectives; he manages a system of several enterprises and may find that the value of the intercrop more than compensates for its negative effect on cocoa yield. Instead, a researcher can profitably begin by developing an understanding of the small farmers' circumstances and priorities. The researcher then proposes changes that will increase productivity, and at the same time be acceptable and feasible to clients.

Second, researchers operating on stations are often physically removed from extension agents and their hillside clients. There is minimal interaction between farmers, extension agents, and researchers, and consequently low probability that the conditions under which experiments are mounted are similar to those farmers face.

Third, research focuses on a single enterprise or discipline, lacking the perspectives of the other disciplines on the complex nature of farmer problems.

Lack of Crucial Support Services for Research: Biometrics and Economics

Biometricians have not been available to review the design of experiments; thus many have been set up in an improper manner, yielding ambiguous and unreliable results. Furthermore, there is no economic analysis or interpretation of experimental results. As a result, recommendations are generally based on maximizing yield or minimizing soil erosion rather than on an economic criterion more relevant to the farmer.

Inadequate Priorities for Research

The current system of establishing research priorities is not working as effectively as it should. The research commodity committees include researchers, extension agents, farmers, and other participants in the agricultural sector. However, in the cases examined for this report, the priorities they established were long shopping lists of experiments. Researchers are generally free to select from these long lists those few projects that they think best. The projects may or may not address the problems most critical to farmers.

There is a serious underemphasis on soil management and a shortage of data on crop production on the diverse soils of the island. Moreover, there appears to be a serious overemphasis on varietal research in the crops-soils division; about 80 percent of the research carried out in this division involves such research. Some of this work is essential, such as the sweet potato variety trial at Orange River that aims at identifying and establishing the principal characteristics of Jamaica's most important sweet potato varieties.

Extension Service Distracted from Educational Role

A large percentage of the extension agent's time and effort is devoted to an array of development tasks, many of which are essentially unrelated to his primary function of advising farmers. These tasks include administering land preparation and planting material subsidies, supervising both housing and water tank construction programs, and administering credit programs.

The broadness of this extension role causes two problems. First, subsidiary tasks seem to take precedence over what should be the extension service's primary role, that of training farmers. As a result, administering government programs becomes the extension agent's principal role, and only residual time is allocated to farmer training. Second, many of the extension agent's activities actually conflict with his training duties and thus limit his effectiveness as a trainer. For example, involvement in credit disbursement and repayment causes insurmountable friction between the agent and the farmers. Furthermore, when extension agents assume responsibility for the allocation of subsidies, farmers respond only to extension programs that offer subsidies. For example, in some areas the extension service is unable to form farmer groups to implement TVM because of the farmers' refusal to act without subsidies.

Poor Linkage Between Research and Extension

Working relationships between research and extension are fragmentary and ad hoc. The crop and livestock DOs are suppossed to foster links between research and extension, but they appear to receive little guidance on their exact role and functions. For example, some officials perceive the DOs' role as primarily

one way, to provide extension agents with research results. Others assert that the DOs should also advise researchers on research planning. However, it is not clear how this second function would be undertaken. Extension aspects do not receive the benefits of research through regular training.

Watershed Management

Over the past three decades numerous attempts have been made to reduce hillside erosion caused by cultivation on small farms. These have occasionally met with limited success, for example, the Upper Yallahs Valley where many farmers have adopted erosion control practices. But more often than not results have been disappointing, and in some recent instances, such as IRDP-II, they have failed to be accepted. Some of the major reasons for these disappointing results are considered below.

Concentration on Structural Treatments

Although laudable as an erosion control measure, the terracing system promoted by the Soil Conservation Unit has been too complex, costly, and unacceptable to small farmers to be applicable to Jamaican hillside farming. It has been applied with single-minded vigor to the near exclusion of simpler vegetative methods; the cost-effectiveness of simpler methods appears to have been underestimated. For example, in hand-out materials from the Smithfield station (the experimentation runoff and soil loss for yellow yams and bananas), it is evident that in the case of yellow yams hillside ditches reduce soil losses by 70 percent; bench terraces reduce losses by only another 16 percent, but at a fivefold increase in cost. A grass cover for bananas

reduces soil loss by 83 percent, while terraces reduce loss only another 11 percent at a cost increment that would be in excess of five times, since the grass cover requires no structural treatment. The push for the terracing system was in part an attempt to reach a target erosion rate of 10 tpa; this appears to be unrealistic against a base-line or geologic rate of 15 tpa. With erosion on hillside agricultural areas averaging 50 tpa, it would seem better to opt for a simpler, attainable system that would halve the rate than for an unattainable system.

Fragmentation of Effort

There are six major agencies and several committees involved in the soil and water conservation effort on hillside watersheds. As a result, coordination is difficult and often results in fragmentation of effort. While the middle and lower levels of these agencies make every effort to cooperate in implementation with other agencies, they are severely hampered by a lack of policy directives within and between agencies and ministries.

Lack of Continuity

Conservation work takes time. Significant improvement on a large scale takes decades. Against this time requirement, the frequent reshuffling of programs and responsibilities and the reforming of agencies constrain the development of a long-term policy that will be pursued through implementation. The negative effects of this lack of continuity over the past two decades are becoming increasingly evident on the hillsides.

Lack of Trained and Equipped Extensionists

Every agency involved in hillside soil and water conservation is severly hampered by a lack of trained extensionists at the professional level. The knowledge and facilities to train professional conservationists exist in the front-line agencies, but the positions and funding for them do not. Once trained, an extensionist is not much use unless he can travel around his district to impart his knowledge and skills to his constituents. Those few extensionists who are on staff at present are severely limited in their effectiveness by a lack of transportation and even the simple tools and equipment they need to do their jobs.

Non-involvement of Farmers

Many of the conservation practices implemented on the hillsides have been planned and executed in a top-down manner without consideration of the hillside farmer's needs, capabilities, and motivations. The result has been failures such as those at IRDP-II, which have already been described in the Interim Report, and which continue to be demonstrated when farmers tear down the terrace risers so they can plant on them.

Planning, Organization, and Management

The organizational fragmentation of hillside development and watershed management contributes to a lack of focus on the critical issues. In the absence of an overall strategy that relates agricultural development to soil conservation, each of the various units operates independently. These efforts may or may not be mutually supportive in a given case, but these organizations do not have the same priorities, and the national

interest would be better served by closer coordination. This does not necessarily argue for a single organization, but it does at least suggest that in a resource-scarce situation there should be a clear set of priorities and a system of implementing projects that efficiently utilizes the resources of all the organizations.

CHAPTER FOUR

A PROPOSED STRATEGY

OBJECTIVES

Development of hillside agriculture serves the same objectives as development of Jamaican agriculture generally. These objectives may be summarized as follows:

- Increase the income of rural residents;
- Conserve and strengthen the productive resource base, including Jamaica's scarce soil and water resources;
- Improve the diet of the population;
- Increase economic production;
- Provide greater opportunities for productive employment;
- Increase the supply of food to urban residents while holding down the cost;
- Increase foreign exchange earnings through growth of exports; and
- Decrease foreign exchange expenditures through displacement of currently imported agricultural products.

While there is no explicit contradiction in attempting to meet all of these objectives at one time, the reality of scarce governmental and other resources forces agricultural planners to make at least implicit choices among these goals. For obvious political and practical reasons, the Jamaican government has preferred not to make these choices explicit, emphasizing complementarities rather than conflicts. In recent years, the growing concern over foreign exchange shortages and the deterioration of the resource base has led to a perceptible

increase in attention to the second and seventh items on the list, but there has not been a corresponding decrease in emphasis on the growth of rural income, employment, or total production.

Given that the tradeoffs among these necessarily competing goals remain implicit in the strategy for development of the agricultural sector as a whole, an explicit weighting of these various objectives cannot be drawn upon to guide development of a hillside strategy. Thus the assumption has been made that the strategy must address all of these objectives, leaving the relative weight to be attached to each as an issue for implementation.

Nonetheless, the first two objectives -- increased rural incomes and resource conservation -- are preconditions to achieving the other objectives. It is the farmers who will implement the hillside development strategy, not the government. They will increase their production of food and export crops in response to opportunities for expanded personal income, not to meet the government's macroeconomic and political goals. Strategies that do not increase their income will not work.

At the same time, the farmers cannot achieve lasting increases in income, production, and efficiency if the essential soil and water resources upon which they depend are destroyed in the process. For growth to be sustainable, short-term gains in production and income must not be realized at the cost of permanent damage to Jamaica's limited resource base.

STRUCTURAL CHARACTERISTICS OF A HILLSIDE STRATEGY

The critique of the current strategy for hillside development identified several structural weaknesses in the current strategy that have reduced the effectiveness of the strategy in reaching its goals. The strategy outlined below has been developed with a view toward overcoming these limitations. Its main features are summarized below.

- Long-Term in Orientation

  Although practical necessities require short-term results, the sound development of Jamaica's fragile hillsides requires continuous attention to the long-term implications of current activities, and a balance between actions designed to generate immediate increases in production and income and those that will lead to greater gains, but over a longer period.

- High Return

  Scarce investment resources must be focused where they will be most productive. They should neither be spread across too large an area (in response to political pressure, for example) so that they have little impact on high-priority areas, nor overconcentrated so that the return does not justify the investment per acre or farm family.

- Bottom-Up

  Programs must be designed and implemented with the needs of the farmers in mind. This can be achieved only if the farmers are actively involved in deciding what should be done in their area and in actually carrying it out.

- Integrated

  The strategy must consist of an internally consistent and coherent set of programs, rather than an aggregation of discrete and independent projects.

- Jamaican-Led

  The government must take the lead in defining its programs together with the rural residents, breaking the pattern of overreliance on donor-led design.

- Flexible

  The strategy must permit adjustment to changing circumstances and opportunities within both the Jamaican and the world economies.

- Responsive to Diversity

  The strategy must recognize and respond to the high degree of diversity existing in Jamaica's hillside agriculture. Programs and projects appropriate for one area may be ineffective and even damaging in areas with a different resource base and economy.

These characteristics are important indicators for development of an improved hillside strategy, but alone they do not provide sufficient guidance to complete the process of designing a workable approach. The criteria listed above are too general to develop alternative strategies for evaluation. Therefore, three additional criteria are proposed.

- The strategy must merit the support of the hillside farmers.

  The hillside farmers are the front-line managers of the hillside agricultural resource base, and their decisions will be made primarily on the basis of what benefits them in the short run, rather on what serves the long-term interest of the national economy, environmental goals, or social objectives.

- The strategy must reduce damage to the soil and water resources below that created by the current use pattern.

  In addition, it must not raise the cost to the government significantly above current levels, and the investments necessary must be economically justifiable for both the farmer and the national economy.

- The strategy must raise total agricultural production and do so without reducing the production of annual food crops.

  This criterion assumes that more intensive production systems (generating increased production per unit of area through greater use of labor and other inputs) can be found that are technically feasible, environmentally sustainable, and economically attractive to the Jamaican

farmers, particularly those in the hillsides. Significant expansion of the agricultural area is not possible.

Each of these criteria deserves some comment before alternative scenarios and the actions necessary to implement them are considered.

Farmer-Based Resource Management

The farmers make the key management decisions on which erosion control measures, if any, are to be taken on the agricultural land. They are also important as secondary decision makers in the management of the non-farm lands (the upland forest areas, streams, rivers, and roadways), and their actions can effectively undo the corrective measures taken by the government.

In the past, government programs have recognized the farmers' role as suppliers of labor for on- and off-farm land management activities, but have not given sufficient consideration to their role as decision makers. Reliance has been placed on immediate monetary incentives (wages and subsidies) to gain the farmers' cooperation. Such cooperation has been as short lived and sporadic as the payments to the farmers, however, and does not provide the basis for lasting progress.

The damaging effect of ignoring the farmers' managerial role goes beyond the failure of the individual programs (although this is certainly a major problem). The subsidy orientation has permitted the government to leave the farmers' goals and orientation out of the analysis, since their participation has been ensured by direct payment. As a result, too little

attention has been given to developing technologies that are profitable for the farmers in the short term and that fit within their resource availability.

The emphasis on payment to individual farmers, rather than on measures that the farmers are ready and willing to finance themselves, has also meant that the average budgetary cost per acre has been high. This has severely limited the area treated. Government resources would stretch further if they were reserved for off-farm expenditures such as control structures on streams and rivers, reforestation of public lands, and appropriate training of farmers in on-farm technologies.

Low-Cost Erosion Control Measures

The emphasis on highly effective but costly measures such as bench terraces has been identified as a serious failing of the current strategy. The revised hillside strategy must offer a viable alternative to this approach. Such an alternative is likely to consist of two types of technologies, employed in tandem:

- On-farm measures. In view of the need to keep these measures within the means of most farmers, on-farm measures would be primarily restricted to agronomic or vegetative control practices (such as contour ditches and grass strips), except in the most productive areas with high-value crops, where higher investments could be justified.

- Off-farm measures. Physical control structures are necessary where the danger of erosion is high. Since these structures are by their nature relatively high cost, their application should be limited to priority areas. The remainder of the areas should be treated with lower-cost measures, such as reforestation.

Intensification versus Extensification of Jamaican Agriculture

On strictly environmental grounds, most Jamaican lands should not be used for agricultural purposes at all. In the future, it may be feasible to limit agriculture to the most productive lands along the coast, financing the inevitable food deficit by expanded industrial exports, tourism, and other earnings, and leaving the hillsides in natural vegegation, extensive pastureland, or tree crops.

This choice is not feasible at the present time, however. Jamaica cannot afford to reduce its agricultural production, nor is there sufficient alternative employment for the small farmers. On the contrary, the current policy calls for increasing agricultural production in both the food crop and the export crop areas. The farmers themselves will naturally find little attraction in shifting to systems of agriculture that benefit the land at the expense of their families' welfare.

The choice is not simple, however. Since Jamaica has very little new land not now classified as farmlands (other than the swamps) that could be converted to agriculture, increasing production means increasing the level of productivity on existing farmlands through improved technology and management. The task of intensifying Jamaican agriculture without accelerating the damage to the resource base is complicated by three issues discussed below.

Intensity and the Jamaican Land Base

Two problems must be overcome to optimize the intensity of agriculture in Jamaica:

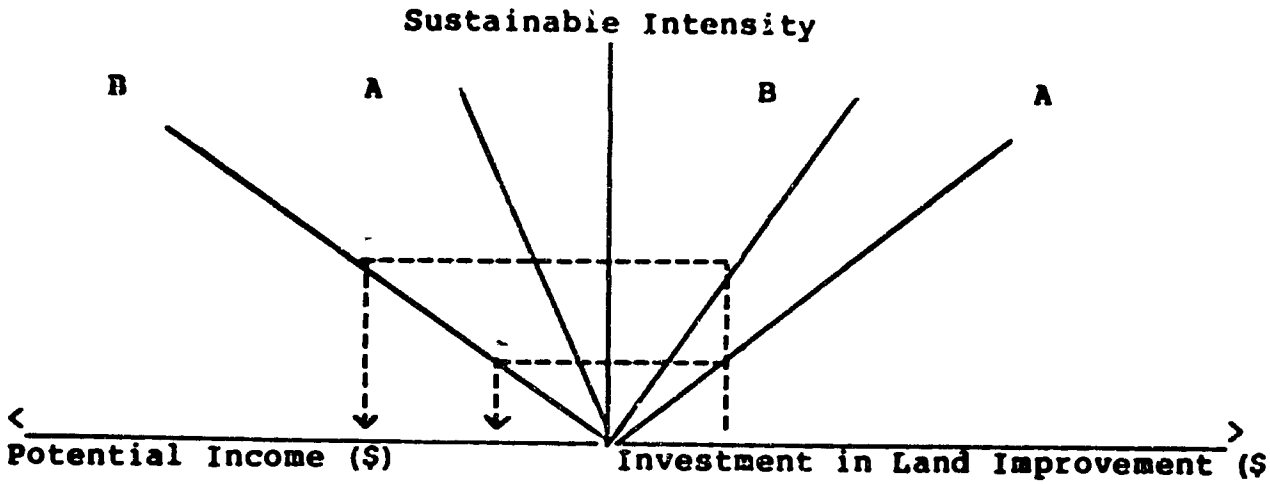
- The most productive lands, those most suited to intensification, are currently held primarily in larger holdings in the lowland or rolling areas.
- The small farmer lands (the hillsides) are comparatively unproductive lands because of their slope, soil type, and distance from markets. On the one hand, high-value annual crops cannot be grown safely without considerable investment in erosion control; on the other hand, they are not sufficiently profitable or productive in most cases to make large investments worthwhile.

In other words, Jamaica has its farmers in the wrong places, relative to where they should be to maximize production. The small farmers should, in theory, be on the most productive land, while the relatively unproductive areas should be in large holdings devoted to extensive cultivation, fruit trees, grazing, and forestry. Unfortunately, this situation is unlikely to come about without heavy enviromental, economic, and social costs.

The following graph illustrates this problem. It shows two farms, A and B. In both cases, the farmer can increase the sustainable level of intensity (on the vertical axis) by increasing his investment in the land (shown on the right-hand axis). As the intensity of cultivation is increased, the income-earning potential (shown on the left-hand axis) also increases. Farm A is on poor land that requires considerable investment to sustain intensive cultivation. At the same time, the same level of intensity (measured by the total value of inputs per unit of land) results in lower income, because the land is simply not very productive. Farm B requires a lower investment to reach a higher level of intensity and, at this level, can produce more

income than farm A. Under these circumstances, it is clear that farmer B has a higher incentive to invest in his land, even though it is farmer A whose land most needs protection.

Sustainable Intensity, Investment in Land, and Potential Income



Resource Availability

A second issue related to intensification of agriculture in the hillsides is that of resource availability at the farm level. To reach the higher levels of production that are necessary to increase income without irreparably damaging their land, the small farmers must increase their level of inputs. Opportunities for increasing output without increasing inputs undoubtedly exist, but experience in other countries suggest that these are rare. Two basic factors in this category limit the growth of production.

- Labor. In view of the relatively older age structure of the rural labor force, many farmers may not be willing or able to increase the labor input into their farms, even to gain higher incomes. This is demonstrated indirectly by the fact that large areas are currently fallow even on relatively small farms. Many small landholders are fully or partially employed off-farm and use the farm as security, residence, and subsistence garden.

- Capital and other inputs. Small farmers do not have sufficient access to the technological information credit, material inputs, and marketing services that they need to expand their production.

Annual Crops versus Permanent Crops

One approach to reducing the intensity of cultivation on fragile lands to a sustainable level is to equalize the current intensity on these lands. In other words, lands now in "demanding" annual crops and lands now fallow would both be shifted to "less demanding" permanent crops. This would spread the labor and other farm inputs across the entire farm.

This transition, while theoretically desirable, raises several problems at the farm level:

- Total income. The more scarce resource for many of Jamaica's small farmers is labor, not land. Many permanent crops provide good return to land, but do not generate high returns per labor day when compared with annual crops (see Annex B). This situation is not immutable: productive practices may be known elsewhere, or adaptive research can discover technological improvements that make permanent crops more profitable for the small farmer. Improved services and marketing channels can reduce the farmer's costs for inputs and marketing. (In contrast, research on improved technologies for annual crops may make these crops more profitable and therefore encourage farmers to increase the area in such crops.)

- Farmer preferences. The high cost of buying foodstuffs in rural areas, uncertainty of the markets for export cash crops, and preference for a secure food supply all encourage the farmer to keep at least part of his land in annual crops as a source of food for his family. Given current cultural practices, which require the farmer to move his annual crop plot every few years, much of the apparently idle land is, in fact, fallow. These lands are not available for planting to permanent crops, unless the farmer is provided with technologies permitting him to keep a given plot in annual crops indefinitely, without a drop in production or greatly increased costs.

ALTERNATIVE SCENARIOS FOR HILLSIDE DEVELOPMENT

A strategy for hillside development should consider the desired outcome of such a strategy. What would the hillsides look like if the strategy succeeded? What scenarios describe the alternative paths that development should take in hillside agriculture and, indeed, in the sector as a whole? Formulation of these scenarios also helps to clarify the issues to be resolved in the strategy and identify what should be done to bring about productive change in the hillside economy.

Four alternative scenarios describe what hillside agriculture might be like at the turn of the next century. One of these is labeled the base case, implying that it will result if current trends continue unchecked. The other three represent a range of alternative futures possibilities for the hillsides.

The scenarios set up situations for comparative analysis, and there is no attempt in this section to make qualitative judgments on whether any of the alternatives except the base case could, in fact, realistically be reached at all.

The choice of a desired outcome (which might be one of those discussed below, a combination of two of them, or another alternative altogether) nonetheless implies a commitment to make the decisions that lead to that outcome. Each of these scenarios requires a different answer to several basic questions, including the following:

- How much of the country's investment resources should be devoted to hillside development?
- What types of technologies should the research and extension apparatus be directed to develop?

- What is the role of hillside agriculture in generating export crops?
- What is the role of hillside agriculture in producing food for domestic consumption?
- What is the role of hillside agriculture in generating employment?

Each of the alternative scenarios would be described in terms of its effect on five basic variables that together define the hillside economy:

- Total rural population and its age distribution;
- Total agricultural production and the mix of annual crops, permanent crops, and livestock production;
- Watershed management and the status of the land and water resources;
- Employment, labor use, and rural incomes; and
- Land use and land tenure.

Within the scope of this study, it has not been possible to provide economy-wide estimates of the investment required to realize these competing scenarios or the total value of agricultural income in each case. The intention has been to draw scenarios that, with the exception of the base case, are comparable in terms of both income and investment. The base case assumes a continuation of the current situation of low (or ineffective) investment and low production.

Scenario One: The Base Case

The Rural Population	The rural population would continue its gradual decline. The population profile would continue to shift to the dependency age groups (under 15 and over 60) as young people left the hillsides for more attractive opportunities upon reaching employment age.
Agricultural Production	Hillside agriculture would stagnate as food crops were increasingly produced on the lowlands, and upland farmers could not compete with high technology, high-input systems located close to market outlets. The area cultivated would shrink as soils eroded and became even less productive, and as farmers retreated from the market and became progressively marginalized in subsistence agriculture.
The Resource Base	As incomes stagnated, farmers would be increasingly unwilling to make the necessary investment in maintaining the productivity of their land. Erosion, and therefore further drops in land productivity and profitability of hillside agriculture, would continue, encouraging the trends toward outmigration and marginalization of those remaining. If erosion proceeded far enough, it would become impossible to cultivate much of the land, and many areas now cultivated may be deserted entirely. While this would, at least, stabilize the watershed situation, the implications for the hillside economy and the future productivity of these lands would be extremely negative. Moreover, indications from other countries (notably Haiti) are that farmers will continue to farm lands even where the productivity is virtually nil, if they have no other alternatives. The extent of this trend will depend on the availability of other employment.
Employment and Incomes	Employment in the hillsides, and the capacity of the hillside economy to provide jobs for new entrants to the labor market, would both decline. The income of the rural residents

	would grow at an extremely slow rate, and in some areas the income from farming would fall as the land and labor resource base deteriorate.
Land Tenure and Land Use	Although the population would continue to decline, the lack of an effective land market would lead to fragmentation of cultivated lands through inheritance, even though many farms would out of production. The unequal distribution of land between upland and lowland farmers would continue and likely be exacerbated.

Scenario Two: Intensified Hillside Agriculture, Based on Permanent Crops

The Rural Population	The hillside population would stabilize at approximately its current level, although this scenario would also be consistent with a continuation of the trend toward gradual depopulation. Over time, however, higher profitability would encourage younger people to remain in or return to the hillsides, leading to more balanced age distribution in the population.
Agricultural Production	Much of the hillside land now in an annual crop-fallow rotation would be converted gradually to permanent crops, including tree crops (including agro-forestry) and permanent pasture. Annual crops would continue to be grown, but on reduced acreage at greater levels of intensity. Much of the area in annuals would be in the form of intercropping or strip cropping with trees and pastures. The technologies would advance, and the use of production-increasing inputs (fertilizer and improved seed, for example) would increase to produce the income needed to finance and justify the necessary investment in land development and erosion control. Total production on the hillsides would increase substantially, and a greater number of high-value crops (fruits, nuts, and animal products) would be produced. The production of annual food crops would decline slightly.
The Resource Base	Increased use of protective measures and reduced areas in annuals would limit damage from erosion, but some loss would continue to occur. Such losses would diminish as the area in tree crops and pasture increased.
Employment and Incomes	The improved technology applications and more extensive utilization of land with permanent crops would lead to increased demand for labor. The greater variety of crops grown would tend to equalize the labor demands across the year. This scenario would be most consistent with a pattern of full-time farmers operating their holdings primarily with familiy labor and limited use of hired labor for harvesting and other high-labor

	labor for harvesting and other high-labor seasonal tasks. Total income from hillside agriculture would rise, as would average income per acre. Average income per cultivated acre would decline, however, since the permanent crops are on average less profitable than annual crops per acre. On the whole, income per farm would nonetheless show a larger increase than income per acre due to the decline in fallow land and the rise in average farm size that this scenario requires.
Land Tenure and Land Use	This scenario would encourage an increase in mid-size (5-25 acres) owner-operated farms. It would not encourage tenancy but would require an increase in the demand for titling.

Scenario Three:	Intensified Hillside Agriculture, Based on Protected Annual Cropping
The Rural Population	Under this scenario the hillside population would grow, and increasing fragmentation on the occupied lands would encourage more intensive cultivation as the amount of available cultivable land declines. However, as long as family labor is scarce and complementary resources such as capital and yield-increasing inputs are less readily available than fallow land, the small farmers will not find it in their interest to shift to a high-intensity annual cropping system.
Agricultural Production	The production in annual crops would increase as farmers shifted to more intensive management practices within their current rotation pattern. Heavy use of bench terracing and other erosion control measures, along with improved technologies and high inputs, would be necessary. The increase in productivity would be sufficient to finance both the protective measures necessary to maintain the land under a system of continuous cropping and the other inputs that would make it more profitable than the current land-using system. Investment per cultivated acre would therefore increase significantly.
The Resource Base	Despite increase in production of annual crops, the erosion per acre would decrease, as the farmers would be employing protective measures (including both agronomic and physical erosion control practices) to a significantly greater degree than they do now. If, however, the increased profitability of new technologies (without which the scenario would not be implemented) led farmers to increase the total area in annual crops, without a concurrent installation of erosion control measures, then total erosion would be more likely to increase.
Employment and Incomes	This scenario implies an increase in employment and rural incomes, as production of high-profit annual crops expands. If, however, increasing profitability of annual crops leads to over-exploitation of the resource base and, in consequence, its more

	rapid deterioration, the gains in income and employment may not be sustained beyond the medium term.
Land Tenure and Land Use	This scenario assumes a more intensive use of hillside land. It does not necessarily imply a change in the tenure pattern, although it would be consistent with a pattern of increasing fragmentation and leasing.

Scenario Four:	Intensified Lowland Agriculture, with Extensification in the Hillsides
The Rural Population	The hillside population would decline as small farmers and farm workers moved to farm the coastal plains, as food crop production became more intensive. The increased production of tree crops and livestock would lead to more viable family units and a more balanced population profile.
Agricultural Production	Agriculture in the hillsides would become more extensive, with the principal crops being coffee, cacao, and fruit trees for both domestic and export markets. Livestock production for both meat and dairy products would increase. Production of annual food crops would shift to the coastal plains where it is done under more intensive, high technology, mechanized systems. Total agricultural production for the country would increase significantly.
The Resource Base	A shift to tree crops, pasture, and agroforestry would reduce the level of erosion. Annual crops in the hillsides would be limited to kitchen gardens and some high-value crops grown on intensively managed bench terraces.
Employment and Incomes	Employment in agriculture would increase as the more productive lands of the coastal plains were brought into intensive cultivation. However, the danger exists that, if this is not accompanied by shift of smallholders to the lowlands, further proletarianization of agricultural workers would take place, with consequences for equity and political stability. With the increase in tree crops and livestock production in the hillsides, the demand for labor would also increase, somewhat ameliorating the major shift to the lowlands.
Land Tenure and Land Use	Land use would be rationalized as intensively cultivated crops moved to Class I and II soils, and tree crops and pastures moved to the Class III and IV soils in the hills. The current trend of shifting to more medium-size

farms in the hillsides would continue. The large holdings in the coastal areas would be subdivided into cost-effective family farm units for intensive cultivation. This scenario does not imply a forced land reform program, but does assume that land titles will be easily obtained for the small farmers.

SELECTING A STRATEGY

The scenarios spelled out above provide some useful contrasts for discussion. The base case, which might be called the current scenario, is unacceptable as a national strategy. It is both uneconomic for small farmers and destructive of the natural resource base.

Scenario Three, intensified hillside agriculture based on protected annual cropping, is essentially the Smithfield system, which was used in IRDP II. This system works well on the experimental station under a high level of management, but has serious problems when attempted on small farms. The high cost of the erosion control structures puts them out of reach of all but the most affluent farmers, and therefore they require a high level of public expenditure. As a national strategy, this scenario is unaffordable.

This leaves Scenarios Two and Four for serious consideration as acceptable outcomes for a hillside development strategy. These two scenarios each feature heavy expansion of tree crops and permanent pastures with livestock in the hillsides. The difference is that the second scenario assumes a significant level of annual crops on the hillsides, grown in intercrop or other systems with perennials, whereas the fourth scenario transfers the production of annual crops to the flatlands.

On purely ecological grounds, Scenairo Four is the preferred scenario, because it eliminates a large part of the intensive soil cultivation on the hillsides. From an export market perspective, Scenario Four is also preferred because the coastal plains

have a much better potential for becoming competitive in the winter vegetable markets in North America and Europe. For food supply to domestic urban markets, Scenario Four offers lower costs for vegetable crops.

When considering the social and political implications of these two scenarios, the edge goes to Scenario Two, which dislocates fewer people and represents more stability. However, if one takes a longer-term view and anticipates the change to be gradual, social upheaval and political unrest would likely be minimal. Scenario Four thus seems inevitable. Foreign investors with Jamaican partners, using high technology, are producing vegetables for the winter export market. Others will follow this example, and it will not be long before high-technology producers on the plains will be supplying the domestic markets. The hillside small farmers will not be able to compete and will have to shift to tree crops or become subsistence farmers. If this prediction is accurate, the government's hillside strategy will of necessity include the promotion of permanent crops as the basic component.

Scenario Two could become a transitional phase in the strategy, an intermediate step in the long-term movement toward Scenario Four. However, even if a phased strategy is adopted, governmental action will be required to ensure that the high-technology food production on the plains does not move so fast as to displace the hillside producers before they have shifted to a system based on permanent crops.

MAJOR COMPONENTS OF THE PROPOSED STRATEGY

Five major components provide the most useful framework for describing the strategy:

- Improved technology generation and dissemination;
- Watershed management;
- Land tenure;
- Rural institutions and support services; and
- Organization and management.

Technology Generation and Dissemination

The recent restructuring of the Ministry of Agriculture is aimed at decentralizing its primary functions and should be given time to be implemented. Thus the following proposals for improving research and extension seek to strengthen existing structures rather than to reorganize them. The proposals call for greater financial support of agricultural research and a more systematic focusing of research and extension activities on solving the problems of hillside farmers.

Upgrading Support for Agricultural Research

The Jamaican government is currently addressing the problem of the decline of research and development, and proposals have been submitted for rectifying the situation. While the study team strongly supports the promotion of agricultural research in Jamaica, it has reservations about the current proposal to remove research from the current ministry organization and create a separate statutory body. Although this would permit the redressing of many of the research department's complaints, it is

likely to result in increased isolation from the extension services. Effective technological development requires a close working relationship between research and extension. Thus it is recommended that the upgrading of research take place within the current ministry structure. Proposed improvements include:

- Salary increases necessary to recruit and maintain qualified staff;
- Provision of adequate resources to carry out effective research. Currently, over 80 percent of the Research Department's budget is allocated to salaries. Financing should be increased to allow at least 40 percent of the budget for non-salary expenditures in order to develop a sound program; and
- Revision of the incentive system to provide rewards for issuing extension and journal publications, generating research results relevant to clients, conducting training, and advancing professionally. Qualified researchers should be able to advance to Grade A of the civil service, as qualified university professors are currently able to do.

A proposal has been made to improve agricultural research by unifying commodity board and ministry research efforts under a single entity. This does not appear to be necessary, however. Board research is currently more effective than the ministry's program, and in many cases, coordination of efforts is adequate.

Creating a Farming Systems Research and Extension Program

A farming systems research and extension (FSRE) approach is proposed to help increase the ministry's capacity to develop improved technologies for hillside farmers (see Annex A on FSRE for a full description of the farming systems approach). Under this approach, the research and extension functions would be fully integrated under a senior principal research officer.

An effective FSRE program involves a multi-disciplinary team of researchers investigating crops and livestock production problems and studying the economic and social factors affecting the farmers' total operation. It includes testing alternative solutions on farmers' fields with the farmers involved. In the current ministry structure, development officers would play an important role in the FSRE function, but their numbers are inadequate for implementing a national program of significant scope.

It is recommended that teams made up of two DOs and one extension specialist in each region manage FSRE for hillside agriculture. Current staffing levels are sufficient for only one team to start the program in a single region. As more DOs are recruited and trained, teams would be assigned to the three other regions. One DO on each team should be an agricultural economist and one an agronomist, so that both the social science and the agricultural science perspectives are represented. The assignment of each team would be to:

- Identify relatively homogenous groups of farmers, or recommendation domains in an agroecological zone;
- Study the farmers' problems and establish priorities for research;
- Conduct adaptive research experiments in farmers' fields, involving the farmers as much as possible in conducting the experiment; and
- Utilize the on-farm experiment to conduct extension training of other farmers (FSRE fits easily in a training and visit method extension program).

Other research or extension specialists would join the team as particular needs arose; for example, in an area where cattle are important, a livestock officer may join the team during parts of both the investigation and the experimental stage. Furthermore, the teams would collaborate closely with the regional agricultural planning teams of the Physical Planning Unit to select agro-ecological zones for focusing research, and with the scientists on the research stations.

The extension specialist would be stationed with the team at a research station, but would be responsible to the regional extension director. The specialist would be responsible for maintaining links with extension both in the field and at the regional level. In addition to participating in the adaptive research program, he would be responsible for:

- Coordinating the input of local extension agents into surveys and farm trials;
- Using research results to prepare extension bulletins for distribution to extension agents and farmers;
- Coordinating joint seminars of research and extension officers; and
- Organizing and managing in-service training.

The principal research officer for farming systems would be responsible for providing technical assistance and supervision to the teams; facilitating the team's relationship with the rest of the research and extension staff; providing administrative support for the teams at the central level; and participating on

commodity research commitees to be certain that proposals made by the teams for both on-farm and on-station work are adequately considered.

Strengthening Commodity Research

The commodity research agendas should be better focused to match the personnel and resources available for carrying out research. The committees should rank all proposed experiments and implement first those that are judged most important.

Moreover, committee members must address the total needs of farmers, even though these may not always reflect the specific objectives of representatives of particular groups, such as the commodity boards. For example, committees may decide that mixed cropping experiments are useful even though the optimum yield of an individual crop is lower than if planted in pure stand. The principal research officer for farming systems will play an important role in ensuring that the systems' perspective is represented in commodity research planning.

Analyzing Biometric and Economic Research

The ministry should have the services of a biometrician to ensure that all experiments are properly designed to yield information as accurately and efficiently as necessary. The services of an economist are also required to perform economic analysis, where such analysis would prove useful, and to carry out economic analysis of experimental results. The ecomomists on the FSRE teams could carry out these functions. (The fact that FSRE team members have functions outside of their roles as team members will serve to promote their interaction with other scientists.)

Using Development Advisory Officers (DAOs)

Extension agents must not be diverted from their primary and essential task of training farmers. Their involvement in credit, subsidy, and regulatory programs not only absorbs most of their time, but it destroys relationship with farmers as adviser and teacher. A new division of the ministry would carry out non-educational service functions, placing DAOs at the district level, as in the 1960s.

Watershed Management

On-Farm Agronomic Practices

The principal emphasis of the strategy's watershed management component should be with on-farm, agronomic, soil, and water conservation practices, with a minimum of structural works.

Engineering strategies for conserving soil and water resources are rarely successful without consideration of the farmers' goals, the infrastructural arrangements of the region, and crop-based production components. For example, farmers' attitudes may differ because in one region they are nearing retirement age and few young people are availabe to replace them, but the same would not be true in other regions. Thus a strategy is needed that integrates crop production research and extension with the farmers' goals, and matches the agroclimatic and infrastructural components of the country with soil and water conservation practices inherent within the system.

The object is to work with the farmer in the way he farms, and within his capabilities and interests, to reduce the initial movement of soil from raindrop impact that initially detaches

soil particles and surface sheet flow that starts the movement downhill. The idea is to keep the soil in place and keep the water moving into rather than over soil, and for the portion that does get started, to retain as much as possible on the farmer's land and minimize the flow leaving his land. The specific practices this strategy implies include the following:

- Minimum tillage, both in the area tilled and in the degree it is tilled. Open as small an area as possible, leave old roots and stalks and as many soil clods as possible;
- Contour planting, using continuous mounds or furrows or basins and checks;
- Grow canopy and cover crops that also produce food;
- Interplant, with food crops that protect each other, or with grass strips;
- Use leaf and trash mulches; and
- Grow permanent crops.

Exposed soils are subject to direct raindrop impact that disaggregates the soil particles and increases soil crusting, compacting, and surface run-off and erosion. Crop yields often are reduced along with internal water storage capacity, organic matter, soil aggregation, nutrient recycling, and long-term productivity of the land resource (Unger & McCalla, 1980, Akobundu, 1983; Young, 1982; Hayes, 1982; Haynes, 1980, Cannell. 1983; Sidirass et. al., 1983; and Lal, 1983). Worldwide evidence suggests several alternatives to conventional tillage that potentially reduce these crop and soil management problems, while improving production efficiencies at manageable levels.

No-Till

The presence of crop and vegetative residues, including partially tilled stubble, can affect erosion by increasing water infiltration, reducing run-off, and improving soil structure and productivity. Fallow rotations provide a primary source of vegetative cover (Ruthenberg, 1971; Posner, 1979), but farmers often burn the dead or partially dry vegetation before planting. Burning rids the field of unmanageable debris, increases pH of the surface soil, and releases certain plant nutrients. Unfortunately, burning also removes the protective cover and oxidizes some soil nitrogen that is lost to the atmosphere. If farmers insist on burning, they should use controlled burns, where fire lines are established and burning occurs in the morning when humidity is high and winds reduced, so that adjacent forest areas are not destroyed.

On property lines, contour banks, and extremely steep slopes where crop and livestock production is marginal, fast-growing legumes should be planted (Wilson, 1983). These trees and shrubs offer a degree of soil stability, nitrogen for soil, livestock feed, firewood, and yam stakes. Within one to three years, the branches can be harvested and used as an organic mulch to reduce weeds and improve soil protection from rain, while improving soil aggregation and moisture retention.

Contour and Strip Cropping

Contour planting of crops, particularly in conjunction with stripping, is the basic management practice for on-farm erosion control. Alternating rows of trees with strips of permanent pasture and grass-covered contour banks is a common

example of a method that would work well in Jamaica. On the better soils, with less steep slopes, rows of annual crops could be planted with minimum tillage and mulch, without causing heavy erosion.

Recent evidence from Sri Lanka and Nigeria (Wilson, 1983; Wilson & Akapa, 1983) suggests that alley cropping might be introduced and adapted by Jamaican farmers. The cropping system involves planting a fast-growing tree legume such as Leucaena or Gliricidia between every two rows of yams on the contour. Other row crops such as red peas could be interplanted the first growing season to help protect the soil and provide food or cash income. During the second season, two rows of yam hills are prepared on each side of the legume for eventual trellising on the live pole. After yam planting, the lower leaves and small branches are removed from the live pole and chopped to form a mulch that provides nitrogen fertilizer, reduces weed growth and soil temperatures, and increases soil aggregation and water infiltration and storage, while growing an annual crop (Wilson & Akapa, 1983; Allison, 1973; Searle et. al., 1981).

As the yam begins to trellis, the remaining branches can be chopped and added to the surface mulch. After the yams are harvested, the legume is allowed to regrow, forming new material for mulching in subsequent seasons and improving the soil for future annual crops.

Live and Dead Mulches

Another potential cropping system for annual crop production is the planting of a cover crop, usually a legume such as *Mucuna utilis* or *Centrosema puberscens*, prior to establishing the crop. The mulch is either killed or suppressed with herbicides, and the crop is planted either mechnically or by hand through the mulch (Agboola & Faymei, 1971; Wilson, 1982; Okobundu, 1980). The primary deterent to implementation of this system is the education and precision required to control the cover crop with herbicides. Although this system is of potential interest in the future, emphasis be placed on the alley-cropping system as a primary strategy.

On-Farm Structural Treatments

Structural treatments on-farm should be limited to what the farmer can afford, build, and maintain himself. The extension service program should eliminate subsidies and concentrate on training farmers in appropriate practices within their capabilities. Examples of simple treatments that can be very effective, if used in conjunction with the agronomic practices mentioned above, are:

- Interceptor ditches leading to grassed waterways;
- Trash barriers in swales and small erosion areas;
- Brush and bamboo bundles stacked across the slope;
- Wattling and other forms of living barriers; and
- Grass-covered contour banks.

Smithfield Terracing System

The Smithfield bench terracing and wide hillside ditches should used selectively on farms with advanced management and good soils. Farmers with the technical knowledge to achieve high yields on high-value crops could justify the installation of physical structures. The Soil Conservation Unit (SCU) should provide the farmer with assistance in design and installation supervision once it is determined whether the farmer is serious and will maintain the structures and use them productively. Financing for structural work should be provided by bank loans. The government subsidy program should be eliminated.

Coordination of Watershed Engineering Divisions, NRCD

NRCD should work with groups of farmers to channel the runoff from their farms (interceptor ditches, for example) in waterways that are placed to serve the farmers' needs and safely conduct concentrated flows down the hillside. These waterways should be grassed and ballasted and have checks and drops as required. These complex structural treatments are beyond the capabilities of the farmers and would be constructed by NRCD contractors who would be encouraged to continue to employ farmers.

Coordination with the Forestry Department

The Forestry Department should continue to have responsibility for erosion control in the forested areas. There should be coordination with SCU and NRCD in those areas where farmlands are contiguous with forests to protect the soil with vegetative cover and water channeling.

Organize into Integrated Sub-Units

Soil and water conservation work should be organized into manageable sub-units in which the total program can be planned and implemented in a coordinated fashion with all of the organizations. Certain organizational changes will be required to bring about the integration of the work of SCU, NRCD, and the Forestry Department.

Not all the farmers will initially participate in a sub-unit. The more progressive ones will join first; others, seeing the benefits their neighbors are attaining, will join in later. Marginal farmers may never join the program. Within a watershed, the program should be planned to allow for this phased development on several levels, so that at first small areas and later larger areas of treated land will aggregate to cover most of the watershed. This strategy can be applied in a number of different regions at once, limited only by the availability of resources.

Land Tenure

The main emphasis is to make the land market work more effectively than at present. This calls for change from a passive to an active strategy for titling of land, so that small farmers are able to use their land wealth for development; offer it as collateral; sell, trade, or consolidate fragmented holdings; or upgrade the quality of a farm.

A program is needed to proceed systematically, area by area, throughout the country to provide titles to all farmers. Data from elsewhere in Caribbean indicate a cost of about $US 200 per

parcel. To the extent possible, the program should focus on small farmers who do not now have title, leaving large farmers and others with title until later.

The basis of the program is a comprehensive cadastral survey and title registration. This approach has been used on several Caribbean islands and elsewhere around the world, often with donor assistance because of cost. (Completed or ongoing programs may be found in Liberia, Costa Rica, Brazil, Seychelles, St. Lucia, Antigua, and Montserrat.)

A titling program generally requires a change in the legal basis of land holding to permit one-time registration. In addition, it is preferable to change inheritance laws to prevent further fragmentation of family lands. This is obviously a difficult problem, but there are a number of innovative possibilities for handling it, such as a trust estate and the use of government bonds or other credit intruments to finance the long-term buyout of co-heirs. St. Lucia is experimenting with the latter.

A change in the land market would not produce immediate results but in time would have dramatic effect. It would help to liberate capital currently tied up in land because there are no buyers. At least some small farmers would be interested in moving to lowlands, if they could sell their land in hills to finance the purchase of new farms.

The first step is to recognize that this is a serious problem constraining growth of the rural economy, and decide to do something about it. The next step is find out what has been done elsewhere to identify alternatives that might be applicable.

Jamaica is not unique, and its landholding situation is similar to that existing in other Caribbean countries and elsewhere in the world.

The program should be implemented over as brief a time as possible. Land registration tends to be disruptive and expensive, and therefore should not be allowed to drag on. It is not advisable to reform the laws but not change the on-the-ground situation for long periods. Indeed, this would be worse than not starting at all.

Politically, a land titling program can be very popular. The main opposition is likely to come from lawyers, but experience elsewhere suggests that legal business booms following change, because the land market rebounds dramatically (one example is the Cayman Islands). Resolution of tenure disputes is a touchy matter, but small farmers are usually happy to cooperate, because they want title.

Rural Institutions and Support Services

Credit

The proposed strategy, with an emphasis on investment by small farmers in the establishment of tree crops and livestock operations, will require considerable financing. Medium-term requirements for orchard and permanent pasture establishment and purchase of livestock will be particularly high. Production credit needs for purchase of inputs also will be increasing steadily as the strategy is implemented. The most important action to be taken on credit is to implement a land-titling program.

The new credit system being implemented by ACB should be continued. At present, the decision to eliminate crop liens seems to be a good idea, given past experience with repayment. Emphasis should be placed on upgrading the capacity of PCBs. Once stable, the individual PCBs can develop other ways to finance small farmers more efficiently. Mutual liability groups and credit unions, for example, are models that have been used elsewhere to administer small farmer credit effectively. Self-managed group lending schemes with strong internal discipline are the only way to provide small farmer production credit on a cost-effective basis with reasonable repayment rates. The discipline must start with the management of ACB, and work down through PCBs to the local credit unions or credit-receiving groups, if the prevailing attitude that government credit is a grant is to be overcome.

Currently, lack of clear title for most farmers serves to limit demand for credit within available supply. This means that credit is not being used for development, a situation that should not be allowed to continue longer than necessary if the banking system is to regain financial viability.

Marketing

A strong marketing component is essential in the overall strategy. A shift in hillside production from an emphasis on annual crops to a system based primarily on permanent crops requires a corresponding shift in the marketing system. Coffee, cacao, bananas and citrus, all expected to expand as small farmer permanent crops, should continue to be handled by the respective marketing boards. The government should seriously consider the

creation of an export development and marketing board for tropical fruits, including mangoes, papayas, avocados, and passion fruit.

The Ministry of Agriculture's domestic food crop marketing program should redirect efforts to strengthen the higgler system, with emphasis on market information, financing of transport and storage equipment, and training. Entrepreneurs prefer their own facilities to government-operated ones and may not want to use government facilities, leading to costly waste of funds and embarrassment. Attention should also be given to developing the production and marketing system for the tourist industry's fresh produce requirements, now largely met by imports.

Farmer Organizations

The proposed strategy places heavy emphasis on building an economy in the hillsides based on viable farm units. The success of this approach depends on the farmers' participation in the planning and management of the development process. An important component of this strategy is to encourage and support the organization and management of farmers organizations (including cooperatives, associations, and credit unions). The objective is to create farmer self-reliance and commitment to development programs. This can be accomplished on a sustainable basis only if the farmers are capable of managing their own organizations.

Near-Term and Long-Term Impact of the Strategy

In the near term, agricultural production will not change dramatically in the hillsides. The effects of the promotion of tree crops will not be evident in the markets for several years.

Increased meat and milk production will start to have a noticeable impact sooner.

On the farm, implementation of this strategy will result in a reduction in soil losses and an increase in the amount of water retained. The result will be better growing conditions for crops, and better yields. With more water being stored in the soil over a wider area, the severity of dry periods will be moderated, tree roots will grow deeper, and the overall precariousness of hillside agriculture will diminish. Over a longer period of time, as the conservation practices take effect and are maintained, a gradual improvement of the soil conditions will develop in the better situated soils. This in turn will improve crop response in those areas.

Concerning the watershed, the retention of increasing amounts of soil and water on the hillsides will reduce peak flows and discharge of silt. This results in benefits all the way downstream: less gulley erosion will occur, less silt will be transported to the rivers, the rivers themselves will be less prone to flooding and will have longer periods of baseflow, there will be less siltation of reservoirs, and the waters from them will require less treatment for removal of turbidity. The cost savings become cumulative as one moves downstream. While those have not been quantified, experience has shown that the savings can be significant. NRCD unofficially indicated that implementation of a conservation program could possibly reduce the need for channeling and stream-bank control work by 30 percent.

The titling program will have a significant impact in the near term. As farmers acquire titles, they will immediately begin using them for loan collateral. The land market will change considerably over time. Serious farmers will consolidate holdings and expand into more cost-effective family farms. Other farmers will sell hillside properties and buy land in the plains for more intensive production.

Implementation of the Strategy

With the acceptance of the proposed strategy by the Ministry of Agriculture, the National Planning Agency, and the other relevant government agencies, it should be proposed to the Prime Minister that the strategy become national policy with the full endorsement of Parliament. The proposed strategy does not require major new government expenditures, and many of the recommendations can be implemented by reallocating funds within the existing budget levels. Other costs could be managed with donor-assisted projects. The land-titling program is the most urgent requirement for new financing and should receive priority attention for implementation.

Obviously, the government has choices with respect to the pace at which it undertakes various aspects of the strategy. Those things that can be done without added cost should to be started without delay, whereas other actions may have to wait until the financing can be identified. The protection of the watershed and the supply of water for urban, industrial, and agricultural uses are urgent matters that should receive immediate attention. Within the existing agencies, the media, and the educational institutions, a coordinated public information and education campaign should be undertaken to create an awareness of the problems and to bring about a public commitment to solving them. Farmers, hillside residents, and businesses, acting on their own, can accomplish a considerable amount if properly motivated. A public information campaign would establish the support base upon which the government programs will be implemented.

The proposed strategy has a number of different components and involves the participation of several ministries, autonomous governmental organizations, and the private sector. Successful implementation will require the commitment and active support of all of these entities. The coordination of field actions involving various organizations requires a central management system in each operational region. It is recommended that the policy and financial matters be managed by a special unit in the Prime Minister's office and that coordination of field implementation be the responsibility of the Ministry of Agriculture.

The two components or actions within the proposed strategy that lend themselves to description as discrete projects for foreign donor assistance are the land-titling program, and farming systems research and extension. Land titling would involve technical assistance and training in titling procedures and electronic data processing, and financing for a contract for an island-wide cadastral survey. This would probably be the most expensive component of the strategy in the short term. FSRE will require technical assistance and training and a small amount of equipment. The ministry already has the facilities and core staff required within the existing research and extension programs to begin an FSRE activity.

The commodity boards dealing with export crops grown on the hillsides should have technical assistance projects to improve their management and marketing capabilities. The new coffee project, financed by the Japanese, is an example of the type of

expansion activity required to increase the production of profitable small farmer crops. More high-quality coffee could be grown, particularly in some of the other areas outside of the Blue Mountain zone. Cacao, citrus and the other fruit crops, spices, and flowers all represent opportunities for development projects. The proposed farming systems program should be closely coordinated with the boards to design small farmer cropping systems based on export crops.

Watershed management offers another opportunity for a project that would include the development of an overall plan and management system coordinating the work of the various organizations involved. It would also include training in the technical aspects of on-farm erosion control in the context of the FSRE program. Financing for acceleration of the off-farm work on waterways and reforestation could be a major component as well.

A technical assistance project to upgrade the entire PCB system is needed, with ACB as the implementing organization. Part of the project would be the development of group-lending mechanisms, such as credit unions and mutual liability, credit-receiving groups.

The current project in domestic food marketing is at present sufficient for the Ministry of Agriculture. Some changes that emphasize local marketing group organizations and support for higglers would strenthen the marketing aspects of the strategy.

Although this proposed strategy offers some difficult choices for the government, the hillside areas are too important to be left in their current situation. They are also too important for strategy decisions to be taken on an ad hoc basis

in the context of various donor projects. The government must take control and set a long-term strategy that has broad political support. With that strategy in force and an action program begun, the government will be in a position to request donor assistance for the projects that have high governmental priority. When that happens, there will be the focusing of resources and the continuity of commitment required to achieve the country's objectives in the hillside areas.

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ANNEX A

FARMING SYSTEMS RESEARCH AND EXTENSION

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INTRODUCTION

Farming systems research and extension (FSRE) aims at improving the effectiveness of national research and extension services in the generation and dissemination of technologies appropriate to small farmers. The approach evolved simultaneously in several developing countries during the past 10 years and is now being advocated by a growing number of national and international research organizations in the Third World.

A farming system may be broadly defined as the way in which a farm family manages the resources it controls within the ecological, social, and economic setting. In the FSRE approach, researchers first develop an understanding of how the farming system functions, then design research to identify improvements that will increase the farm family's productivity and be acceptable and feasible. At the same time, the system must be consistent with national policy objectives.

CHARACTERISTICS OF FSRE

FSRE has the following characteristics that, taken together, distinguish it from the conventional, yield-oriented approach found in agricultural research institutions throughout the Third World (Gilbert, Norman, and Winch; Spaner, Philipp, and Schmel, 1981; Collinson, 1982;)

First, technologies are evaluated from <u>the farmers' point of view</u>, taking into consideration the farmers' objectives and priorities, resource endowment, access to inputs, and attitudes

toward risk. In other approaches, the farmers' perspective enters the picture only as the final criterion against which technologies are measured for acceptability once they are ready for release to the extension service. In the FSRE approach, the farmers' perspective guides the research and extension program throughout its implementation. For example, researchers and extension agents understand the commercial goals of large farmers that are consistent with the modern agricultural orientation agricultural professionals possess. Small farmers, especially those living close to the subsistence level, may have very different goals and objectives from large farmers; this leads to different management strategies and practices. For example, researchers in several countries have recently explained the sound economic rationale behind many mixed cropping patterns. Given their limited resource base and uncertain environment, mixed cropping is often an effective strategy for small farmers to pursue in order to met their objectives, one of the most important of which may be running risk. Thus, in many cases researchers can be more productive by improving the output of current mixed cropping systems than by replacing them with pure stands.

Second, the researcher must consider <u>the farm system as a whole</u>. The farmer generally operates a number of different enterprises, and it is necessary to identify the management strategies farmers use: how individual enterprises contribute to the farmer's welfare, how they compete for scarce household resources, and how they fit together in a life-sustaining system. For example, farmers are often forced to diverge from the ideal management of one enterprise in order to devote resources to other enterprises in the interest of overall system performance. Thus, when researchers focus on a single commodity or operation, they must consider explicitly how the facet under study relates to other system components.

Third, the research team is multi-disciplinary, including both social and physical/biological scientists. The members of the team work together on a commonly defined research agenda, evaluating farm circumstances, problems, and proposed solutions from their differing perspectives.

Fourth, the farmers are active participants in the research. Their viewpoints on ranking of problems and acceptability of technologies are actively sought. Moreover, their experience and knowledge are recognized as valuable sources of information.

Fifth, much of the experimentation is carried out on farmers' fields. The soil type and structure, labor availability, pest problems, and other conditions of a small farm are often different from those found on the research station. Therefore, technologies developed on farmers' fields will be more appropriate to the farmers' circumstances, and their adoption will be more likely. Furthermore, on-farm experimentation provides an opportunity for dialogue among farmers, extension agents, and researchers. It also allows technologies to be tested across a large number of locations.

Sixth, the program crosses the research/extension division. Extension agents participate in all stages of the research, from developing the information base and planning a trial, through implementation, to evaluation of results. FSRE practitioners recognize the iterative overlapping nature of research and extension, rather than regarding research as an exercise from which complete technologies emerge for diffusion to farmers.

Seventh, the research is farmer-group specific. Farmers with similar farming systems have similar problems and opportunities; therefore, they require a common experimental program and set of recommendations. A preliminary step in an FSRE program should be

to identify farmer groups or recommendation domains. Grouping farmers should not be confused with grouping farms; it is farmers and not fields that make decisions. Indeed, subgroups of farmers growing the same crops in a region may have different research needs. They may have different soil conditions, objectives, and resource bases, or operate in different market systems. Experiments should always be planned, with the circumstances and problems of specific farmer groups in mind.

It is not at all inconsistent for commodity boards to mount FSRE programs. For example, an understanding of how cocoa fits into the farming system of a target group of farmers would help a cocoa board research program plan technologies for increasing cocoa production, while addressing total farm productivity. The Coffee Board of Kenya is an example of a commodity board with an effective farming systems research program.

Eight, an FSRE program is consistent with societal objectives. FSRE is used to enhance the welfare of farmers with respect to national policy guidelines and long-term interests of society. On occasion, short-term measures to increase farmer welfare may conflict with these policies and interests, as when an annual crop production scheme for hillside farms results in excessive soil erosion. Because FSRE practitioners draw upon the objectives and considerations of both farmers and policy makers, they are in an ideal position to identify improvements that will serve the interests of both groups.

FSRE'S ROLE WITHIN A NATIONAL AGRICULTURAL RESEARCH INSTITUTION

FSRE is practiced by teams of researchers and extension personnel carrying out surveys of farmer circumstances, and initiating experiments on farmers' fields. However, a strong link between an FSRE team in the field and the station research is

crucial, as is illustrated in Figure 1 (Collinson, 1982). The FSRE team carries out diagnostic surveys of farmer groups (Stage 1) and identifies potential solutions to their problems (Stage 2). Some of these possibilities are relevant and feasible for farmers in the target groups, and may be tested directly on farmer fields (Stage 3). Other proposed solutions may be rejected and require work (Stage 4). Some of these unsolved problems may lead to investigations in commodity or disciplinary research (Stage 5), which in turn contribute to the body of knowledge (Stage 6) available for application to farmer problems (Stages 2 and 3).

For example, an FSRE team may identify soil fertility as a priority problem in Stage 1, the survey diagnosis. In Stage 2, it identifies two potential solutions: low-level application of nitrogenous fertilizer, and application of coffee pulp, which is a locally available coffee by-product. The team notes that nitrogen deficiencies in the soil have been well documented and that low levels of fertilizer are likely to be profitable, feasible, and acceptable to small farmers. Thus, they decide to test low levels of fertilizer application on farmers' fields. However, the team decides that not enough is known about the coffee pulp to test its effect on farmers' fields (Stage 4). Instead, station researchers undertake a chemical analysis of the pulp and mount an on-station trial to measure the pulp's effect on soil structure and fertility and to screen for possible hazardous effects on selected crops (Stage 5). When this information is obtained, it is made available (Stage 6) for possible testing on farmers' fields (Stage 2 and 3).

Team researchers and station researchers are not necessarily two distinct groups. In fact, individual researchers may have responsibilities both on station and in the field. Whereas a team has a core group of perhaps two to five members, it may call upon the services of other researchers and extension agents who have expertise on a particular problem that the team has encountered.

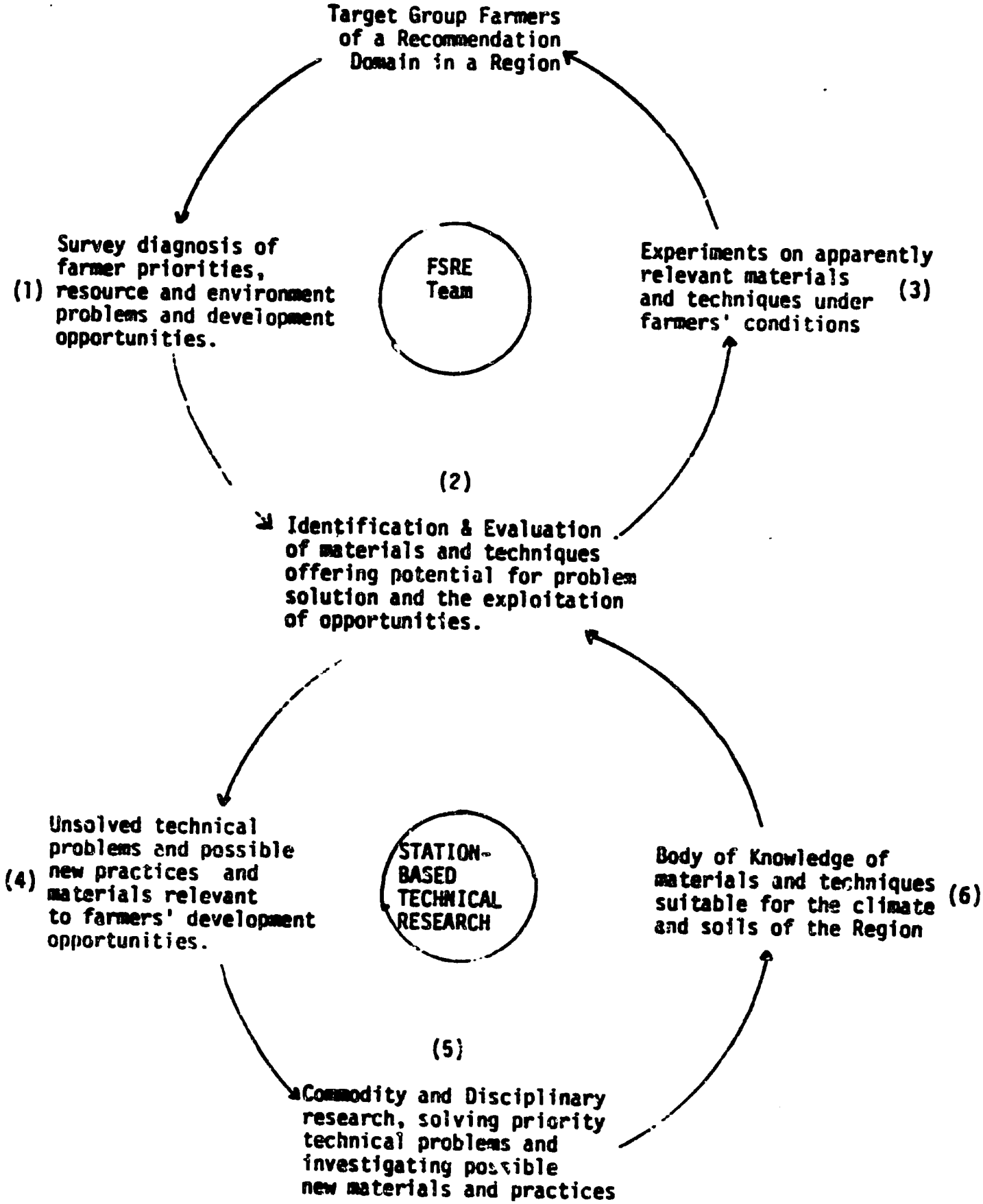

Figure 1. Interactions between Station-based Technical Research and FSRE Team.

FSRE PROGRAMS IN OPERATION

Research organizations in a number of countries have initiated FSRE programs or variants on the theme, to help improve the relevancy of their research programs to small farmers. For example, in Zambia, adaptive research planning teams made up of an agriculturalist and an economist operate in each of the country's nine provinces. The teams collect information on farming systems and collaborate with extension personnel to mount adaptive experiments on farmers' fields (Kean and Chibassa, 1982). In western Honduras, multi-disciplinary extension teams carry out diagnostic rural surveys that first identify problems and then propose solutions to all institutions involved in rural development, not just production researchers. Researchers and extension agents together carry out on-farm trials to test proposed system improvements. Close links between research/extension, and small farmer organizations facilitate the FSRE process (Whyte, 1981). FSRE-type programs are also active in many other countries, including Senegal, Guatamala, Kenya, and Ecuador.

Two examples of FSRE exercises in Kenya illustrate the usefulness of the approach. In these example, the experiences of researchers using conventional, yield-oriented approach is compared with those of researchers using the FSRE approach.

Kissi, Western Kenya

In western Kenya, farmers were planting maize and beans in rows by hand, dropping several maize and bean seeds into each hole. Station agronomists noted that this method adversely affected yields, because of plant competition for food, water, and sunlight. Therefore, they initiated on-station experiments to find a better, that is, a higher-yielding planting pattern. Their recommendations, based on experimental results, were to

plant maize in rows, with one plant per hill, and to plant two rows of beans between each row of maize. Although this method gave higher yields, farmers did not adopt it.

Later, FSRE researchers developed an understanding of farmer management strategies and focused experimentation in a different direction. Researchers found that the farmer's decision to plant many seeds in a few holes was a strategy for minimizing the labor bottleneck at planting time. The rainy season is extremely brief, and farmers rush to plant as quickly as possible after the rains begin to take full advantage of soil moisture. Furthermore, experiments revealed that changes in soil temperature and nitrate availability could reduce yields significantly if planting were delayed for as short a period as one week. Thus farmers were not willing to adopt the recommended planting method because it was too labor consuming and because it delayed planting. Moreover, farmers were unable to weed fields planted in the recommended manner with a traditional hoe because the crop rows were too narrow.

An understanding of the farmers' strategy in planting maize and beans gave researchers a different perspective than they had previously held. Researchers now understood that farmers would not change their current planting practices unless they could establish their crops rapidly. Therefore, research efforts were shifted to helping farmers plant earlier by overcoming the labor constraint (introduction of improved planting sticks and mechanical planters, for example) or by avoiding the labor constraint (such as reducing the risks of dry planting). By improving the efficiency of the sowing operation and moving the time of planting forward, field planting patterns conducive to higher yields could be adopted. In this case, an FSRE approach resulted in a research program more relevant to the specific problems of a group of small farmers.

Central Kenya

In central Kenya, researchers recommend applications of 100 kg of nitrogen and 100 kg of phosphate on coffee, basing these recommendations on the levels necessary for obtaining maximum returns. Few small farmers apply fertilizers at these levels, and some complained that fertilizer applications were not profitable. Farming systems researchers working in the area discovered that the cost of recommended fertilizer applications often approached one-third of the total cash income of small farmers; thus they were unable to afford such a high investment. The researchers mounted experiments testing the effect of low levels of fertilizer application and found that farmers with less than 300 shillings ($30) per ha to spend on fertilizer should invest all of their money in phosphates -- not to split their investment between nitrogen and phosphates. Thus the FSRE approach aided farmers to revise fertilizer recommendations to make them more relevant.

ANNEX B

ECONOMIC ANALYSIS OF CROPPING OPPORTUNITIES

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Tables 1 and 2 compare labor requirements and returns for selected enterprises pursued by Jamaican farmers. The figures for current management levels are based on data from a frame survey of nine watersheds adjacent to Kingston (Laumans, 1982; De Graff, 1982). Data for improved management levels are hypothetical and are from the Ministry of Agriculture, 1982. The data must be interpreted carefully; Jamaica is a diverse country and a data set from a single area cannot be representative of the entire country. Moreover, the returns data shown do not take into account many important factors that influence which enterprises farmers pursue, such as risk assessment, food preferences, seasonal labor bottlenecks, market opportunities, and intercropping patterns. Nevertheless, the data do have some important implications for planners developing cropping strategies for hillside areas.

Table 1 shows the extremely high labor inputs required for producing yams, Jamaica's principal food crop. This is important since the availability of labor is an important constraint in the smallholder sector. Vegetables and legumes have moderate labor requirements, while tree crops have the lowest.

The tables also show that yams have comparatively high returns to both land and labor. Thus in addition to being an important foodstuff, yams are also a relatively profitable enterprise. However, tree crops as currently managed have fairly low returns to land and to labor, particularly considering the level of investment and length of establishment period required before they come into production. Sweet potatoes and small livestock have the lowest returns.

To the extent that profitability is an important criterion in the decision to plant a particular crop, farmers first seek to maximize returns to their most scarce resource. Thus a farmer with scarce labor seeks to maximize returns per unit of labor. Unfortunately, data were not available for calculating returns to capital, another frequently scarce resource.

The proposed strategy for minimizing soil erosion is based to a substantial degree on the substitution of permanent crops for annual crops. However, at current management levels the data indicate that such substitution would not be acceptable to farmers because it would lower returns to both land and labor. Moreover, any attempt to replace yams with other annuals would also not be acceptable, for similar reasons. Given present price relationships and an absence of technological change, it is unlikely that there can be any significant shifts in the areas allocated to different enterprises.

The data on improved management levels are hypothetical but useful indications of the potential of existing enterprises. There is little difference between the labor requirements of enterprises at current management levels and those at improved levels. Tree crops, particularly coffee, have high returns to labor and moderately high returns to land. It is difficult to generalize about other crop categories: tomatoes, sweet potatoes, gungo peas, and cocoyam have high returns to land but only medium returns to labor. English potatoes and red peas have medium returns, whereas bananas, yams, and corn have fairly low returns to labor.

In summary, the economic data support the assertion that technological change is an essential component of a strategy to increase productivity and minimize soil erosion on the hillsides. Yams provide domestic food and high returns to land and labor. If yams are to continue to be grown on the hillsides, improved

technologies are necessary to enable farmers to grow yams in ways that ensure high productivity yet minimize soil erosion. The only alternative is to shift production to the flatlands. Tree crop production is accorded high priority; yet without improved methods to raise returns to both land and labor, there will be little interest in establishing orchards.

Researchers in Jamacia and elsewhere are familiar with improved technologies for increasing the productivity of the crops grown by smallholders. However, new technologies have not been developed and tested in Jamaica at the farm level, taking into consideration farmers' objectives and resource constraints. An adaptive research and extension program as described in the proposed strategy is required to identify and develop new technologies relevant for small farmers.

Table 1: Labor Requirements, Yields, and Returns To Selected Enterprises under Current and Improved Management

	Current Management				Improved Management			
	Person-days/Acre	Yield/Acre	Net Return/ Person-day[3]	Net Return/Acre[3]	Person-days/Acre	Yield/Acre	Net Return/ Person-day[3]	Net Return/Acre[3]
GROUND PROVISIONS								
Yam	138	4.0 tons	20	1304	144	7 tons		
Sweet Potato	65	2.9 tons	9	0	72	5 tons	29	1200
Cocoyam	-	1.5 tons	-	-	87	5 tons	25	1169
Irish potato	-	-	-	-	79	4 tons	22	800
LEGUMES								
Red pea	45	.25 tons	17	250	53	0.5 tons	29	922
Gungo[1]	88	.20 tons	6	0	68	1.0 tons	47	2350
VEGETABLES								
Onion	-	-	-	-	98	3.5 tons	95	7339
Tomato	99	5 tons	53	4000	120	10.0 tons		
Carrots	44	5 tons	19	320	75	5.0 tons	41	3046
Corn	.3 tons	-	-	-	54	0.9 tons	20	450
TREE CROPS[2]								
Coffee	25-50	20 boxes	13-22	300-55[4]	38	100 boxes	50	1875
Cocoa	20	20 boxes	22	500[4]	25	40 boxes	38	950
Banana	-	300 stems	-	-	40	7 tons	17	970
OTHER (returns/farm)								
Chickens	20	-	1-2	0	25	-	10	250
Pigs	45	2-6	0	60	-	-	10	600
Charcoal	23	-	17	130	-	-	-	-
Selling labor	-	12	-					

1 Gungo peas mature in two years.

2 Establishment costs for tree crops are not included here. Thus, returns for tree crops are overestimated when compared with those for annual crops.

3 In net returns per person-day, labor is not costed. In net returns/per acre, labor is costed at $12 per person-day. Land and management are not costed in "current management" but are costed in "improved management."

4 Includes costs and value of intercrop enterprise.

Source: Current data based on Laumans, 1982; De Graaf, 1982. Improved enterprise data based on Ministry of Agriculture, 1982.

Table 2: Relative Ranking of Enterprises by Labor Requirement, Returns to Labor and Returns to Land under Current and Improved Management

Rank	Person-Days/Acre	Net Returns to Labor	Net Returns to Land
		Current Management	
High	Yams	Tomato	Tomatos, Yams
Med.	Tomatos, Sweet Potato	Yams, Red Peas, Carrots, Charcoal, Coffee, Cocoa	Cocoa, Red Peas, Carrots
Low	Red Peas, Carrots, Coffee, Cocoa	Sweet Potatoes, Chickens, Pigs, Gungo	Gungo, Sweet Potato
		Improved Management	
High	Yams, Tomatoes	Carrots, Coffee	Carrots, Tomato, Gungo, Sweet Potato, Cocoyam, Coffee
Med.	Sweet Potato, Cocoyam, English Potato, Carrots	Cocoa, Sweet Potato Cocoyam, English Potato, Red Peas, Gungo, Tomato, Corn	English Potato, Red Peas, Cocoa, Banana
Low	Red Pea, Gungo, coffee, Cocoa, Banana	Yam, Banana, Chicken, Pigs	Yams, Corn