Analysis of Agricultural Research Priorities in the Caribbean

PRIORITIZATION OF AGRICULTURAL RESEARCH IN LATIN AMERICA AND THE CARIBBEAN

IFPRI IDB CARDI IICA

The project *Strengthening of Capabilities and Applications for Prioritizing Agricultural Research in Latin America and the Caribbean* (LAC) was sponsored by the IDB, coordinated by the Area of Science and Technology, Natural Resourees and Agricultural Production of the Technical Consortium of IICA, and co-executed with IFPRI with the collaboration of PROCIANDINO, PROCISUR, CARDI, PRIAG, SICTA, CIAT and the national agricultural research institutions of LAC.

Its principal objective was to develop capabilities for applying prioritization methodologies in support of decisions related to the allocation of resources to multinational and national agricultural research.

The principal activities of the project were:

- To train the management and technical personnel of the NARIs and other agricultural research institutions in the use of evaluation methodologies and applications for prioritizing research.

- To strengthen information systems and data bases on priorities at the regional and subregional levels.

- To develop and apply methodologies for evaluating and prioritizing multinational and national research.

The principal results of the project include:

- Professional trained in the use of methodologies for evaluating and prioritizing research.

- Educational materials related to evaluation and priorities (manuals and software)

- Data bases on agroecological, socioeconomic and technical information

- Computer programs and manuals for the evaluation of agricultural research: *Dream and DreamSur*

- Evaluations of multinational research in the Andean Subregion, the Caribbean and Mesoamerica.

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Project for Strengthening Capacities and Applications in Agricultural Research Priority Setting in Latin America and the Caribbean

The views expressed in this book are those of the authors and do not necessarily reflect those of IICA, IDB, IFPRI or any other institution that took part in the IBP-2 Project, all of which reserve the right to comment on or express reservations regarding same.

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TABLE OF CONTENTS

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ACRONYMS

ADU	Agricultural Diversification Unit
ARPS	Agricultural Research Priority Setting
ARPSS	Agricultural Research Priority Setting System
ARPSSC	Agricultural Research Priority Setting System for the Caribbean
BABCO	Belize Agri-Business Company
BAMC	Barbados Agricultural Management Company
BSI	Belize Sugar Industries Limited
CARDI	Caribbean Agricultural Research and Development Institute
CARE	Cooperative for American Relief Everywhere
CARICOM	Caribbean Community
CARIRI	Caribbean Industrial Research Institute
CATIE	Center for Tropical Agriculture and Training
CEE	European Economic Community
CIAT	International Center for Tropical Agriculture
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEI	Gross Efficiency Index
ICTA	Imperial College of Tropical Agriculture
IDB	Inter-American Development Bank
IICA	Inter-American Institute for Cooperation on Agriculture
IFPRI	International Food Policy Research Institute
IPM	Integrated Pest Management
JADF	Jamaica Agricultural Development Foundation
LAC	Latin America and the Caribbean
MALMR	Ministry of Agriculture and Marine Resources
MARNDR	Ministry of Agriculture, Natural Resources and Rural Development
MOA	Ministry of Agriculture
NARI	National Agricultural Research Institute
NARS	National Agricultural Research System
NEI	Net Efficiency Index
NIHERST	National Institute of Higher Education, Research, Science and Technology
OAS	Organization of American States

ODA	Overseas Development Agency
ORE	Organisation pour la Rehabilitation de l'Environnement
PBDU	Planning and Business Development Unit
PROCICARIBE	Cooperative Program for Agricultural Science & Technology in the Caribbean
RRC	Regional Research Council
R&D	Research and Development
SCMA	Standing Committee of Ministers of Agriculture
SECID	South East Consortium for International Development
USAID	United States Agency for International Development
UWI	University of the West Indies
VOP	Value of Production

FOREWORD

Economic globalization and the growth of international trade, efforts to alleviate poverty, and the sustainable use of natural resources, are key elements of the context in which the countries of Latin America and the Caribbean (LAC) are evolving as the twenty-first century approaches. The forces driving the globalization and liberalization of markets are leading to greater specialization in agricultural production, based on the comparative and competitive advantages of the countries, which are enhanced by technological changes that make it possible to generate more and better products at a lower cost.

One of the benefits of the multilateral agreements of the WTO and the FTAA, the trade blocks that have been established in the region (such as NAFTA, MERCOSUR, the Andean Pact, the Central American Common Market and CARICOM) and the many free trade agreements among countries is that they offer and create opportunities for technological integration. Through multinational research in specific areas, it will be possible to make full use of the agroecological and biological diversity and the research capabilities of the nations, ignoring geopolitical borders, in increasing the production capacity of the region for the good of the population.

The response of national governments to the process of globalization and liberalization of markets has been to make adjustments which, in many cases, have meant selective reductions in public spending. These changes have had a major impact on investment in agricultural research; and funding has decreased in most counties, in real terms. Meanwhile, the elimination of subsidies and taxes is also affecting the profitability of some technologies.

Paradoxically, while funding has been cut, the demand for the services of public and private research institutions has increased and diversified. Governments increasingly demand more proof of the socioeconomic impact of research and, also, that research expand its scope and potential beneficiaries. On the one hand, they require that research meet the existing challenges and, on the other, that it broaden its goals, beyond increasing production, to include objectives such as environmental sustainability and the reduction of urban and rural poverty. Under these circumstances, identifying priorities and making the best possible use of research resources - with fewer funds but with a greater number of objectives – has become a complex and difficult task. However, the changes that are taking place also provide opportunities to tap the advantages offered by multinational research, through new institutional arrangements within the framework of the regional and subregional trade blocks and of the many bilateral free trade agreements.

It is against this backdrop that this new series, entitled *Priorización de la Investigación Agropecuaria en América Latina y el Caribe* (Prioritization of Agricultural Research in Latin America and the Caribbean), is being published. The series describes several methodological approaches to the *ex ante* economic evaluation of research that can support decision making related to R&D investment by "visualizing" its implications for the future.

In 1995, IICA and the IDB signed a cooperation agreement to execute the *Project to Strengthen Capabilities and Applications for Prioritizing Agricultural Research in Latin America and the Caribbean*, coordinated by the Directorate of the Area of Science and Technology, Natural Resources and Agricultural Production of the Technical Consortium of IICA, and co-executed with IFPRI, with further collaboration from PROCIANDINO, PROCISUR, CARDI, PRIAG,

SICTA, CIAT and the national agricultural research institutes of LAC. The principal objective of the project was to develop the capability to apply prioritization methodologies for supporting decisions related to the allocation of resources to multinational and national agricultural research.

The series, which disseminates the principal outputs of the Project, consists of eight documents: 1) *Prioridades de Investigación Agropecuaria en América Latina y el Caribe: Cinco Años de Experiencia Conjunta IICA-BID* (Agricultural Research Priorities in Latin America and the Caribbean: Five Years of Joint IICA-IDB Cooperation); 2) *Dream: Manual para el Usuario* (Dream: A User's Manual); 3) *Impacto de la Investigación del Arroz en Latinoamerica y el Caribe Durante las Tres Ultimas Décadas* (The Impact of Rice Research in Latin America and the Caribbean over the Last Three Decades); 4) *Una Revisión del Software de Evaluación de la Investigación Agropecuaria* (A Review of Software Used in the Evaluation of Agricultural Research); 5) *Evaluación Económico-Ecológica de Temas de Investigación Agropecuaria en los Países Andinos* (Economic-Ecological Evaluation of Agricultural Research Topics in the Andean Countries); 6) Analysis of Agricultural Research Priorities in the Caribbean; 7) *Evaluación Económico-Ecológica de Temas de Investigación Agropecuaria en Mesoamérica* (Economic-Ecological Evaluation of Agricultural Research Topics in Mesoamerica); and 8) *Caracterización de Cadenas Agroalimentarias para Evaluar Investigación en el Cono Sur* (Characterization of Agrifood Chains in Evaluating Research in the Southern Cone). In addition to disseminating the methodologies and software developed, the series includes some specific results, such as the fact that the economic benefits of multinational research in combating *Phytophthora* in potatoes in the Andean Subregion may reach US$298 million over twenty years; in Mesoamerica, the economic benefit of projects designed to generate and adopt new varieties of rice, which cover only part of the subregion, will easily reach US$160 million over fifteen years; and among the islands of the English-speaking Caribbean, the economic benefits of research on, and the adoption of, vegetables to meet domestic demand and tourism total almost US$23 million a year. The project also had less tangible results, such as training in prioritization and the *ex ante* evaluation of agricultural research for 58 professionals from LAC, which will permit the creation of a network on these topics.

We believe that this series of publications, the principal output of the project, meets the current need for analytical instruments, methodologies, software, and examples of *ex ante* and *ex post* evaluation of the impact of investment in multinational research in LAC, within the framework of free trade. In this regard, it provides up-to-date inputs for making decisions related to investment in research. It is hoped that it will be useful to managers, researchers, planners and scholars specializing in the evaluation of the impact of investment in agricultural research in the region.

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1. INTRODUCTION

The Caribbean subregion is facing significant challenges in making agriculture and agribusiness sectors more competitive in an era of global trade liberalization. A key strategy in improving agricultural efficiency and international competitiveness in a sustainable way is the constant development, adaptation and application of appropriate technologies.

However agricultural research and development (R&D), the source of such innovations, is itself under threat. Funding from traditional sources continues to decline in real terms while the goals of public sector R&D have broadened to encompass not only increased productivity and international competitiveness, but also increased social equity and sustainability of the natural resource base. All of these factors interact to place growing pressure on research managers (a) to demonstrate that R&D investments provide significant benefits to their intended clients, and (b) to improve the efficiency of the R&D process through better allocation of scarce research resources.

The Project for Strengthening Capacities and Applications in Agricultural Research Priority Setting in Latin America and the Caribbean (IBP-2) was designed to strengthen the capacity of research analysts from Latin America and the Caribbean (LAC) to respond to demands for more and better information to support R&D investment decision-making at both the regional and national levels. The project was sponsored by the Inter-American Development Bank (IDB) and executed by the Inter-American Institute for Cooperation on Agriculture (IICA) and the International Food Policy Research Institute (IFPRI), with the collaboration of the International Center for Tropical Agriculture (CIAT). In the Caribbean, the activities of the project were executed with the support and collaboration of the Caribbean Agricultural Research and Development Institute (CARDI).

For this project a group of research analysts, research program planners and research managers from ten CARICOM countries reviewed and tested a structured, quantitative method for identifying agricultural research priorities at the national and regional level. This process involved two workshops as well as in-country data collection by the workshop participants. The participants were drawn from Antigua and Barbuda, the Bahamas, Barbados, Belize, Guyana, Haiti, Jamaica, Saint Lucia, Suriname and Trinidad and Tobago, as well as two regional institutions concerned with agricultural research (CARDI and UWI). As a result of these activities, IICA and IFPRI have facilitated a dialogue among concerned regional and national parties on the mechanisms for priority setting, as well as on the need to focus attention on capacity building in research evaluation skills.

This document is a final report of activities and products of the IBP-2 project.

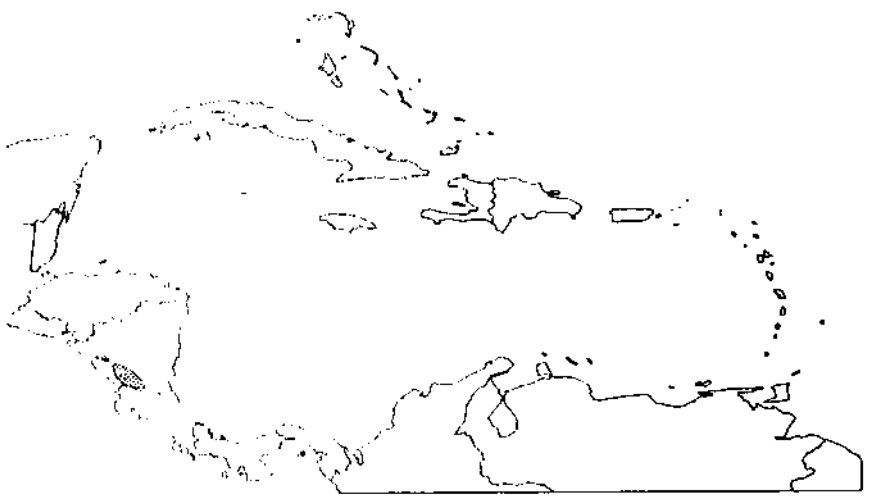
1.1. Project Objectives

The main objectives of the IBP-2 project in the Caribbean were to (a) develop capabilities that identify agricultural research priorities at the national and multinational level, and (b) design the technical component of an Agricultural Research Priority Setting System for the Caribbean (ARPSSC). It is expected that the ARPSSC will continue to evolve well beyond the lifetime of the project.

To achieve these objectives a workplan was developed together with CARDI to conduct agricultural research priority setting activities in the subregion (appendix 1). The activities of the project included the execution of two training workshops. The identification of appropriate priority setting methods and their subsequent application to the real-world scenario were performed in a dialogue with, and among, the workshop participants. At the same time, through the execution of the workshops, the building blocks of an Agricultural Research Priority Setting System (ARPSS) were visualized, debated, and documented.

1.2. Report Structure

This report is structured as follows: chapter 1 provides this brief introduction. In order to set the background for priority setting in the Caribbean, chapter 2 provides a brief description of several National Agricultural Research Systems (NARS) and of CARDI. In chapter 3, the alternative methodologies reviewed with workshop participants are presented. The core of this report is contained in chapter 4. This chapter provides a model of an ARPSSC, along with some evaluations of research themes of common interest in the Caribbean. Chapter 4 also introduces a scoring model that can be used as a starting point to set priorities at the subregional level. Finally, chapter 5 presents concluding remarks and recommendations based on the experience of the project in the Caribbean.



2. THE AGRICULTURAL RESEARCH AND DEVELOPMENT SYSTEMS OF THE CARIBBEAN

2.1. The Caribbean Agricultural Research and Development Institute

The Caribbean Agricultural Research and Development Institute (CARDI) was founded in 1975 as a regional institute to serve the R&D needs of countries within the Caribbean Community (CARICOM) region[1]. The institute succeeded the Regional Research Council (RRC) of the Faculty of Agriculture of the University of the West Indies (UWI). The Campbell Commission had recommended this initiative and member governments agreed to fund and govern the organization.

CARDI inherited the staff and resources of the RRC, which had offices and representation in several subregions. Today there are staff, offices, laboratory and equipment in each CARICOM country. A country representative heads the team, whose mandate varies from country to country. A consultation process among national planners and decision makers initiates R&D activity. CARDI's government is a Standing Committee of Ministers of Agriculture (SCMA). There is a board of directors composed of representatives from member countries, the University of Guyana, the University of the West Indies, the Caribbean Food Corporation, the Caribbean Development Bank, the CARICOM Secretariat and the Inter-American Institute for Cooperation in Agriculture. The chief executive is an executive director and there are two deputies. This organization has relational and funding support from many other local and international agencies, which provide project activity for several of CARDI's research efforts. It also has an information dissemination portfolio, which maintains a current database of information for the region's farmers and agricultural scientists.

CARDI has country specific interventions based on the needs of national governments, as well as regional objectives that serve the common interests of the region. The organization's headquarters is in Trinidad and Tobago. CARDI's R&D efforts have impacted agricultural development in numerous ways. The organization has developed technological packages for many productive activities. It has provided many informational materials derived from its research and these are used throughout the region. It participates in, and sometimes organizes, workshops, seminars, lectures and other forums in order to meet its outreach objective. In some countries the organization has introduced new commodities for the agricultural sector.

In order to streamline its efforts CARDI recently developed a number of systems. These are as follows:

- A **planning and monitoring system** for use by scientists. This utilizes a computerized database and is designed to provide an activity network by which all researchers are kept in touch.

- A **budget control system** designed to carefully streamline all spending within the organization. This is complemented by a Business Development Unit, which is designed to market research services where this is appropriate and cost-effective.

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1 These descriptions were compiled with the assistance of submissions from the following country representatives: Florita Kentish (Antigua and Barbuda), John Hammerton and Charmaine Price (the Bahamas), Harold Parham and Lisando Quiros (Belize), Michael Hunt and Winston Small (Barbados), Colette B. Zaongo (Haiti), Jean Dixon (Jamaica), Julius Poluis (St. Lucia), and Thomas Carr and Hugh Wilson (Trinidad & Tobago).

- A **human resource management system** for administrative organization.
- A **scientific management system** to manage scientists within the organization.

CARDI is, therefore, well positioned to continue to serve the needs of countries within CARICOM. In addition, it is promoting and helping in the foundation of PROCICARIBE[2].

2.2. National Agricultural Systems

The National Agricultural Research Systems (NARSs) within the CARICOM region emerged from national government policies in the post-independent Caribbean. This was in the decade of the 1960s when most of these countries had begun to receive their independence from Britain. It was also at the time when the Imperial College of Tropical Agriculture (ICTA) became incorporated into the new UWI.

Historically, several commissions, namely the Asquith Commission of 1944, and the Kearns, Bradfield and Baskett of 1963, had gradually perceived the role for regional university research that interfaced with the national systems. This new research thrust was expected to depart from the approaches of the former ICTA, which had a mandate to concentrate on research objectives for the tropical world that Britain had colonized and which extended far beyond the borders of the Caribbean. Britain's particular interest was in plantation crops, which were of commercial importance to the United Kingdom. These included mainly cocoa, coffee, bananas, rubber and sugarcane. There was a notable absence of foodcrops for the local population and a lack of research in the area of livestock improvement.

The NARSs that are presented below represent a further evolution in the direction of appropriate research organizations to meet the needs of national agricultural policies in the respective CARICOM countries.

2.2.1. Antigua and Barbuda

These islands, situated in the eastern Caribbean, occupy 440 square kilometers of land and have a population of approximately 68.000 inhabitants (1996). Eleven thousand hectares are utilized in agriculture, with approximately 38% of the population active in.this sector. The country's tourism sector is by far the most important, but there is merit in using agriculture to supply products for that industry. The agricultural sector contributes 5.7% of the Gross Domestic Product (GDP). Currently, the government is successfully encouraging the production of fruits and vegetables under irrigation to serve the tourist sector. A small number of farmers engage in local livestock production, including production of fresh milk, eggs, mutton, pork, beef and veal.

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2 PROCICARIBE is the Cooperative Program for Agricultural Science and Technology in the Caribbean. Its goal is to develop science and technology among public and private agricultural entities in support of agriculturally based industries in the Caribbean region. These activities are aimed at attaining international competitiveness and sustainable development of the region's agricultural sector. CARDI promotes and administers PROCICARIBE within its Research Coordination and Linkages Programme.

No formal research priority setting mechanism is in place in Antigua and Barbuda. However, recently there have been consultations between farmers, government departments and private sector agricultural institutions in order to identify research themes. This consultative process has provided the basis for the preparation of a list of major issues to be addressed by research, including the following:

- the number of farmers who benefit from the research
- availability of funds
- availability of appropriate human resources
- traditional and nontraditional commodities with export potential.

The major constraints identified were as follows :

Water resources

Research in this area should be aimed at increasing the efficient use of this resource, taking into consideration the quantity and period of utilization. Antigua and Barbuda are very dry islands with limited watershed capacity, hence this consideration. Much has to be done to engage the correct form of irrigation.

Marketing

Emphasis should be placed on how best to improve marketing intelligence and forecasting with a view to producing vegetables and other commodities for the tourist sector and increasing the export of these commodities. This can result in a thriving import substitution business.

Agro-ecological considerations

There is need to assess productivity based on the marked variability among local soil types. There are different micro agro-ecological zones that must be thoroughly understood.

The Ministry of Agriculture (MOA) and CARDI are currently conducting a series of research projects designed to test the adaptability of technologies to the local environment. CARDI seeks the approval of the government through the MOA for its involvement. It does this by way of a triennial consultation involving farmers, top decision makers, other technicians and experts from existing international agencies. But more meaningful collaboration is required, especially in the sharing of research information and results and in conducting useful demonstrations that are directly useful to farmers.

The MOA currently places emphasizes on the production of the following crops: Sea island cotton, hot peppers, squash, pumpkins, sweet potatoes, onions, carrots, cucumbers, pineapples, sweet peppers and eggplant. A research priority setting mechanism could help in the allocation of scarce resources among this wide variety of vegetable crops.

2.2.2. The Bahamas

This is an archipelago of 700 islands and cays in the north Caribbean that occupies an area of 13,939 square kilometers, with a population of 280,000 (1996). The islands are coral in nature and consist of mostly oolitic limestone, the type formed by shallow precipitations of calcium carbonate. Agriculture opportunities are limited by this geology, as there are only pockets of soil formations among hard, difficult-to-manage coral. On several islands the main vegetation is pine forest, while on others there is a coppice-type vegetation. Agriculture contributes approximately 3% of the country's GDP and a small percentage of the population engages in the industry. The economy is heavily dependent on tourism, a sector that must import 90% of its food needs.

There are three major agro-ecological zones and these influence the type of agricultural activity. Thus, there is considerable diversity of production systems from the northern islands to the southern ones. Large-scale production using more modern technologies are characteristic of those islands in the north. In the south, there is a preponderance of small-scale activity, and in the central area, there is a mixture of both systems.

Citrus is the major export crop. Its cultivation is managed by joint venture investments between US companies from the state of Florida and local investment interests. There is no local research support for this crop and technology is transplanted from Florida. Similarly, technology for commercial vegetable production (where this exists) is transferred from Florida.

The MOA is the sole institution involved in agricultural research, and current budget allocations are insufficient to meet research needs. CARDI's activities on these islands are presently minimal. The Inter-American Institute for Cooperation on Agriculture (IICA) is setting up a local technical agency. There are no externally funded agricultural projects. There is a single research and demonstration station located on the island of New Providence, where the capital city, Nassau, is located. Yet occasionally some trials are conducted in several of the northern islands.

There is no formal mechanism for the prioritization of research areas. Priority is currently being given to research that is intended to benefit the small producers of vegetables, including tomatoes, lettuce, sweet peppers, cabbages and onions. These products have a thriving market locally among the hotels, restaurants and local food stores.

Another areas of research could pertain to increasing swine, sheep and goat production. The central experimental research station has imported improved breeds in order to upgrade the carcas quality of these animals.

Suggested areas of research interest should include the following:

- water resource management
- on farm testing of varieties of grapes and papayas
- hydroponics for vegetable production
- organic farming and research on the implication of production in saline soils

In the future, there will be a need for research on pasture improvement, as increasing interest is given to goat and sheep production.

2.2.3. Barbados

Barbados occupies an area of 430 square kilometers and has a population of 263,000 (1996). Agriculture occupies 16,200 hectares of land, of which sugarcane is cultivated on 62%. The agricultural sector contributes approximately 33% of the GDP. Tourism is the most important productive sector. Large-scale, plantation type agriculture dominates. Sugarcane is intercropped with approximately 2000 hectares of yams and sweet potato. Livestock production is also expanding. There are also initiatives in the area of papaya, peanut, mango, banana and cherry production. Barbados, however, is a large importer of food commodities.

Research within the sugar industry is financed by the industry. Research areas are also prioritized and managed by this subsector. There is a West Indian Cane Breeding Station, which supplies the industry with appropriate planting material.

Agricultural research among other commodities is conducted by the Ministry of Agriculture and Rural Development. Major interest lies primarily in crops, livestock and natural resource management. Additionally the Department of Biology at the Cavehill Campus of the UWI conducts work in genetic engineering. CARDI conducts work in crops and livestock. The Barbados Agricultural Management Company (BAMC) also conducts some research on sugarcane. There are efforts at research collaboration among these institutions in order to maximize the utilization of resources.

There is no formal mechanism for the prioritization of research areas. A process of consultation with farmers, technicians and planners provides the basis for making informed decisions.

Funding on research is provided through annual budget allocations. There is a plan to develop a National Research Council and an Integrated National Research Fund. The other research agencies are funded in large measure through government subventions. For example, CARDI and the UWI receive funding through an agreed regional formula, and the BAMC receives a subvention from the Ministry of Finance.

A five-year development plan, prepared through consultations with key players within the sector, provides the policy framework for development of the agricultural sector.

Government policy emphasizes the prioritization of research on commodities with foreign exchange earning potential. Cotton and cut flowers are some nontraditional commodities that have been showing increasing importance as foreign exchange earners.

Barbados is a large importer of food commodities. The question of import substitution and food security are therefore important criteria in agricultural research prioritization. Research programs aimed at improving the productivity of locally produced crops such as yams and fruits are therefore being encouraged.

Urgent attention is presently directed to addressing issues related to the pink mealy bug and the amblyomma tick. The pink mealy bug is a recent threat to the region's agricultural production, while the amblyomma tick is a long-standing pest of ruminant livestock.

2.2.4. Belize

Located on the eastern coast of Central America, this is the only member of CARICOM in that subregion. It is a country of 22,799 square kilometers with 450 tiny island cays in its innercoastal waters. There is a population of 221,000 (1996), of which approximately 7,600 (3.5%) engage in primary production. The country's economy was once based on forestry, mainly the export of logwood, mahogany and chicle. Agriculture, ecotourism and manufacturing are now the main contributors to the GDP, with agriculture contributing 20.7% to the GDP. The main agricultural products include sugarcane, cocoa, citrus, mangoes, bananas, corn, beans, vegetables, tropical fruit, peanuts and coconut. These are produced particularly for local consumption. The livestock subsector caters to local needs and includes the production of poultry meat, pork, mutton and milk. The marine fisheries subsector exports shrimp, lobster and fin fish.

There are five main agricultural research institutions in Belize. These are the MOA, the Citrus Growers Association, the Banana Growers Association, Belize Sugar Industries Limited (BSI), Belize Agri-Business Company (BABCO), CARDI and Hummingbird Hershey's Limited. Areas of research among these institutions are aimed at efficient commodity production, pasture development, animal breeding, developing research-extension linkages and postharvest technology.

Consultations and interactions between farmers and technicians provide the information used for decision making and planning for agricultural research. The following are criteria for research prioritization:

- the length of time before an impact is achieved
- food Security
- the number of direct beneficiaries
- foreign exchange generation
- environmental impact and emergency issues (such as the arrival of a pink mealy bug)

The research budget of the MOA is financed by the ministry's annual budgetary allocation, and in addition, some research funding is provided by international institutions such as the Organization of American States (OAS), the Overseas Development Agency (ODA) of the United Kingdom and CATIE . There are also bilateral agreements with countries such as Cuba and China.

2.2.5. Guyana

Guyana has an approximate area of 214,000 square kilometers. Its population is 844,000 (1996) and most inhabit a coastal strip stretching 284 kilometers. The agricultural sector accounts for 50% of the county's export earnings and employs 40% of the labor force. As a key sector, agriculture contributes 25% of the GDP. Major export crops are sugar, rice, coconuts, pineapples and peanuts. In addition, a range of vegetables are grown for local use. There is a fledgling, though potentially lucrative, dairy cattle and beef industry. Pork, sheep and goats are also produced. Mining is a rival commercial activity to agriculture. Fishing, forestry and ecotourism are also important aspects of Guyana's economy.

An evaluation of the system of agricultural research in Guyana reveals that there has been little analysis of the issues of strategy, planning, organization and management of agricultural research at the national level. In the draft agriculture policy document prepared in 1994, mention is made of the importance of defining a research policy for the agricultural sector. There is, however, an apparent lack of coordination and collaboration between research institutions in Guyana.

Agricultural research priorities are closely determined by a country's social, economic and political circumstances. Guyana is basically an agrarian economy with rice and sugar being the two main export crops. The production of both these crops is presently coordinated by agencies that operate with a significant amount of autonomy from the government. Research activities within these two subsectors are presently dictated by the need for increased competitiveness of rice and sugar on the world market. In the production of both commodities, the question of productivity is of major concern. Yields per acre of both crops are relatively low by international standards, with production cost being comparatively high. Research activities in both of these industries are presently being oriented towards resolving specific problems related to improving productivity.

Apart from being an important export crop, rice is the staple food of the Guyanese population. Rice is grown primarily on the coastal plains of Guyana, where it competes with livestock, sugar and other crops for available arable lands. Improving productivity in terms of yield per acre is, therefore, emphasized from the point of view of food security and land utilization.

In Guyana, the National Agricultural Research Institute (NARI) presently has the responsibility of conducting research activities related to the production of nontraditional crops (fruits, vegetables, tubers, etc.). A commodity approach is presently being adapted for agricultural research at this institution, with interdisciplinary teams of scientists investigating specific problems that face crops with good market potential. Links are maintained with the marketing agency, the Guyana Marketing Corporation and producers, in order to ensure that research programs are prioritized in accordance with the market demand and the needs of producers.

The CARDI Guyana country work programme is developed through a series of consultations (formal and informal) involving the MOA and other government and nongovernmental agencies involved in the development of the agricultural sector.

Policy direction is provided from the MOA, which is a member of the SCMA of CARDI, and the Permanent Secretary is a member of the board of directors. Technical policy guidance is dispensed through the Agricultural Research Council of the Board of Directors of the NARI.

CARDI's entire research programme must have the guidance and endorsement of the Government of Guyana and must complement the national agricultural development policy. CARDI's "share" of the national research and development programme, as identified in the national agricultural research and development policy framework, is as follows:

- support to the livestock industry
- institutional support to the rice industry
- integrated development on the Intermediate Savannahs

Concerns related to increasing pressure caused by the existing competition for agricultural land and for residential land in the coastal regions have caused the government to focus attention on developing the Intermediate Savannahs. This area is being referred to as the "Next Frontier." In this respect, CARDI's research program in the Intermediate Savannahs is considered valuable, particularly from the point of view of the need to develop and evaluate the technological packages recommended for production systems. The prioritization of agricultural research in the Intermediate Savannahs could also be justified in light of the increasing need to diversify agricultural production. CARDI's ongoing and future R&D focus for this area will be on production and marketing systems for orchard crops and livestock.

2.2.6. Haiti

Haiti occupies the western side of the island of Hispaniola. It has an area of 27,800 square kilometers, and a population of 7.329 million (1996). Much of the country's agricultural production is carried out with the use of irrigation. There are approximately 600,000 smallholders engaging in traditional systems of cultivation. The agricultural sector is characterized by low production and productivity, with a low level of technology. The main crops are bananas, sweet-potatoes, maize, millet, cassava, yams and beans. Several treecrops are widely grown, including cocoa, coffee and mango. Sugarcane is also cultivated, with a great deal being used locally as a source of energy, and some in the manufacture of alcohol.

In Haiti research priorities are informed by interaction with farmers. This interaction serves as a basis for identifying areas for research. The research program of the ministry focuses on basic food commodities such as rice and legumes. This reflects an interest in providing adequate recommended daily requirements for the country's large and poor population. Food security needs, therefore, dictate the priorities for research.

Research is conducted by both governmental and nongovernmental organizations. There is a Ministry of Agriculture, Natural Resources and Rural Development (MARNDR), which is concerned with water management, agrarian reform and countrywide technical support services. The MARNDR has a central unit, the Center for Research and Development, which plans and executes and the respective research activities. The main topics for research are crop improvement in rice, beans, corn, sorghum, tubers, coffee and cocoa, soil conservation, animal production, fisheries and forest conservation.

Funds for research are obtained through budgetary allocations and from international agencies such as the United States Agency for International Development (USAID), the Food and Agriculture Organization (FAO) and the European Economic Community (EEC). These institutions also fund scholarships to the Faculty of Agronomy and Medicine at the local university.

Some nongovernmental agencies are involved in research. SECID works in the areas of soil conservation and the genetic improvement of forest trees. The Cooperative for American Relief Everywhere (CARE) works with soil conservation and organic agriculture. ORE works with seed improvement in corn, sorghum, beans and fruit trees.

2.2.7. Jamaica

Jamaica is the third largest island in the Caribbean, with an area of 10,940 square kilometers. It has a population of 2.47 million (1996). More than half of the population live in the capital city, Kingston. Agriculture contributes 5% to the country's GDP. A thriving export agriculture trade in many commodities exists, which includes sugarcane, bananas, coffee, coconuts, root crops, vegetables, pimento, corn and potatoes. There is an active livestock industry that provides milk and milk products, beef, mutton, poultry and pork. An inland fisheries sector exists and this provides protein for a large section of the population and for export. There are tropical horticulture endeavors in ornamentals for an export market. This highly endowed agricultural economy had its origins in the successful plantation economies of the island's former colonizers and has been strengthened by the wide range of tropical microclimates. Tourism, mining and manufacturing are other important sectors in Jamaica's economy.

The following institutions are involved in agricultural research in Jamaica: the MOA; the many commodity boards for forestry, sugar, coffee, bananas, coconuts and cocoa; CARDI; departments within the Mona, Jamaica and Saint Augustine campuses of the UWI; and several aid and private agencies. There is a special Jamaica Agricultural Research Programme of the Jamaica Agricultural Development Foundation (JADF). This agency was created with the help of USAID in response to the need for a more production-oriented agricultural research system to arrest declining agricultural production and to enhance development in the sector, especially among small farmers. Funding of research activities by the MOA is provided by budget allocations, with some amount of external funding also available. Commodity boards also receive funding from external sources through specific projects and through contributions from the sale of farmers' products.

The MOA focuses on the following research areas:

- nontraditional commodities with export potential
- the pink mealy bug, which is considered to be of national priority
- agricultural products utilized by the tourism sector (vegetables and fruits)
- domestic food production.

In Jamaica, CARDI is involved in research in the following areas: the coffee berry borer; integrated pest management, peanut production and environmental issues (soil maps, geochemical maps).

Several factors have been identified as influencing the prioritization of research areas:

- the impact on employment
- the number of small farmers affected
- food security and its effects on nutritional levels among the population
- export market potential
- agro-ecological sustainability
- import substitution
- strategic alliances

2.2.8. Suriname

Suriname occupies an area of approximately 163,270 square kilometers. There is a population of 428,000 (1996). Agriculture is second to the mining sector and contributes to employing 14% of the labor force. There is a thriving forestry sector. Most of the population live on a narrow coastal strip, which occupies 3% of the total land mass. Rice is the most important crop followed by palm oil, with some of the latter being cultivated by government owned para-state companies and some smallholders. Most of the refined oil is consumed locally but small quantities are exported. Small producers grow the bulk of citrus, peanuts, vegetables and coconuts. There is a livestock industry with a dairy cattle sector and there is substantial production of mutton and pork for local consumption.

A review of literature reveals that the nearest approximation to a recent policy statement is an extract from the government's policy statement of 1988-1993: "A framework for general provision for efficient production will be effected. This will specifically comprise facilities that can be considered encouraging as well as supporting in promoting private enterprise in agriculture, cattle rearing and fishery. Agricultural research will be concentrated on the improvement of crops, crop fertilization and mechanization and pest control."

The absence of a clearly defined national agricultural research policy in Suriname has resulted in a situation where there is little collaboration between research institutions. In fact, the research institutions are involved in research programs that reflect the interests of the specific institutions.

The areas of priority research within the research department of the MOA seemed to be based upon, among other things, the principle of import substitution in order to reduce the utilization of foreign exchange for the purchase of inputs.

Suriname is almost self-sufficient in livestock products, with the exception of milk and other dairy products. Most of the supplementary feed consumed in the livestock industry is produced by three private feed factories, and is based on imported maize, soya beans, vitamins and nutrition. This results in locally produced livestock products being relatively expensive. Local producers are, therefore, unable to compete successfully with rival imported products. The current difficult economic situation in the country and the associated lack of foreign currency have resulted in an intensification of research into improving the domestic production of corn and soya bean.

Other areas of researchs presently conducted at the Agricultural Research Department, include a program aimed at cost effective production of vegetables and bio-compost production. These have been prioritized based on the need to conserve and generate foreign currency. The price of locally produced vegetables has risen steadily as a result of the increasing scarcity of imported processed vegetables and the exorbitant prices that local producers have to pay for imported inputs (agrochemical). There is an existing potential for the export of vegetables to Holland. However, this market would demand the production of vegetables of a specified quality (minimum quantities of chemical residues) at competitive prices. Discussions are being conducted with the IICA's Agricultural Health program leader in Guyana to prepare a project to encourage the safe use of pesticides in Suriname, primarily as a response to human health and trade issues.

The ongoing research to monitor and eradicate the carambola fruit fly has significant importance to the economy in terms of facilitating the export of fruits from Suriname.

Research activities are funded by the MOA's budget allocation and international projects (Regional Carambola Fruit Fly Project)

2.2.9. Saint Lucia

Saint Lucia has a population of approximately 144,000 (1996), of which 37% are actively engaged in agriculture. It occupies an area of 616 square kilometers and has 20,000 hectares under cultivation. Agriculture contributes 15% to the island's GDP, with Saint Lucia's main export crops being bananas and coconuts. Some amount of citrus is also cultivated. More recently, a thriving vegetable production business has developed targeted at a very successful tourist industry. Rootcrops and breadfruits are cultivated as local staples in the population's diet. Some of these commodities are part of an inter-regional trade network with the northern islands of the eastern Caribbean and Barbados. Traditional fruit and ginger are also exported.

There is a livestock research station, which concentrates efforts on dairy and beef production and sheep farming. Recently there has been an increase in the production of poultry, meat and eggs.

This country's banana industry has been the focus of much attention from research. The banana growers association, which represent all active exporters of bananas, has defined the direction of research to encourage and introduce new technologies that would result in higher yields while maintaining good quality for a competitive export market.

With the threat of closed markets by traditional European buyers, there is need to diversify production out of bananas. Efforts in this respect are assisted and advised by an Agricultural Diversification Unit (ADU), which is based in the neighboring island of Dominica.

In St. Lucia, CARDI is involved in basic research, which compliments the diversification thrust of the MOA. Production is aimed at supplying the growing tourism sector with agricultural products. There is also an interest in managing the sustainability of hillside cultivations, as much production occurs on steep hillsides and watershed environments.

Technicians within the MOA, who work at the front-line farm level, inform the planners and policy makers about research needs. These two groups make the final decisions about what must be done based on the availability of resources.

2.2.10. Trinidad & Tobago

The combined area of this twin island state is 5,000 square kilometers. There is a population of 1.32 million (1996), with an estimated 1% engaged in agricultural occupations. Agriculture contributes 2% to the GDP (1997).

The country is self-sufficient in several vegetables and foodcrops, although there is potential for an export market among some crops. There also exist opportunities for postharvest processing which can add value to these crops. There are presently new and successful expansions in the rice and ornamental industries. Aquaculture, although enjoying investment, has not adequately expanded. There are viable contributions from a marine fisheries and a forestry sector. Export agriculture involves the production of cocoa beans, sugarcane and coffee. There is a livestock sector which is self-sufficient in poultry, and production of pork, beef (including buffalo), mutton and milk complements imports.

In Tobago there is less productive agriculture and the country is yet to rehabilitate the sector after major hurricane damage in the 1960's. Most products are, therefore, imported from Trinidad. There is potential to reengage cocoa and other treecrop production and also mutton production among family farms. Tourism is growing rapidly and presently provides employment for much of the island's population. In Trinidad there is a dominant crude oil and natural gas sector, which provides the country's main export earnings, along with the manufacturing base that takes advantage of relatively cheap and available energy.

Although a formal mechanism for research prioritization is not in place, planners and decision makers use several criteria in determining the kind of research activities that will be conducted. These include the following:

- the potential for generating employment
- the use of principles of integrated pest management
- the potential for impacting on foreign currency earnings and savings
- national emergencies that warrant immediate research activity, such as the recent invasion of Trinidad by the pink mealy bug
- food security issues

The research activities of the Ministry of Agriculture and Marine Resources (MALMR) are funded by research budget allocations. Strategic alliances in various areas of research exist with the key research institutions, such as CARDI, the Caribbean Industrial Research Institute (CARIRI) and the UWI.

The research unit operated as part of a government-owned Sugar Cane Company Caroni 1975 Limited conducts research in areas that would impact positively on productivity of the industry. Research themes include crop management practices, pest control and variety selection in sugarcane. The company actively researches possible replacements for sugarcane.

There is a relatively new institute, the National Institute of Higher Education, Research, Science and Technology (NIHERST), which has adopted quantitative methodologies in order to prioritize research. In particular, the NIHERST scoring technique involves a measurement of the following criteria: R&D capacity of the organization, potential benefits and the ability to capture benefits. These criteria are meant to reflect the attractiveness and feasibility of undertaking a particular research. Interest in the topic is ongoing in Trinidad.

3. REVIEW OF METHODOLOGIES TO SET AGRICULTURAL RESEARCH PRIORITIES IN THE CARIBBEAN

This chapter presents a review of some of the important methodologies used in research priority setting. These were reviewed during the first workshop to provide the participants with a clear understanding of their application, advantages and drawbacks.

3.1. Preliminary Remarks

Before discussing these methods it is appropriate to note certain points. The first of these is that there are three main reasons why agricultural research priorities are set:

1. To maximize the desired outcomes of R&D from any given set of R&D resources.
2. To guide the allocation of R&D resources to R&D activities.
3. To condition R&D support processes, for example human resources planning, facilities planning and funding strategies.

A structured method of research priority setting in research is needed in order to:

a) organize data and other information in order to ensure logical consistency and to
b) help resolve the often conflicting demands that producers, politicians, scientists and other groups place on the research system.

Research priorities are set at several levels within a research system:

1. **Strategic level.** National, regional and state level priorities are set among commodity and noncommodity research programs. The programs may represent disciplines such as plant breeding entomology or animal nutrition, or broader areas such as crop protection, natural resource management and social science research.
2. **Program level.** Within each program, priorities are set and resources are allocated among research projects.
3. **Project level.** Within each project, priorities are set among experiments, studies and other tasks. (Norton and Pardey, 1994).

3.2. Quantitative Methods for Setting Agricultural Research Priorities

Several quantitative methods are used in the setting of research priorities. These include scoring, economic surplus, econometrics and linear programming methods. In some cases these models are alternatives but sometimes it is possible to use them in combination. Of these methods the scoring and economic surplus methods, and a reduced form of the latter, will be described in this report.

3.2.1. Scoring methods

Scoring methods provide only a rough ranking of research programs. The steps involved in the use of this methodology in a given institutional setting are the following:

1. Identification of the strategic R&D objectives of the institution.
2. Identification of criteria corresponding to each objective (the criteria will serve to measure progress towards achieving the objective).
3. Allocation of weights that reflect the relative importance of each objective identified.
4. Allocation of weights that reflect the relative importance of the criteria identified for each objective.
5. Collection of data of the criteria identified for all R&D activities.
6. Application of the weighting schemes (for criteria and for objectives) to the criteria dataset to obtain overall scores for each R&D activity.
7. Ranking of the R&D activities by score.

Some of the main R&D objectives defined by research policy makers are as follows:

- **Productivity and efficiency.** This objective emphasizes the increase in production of food and tradeable goods per unit of agricultural input in order to satisfy the demands of current and future generations.
- **Equity.** This objective is to improve the income of the poor.
- **Environment sustainability.** This objective looks to make possible the continuous use of the natural resource base without unacceptable levels of degradation. (Cap *et al.* 1993).

The allocation of weights for objectives is determined by several factors. The general sectoral policy direction is often a good benchmark for attributing weights. It is recommended that this process involve policy makers, informed planners, technicians and representatives of stakeholder groups, for instance farmers and consumers. Weights are allocated by percentage, the sum of which should total 100% (see figure 3.1, where an example to prioritize Agroecological Zones with a view to allocate resources for research is shown).

For each objective several criteria can be selected. For example, the objective productivity and efficiency could be represented by the two criteria, Value of Production (VOP) and Expected Yield Increase.

Weights are also given to each criteria. The sum of criteria weights for each objective should equal 100%.

The overall score of each research theme or research option is determined by the (twice) weighted sum of its criteria values, and then scores are ranked in descending order. Based on the logic of this approach, the research theme or research option with the highest score has the greatest research priority.

Table 3.1 shows an example of the scoring method applied to the case of commodity research in Honduras.

3.2.2. Economic surplus method

Why is economic analysis of research benefits an integral part of research priority setting?

Agricultural research involves investment of scarce resources in the production of knowledge in order to increase future agricultural productivity. Investing in research is an economic problem, as research must compete with other activities for scarce resources and choices must be made about the resources to devote to research and alternative programs.

What is economic surplus?

Economists usually conceptualize economic effects in terms of supply and demand for goods and services. We represent supply and demand on a graph with a demand curve and a supply curve. The graph has price on the vertical axis and quantity on the horizontal axis. The demand curve (D) for goods or services slopes downwards because consumers will demand more as the price drops. The supply curve slopes upward because producers will supply more at a higher price. Market equilibrium is set at the price P_e where demand equals supply at the quantity Q_e(see figures 3.2.-3.5.).

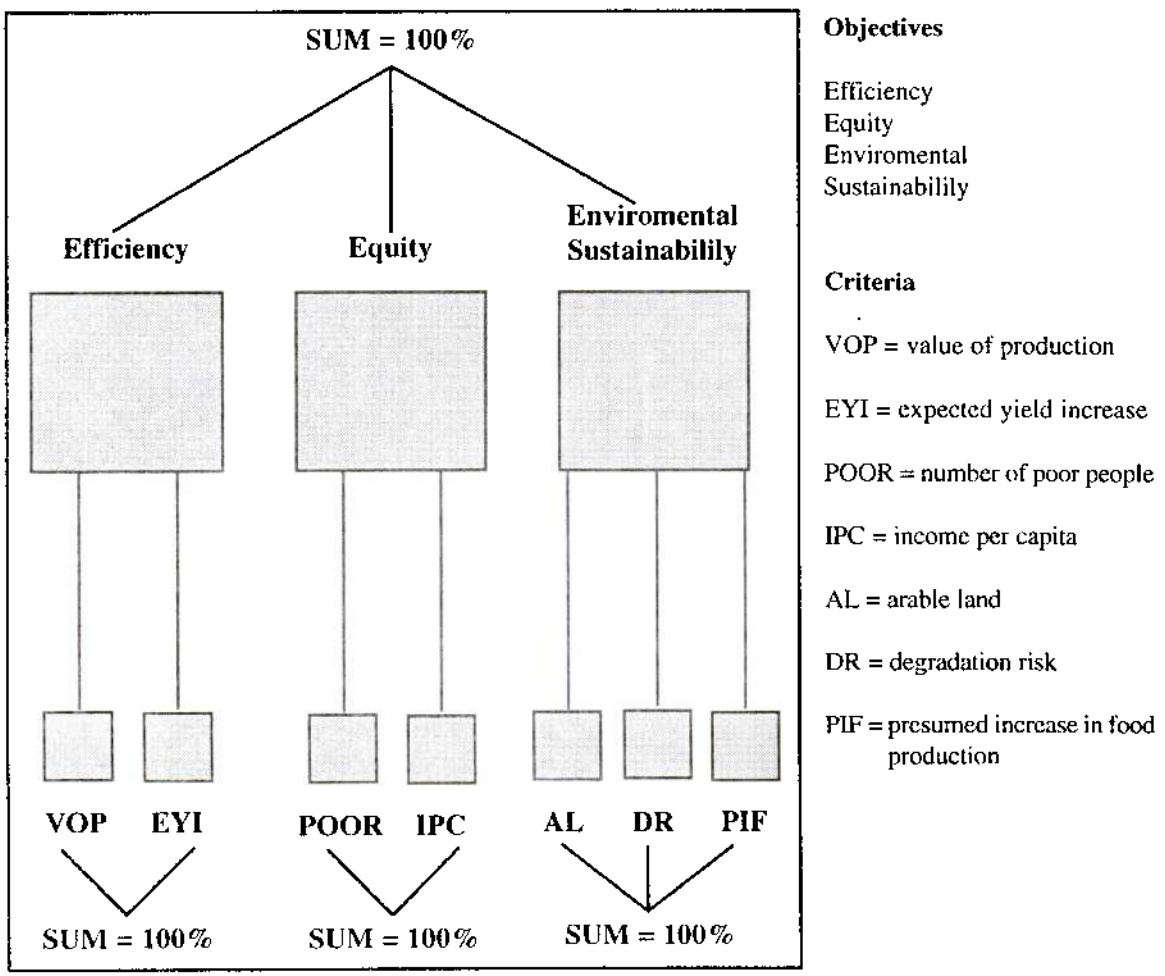

Figure 3.1. Sample Schema for Objective and Criteria Weights.

Consumer surplus is defined by the area above the price and below the demand curve and represents the additional benefits that consumers gain by consuming the quantity Q_0 at the price P_0 rather than at a higher price (see figure 3.2.). This is because at any lesser level of supply ($< Q_0$) consumers would have been willing to pay higher prices. Similarly, the producer surplus is depicted as the area above the supply curve and below the given price (see figure 3.3.). This area represents a producer surplus because producers would have been willing to supply any lesser quantity ($< Q_0$) at a lesser price.

Adoption of new technology shifts the supply curve from S_0 to S_1, resulting in a new equilibrium price and quantity of P_1 and Q_1. The supply curve shifts because the new technology increases yield or lowers the cost of production per unit of output. Therefore, producers will supply more at every price (see figure 3.5).

Gross annual research benefits are measured as the shaded area between the supply curves and beneath the demand curve. This area represented by I_0abI_1 is called the change in economic surplus. This area can be divided into producer benefits and consumer benefits. Producers may gain or lose. They may gain because they are producing more at a lower cost. They may lose if the price declines too much, but consumers will always gain as long as there is a price decline.

The economic surplus measure can be modified to account for effects of trade, pricing policies, demand shifts, and so on, and can be used to apportion benefits between different groups in society.

The economic surplus measure presented in figure 3.5. illustrates the benefits of research in one time period, say, a year. Because research takes time to complete, adoption of new technologies may occur over several years, and technologies may eventually become obsolescent, analysis of the effects of research programs should attempt to calculate the effects of research year by year. A series of calculations of shifts in supply curves and of economic surplus changes can be made over, say, 15 to 20 years tracing the benefit flows arising from a given pattern of research expenditure.

Agricultural research is a high-risk activity. Uncertainty is inherent in virtually all aspects of the research process. It surrounds most of the variables involved in the calculation of research benefits. There is uncertainty whether the research will be scientifically successful and commercially successful, and if so, how much so. The time lags and adoption paths are uncertain and so are several of the market parameters. Representing uncertainty appropriately in agricultural research evaluation and priority setting is not straightforward. At a minimum, however, it is important to take into account the possibility of failure of research through the use of some measures of probabilities of success. These probabilities vary by commodity and type of research and can be used to adjust the size of the supply curve shift.

In conclusion, total economic benefits of research and their distribution to different groups can be approximated by measures of changes in economic surpluses. Time lags, adoption patterns, research depreciation and uncertainty should be considered in the calculations.

The basic economic surplus model is the most commonly used tool for agricultural research evaluation.

Table 3.1. Determining the Importance of Research Themes Based on the Scoring Method (The Case of Honduras).

	OBJECTIVES	ECONOMIC IMPORTANCE WEIGHT: 0.5			EFFICIENCY IN USE OF RESOURCES WEIGHT: 0.2				EQUITY WEIGHT: 0.15			ENVIRONMENT WEIGHT: 0.15	OVERALL SCORE
	CRITERIA	0.333 value of production	0.333 value of int. trade	0.333 future demand	0.1 impact tech. yields	0.3 experience in research	0.5 strategic alliances	0.1 Agro-ecological suitability	0.1 importance in diet	0.6 no. of small producers	0.3 impact of tech on employment	1 impact of tech. on environment	
1	BANANA	44	45	42	45	45	45	45	40	16	45	45	39 47
2	BEEF	45	43	28	45	30	45	45	35	44	6	45	37 65
3	COFFEE	42	44	17	45	42	45	45	12	42	45	45	37 01
4	COCOA	43	36	35	45	36	45	8	23	32	45	45	36 82
5	PLANTAIN	33	34	34	45	34	45	33	37	37	45	45	35 91
6	CORN	41	19	28	45	44	45	45	35	45	45	45	35 64
7	BEAN	37	17	34	45	43	45	45	44	43	45	45	35 39
8	PINEAPPLE	40	40	20	45	41	45	33	30	29	45	45	35 36
9	POULTRY	38	29	43	45	14	45	33	39	39	7	45	34 42
10	SOYA BEAN	18	39	42	45	37	45	45	11	24	45	45	34 50
11	CITRUS	36	35	28	45	22	45	33	30	33	45	45	34 43
12	POTATO	24	28	34	45	34	45	45	36	36	45	45	33 89
13	TOMATO	19	25	42	45	34	45	45	22	30	45	45	33 05
14	CANTALOUPE	25	38	31	45	24	45	33	30	24	45	45	32 99
15	RICE	35	16	21	45	39	45	45	41	41	45	45	32 55
16	MANGO	21	20	45	45	34	45	45	32	36	45	45	32 30
17	SUGARCANE	34	41	12	45	36	45	33	41	10	45	45	32 10
18	FOREST	39	42	14	45	34	45	33	2	31	6	45	31 74
19	SORGHUM	28	13	28	45	39	45	45	14	40	45	45	31 58
20	ONION	30	13	45	45	22	45	8	22	24	45	45	31 55
21	WATERMELLON	22	39	31	45	16	45	33	30	25	45	45	30 95
22	SQUASH	27	13	42	45	15	45	33	22	17	45	45	29 90
23	COCONUT	23	31	17	45	34	45	33	33	19	45	45	29 77
24	CASSAVA	31	13	20	45	22	45	33	35	33	45	45	29 63
25	CABBAGE	26	21	20	45	26	45	33	22	28	45	45	29 30
26	MARANON	18	23	31	45	13	45	33	30	24	45	45	28 97
27	GARLIC	18	13	42	45	22	45	33	12	12	45	45	28 17
28	SESAME	18	13	28	45	34	45	33	12	26	45	45	28 25
29	GOAT	18	13	37	45	22	45	33	12	38	6	45	28 20
30	GRAPE	18	27	28	45	12	45	33	12	12	45	45	27 77
31	PALM	29	13	17	45	25	45	33	42	16	45	45	27 26
32	APPLE	18	33	17	45	12	45	33	12	12	45	45	27 02
33	TAMARIND	18	13	37	45	12	45	8	30	12	45	45	26 39
34	PEACH	18	37	11	45	12	45	33	12	12	45	45	26 72
35	AVOCADO	18	18	28	45	12	45	33	31	12	45	45	26 70
36	CUCUMBER	20	32	11	45	12	45	8	22	16	45	45	26 28
37	HOT PEPPER	18	26	11	45	24	45	33	22	12	45	45	25 94
38	PORK	32	35	1	45	22	45	45	34	35	6	45	25 50
39	CARROT	18	13	11	45	12	45	8	22	28	45	45	24 24
40	PEANUT	18	22	11	45	14	45	8	12	12	45	45	24 09
41	COTTON	18	24	13	45	34	45	8	2	12	6	45	23 98
42	PAPAYA	18	13	11	45	12	45	8	30	19	45	45	23 52
43	BEET	18	14	11	45	12	45	33	12	12	45	45	23 27
44	LETTUCE	18	13	11	45	12	45	33	22	12	45	45	23 27
45	PASSION FRT	18	13	11	45	12	45	8	12	12	45	45	22 02

Source: Medina Castro 1991

(e.g., Banana. Score 39.47 = 0.5 [(0.33*44)+(0.33*45)+(0.333*42)] +0.2 [(0.1*45)+(0.3*45)+(0.5*45)]+(0.1*45)] + 0.15 [(0.1*40) + (0.6*16) + (0.3*45)]+0.15[1*45]

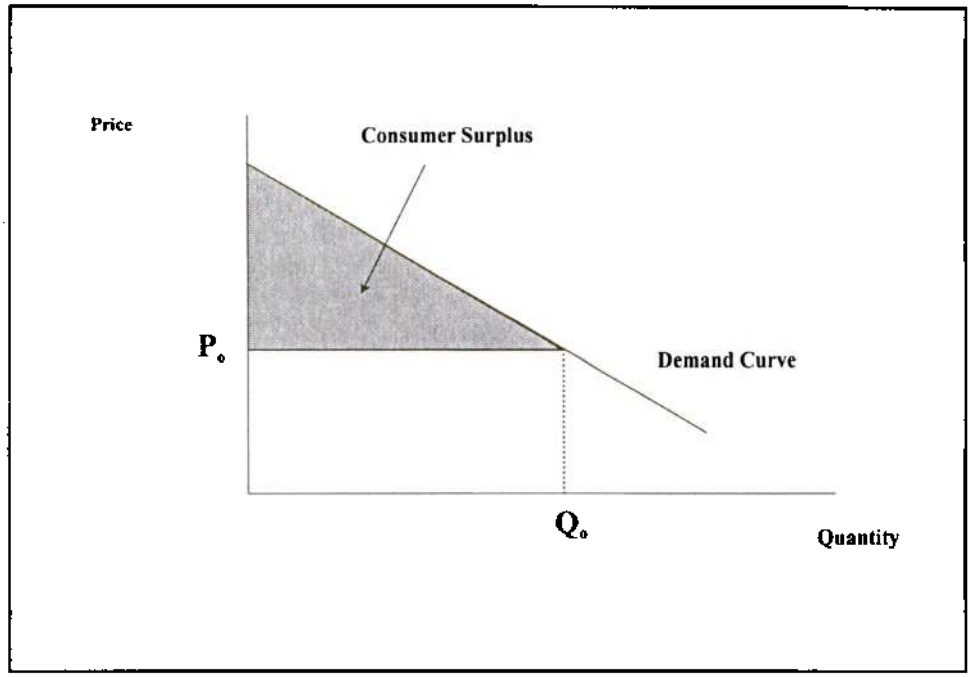

Figure 3.2. Demand Curve and Consumer Surplus.

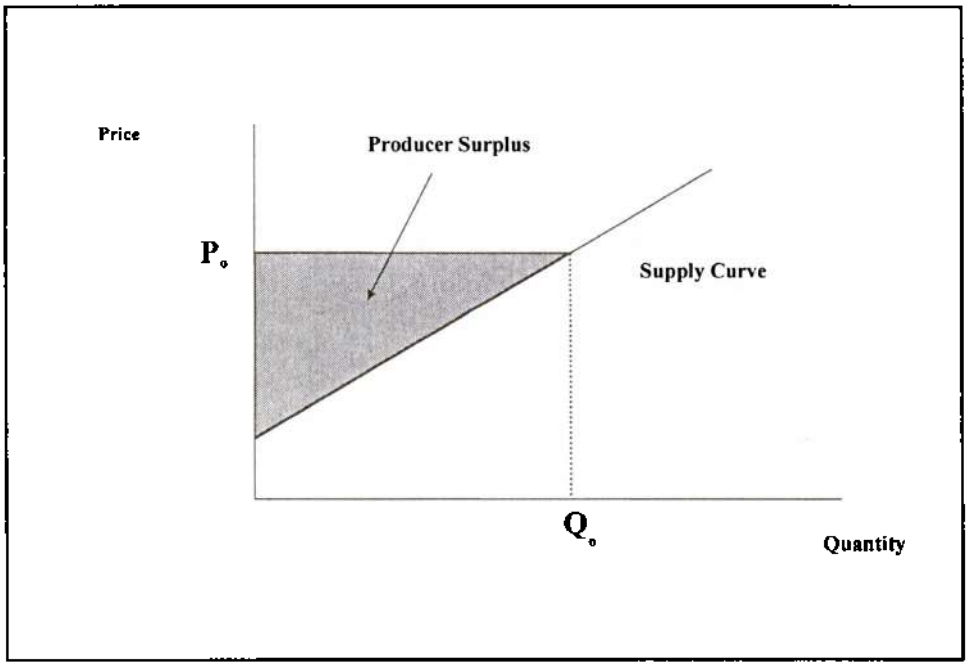

Figure 3.3. Supply Curve and Producer Surplus.

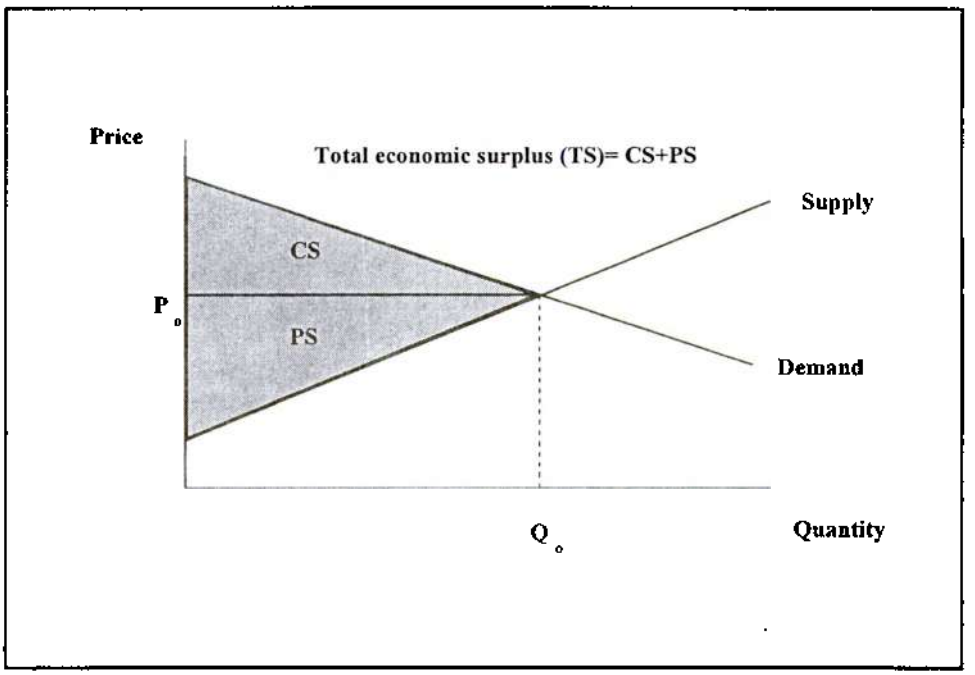

Figure 3.4. Market Equilibrium and Economic Surplus.

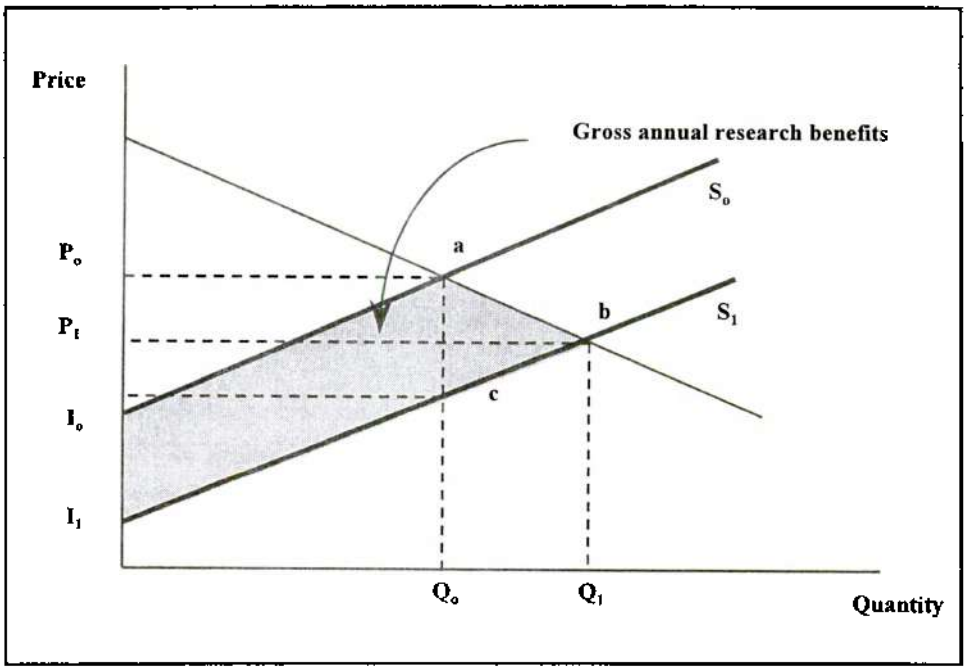

Figure 3.5. Market Effects of Technical Change.

3.2.3. Reduced form of the economic surplus method

It is possible to derive an efficiency index of new technology that corresponds relatively close to economic surplus measures[3]. This index has been calculated in an exercise for Venezuela (Lima and Norton, 1993) and is given by the following equation:

$$(1)\quad G_i = (P_i * Q_i)* A_i * p_i * Y_i$$

Where the base-line value of production of each commodity, *i*, $P_i * Q_i$ is multiplied by the proportion of farmers likely to adopt the new technology (A_i), the probability of success of the new technology (p_i), and the anticipated proportional reduction of cost or proportional yield increase (Y_i). If the new technology increases yield and at the same time increases the cost of production, then Y_i consists of the proportional increase in yields minus the proportional increase in cost.

This is a proxy for annual research benefits. However, many factors are excluded, including the time flow of cost and benefits.

A net efficiency index, N_i, can be derived dividing the gross efficiency index by the research cost R_i. Hence,

$$(2)\quad N_i = G_i / R_i$$

In addition, if it were relevant, a small producer index could be derived by multiplying the net efficiency index by the percentage of small producers.

3.2.3.1. Efficiency index for research components

An efficiency index can be calculated for components of research programs, such as plant breeding, crop management and soil science. For a specific component (c) of a commodity research program, the net efficiency index can be defined as follows:

$$(3)\ N_{i,c} = \{(P_i * Q_i) * A_{i,c} * p_{i,c} * Y_{i,c}\} / R_{i,c}$$

In this formula, $A_{i,c}$, $p_{i,c}$, $Y_{i,c}$ and $R_{i,c}$ have the same meaning as in formula (1) applied to the component c of the research program of commodity *i*.

The net efficiency index can be computed for the commodity research programme as a whole. This index consists of the weighted average of the indices of the components of the research program. If the program consist of (C) components, the index is given by

$$(4)\quad N_i = \sum_{c=1}^{c} (R_{i,c} / R_i) N_{i,c}$$

3 This section draws from Alston, Norton and Pardey 1995

In table 3.2 efficiency indices are calculated for components and research programs for several commodities from an exercise undertaken in Venezuela (Lima and Norton 1993).

Below is an explanation of the parameters described in table 3.2:

a. $P_i Q_i$ = value of production without research for commodity *i*.
b. Maximum proportional yield change due to research, presuming that research is successful (or total change in the unit cost of production).
c. Proportional yield (unit cost) change due to plant breeding, plant production, crop management, soils and others.
d. Probability of success of obtaining the expected results.
e. Maximum proportion of farmers likely to adopt the research results.
f. Gross efficiency index for each research program component = (value of production) x (total yield (unit cost) change) x (proportional yield (unit cost) change of component) x (probability of success of component) x (maximum adoption rate by program); see formula (l) above.
g. Net efficiency index = sum of program components area gross efficiency indices/research cost (or number of scientists in the program).
h. Small farm index = (net efficiency index) x (percent small farmers); a small farm index could also be developed for each program component.

3.3. Comparative Summary of Research Evaluation Priority Setting Methods

After being provided with theoretical and practical information on the three quantitative methods described above which may be used for research evaluation and prioritization, participants of the first workshop helped to compile a comparative summary of the methods. The results of this exercise is shown in table 3.3.

3.4. Questions and Comments by Participants of the First Workshop

1. The proper understanding and utilization of the economic surplus method may be difficult for someone who does not have a good background in economics.

2. For some countries it is a big jump to move from a system where there is no structure in determining research priorities to one in which quantitative methodologies are used.

3. In the context of existing financial constraints, how do small developing countries develop the mechanisms/systems to utilize these quantitative methods in research priority setting?

4. With limited funding many countries with small research budgets end up focusing on research areas that might be of urgent need but not necessarily a top priority.

5. The private sector should become more involved in research. Actual examples of this were cited: the sugar industry in Barbados and the large banana farmers in Jamaica. Mention was also made of the support given by small citrus farmers to citrus research programs in Belize.

Table 3.2. Derivation of Net Efficiency Indices of Research Commodity Programs.

No. Commodity	(a) Value of Production (MILL.BS)	(b) Total Yield Change (%)	(c) Proportional Yield Change by Component: Breeding (%)	Plant Protection (%)	Crop Management (%)	Soils (%)	Others (%)	(d) Probability of Success: Breeding (%)	Plant Protection (%)	Crop Management (%)	Soil (%)	Others (%)	(e) Adoption rate: Breeding (%)	Plant Protection (%)	Crop Management (%)	Soil (%)	Others (%)	(f) Efficiency index: Breeding (MILL BS)	Plant Protection (MILL BS)	Crop Management (MILL BS)	Soil (MILL BS)	Others (MILL BS)	(g) Net Effic. Index	(h) Small-Farm Index
1. Corn	11140	15	30	20	30	18	2	70	30	65	65	30	30	30	40	30	30	105.3	30.1	130.3	58.7	3.0	20.5	7.2
2. Rice	5945	10	30	20	50	0	0	80	70	90	0	0	90	70	70			128.4	58.3	187.3	0.0	0.0	34.0	13.6
3. Sorghum	5507	0	30	20	50	0	0	80	50	50	0	0	80	60	40			0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Chickpea	399	12	50	10	30	0	10	70	65	75	0	40	30	30	30		20	5.0	0.9	3.2	0.0	0.4	4.8	2.9
5. Beans	1993	10	40	25	25	0	10	70	55	75	0	40	35	30	40		20	19.5	8.2	14.9	0.0	1.6	8.9	3.5
6. Lentils	197	17	40	20	30	0	10	70	65	80	0	40	25	30	30		20	2.3	1.3	2.4	0.0	0.3	2.1	1.5
7. Potato	3144	5	25	30	20	0	25	70	80	80	0	60	35	50	40		30	9.6	18.9	10.1	0.0	7.1	4.6	3.0
8. Cassava	3013	45	30	10	20	20	20	90	80	80	80	70	30	20	30	30	40	109.8	21.7	65.1	73.2	75.9	38.4	23.0
9. Avocado	522	10	5	70	25	0	0	40	70	40	0	0	50	40	40			0.5	10.2	2.1	0.0	0.0	4.3	3.0
10. Banana	6556	5	20	50	30	0	0	30	65	55	0	0	40	25	30			7.9	26.6	16.2	0.0	0.0	12.7	8.9
11. Plantain	4699	10	25	45	30	0	0	30	65	55	0	0	40	25	30			14.1	34.4	23.3	0.0	0.0	17.9	12.6
12. Mango	531	10	5	70	25	0	0	25	60	60	0	0	50	50	40			0.3	11.2	3.2	0.0	0.0	4.9	3.4
13. Orange	2102	15	30	30	20	20	0	30	70	50	40	0	40	50	50	40		11.4	33.1	15.8	10.1	0.0	17.6	8.8
14. Onion	1213	1	20	40	40	0	0	80	70	50	0	0	50	60	50			1.9	2.0	1.2	0.0	0.0	2.1	1.3
15. Pepper	557	0	10	50	40	0	0	60	70	70	0	0	30	30	50			0.0	0.0	0.0	0.0	0.0	0.0	0.0
16. Tomato	2601	5	25	40	20	15	0	50	70	40	40	0	40	60	60			6.5	21.8	6.2	0.0	0.0	8.6	4.3
17. Garlic	625	0	0	0	0	0	100	0	0	0	0	30					70	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18. Ajonjoli	1671	10	20	25	20	25	10	50	70	70	50	50	70	70	60	70	70	11.7	20.5	14.0	14.6	5.9	13.3	2.7
19. Cotton	2404	5	20	40	15	15	10	50	60	70	70	80	60	50	30	50	40	7.2	14.4	3.8	6.3	3.8	5.9	1.2
20. Palm Oil	14	10	5	30	30	35	0	50	70	70	90	0	40	90	90	90		0.0	0.3	0.3	0.4	0.0	0.2	0.0
21. Coconut	4112	13	40	30	30	0	0	80	80	50	0	0	30	30	40			51.3	28.9	32.1	0.0	0.0	37.4	7.5
22. Sunflower	1727	15	10	30	60	0	0	50	80	60	0	0	40	70	60			5.2	43.5	56.0	0.0	0.0	26.2	2.6
23. Cacao	987	70	20	60	20	0	0	50	60	70	0	0	10	30	30			6.9	74.6	29.0	0.0	0.0	15.8	11.1
24. Coffee	5730	50	40	5	10	40	5	90	90	80	50	70	40	30	30	20	20	412.6	38.7	68.8	114.6	20.1	43.6	34.9
25. Sugarcane	5749	5	40	20	30	10	0	90	90	80	70	0	70	70	70	70		72.4	36.2	48.3	14.1	0.0	8.6	5.1
26. Milk	20241	30	30	20	40	10	0	70	70	70	70	0	10	60	40	30		127.5	510.1	680.1	127.5	0.0	43.8	13.1
27. Beef	37988	25	15	20	50	15	0	35	50	60	50	0	10	50	30	30		49.9	474.8	854.7	213.7	0.0	48.3	4.8
28. Lamb	234	20	20	0	40	20	0	40	0	60	60	0	10		10	10		0.4	0.0	1.1	0.6	0.0	1.0	0.7
29. Goat	755	10	50	0	50	0	0	80	0	80	0	0	50		50			15.1	0.0	15.1	0.0	0.0	4.3	4.3
30. Pork	9208	5	20	30	30	20	0	50	80	80	40	0	60	80	80	30		27.6	88.4	88.4	11.0	0.0	53.9	0.0
31. Poultry	38868	1	20	10	40	20	10	50	50	80	50	30	80	90	60	60	40	29.5	16.6	70.8	29.5	4.4	21.5	4.3

Source: Lima and Norton 1993.

Table 3.3. Comparative Summary of Research Evaluation and Prioritization Methods.

Method	Data	Advantages	Disadvantages	Remarks
Scoring	- Objectives and weights - Criteria and weights - Scores	- Very easy to explain & implement - Can be used for all types of R&D - Brings structure to priority setting process - Valuable screening tool	- Subjective - Possible double counting (can be minimized by using criteria that are not closely related) - Problems with units and aggregation	- Can separate feasibility and attractiveness
Reduced-Form Economic Surplus	- Price - Quantity - Yield/cost change - Probability of success - Maximum adoption - Area change - R&D costs	- More economic rigour than scoring - Output more useful for resource allocation - Minimizes double counting and unit problems	- Commodity and production level based - Requires more data	- Can obtain efficiency indexes of research programs
Economic Surplus	- *As above plus* - R&D time lag - Adoption time lag - Supply elasticity - Demand elasticity	- Recognizes price-quantity linkages - Recognizes time dimension - Producer and consumer benefits	- Data intensive; - Commodity and production level based - Probably infeasible without inputs of a trained economist	- Can allow for exogenous growth and policies (taxes & subsidies) - Multiregion analysis

6. Mention was made of the relative difficulty of obtaining funding for research related to nontraditional agricultural crops, as compared to crops of more economic importance. Efforts should therefore be made to develop networks for research activities related to these crops. This would result in significant rationalization in the use of resources.

7. The possibility of utilizing the expertise of CARDI's Planning and Business Development Unit (PBDU) to assist interested countries in the utilizing the quantitative approaches

4. TOWARDS AN AGRICULTURAL RESEARCH PRIORITY SETTING SYSTEM FOR THE CARIBBEAN

This chapter sets out the building blocks of an Agricultural Research Priority Setting System for the Caribbean (ARPSSC). In this respect, a simplified model of an ARPSSC is proposed. Three of its key components were developed during the course of the project and are as follows: (1) the set of methodologies that were exposed to workshops participants (see chapter 3); (2) evaluations and relevant information of an initial set of research themes of common interest, proposed by workshop participants (section 4.2); and (3) a scoring schema to set agricultural research priorities at the regional level. This schema was proposed by the country representatives who participated in the second workshop (section 4.3).

4.1. A Simplified Model of an ARPSSC

An ARPSSC would be a mechanism by which agricultural research priorities at the national and regional levels could be identified. The ARPSSC aims to reach stakeholder consensus on priorities in order to aid meaningful decisions about allocating resources to research at national and regional levels.

The mechanism has three main components: (1) a process (i.e., a set of interrelated activities) to identify appropriate R&D interventions and to set priorities; (2) a set of methodologies to evaluate ex-ante research, and (3) a set of relevant information pertaining to R&D and its potential impacts. The main outputs of the ARPSSC are agricultural research priorities of research options at both national and regional levels.

The rationale for this approach includes the following:

- It increases the relevance of research by fostering consultation/participation in the identification of research demands.
- It promotes the use of consistent, transparent and readily applied methods for screening identified research themes[4].

4 Research themes are equivalent to individual "Center of Focus" activities as defined in CARDI planning documents (e.g., IPM for rice, improvement of small ruminants - goats, and sustainable farming systems for the dry hillside regions).

The simplified model of an ARPSSC consists of two levels of identification of priority research themes (national and regional), as described in the flow chart of figure 4.1. The model assumes that national research priorities are the primary inputs used to derive research themes of regional common interest. A scoring schema can then be applied to screen regional themes of common interest.

4.1.1. National level identification of priority research themes

1. The first step of the process consists of the identification of clients and stakeholders of the National Agricultural Research System (NARS), such as associations of producers, sector representatives (tourism, agroindustry) and conservation specialists. The overall goals and objectives of agricultural R&D must be articulated, reviewed, and agreed upon, in terms of the goals and objectives of clients and stakeholders. Consensus is then required on establishing criteria by which research options may be evaluated.

2. A second stage involves the identification of constraints, research demands and scientific opportunities. This involves consultation with scientists, research managers, extension workers, and technology users. In addition, feasible research responses should be identified, both from a national (countrywide) and international (collaborative research) perspective.

3. A third step consists of drawing up a schedule of potential research themes based on the results of steps 1 and 2.

4. The fourth step involves screening potential research themes and using an agreed-upon methodology to generate ex-ante assessments of potential contribution to identified R&D goals, and hence a proposed set of national priorities.

5. The fifth step of the ARPSSC at the national level consists of consultation with relevant stakeholders to review the ex-ante evaluations and initial assessments of national priorities. On the basis of this technical, and other nontechnical, information, this consultation process determines national R&D priorities.

4.1.2. Identification of priority research themes at the regional level

1. At this level, representatives of national institutions or regional research entities begin the process when they submit research themes to be considered at the regional level. These themes are usually based on national priorities. However, the opportunity will always exist for research themes to be proposed by regional or extra-regional entities.

2. A second element of the process consists of reaching consensus between national and regional parties about objectives and criteria to evaluate regional research themes of common interest. In this step, the objectives and representing criteria of a scoring schema should be clearly specified (a scoring model for this purpose is proposed in section 4.3).

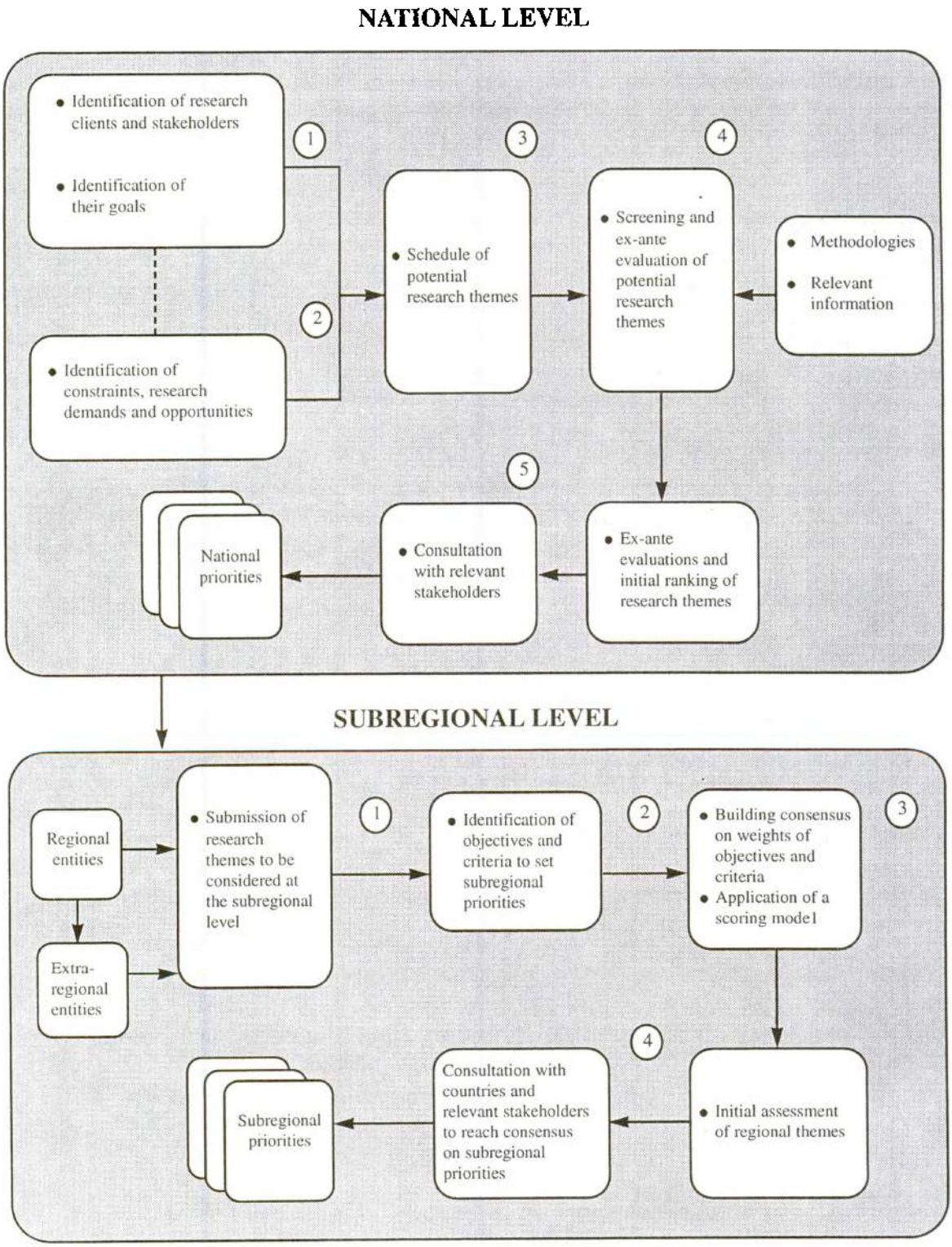

Figure 4.1. A Model of an Agricultural Research Priority Setting System for the Caribbean.

3. The third step of the process builds consensus on weights of objectives and the corresponding criteria, and the scoring model is applied to obtain an initial ranking of research themes.

4. The final stage of the ARPSSC involves consultation with countries, relevant stakeholders and regional entities in order to reach consensus on research priorities at the regional level.

Information on identified priorities should be widely available to help create a common vision of priorities.

4.2. Ex ante Evaluation of Research Themes of Common Interest

4.2.1. Selection of themes

In the first workshop participants were divided into three groups. Each was required to identify six research themes of national importance that could also represent regional priorities. They then defined specific research objectives and related criteria that helped them to select these themes. A plenary session arrived at a final consensus of themes of common interest at the regional level and the method to evaluate them ex ante.

The three groups consisted of the following representatives: Group 1 -Belize, Guyana, and Haiti; Group 2 -Antigua and Barbuda, the Bahamas, Barbados, and Saint Lucia; Group 3 -The Dominican Republic, Jamaica, and Trinidad and Tobago. Each group organized their own discussions but were mandated to appoint a chairperson responsible for coordinating and reporting the group's results.

Group 1 selected themes related to research in rice production and in livestock development.

With respect to rice, the following specific themes were indicated:

- water management.
- breeding for appropriate varieties
- integrated pest management
- processing and utilizing by-products
- mixed farming systems, e.g., rice/cattle, rice/grain legumes, rice/vegetables and rice/aquaculture.

With respect to livestock, the following specific themes were named:

- internal parasite control
- the utilization of rice straw
- the development of animal genetic resources.

Group 2 recognized the dependence on monoculture operations that existed in their countries. They also asserted the significance of the tourism sector and felt that it was important to consider its effect on the agricultural sector. These factors influenced the choice of themes, which were as follows:

- year-round production of salad vegetables
- the production of lamb for a local niche market
- the production of tree crops for a niche export market
- production systems for the postharvest handling of root crops
- production systems for fresh herbs in underutilized areas
- the development of rapid response systems for the control of the pink mealy bug.

Group 3 identified the following commodities as focus areas for research: sugar, bananas, plantains, citrus, papaya, cocoa and meat and dairy. They concluded that program objectives should aim to reduce production costs, improve yields and generally improve quality. This group identified several project areas that could be guided by the research program objectives:

- improvement through genetic engineering, traditional breeding and testing
- management practices related to plant density, trace element nutrition, water management, mechanization and crop rationing (especially with regard to sugarcane)
- improved product quality as it relates to shelf life, aesthetics and nutritional value
- improved pest management, especially with regard to lower pesticide residues and usage
- genetic improvement in cattle
- the use of embryo manipulation in cattle
- the use of improved feed for cattle.

The three groups met in plenary in order to select 6 themes out of 19, which could be an initial priority list for an ex ante evaluation. The discussion that followed served to further clarify their understanding of the methodology, and participants realized that arriving at a consensus was a useful practice. Many of them experienced the shortlisting dilemma when they needed to prioritize objectives in their own countries. They acknowledged that since the longer list was based on general interest in particular commodities, it might be easy to select six. This underscores the issue of stakeholders' interest in the process. It was decided that each group propose two items. The following themes were finally selected:

- water management in rice production
- the control of internal parasites in small ruminants
- year-round production of salad vegetables
- genetic improvement in sugarcane
- reducing the use of pesticides in papaya
- the production of fresh herbs on underutilized land.

A research theme in this context was defined as a "cross" between a researchable area, e.g., water management, and one or more commodities within that particular area, e.g., rice production. Table 4.1. shows the selected themes and the countries that were interested in evaluating them in a second workshop.

Table 4.1. Matrix of Research Areas of Interest by Country.

R&D Themes	Belize	Bahamas	Haiti	D.R.	St. Lucia	Antigua	Jamaica	Barbados	Guyana	Suriname	Trinidad
Rice											
- Water management	x		x	x					x	x	x
Livestock (small ruminants)											
- Internal parasite control		x	x		x	x		x	x	x	x
Salad vegetables											
- Year-round production	x	x	x		x	x	x	x		x	x
Fresh herbs											
- Production sys. for underutilized areas		x			x	x		x			x
Sugar											
- Genetic improvement			x	x			x	x	x		x
Papaya											
- Reduce pesticides residues				x			x				

4.2.2. Selection of a quantitative method

The next task concerned the selection of one of the three methods for priority setting, the scoring method, the economic surplus method or the reduced-form, economic surplus method. Following review and debate, the group selected the final method and designed a questionnaire for collecting the appropriate data. This instrument was designed to collect data pertaining to each research theme/commodity in each country, and is presented in appendix 2. Each representative agreed to complete the questionnaire for their own themes of interest, and to send the data to the workshop facilitators prior to the second workshop. There was no follow-up involvement from the Dominican Republic and Guyana, hence the analysis in the second workshop proceeded without the inclusion of these countries.

4.2.3. Evaluation of research themes of common interest

Table 4.2 sets out the benefit indices for the research themes of common interest, as estimated by the participants using the reduced-form, economic surplus model with their own national data. As described in chapter 3, the gross efficiency index (GEI) represents the potential value of R&D as characterized by four key factors: (1) value of production, (2) level of adoption, (3) the net unit cost reduction brought about by research, and (4) the probability of research success. The net efficiency index (NEI) refers to the GEI divided by an estimate of the R&D cost. In this case it is assumed that the number of (full-time equivalent) scientists is a reasonable proxy indicator of total R&D costs.

These indices are crude approximations to gross and net research benefits. Nevertheless, the following observations can be made. From table 4.2, one notes the likely high payoff for research on salad vegetables, especially in the Bahamas, Barbados, Jamaica and Suriname. This result is related to the fact that salad vegetables, which supply the tourism sector of the first three countries, are agricultural products with a high value of production. Even when the net efficiency index (annual net benefits) is considered, research on salad vegetables still has a high return. The detailed tables contained in appendix 3 show that: in Barbados there may be high returns to research on cabbage, cucumber and carrots, while in Jamaica research on lettuce and tomato appears to have a high return. Research on fresh herbs has a high payoff in the Bahamas, St. Lucia, and Trinidad and Tobago.

The high gross return to research on sugarcane in Jamaica and Trinidad and Tobago is noteworthy, as is the high net efficiency index of the latter. Rice research has high gross returns for Haiti, Suriname, and Trinidad and Tobago. Finally, research on small ruminants is likely to have a high payoff in St. Lucia.

Further detailed insights can be derived from the results presented in appendix 3.

Table 4.2.a. Benefits of Research by Country.

Research / Themes/area	Bahamas		Barbados		Belize		Haiti	
	Gross Efficiency Index (US$/year)	Net Efficiency Index per $	Gross Efficiency Index (US$/year)	Net Efficiency Index per $	Gross Efficiency Index (US$/year)	Net Efficiency Index per $	Gross Efficiency Index (US$/year)	Net Efficiency Index per $
Tree crops	459,383	1.7						
Fresh herbs	148,579	3.0						
Root crops	63,204	0.7	538,118	20.0				
Salad vegetables	987,765	11.8	1,640,116	12.2				
Small ruminants	223,834	1.7	18,222	0.7			n.a.	n.a.
Rice					152,421	0.8	6,386,307	n.a.
Sugarcane								
Papaya								

Table 4.2.b. Benefits of Research by Country.

Research / Themes/area	Jamaica		St. Lucia		Suriname		Trinidad & Tobago	
	Gross Efficiency Index (US$/year)	Net Efficiency Index per $	Gross Efficiency Index (US$/year)	Net Efficiency Index per $	Gross Efficiency Index (US$/year)	Net Efficiency Index per $	Gross Efficiency Index (US$/year)	Net Efficiency Index per $
Tree crops								
Fresh herbs			24,734	1.9			574,910	2.9
Root crops								
Salad vegetables	18,677,458	8.6	323,785	0.6	928,813	10.9	116,315	0.4
Small ruminants			12,467	3.4	8,430	0.0	14,624	0.5
Rice					2,634,217	12.4	1,180,138	n.a.
Sugarcane	1,756,413	2.2					1,456,782	57.8
Papaya	451,873	0.9						

Source: Elaborated with data from appendix 3, which was provided by participants in the second workshop.
See section 3.2.3. for details on the calculations of GEI and NEI.
n.a.: Not available.

4.3. Scoring Schema for Setting Regional Agricultural Research Priorities in the Caribbean

Participants at the second workshop discussed a proposed scoring model aimed at setting priorities in the Caribbean at the regional level. In this context, the discussion sought to define objectives and to consider the measurable criteria that best represent the objectives proposed. This was an important aspect of the prioritization process, since objectives were the point of focus. While policies and policy weights (and, hence, R&D goals) may be fixed by broader political processes, research objectives refer to solutions that are attainable by researchers.

Four broad research objectives were identified and further discussed by participants: equity, efficiency, environmental sustainability, and indigenous resource development. The deliberations concerning these are described below.

4.3.1. Equity

This objective aims at attaining a more equal distribution of income from research results. In other words, disadvantaged groups must not be further disadvantaged by the adoption of new technologies. Criteria for its measurement must, therefore, reflect whether research benefits are more equitably distributed. Some participants expressed concerns over bias in the consultations with stakeholders. For instance, there could be large private sector investors whose research interests may generate more sophisticated demands for technology, excluding other, less powerful, stakeholders.

Equity will always be a difficult objective to achieve. And it is not always clear that research is the most appropriate means at society's disposal for achieving it. However, two criteria for addressing the equity issues of R&D were identified:

- provision of opportunities to improve the income of the disadvantaged poor, and
- improvement of food security, the availability of adequate quantity and quality of food at an affordable level.

4.3.2. Efficiency

This objective relates to growth in productivity through research, contributing to the increased production of food and tradable goods that satisfy the demands of current and future generations.

The meeting identified yield increase, cost reduction, and/or improved quality of product, net benefits and domestic resource costs as measurable criteria. Increased yields or cost reduction can be converted into a gross efficiency index as defined by the reduced form of the economic surplus method. The criteria pertaining to this objective were summarized as follows:

- gross and/or net efficiency index
- improvement of product quality

4.3.3. Environmental sustainability

This objective seeks to ensure the continuous use and improvement of the natural resource base of the region, and was viewed as an important objective. Research activities must be weighted according to their ability to reduce negative impacts on the natural resources of a country. The criteria representing this objective were summarized in the following:

- impact on flora and fauna
- impact on air, soil and water resources
- impact on marine, coastal and forest resources

4.3.4. Indigenous resource development

This objective has its origins in the concern that researchers within the region often take a reactive technology development role rather than a proactive one. This results in a number of endeavors that test technologies from other regions rather than trying to promote technologies which seek to use indigenous resources competitively. Thus, there is a plethora of technologies that rely on costly imported requirements for their proper implementation and use. It is therefore important to measure criteria related to this objective. The use of indigenous resources could deliver unique products to the market, consequently developing a market niche.

The potential exploitation of underutilized crops, such as the ackee fruit from Jamaica and several other indigenous ornamental products, highlight this perspective. In the livestock sector there are similar examples of underutilization, for instance the Jamaican breed of cattle and the buffalypso breed of buffalo in Trinidad. The meeting noted one success story in the proliferation and sale of the Senepol cattle from the U.S. Virgin Islands. This breul was developed, in part, from breeds of local cattle and is marketed internationally.

The meeting identified the following criteria related to this objective:

- development of new markets or market niches
- promotion of appropriate technology
- promotion of natural competitive advantage (including the domestic resource cost as a measure)

Table 4.3 provides a summary of a proposed objective and criteria schema for use with the scoring method at a regional level. This can be considered as a first approximation of a model to set regional agricultural priorities in the Caribbean.

Table 4.3. Research Objectives and Associated Criteria to Support Priority Setting in the Caribbean.

Objective	Criteria
Equity	To improve the income of the disadvantaged poor
	To ensure the availability of adequate quantity and quality of food at an affordable level
Efficiency	To attain a suitable gross and/or net efficiency index
	To improve product quality
Environment sustainability	To minimize damage to the flora and fauna
	To prevent water, air and soil pollution
	To prevent negative impacts on marine, coastal and forest resources
Indigenous resource development	To develop new markets or market niches
	To promote appropriate technology
	To promote natural competitive advantages

5. CONCLUDING REMARKS AND RECOMMENDATION

The review of objectives and activities of the Caribbean NARS reveals a range of opportunities for a more productive collaborative approach to R&D that could use limited national financial and human resources in more creative ways In this respect the PROCICARIBE initiative has a key role to play in improving efficiency in the use of R&D resources in order to attain international competitiveness and the sustainable development of the Caribbean agricultural sector.

A preliminary framework for the overall ARPSS has been designed with a view to aiding R&D investment decisions at both the national and subregional levels. This is a first but important step in rationalizing the allocation of resources to R&D in the Caribbean Subregion, where it is critical to make economies of scale and scope in R&D activities.

The reduced form economic surplus method can provide indicative estimates of the likely economic returns for many types of R&D in the Caribbean Subregion. The high potential payoff

of R&D on salad and vegetables, that are a key element of the food supply for the tourist sector, is very noteworthy. Further analysis would be developed to estimate the returns to R&D with greater accuracy, taking into account the fact that R&D activities, and adoption of its results, take place overtime.

It is expected that the initial output from the ARPS exercises can be built upon by the researchers who participated in the workshops. All participants expressed a strong desire to continue developing and applying the tools and procedures beyond these initial experiences. Thus, if appropriate means of support can be identified, there is a solid, client-driven opportunity for these activities to be advanced both at NARS and regional agencies.

The Caribbean professionals stated that the workshops had challenged them to think in different ways about the output, adoption and ultimate impact of their research. They felt that the workshops and the materials presented had served as a useful catalyst in making technocrats aware of relationships between agricultural research and socioeconomic variables in both a national and regional context. For example, discussion of scoring methods and the selection of appropriate objectives and criteria, as well as the assignment of weights, had sharpened their focus on outcome-oriented research assessment.

Discussions anong the IICA/IPPRI resource persons, CARDI, and the participants in the two workshops helped in the process of visualizing and documenting the initial design of an ARPSSC. This is a first step in designing and implementing an ARPSSC. It is expected that both the methods and, particularly, the institutional arrangements and procedures will continue to evolve well beyond the conclusion of the IBP-2 Project.

The following recommendation was made by the participants in the final plenary session of the second workshop:

> *There must be further follow-up to sensitize National Agricultural Research Systems in respective CARICOM countries about the ARPS process. Workshops must be held in countries to focus attention on, and develop continued support for, that process, as well as to enhance in-house capability to evaluate agricultural research and set priorities in both private and public sector institutions.*

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APPENDICES

APPENDIX 1

CARDI

WORKPLAN FOR THE CARIBBEAN
May 1996

1. Introduction

The Caribbean subregion is facing significant challenges in making its agriculture and agribusiness sectors more competitive in an era of global trade liberalization coupled with great dynamism in regional trading partnerships[5]. A key strategy in improving agricultural efficiency and international competitiveness in a sustainable way is the constant development, adaptation and application of appropriate pre-production, production and post-production technologies.

However, agricultural R&D, the source of such innovations, is itself under threat. Funding from traditional sources continues to decline in real terms while the goals of public-sector R&D have broadened to encompass not only increased productivity and competitivity, but also increased social equity and a sustainable use of the natural resource base. All of these factors interact to place increasing pressure on research managers to (a) demonstrate that R&D investments provide significant benefits to their intended clients, and (b) improve the efficiency of the R&D process through better allocation of scarce research resources.

In this context, the IBP2 project is designed to increase the number, and strengthen the capacity, of Latin American and Caribbean research analysts to respond to demands for more and better information to support R&D investment decision-making, at both the multinational and national levels. This document sets out the workplan agreed upon between CARDI and IBP2 to conduct agricultural research priority setting activities in the subregion. These activities include not only training workshops and real-world applications of appropriate methodologies, but also support the design of an overall Agricultural Research Priority Setting System (ARPSS) for the Caribbean. The project has been designed to provide the means for the ARPSS to continue and evolve well beyond the lifetime of project activities.

2. Objectives

The main objectives of the IBP2 project in the Caribbean are (a) to develop capabilities to identify agricultural research priorities at the national and multinational level, and (b) to design the technical component of an ARPSS for the Caribbean.

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5 This workplan was written by Héctor Medina (IICA) and Stanley Wood (IFPRI/CIAT), in consultation with Hayden Blades, executive director of CARDI and the Planning and Business Development Unit.

3. Expected Results

The objectives will be achieved through the development of the following products:

a. Trained Caribbean professionals able to develop agricultural research priorities at the national and multinational level.

b. Improved analytical capacity of CARDI´s Planning and Business Development Unit (PBDU) through training in quantitative ex ante research evaluation and the provision of software, manuals and the appropriate subsets of the LAC regional database.

c. A design document for the technical component of an ARPSS for the Caribbean.

d. Summary reports of procedures followed, analysis undertaken, and recommendations made in establishing thematic research priorities for international collaborative research.

4. Main Clients and Users

The above products of IBP2 in the Caribbean are targeted to the needs of NARS and CARDI and are designed to strengthen the core of professional expertise in agricultural research priority setting at both national and subregional levels.

5. Activities

5.1. To design the technical component of an ARPSS for the Caribbean

The system will adopt the principle of setting subregional agricultural research priorities, taking into account previously identified national priorities. The design will include procedures for the establishment of national and subregional priority research themes and the subsequent formulation and evaluation of research projects. The ARPSS will outline and describe the interrelation among technical and institutional procedures, information, analyses and presentation of results, at the national and subregional level, in ways which are useful for decision makers. A more detailed outline of the proposed contents of the ARPSS design document is contained at the end of this appendix.

Following agreement by CARDI to the technical component of the ARPSS, particularly of the prioritization method to be adopted, arrangements can be made to conduct the first CARDI-IBP2 workshop.

5.2. To carry out the first CARDI-IBP2 Workshop on setting agricultural research priorities at the national level

The purpose of the workshop is to train professionals in CARDI and CARDI´s member countries for three days in agricultural research priority setting at the national level, according to the methodology set out in the ARPSS design document.

The team of IBP2 will be responsible for the technical realization of the workshop.

The PBDU will prepare the proceedings of the workshop.

5.3. To collaborate with the PBDU in training and demonstration of more quantitative ex ante research evaluation methods that adopt a multimarket, multiagroecological zone framework

The team of IBP2 will provide this collaboration for two days after the first workshop takes place. The model and databases used for this activity will be taken from the LAC regional level activities being undertaken by the IBP2 team at CIAT.

5.4. To develop a provisional set of national agricultural research priorities

In collaboration with the PBDU, the workshop participants will carry out this activity within two months of the first workshop. The main activities in each country consist of the following:

- consultation on research demands and opportunities
- agreement on the criteria to be used in the prioritization of national research themes
- collection of information
- application of priority setting methodology at the national level
- consultation to confirm results with relevant stakeholders

The PBDU will coordinate these country-level activities along with the respective governments.

5.5. To carry out the second CARDI-IBP2 workshop on setting subregional agricultural research priorities

Subregional agricultural research priorities will be identified, taking into account the agricultural research priorities set at the national level in each country. The identification process will be based on the methodology recommended in the ARPSS design document.

The workshop will be divided into three parts, as follows:

- presentation of the provisional national research priorities
- agreement on appropriate procedures and criteria for setting subregional research priorities
- formulation of proposed subregional agricultural research priorities

The IBP2 team will be responsible for the technical realization of the workshop.

PBDU will prepare the proceedings of the workshop

5.6. To provide assistance to the PBDU in undertaking sample simulations with the multimarket ex ante evaluation model for selected subregional priorities

The IBP2 team will provide this assistance for two days immediately after the second workshop.

5.7. To prepare the final report setting out the results and recommendations of the IBP2 funded activities

PBDU will be responsible for the preparation of the final report, containing the following:

- summary of the design document for the technical component of the ARPSS
- proceedings of the workshops
- summary of reports of national priorities established
- procedures followed, analysis undertaken, and recommendations made in establishing priorities of research themes at the subregional level
- a brief description of how the DBPU has been strengthened through the IBP2 project
- recommendations for future development and implementation of the ARPSS for the Caribbean

Table A1.1. Timeline for CARDI-IBP2 Activities in the Caribbean.

Activity	Month							
	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
1. Design of the technical component of ARPSS	XX	XX						
2. Review and approval of CARDI of activity 1		XX	XX					
3. First workshop				X				
4. Postworkshop collaboration (PBDU)				X				
5. Development of national agricultural research priorities				X	XXXX	XXXX		
6. Second workshop							X	
7. Postworkshop collaboration (PBDU)							X	
8. Final report							XX	XX

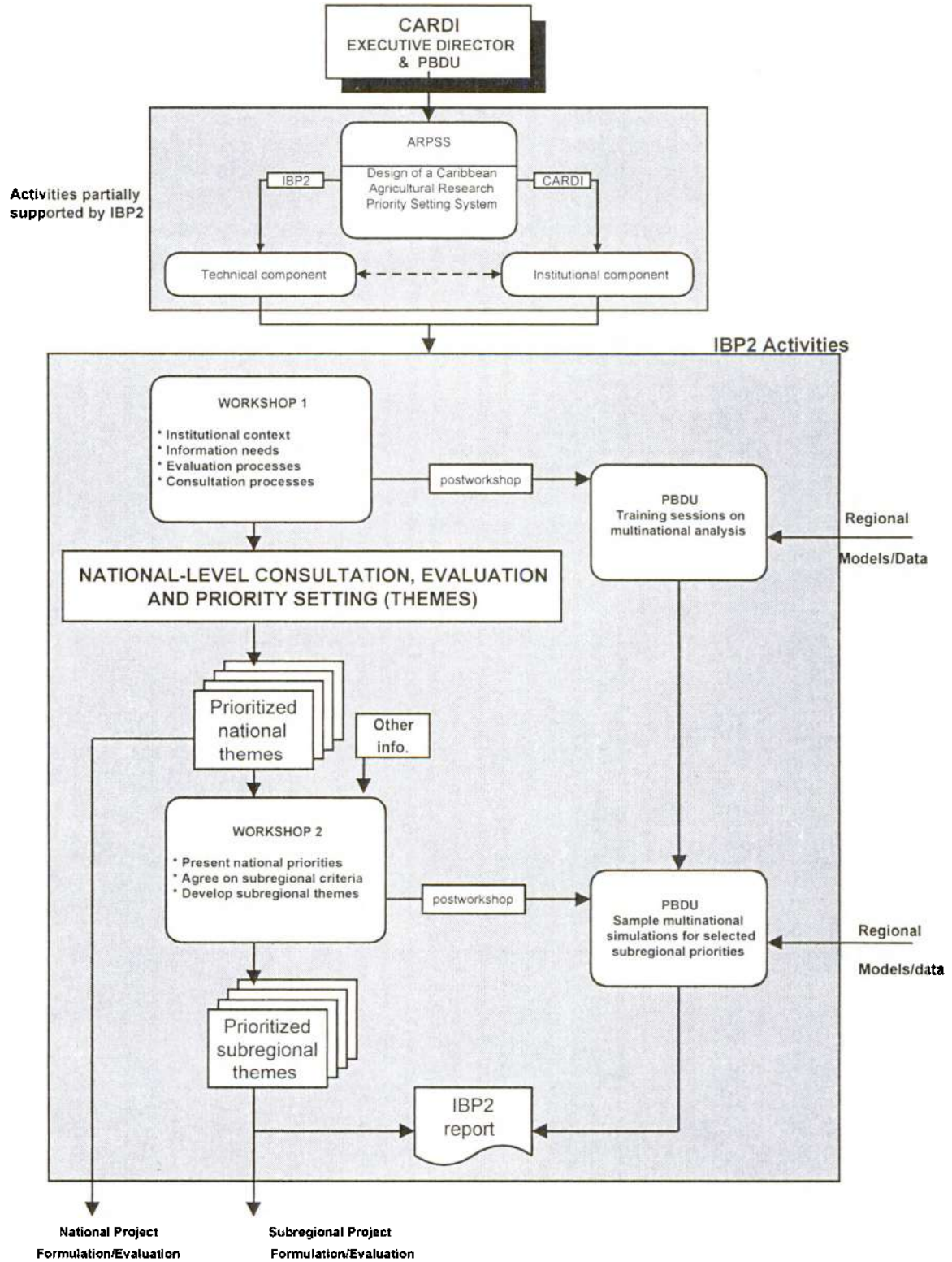

Figure A1.1. An Outline of IBP2-related Priority Setting Activities in the Caribbean Subregion.

Table A1.2. Project Budget.

Activity	Product	Responsible	Amount (US$)
1. Design the technical component of the ARPSS	Document	IBP2 in consultation with CARDI	7,500
2. First workshop	1. Trained personnel	1. IBP2	8,000
	2. Proceedings	2. CARDI	500
3. Postworkshop collaboration with CARDI's PBDU	1. Trained personnel	IBP2	1,000
4. Development of proposed national agricultural research priorities	Provisional list of agricultural research priorities for CARDI member countries	NARs and CARDI	Countries
5. Second workshop	1. Trained personnel	IBP2	8,000
	2. Subregional agricultural research priorities		500
6. Postworkshop collaboration with CARDI's PBDU	Trained personnel	IBP2	1,000
7. Final report	Document	CARDI	1,500
8. Contingencies			2,000
TOTAL			**30,000**

Outline Contents of a Report on

The Development of an Agricultural Research Priority Setting System (ARPSS) for the Caribbean

Introduction

- The need for, and special problems of, agricultural research priority setting in the Caribbean
- The existing relationships among national and subregional level agricultural research agencies that influence investment decision-making at the subregional level.

Rationale for the Basic ARPSS Approach

- To increase the relevance of research by fostering consultation/participation in the identification of research demands
- To promote the use of consistent, transparent and readily applied methods for screening identified research themes
- To develop procedures for reaching stockholder consensus on priorities and appropriate information systems to keep key individuals and institutions appraised of them
- A two stage (national and subregional) and a two level (research theme and project) priority setting system framework[6].

National Level Identification of Priority Research Themes

- National coordination responsibilities
- Identification of clients and other stakeholders
- Compilation of basic information
- Consultation: identify constraints, research demands and scientific opportunities
- Identification of the goals and objectives of national R&D endeavors and agreeing criteria to evaluate research themes against those goals and objectives.

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6 Research themes are equivalent to individual "Center of Focus" activities as defined in CARDI planning documents (e.g., IPM for rice, improvement of small ruminants-goats, sustainable farming systems for the dry hillside regions).

- Screening of potential research themes using agreed methodology to generate initial assessment of national priorities
- Reviewing and finalizing of national priorities based on stockholder consensus

Subregional Level Identification of Themes of Common Interest

- Subregion coordination responsibilities and mechanisms
- Identification of subregional clients and stakeholders
- Compilation of basic information
- Identification of constraints and opportunities at the subregional level (focus on potential marketing and trade impacts of R&D, as well as economies of scale and scope in the conduct of R&D), this could include optimizing the location of research to maximize the spillover potential of technologies between countries and strengthening the institutional mechanisms that could facilitate such transfers
- Identification and characterization of funding opportunities for subregional R&D
- Agreeing criteria to evaluate priority research themes in the subregional context
- Together with other relevant information and with research themes identified at the subregional level, national research themes can be incorporated into the agreed methodology to generate an initial assessment of subregional themes of common interest
- Review and finalization of subregional priority themes based on stockholder consensus
- Ensuring information on identified priorities and the priority setting process is made available on a continuing basis to appropriate decision makers and institutions within and outside of the region

Project Formulation (National and Subregional), Screening and Selection (Subregional)

- Based on prioritized research themes, project proposals can be formulated according to the standards and procedures operating at national and subregional levels
- Procedures must be designed and agreed upon by stakeholders for the review and selection of individual projects at the subregional level
- Procedures must be established for monitoring and evaluating (M&E) subregional projects that are selected for implementation
- Procedures should be established to feed information from the M&E system back to enhance the ARPSS over time

APPENDIX 2

QUESTIONNAIRE FOR RESEARCH AND DEVELOPMENT EVALUATION DATA

Country: _____

Commodity: _____

Research Area: _____

Basic Market and Socioeconomic Data

Item	Unit	1993	1994	1995	Average
Price received by farmers	local$/ ton				
Quantity produced	ton				
Quantity consumed	ton				
Total population	persons				
No. of producers	persons				
Cost of living index					
Exchange rate	local $ to US$				

Research and Development Data

1. Expected change in yields if the research is successful and is fully adopted? _____%
2. Expected change in production costs if the research is successful and fully adopted? (may be positive or negative) _____%
3. How long will it take for the R&D until the new technology is made available for adoption? _____years
4. What is the probability that the research will be successful in achieving its goals? _____%

Adoption

1. What is the expected ceiling level of adoption of the new technology? _____%

2. How many years after the technology is first available will the ceiling level of adoption be reached? _____ years.

Change in Production Area

1. What is the likely change in area of production as a consequence of the new technology? _____%

Research and Development and Extension Costs

1. How many person years (in full-time scientist equivalents) would the R&D require? _____ person years

2. What are the likely total costs of R&D and extension to generate and disseminate the new technology _____ local $

Persons Interviewed:

Name	Position	Location	Date

APPENDIX 3

Table A3.1. Bahamas: Gross and Net Efficiency Indices of R&D.

Research Themes/area	Value of Production a/ (1994)	R&D					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of succes	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	(pers. years)	($ Local)	(US$)	(US$/pers.yr)	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Tree crops	742,437	300	25	275	5	75	30	5	100	459,383	5 0	275,000 0	275,000 0	55,000 0	1 67
Fresh herbs	41,158	400	20	380	1	95	100	n a	100	148,579	1 0	50,000 0	50,000 0	50,000 0	2 97
Root crops	351,133	50	5	45	3	80	50	n a	10	63 204	2 0	85,000 0	85,000 0	42,500 0	0 74
Salad vegetables	4,621,121	50	20	30	1	95	75	n a	10	987,765	2 0	84,000 0	84,000 0	42,000 0	11 76
Lamb / chevron	397,927	100	25	75	3	100	75	n a	10	223,834	3 0	135,000 0	135,000 0	45,000 0	1 66

Notes

a/ Weighted average (1993-95)

Column 5 = Column 3 - Column 4

Column 11 = Column 2 * Column 5 * Column 7 * Column 8 (see chapter 3)

Column 14 = Column 13 / exchange rate

Column 15 = Column 11/ Column 12

Column 16 = Column 11/ Column 14

n.a. = not available

Source: Based on R&D evaluation data provided by country representatives from Bahamas.

Table A3.2. Barbados: Gross and Net Efficiency Indices of R&D.

Research Themes/area	Value of Production a/	R&D					Adoption		Area change	Gross efficiency Index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	(pers. years)	($ local)	(US$)	(US$/pers.yr)	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Root crops:															
Carrot	2,097,925	40	10	30	2	90	95	2	10	538,118	1 5	53,890	26,945	358,745	20.0
Salad vegetables:										1,640,116	7.5	269,452	134,726	218,682	12.2
Hot pepper	301,552	30	-5	35	2	75	90	2	50	71,242	2	71,854	35,927	35,621	2 0
Tomato	1,504,460	30	-5	35	2	90	90	2	10	426,514	1.5	53,890	26,945	284,343	15.8
Onion	463,050	50	-15	65	3	60	90	2	40	162,531	2	71,854	35,927	81,265	4 5
Cabbage	2,167,905	50	-5	55	1	95	50	1	10	566,365	1	35,927	17,963.50	566,365	31.5
Cucumber	1,435,641	30	-10	40	2	80	90	2	20	413,465	1	35,927	17,963.50	413,465	23.0
Lamb chevron:															
Sheep	253,080	50	5	45	1	80	20	5	5	18,222	1.5	53,890	26,945	12,148	0 7

Notes:
a/ Weighted average (1993-95)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15 = Column 11/ column 12
Column 16 = Column 11/ column 14

Source: Based on R&D evaluation data provided by country representatives from Barbados.

Table A3.3. Belize: Gross and Net Efficiency Indices of R&D.

Research themes/area	Value of production	R&D					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr.	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	pers. years	($ local)	(US$)	(US$/pers.yr.)	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Cereals:															
Rice	2,419,379	50	38	12	4	75	70	5	50	152,421	11	400,000	200,000	13,856	0.76

Notes:
a/ Weighted average (1993-95)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15 = Column 11/ Column 12
Column 16 = Column 11/ Column 14

Source: Based on R&D evaluation data provided by country representatives from Belize.

Table A3.4. Haiti: Gross and Net Efficiency Indices of R&D.

Research themes/area	Value of production	R&D					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr.	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	(pers. years)	($ local)	(US$)	(US$/pers.yr.)	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Rice	32,583,200	40.00	0.00	40.00	4.00	70.00	70.00	8.00	n.a	6,386,307	3.00	n.a	n.a	2,128,769	n.a
Livestock	144,297,500	17.50	7.50	10.00	5.00	100.00	50.00	10.00	20.00	7,214,875	5.00	n.a	n.a	1,442,975	n.a

Notes:
a/ Weighted average (1993-95)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15 = Column 11/ Column 12
Column 16 = Column 11/ Column 14

Source: Based on R&D evaluation data provided by country representatives from Haiti.

Table A3.5. Jamaica: Gross and Net Efficiency Indices of R&D.

Research themes/area	Value of production	R&D					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr.	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	(pers. years	($ local)	(US$)	(US$/pers.yr.	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Papaya	6,276,015	0.0	-15.0	15.0	10	60.0	80.0	4	12.5	**451,873**	**9.0**	**18,000,000**	509,194	50,208	0.9
Salad vegetables										**18,677,458**	**42.0**	**77,000,000**	**2,178,218**	444,701	8.6
Tomato	21,419,700	35.0	-30.0	65.0	5	60.0	85.0	2	0.0	7,100,631	20.0	35,000,000	990,099	355,032	7.2
Lettuce	5,501,500	75.0	-50.0	125.0	2	95.0	90.0	3	50.0	5,879,728	4.0	7,000,000	198,020	1,469,932	29.7
Cucumber	7,766,333	30.0	-20.0	50.0	2	85.0	50.0	2	15.0	1,650,346	6.0	10,000,000	282,885	275,058	5.8
Sweet pepper	8,138,267	45.0	-40.0	85.0	3	65.0	90.0	1	30.0	4,046,753	12.0	25,000,000	707,214	337,229	5.7
Sugarcane	67,554,333	0.0	-4.0	4.0	4	65.0	100.0	6	0.0	**1,756,413**	**5.0**	**28,000,000**	**792,079**	**351,283**	**2.2**

Notes:
a/ Weighted average (1993-95)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15 = Column 11/ Column 12
Column 16 = Column 11/ Column 14

Source: Based on R&D evaluation data provided by country representatives from Jamaica.

Table A3.6. St. Lucia: Gross and Net Efficiency Indices of R&D.

Research themes/area	Value of production	R&D					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr.	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	pers. years	($ local)	(US$)	(US$/pers.yr.	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Small ruminants	**46,660**	25	-10	35	0.5	85	90	1.5	25	12,467	2	10,000	n.a	6,233.3	n.a
Salad vegetables	**1,377,662**									**323,785**	**5**	**1,500,000**	n.a	**64,757.0**	n.a
Tomato	486,397	30	-12.5	42.5	(1,5-3)	70	79	(1-3)	25	114,315	1.25	375,000	n.a	91,452.3	n.a
Lettuce	226,003	30	-12.5	42.5	(1,5-3)	70	79	(1-3)	25	53,116	1.25	375,000	n.a.	42,493.1	n.a
Cabbage	455,978	30	-12.5	42.5	(1,5-3)	70	79	(1-3)	25	107,166	1.25	375,000	n.a.	85,733.0	n.a
Sweet pepper	209,284	30	-12.5	42.5	(1,5-3)	70	79	(1-3)	25	49,187	1.25	375,000	n.a	39,349.5	n.a
Fresh herbs	**55,210**									**24,734**	**4**	**35,200**	n.a.	**6,183.6**	n.a
Parsley, celery	13,250	50	-20	70	1	80	80	3	50	5,936	2	17,600	n.a	2,968.1	n.a
Thyme	41,960	50	-20	70	1	80	80	3	50	18,798	2	17,600	n.a.	9,398.9	n.a

Notes:
a/ Weighted average (1993-95)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15 = Column 11/ Column 12
Column 16 = Column 11/ Column 14

Source: Based on R&D evaluation data provided by country representatives from St. Lucia.

Table A3.7. Suriname: Gross and Net Efficiency Indices of R&D.

Research themes/area	Value of Production	R&D					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max.level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr.	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	pers. years	($ local)	(US$)	(US$/pers.yr.)	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Cereals	23,519,794	25	5	20	3	70	80	4	0	2,634,217	2	100,000,000	213,106	1,317,108	12.4
Salad vegetables	10,320,144	40	20	20	3	50	90	3	50	928,813	6	40,000,000	85,242	154,802	10.9
Small ruminants	58,543	25	5	20	5	80	90	3	40	8,430	9	120,000,000	255,727	937	0.032966

Notes:
a/ Weighted average (1993-95)
b/ Salad vegetables only (tomato, bell pepper, cabbage, cucumber, gerkins, lettuce, pumpkin)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15 = Column 11/ Column 12
Column 16 = Column 11/ Column 14

Source: Based on R&D evaluation data provided by country representatives from Suriname.

Table A3.8. Trinidad & Tobago: Gross and Net Efficiency Indices of R&D.

Research themes/area	Value of production	R&D Data					Adoption		Area change	Gross efficiency index (benefits)	R&D costs			Net efficiency indicators	
		Expected yield change	Expected cost change	Net unit cost reduction (K)	R&D lag time	Probability of success	Ceiling level	Time to max. level			Scientist inputs	Local currency	US$	Annual benefit per scientist yr.	Annual benefit per $ invested
	(US$/year)	(%)	(%)	(%)	(years)	(%)	(%)	(years)	(%)	(US$/year)	pers. years	($ local)	(US$)	(US$/pers.yr	(US$)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Sugarcane	**29,730,246**	9	-5	14	3	70	50	4	0	1,456,782	0.44	150,000.00	25,219	3,310,868.3	57.77
Salad Vegetables	**2,418,439**			19		74	27			116,315	40	1,680,000.00	282,447.9	2,907.9	0.41
Cucumber	759,158	15	5	10	2	60	20	4	30	9,110	12	504,000 00	84,734	759 2	0 11
Lettuce	638,041	35	5	30	2	90	40	4	20	68,908	12	504,000 00	84,734	5,742 4	0 81
Cabbage	1,021,239	25	5	20	2	75	25	4	25	38,296	16	672,000 00	112,979	2,393 5	0 34
Herbs	**8,888,883**			24		68	31			574,910	28	1,176,000.00	197,713.5	20,532.5	2.91
Chive	3,854,011	15	5	10	2	60	20	4	20	46,248	12	504,000 00	84,734	3,854 0	0 55
Celery	5,034,871	40	5	35	2	75	40	4	30	528,661	16	672,000 00	112,979	33,041 3	4 68
Rice	**4,683,088**	50	5	45	3	80	70	4	40	1,180,138	0	0.00	0		
Small ruminants	**203,108**	20	5	15	4	80	60	3	20	14,624	3	180,000.00	30,262	4,874.6	0.48

Notes:

a/ Weighted average (1993-95)
Column 5 = Column 3 - Column 4
Column 11 = Column 2 * Column 5 * Column 7 * Column 8
Column 14 = Column 13 / exchange rate
Column 15= Column 11/ Column 12
Column 16= Column 11/ Column 14

Source: Based on R&D evaluation data provided by country representatives from Tridad & Tobago.

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