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INSTITUTIONALIZATION OF AN INFORMATION GENERATION SYSTEM FOR  
RESEARCH PRIORITIES IN PHILIPPINE AGRICULTURE

William D. Dar, Ma. Cynthia Bantilan, Josefina Lantican  
and Jeff Davis

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INSTITUTIONALIZATION OF AN INFORMATION-GENERATION SYSTEM  
FOR RESEARCH PRIORITIES IN  
PHILIPPINE AGRICULTURE

William D. Dar,<sup>1</sup>/ Ma. Cynthia S. Bantilan,<sup>2</sup>/  
Josefina M. Lantican,<sup>3</sup>/ and Jeff S. Davis<sup>4</sup>/

1. INTRODUCTION

There is a considerable body of literature which has addressed the issue of evaluation of agricultural research. Much of this literature has considered various aspects of the methodology which can be used to undertake these evaluations, see for example Norton and Davis (1981) and Alston (1991) for reviews of this part of the literature. There is also an evaluation of actual research efforts. While there has been a strong demand for support with research priority setting most of the efforts in this area have focused on what have been called "scoring model" approaches. In most cases these scoring model applications have not made use of the types of methodology developed in the main body of the research evaluation literature. Examples of some exceptions to this have been reported in, for example, Davis and Ryan (1994).

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<sup>1</sup>/ RPPAP Administrator and Director of the Bureau of Agricultural Research, Department of Agriculture, Quezon City, Philippines.

<sup>2</sup>/ RPPAP Project Leader and Principal Scientist, Department of Economics, International Crops Research Institute for Semi-Arid Topics (ICRISAT), Andhra Pradesh, India.

<sup>3</sup>/ RPPAP Research Team Member and Supervising Agriculturist, Bureau of Agricultural Research, Department of Agriculture, Quezon City, Philippines.

<sup>4</sup>/ Coordinator, Economic Evaluation Unit, Australian Center for International Agricultural Research (ACIAR), Conberra, Australia.

There are few if any papers which have provided details of efforts to integrate the research evaluation quantification into the research decision-making processes of research institutions.

This paper attempts to begin the process of filling this gap in the literature. It briefly describes the results of a project called "Research Priorities for Philippine Agriculture Project" (RPPAP). It then outlines the procedures and processes which have been adopted to institutionalize the results of this project into the decision-making mechanisms in Philippine agricultural research institutions. An illustration of how the information was used as an important input into the development of a National Agricultural Research and Extension Agenda (NAREA) is then provided. This includes an assessment of the possible impact this additional information may have had on the final decisions and therefore nature of this planning document. Some plans for future evolution of the information system are also highlighted.

## 2. BACKGROUND TO PRIORITY SETTING FOR AGRICULTURAL RESEARCH IN THE PHILIPPINES

The agriculture sector is viewed as the key factor that will propel the nation's economic growth based on its vital contribution to the Philippine economy. This points to the need to increase agricultural production efficiency which hinges largely on the generation and transfer of appropriate technology. The country's research resources, however,

appear to be inadequate, placed at only 0.23 percent of the gross value added in agriculture, much below the World Bank's recommendation of 1 percent. For research to play a significant role in the over-all development strategy and to attain the goals and objectives of the agricultural sector amidst budgetary constraints, it has to be allocated effectively, and especially to the projects which are expected to give the greatest national benefits. But how to allocate agricultural research resources among various projects to get the highest benefits is a complex decision-making issue. Research needs to be prioritized within the existing budget and over-all framework of agricultural development, encompassing the concern for efficiency, food security, or equity. Priorities should also be determined at different levels to suit national, regional, and provincial needs considering the respective agro-ecological environments. In establishing research priorities in the Philippines, the most common process used until recently has been the, so called, simple scoring model. This type of process is subjective in nature, based on the decision-makers' knowledge, understanding, intuition, and other pressures. Most often, the decision-makers and research administrators do not have a clear perspective of the outcome of projects to be implemented. Hence, a decision-support system that would provide a clearer basis for research prioritization and ex-ante evaluation is necessary. With such a system of ex-ante measures which estimates economic

returns from potential research investment on major commodities, it is easier to convince policy-makers to support activities which give significant pay-offs.

In view of the foregoing, the Research Priorities for Philippine Agriculture Project (RPPAP) was undertaken. The RPPAP output serves as a decision-support for systematic research prioritization covering twenty-four (24) agricultural commodities.

The RPPAP was a joint undertaking of the Department of Agriculture (Bureau of Agricultural Research, Bureau of Agricultural Statistics and Planning and Monitoring Service), the University of the Philippines at Los Baños-College of Economics and Management (UPLB-CEM), the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), and the Australian National University (ANU). Supported by the Australian Center for International Agricultural Research (ACIAR), the RPPAP used some quantifiable parameters utilizing an economic model to improve the subjectivity of and provide a more systematic basis for the remaining subjectivity in establishing research priorities. The model, therefore, does not intend to replace the existing systems of research prioritization, mostly based on the simple scoring model approach, but to improve on them by injecting objectivity and clarity in priority setting.

The project started in March 1988 and officially ended in May of 1991. The initial activities undertaken by the project were the preparation of the background papers on the Philippine Agricultural Research System [see for example, Bantilan (1991), Bantilan and Corpuz (1991), Corpuz and De Leon (1990), Lantican and Buetre (1991), Mangabat et.al. (1990) and Tumbali and Cabugua (1990)], conceptualization of the theoretical framework [see, for example, Davis (1987, 1991) Davis and Bantilan (1990, 1991) and Bantilan and Davis (1991a, b)], data collection and development of computer files [see, for example, Catli (1991), Davis and Navarro (1990), Miranda and Bantilan (1991), Olalo et.al (1990)] and development of effective methods for presenting the output to decision members [see, for example, Davis and Ryan (1994, Chapter 17)]. The data used to support the analysis were gathered from both primary and secondary sources.

### 3. OVERVIEW OF THE RPPAP INFORMATION SYSTEM STRUCTURE

The research team of the RPPAP was composed of the regular staff from agencies responsible for setting the direction of research to ensure continuity in the implementation and possible refinements of the model. A consultative committee, which served as an advisory body, was included as a crucial part of the project structure to ensure that the information generated by the project was of the type and form relevant to research resource allocation decision making. The body was convened by the then Assistant

Secretary for Research, Training and Extension of the Department of Agriculture. The team included the decision makers from various agencies, namely: The National Economic and Development Authority (NEDA), Department of Agriculture (DA), Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Bureau of Agricultural Research (BAR), Bureau of Agricultural Statistics (BAS), and the Philippine Council for Aquatic Marine Research and Development (PCAMRD). Noted socio-economic researchers from the University of the Philippines at Los Baños (UPLB) and the International Food Policy Research Institute (IFPRI) were also included in the Project Consultative Team. The Committee regularly evaluated the information - generating system developed by the project as well as its institutionalization and future plans. The methodologies and final results of the RPPAP were presented during the inter-country workshop held in Malaysia in May 1991, where Indonesia, Thailand and Papua New Guinea presented their counterpart projects [a detailed outline of all these efforts appears in Davis and Ryan (1994)].

#### 4. BRIEF SUMMARY OF THE PROJECT OUTPUT

The estimation of research benefits used in the RPPAP decision-support system was based on the principle of economic surplus to measure the size and distributional consequences of research-induced technological change. This approach utilizes the basic concepts of demand and supply to represent the production and consumption environment. This



measure is referred to as welfare -theory based measure. The economic surplus is represented by the area aegh in Figure 1.

Refinements to the above approach have expanded the framework to incorporate probability of success (in the case of ex-ante assessment), spill-over effects of research across locations/commodities, multi-regional trade and government intervention.

In utilizing the welfare-theory based measure the following data set was used in the development of RPPAP model:

#### Information/Variables

##### Economic Variables

- Production
- Consumption
- Prices
- Elasticities
- Research Expenditure
- Manpower/Equipment
- Ceiling Level of Technology Adoption
- Rate of Adoption

##### Technical Information

- Research Objectives
- Time Lags
  - innovative research
  - adoptive research
- Externalities

##### Subjective Data

- Probability of Research Success
  - across location
  - across commodities
- Spillover Effects of Research

The RPPAP system includes the estimation of the net present values of benefits that accrue from research. The system gives the level of benefits that accrue to the whole economy and how these benefits are distributed among the political regions of the country, given that research is undertaken in a specified region. Moreover, this information provide basis in the identification of the comparative advantage of certain regions in generating substantial benefits from research investments. This is illustrated in Table 1.

The RPPAP decision - support system shows the benefits that would accrue from research on the 24 commodities and an assessment of the existing system of research prioritization. As reflected by the output, the highest average benefits could be derived from research on rice, amounting to \$22.4 million, followed by corn with \$16.4 million and sugarcane with \$11.4 million (Table 2). When the set of information for rice is combined with similar information for the other 23 commodities, one obtains a basis for priority assessment. The values in column 2 of Table 2 indicates the potential impact of research for each commodity, implying a set of relative research priorities, if the objective is to maximize the welfare gains in the whole economy, then the ranking suggested by these figures serves as a basis for a priority-setting index. It is to be noted that international spillover effects of research are incorporated in Table 2. The regional benefits from the 24 commodities were also estimated. For

rice, for instance, the distribution of benefits by regions shows that Central Luzon and Southern Tagalog could expect the most from research, estimated at \$30.7 million and \$28.5 million, respectively. This could be explained by the fact that the leading rice research institutions are located in these regions and therefore the chance of successful research was highest, and by the agroclimatic suitability of the areas for rice growing.

Furthermore, the RPPAP system also estimated the national benefits that could be derived from research on 24 commodities when these are conducted in poor, moderately poor, and non-poor areas of the country. This categorization is important in the setting of research priorities where poverty alleviation in the countryside is one of the national goals.

The 24 commodities, listed according to their relative standing with respect to rice is presented in Table 3 (Column 4). For example, coconut research achieves about 17% of the benefits of rice research, while tomato research achieves about 5%. The relative standing of the 24 commodities derived by the use of the indexing procedure described above is illustrated in Figure 2. Another way of interpreting the results is given in column 5 of Table 3. A priority index is obtained by computing the cost of benefit as that of rice. In this case, research on chicken would require a unit cost reduction about 3 times as much as the unit cost reduction

from rice research to achieve the same level of benefits. In another case, it would require about 20 times the unit cost reduction from cattle research as you would from rice research to achieve the same level of benefits.

Commodity priority groups may be set up by using the two indices described. To illustrate this, a six-level priority grouping (using the indices in column 5 of Table 3) which is consistent with maximization of national welfare gains is suggested in column 1.

If the concern, on the otherhand, is the determination of research options where focus is placed on the welfare of a particular region, then useful information is obtained by referring to the regional benefits accruing to the region of interest. This question of regional welfare has been one of the central issues among research managers in the regions, e.g. the consortia coordinators of the NARRDN. The RPPAP outputs also illustrate the results for the thirteen geopolitical regions of the Philippines -- where the suggested relative research priorities for achieving maximum regional benefits are shown. This type of information for all 13 geopolitical regions serves as a useful planning guideline for national as well as for regional research.

Another angle in viewing the issue of prioritization is consideration of trade-offs or opportunity costs, e.g. how much benefit accrues to the whole society and to particular regions of the country. In this context, two potentially

conflicting research objectives may be considered, i.e. maximization of national welfare gains versus maximization of regional welfare gains to one region. Table 4 yields a comparison of the national benefits with regional benefits to Southern Mindanao.

The diagrams labeled Figure 3a and 3b are examples of a presentational format useful in analyzing the above results. The columns are grouped into high (H), medium (M) and low (L) priority; similarly, the rows are so grouped. The priorities suggested by the national welfare objective is represented on the horizontal scale; and the priorities suggested for maximizing Southern Mindanao regional welfare is represented on the vertical scale.

The congruence of non-congruence of the two objectives can be seen by referring to the diagonal of the diagram. Commodities covered by the congruence band (i.e. the left to right upward diagonal) are those which imply the same priority. Non-congruence is indicated for groups of commodities outside the congruence band. For example, chicken, hog and sugarcane are implied to be important in maximizing national welfare gains but are inconsequential for maximizing welfare gains to the Southern Mindanao region. This illustration also indicates compatibility of benefits to the national economy and to the Southern Mindanao region if research investments were given to rice, corn, banana, coconut and coffee.

If the research manager desires to achieve simultaneous optimization of both national and regional welfare, then the following priority classification may be followed:

Benefit Level	Priority Group
HnHr	I
HnMr	II
MnHr	
HnLr	III
MnMr	
LnHr	
LnMr	IV
MnLr	
LnLr	

where:

H - high priority	n - national welfare
M - medium priority	r - regional welfare
L - low priority	

An assessment of the research expenditures vis-a-vis national benefits is facilitated through the use of a box diagram (Figure 4). Scanning the rightmost boxes under High Priority groups 1 & 2 the highest national benefits would accrue from research on rice, corn, hog, sugarcane, chicken, coconut, banana, coffee and roundscad. The lowest potential research benefits are expected from cotton, soybeans and cocoa as shown by the leftmost columns priority group 6. Looking at the levels of research expenditures, as indicated by the vertical lines or row groupings, the highest budget share was placed on rice, corn, coconut, tobacco, carabao, cattle. Using a congruence band, there is congruence allocation of the budget and the expected levels of national benefits on only a few commodities, namely: rice, corn, hog,

sugarcane, coconut, cassava, tomato, cocoa and tilapia. The national and regional welfare gains are most likely to be maximized if the commodities scattered in the box diagram could cluster within the congruence band.

5. **ACTIVITIES UNDERTAKEN TOWARDS THE INSTITUTIONALIZATION OF THE USE OF THE RPPAP MODEL IN THE NATIONAL AGRICULTURAL RESEARCH SYSTEM**

Institutionalization is crucial to the ultimate success of the project. In this regard, it is important that the decision makers, research managers and users of the information become involved outright in the development of the types of information and presentation formats.

A series of policy briefs based upon the project results was undertaken in order to facilitate the implementation of the methodology and procedures developed as a planning tool at the various levels of research planning and decision making in the Philippine agricultural research system.

The RPPAP decision support system for agricultural research is envisioned to provide the information needs of policy makers on issues related to research and development. This system involves both government institutions (such as DA, Department of Science and Technology, Department of Environment and Natural Resources, and state universities and colleges) and research oriented agencies non-government organizations (NGOs). Each of these agencies have stand-alone subsystems which can be used by the management for

planning within their area of concern and/or sphere of influence. However, these subsystems are to be monitored by a Central Coordinating Unit which will then be responsible for providing the necessary information to the Research and Development Committee. The said committee, which is composed of representatives from government and non-government research institutions, meets regularly to discuss and decide on research related issues such as prioritization. Figure 5 presents a diagram of the interrelationships of the Decision-Support System (DSS) for agricultural research.

The institutionalization of the RPPAP system was already envisioned during the early days of project implementation. Various activities were undertaken by the team towards this end. Specifically, these are as follows:

<u>Institutionalization Activities</u>	<u>Dates</u>	<u>Results</u>
1. Training of research team members	1989 - to -date	One member obtained a Ph.D. degree while 2 are still enrolled in Ph.D. program
2. Roadshow Presentation	Late 1991 to early 1992	Approved by Policy-Makers
3. Trainers' Training on the Use of the RPPAP Model	December 9-13, 1991	Workshop outputs used in updating the NAREA
4. Installation of Computer Programs in the DA Field Offices	1992	Installed in only one region due to limited memory capacities. Hard disks to be upgraded
5. Refresher Course on the Use of the RPPAP model	June 29 to July 4, 1992	Applied in the formulation of the RAREA
6. Formulation of the Reg'l. Agricultural and Fishery Extension Agenda (RAREA)	August to September 1992	Bases in the formulation of the National Agriculture and Fishery R & E Agenda



- |   |          |   |
|---|----------|---|
| 7. Printing of the proceedings on validation of parameters used in the RPPAP and manual | 1993     | A number of copies distributed to policy-makers |
| 8. Collection of National and Regional Data for Other Major Commodities                 | on-going |   |

1. Training of Permanent Technical Staff in Research Institutions

The RPPAP has a training dimension aimed at staff working permanently in the research institutions to facilitate the institutionalization of the system. The training includes research team methodology seminars as well as support for postgraduate study. One of the team members has obtained a Ph.D. from the University of the Philippines at Los Baños through the project. In 1989-1990, a member commenced studies for a Ph.D. degree under the ACIAR/AIDAB Fellowship at La Trobe University, Australia. Another member was sent to the same university in 1992 to also work for a Ph.D. degree.

Furthermore, the team members were given hands-on-training on the use of the RPPAP computer programming by the other members in charge of its development.

2. Roadshow Presentation of the RPPAP Model

In late 1991 through 1992, the result of the RPPAP system was presented by the over-all project leader to various decision and policy - making bodies of the DA, PCARRD, and DOST. This was undertaken to get their stamp

of approval for the institutionalization of the use of the RPPAP model in the national agricultural research system in the process of research prioritization. Seeing the need to rationalize the allocation of the existing limited research resources in the country to maximize the benefits from research, the use of the RPPAP system in research prioritization was resolved in these fora. Specifically, these decision and policy-making bodies focused on the Technical Advisory Committee (PCARRD), Management Committee (DA), Research and Development Committee (PCARRD), and the Governing Councils of PCARRD & DOST.

3. **Trainers' Training on the Use of the RPPAP Model, Continuing Education Center, UPLB, Los Baños, Laguna)**

In an effort to institutionalize the adoption of the RPPAP model in setting research priorities in the national research system, a four-day training was conducted. This was spearheaded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture in cooperation with UPLB and PCARRD. The participants were the DA Regional Research Division Chiefs and the Regional R & D Consortia Coordinators from the 13 regions of the country. Others were a number of commodity and technical staff from BAR, PCARRD and PCAMRD. They were oriented on the methodologies utilized in the development of the model and the theoretical framework used. They were given hands-on-training on how

to use the RPPAP Computer program (RE4) by following a simplified step-by-step procedure. The manual on the use of the RPPAP model was reproduced in mimeograph form for the use of the participants during the training.

The trainees representing each region were able to get the respective computer print-outs containing the national and regional benefits that would accrue from research on the 24 commodities covered by the model. The participants were given the option to re-prioritize the 24 commodities for each region and identify corresponding researchable areas for each commodity.

#### **4. Installation of the Computer Programs in the Regions**

In 1992, the BAR staff attempted to install the RPPAP Computer Programs in all the regions to enable the trainers to re-echo what they had learned from the Trainor's Training. But the computers of the DA Field Offices (except 2) had limited capacities that could accommodate the programs. So far only Region VII has re-echoed the training course attended by 50 participants. However, only the theoretical aspects were imparted to the participants.

Now that the new computers have been installed in the DA Field Offices, the envisioned re-echoing of the use of the RPPAP model can materialize. The re-echoe trainings in the regions could be initiated by BAR in collaboration with the Research Divisions Chiefs of the DA Field

Offices and Regional R & D Consortia coordinators. Targets of trainings are the researchers and data controllers.

**5. Refresher Course on the Use of the RPPAP Model**

The refresher course was undertaken in preparation for the conduct of the "Regional Agricultural and Fishery Research and Extension Planning Workshops" in all the regions where the RPPAP model was to be piloted. This was conducted by BAR in collaboration with PCARRD, PCAMRD and UPLB. The participants were the commodity/technical experts from BAR, PCARRD and PCAMRD. In this course, the participants simulated the ranking of commodities and researchable areas for Region III, using the RPPAP output. It was observed that the participants easily imbibed the procedures in running the RPPAP computer program and its concept.

**6. Formulation of the Regional Agricultural and Fishery Research and Extension Agenda (RAREA), 1993-1998**

Implementation of the project results and methodology has been initiated in the update of the Philippine National Agricultural Research and Extension Agenda (NAREA). Workshops to introduce the decision-support model to policy makers and research managers have been conducted. This was followed by the validation of the NAREA using the developed prioritization scheme.

A series of regional planning workshops was conducted from August through September, 1992 in all the 13 regions of the country. Likewise, this was done in cooperation with PCARRD and PCAMRD following a consultative process. Participants were representatives drawn from the member agencies of the Regional R & D Consortia, farmers' organizations and Provincial and Municipal Agricultural Offices.

BAR staff briefed the participants on the methodologies used in the development of the RPPAP model and on the benefits that would accrue from research on the 24 commodities. The start-off points in the formulation of the RAREAS were the outputs of the Trainers' Training held in December 1991 at Los Baños, Laguna. The participants were given the option to delete from the list of 24 commodities and/or inject to the list other commodities which were deemed essential in the respective regions. Priority commodities were ranked by development zones, regardless of sector, i.e. crops or livestock. A separate ranking was done for the fishery sector, considering its equal importance to the national economy. Research disciplines and researchable and extension areas were identified for each commodity.

#### 7. Printing of the Two Books on RPPAP

To further gain the momentum for the institutionalization of the RPPAP model in setting

research priorities in the national research system, two

(2) books were printed. These are:

- 7.1 Proceedings of the "Validation of the Quantitative Parameters Used in Research Prioritization Model"
- 7.2 Manual on the Use of the RPPAP Model in Research Prioritization

The first book documents the proceedings of the workshop where the results of the sets of questionnaires sent to technical experts were validated last February 28 to March 1, 1991 at PCARRD, Los Baños, Laguna. The data elicited were in relation to the three parameters used in the development of the RPPAP model. These are:

- a. Probability of Research Success
- b. Ceiling Levels of Technology Adoption, and
- c. Spill-over Effects of Research.

Furthermore, the figures on demand and supply elasticities gathered from various studies were validated by experts.

The workshop participants were selected from various research institutions such as State Universities and Colleges (SUCs), Southeast Asian Fisheries Development Center (SEAFDEC), PCARRD, PCAMRD, and the DA's various agencies with agricultural research concern.

The second book intends to provide decision-makers an aid for research prioritization and basis for ex-ante evaluation of research programs on the 24 commodities. The book reflects some theoretical considerations on the

development of the RPPAP and information on the benefits that would accrue from research on the 24 commodities. It also shows the outputs of the participants during the Trainor's Training on the used of the RPPAP model.

8. Collection of National and Regional Data for Other Commodities (On-going)

The Bureau of Agricultural Statistics has already institutionalized the collection of basic data on production and prices not only for the 24 commodities included in the RPPAP model but also for a number of other agricultural commodities as well. The level of data disaggregation and organization, however, are not organized and presented in the format prescribed by the model. Data on prices are available only in selected major producing provinces for some agricultural commodities.

Other data requirements of the RPPAP model such as price elasticities, consumption, ceiling levels of adoption, probability of success, production environments and proportions are not being undertaken.

6. OUTPUTS OF THE REGIONAL AGRICULTURAL AND FISHERY R AND E WORKSHOPS

1. Scope and Prioritization

For crops and livestock, there were thirty-nine (39) commodities identified as priorities by the 13 regions, covering nineteen crops and livestock included in the RPPAP

model. The commodities cited by all regions as priorities are rice, corn, cattle, chicken, and swine. The frequency by which the commodities were cited as priorities by the regions are shown as follows:

RPPAP Commodities	No. of Regions Reporting	Other Commodities	No. of Regions Reporting
1. Rice	13	1. Goat	13
2. Corn	13	2. Citrus	11
3. Cattle	13	3. Mango	11
4. Chicken	13	4. Mungbean	10
5. Swine	12	5. Sheep	10
6. Carabao	12	6. Peanut	9
7. Tomato	11	7. Cashew	7
8. Banana	9	8. Multi-purpose Trees	7
9. Sweet Potato	8	9. Ornamentals	6
10. Cassava	8	10. Bamboo	5
11. Coffee	8	11. Ducks	5
12. Coconut	6	12. Yam	4
13. Cacao	5	13. Abaca	4
14. Sugarcane	5	14. Watermelon	4
15. Pineapple	4	15. Rubber	4
16. Soybean	4	16. Cowpea	3
17. Garlic	3	17. Durian	3
18. Cotton	2	18. Pili	3
19. Tobacco	2	19. Papaya	2
		20. Castorbean	1

At the national level, the ranking of priority commodities was influenced by the Science and Technology Agenda for National Development (STAND Philippines 2000) for the medium-term, 1993-1998. The priority agricultural commodities were categorized and ranked in this order: 1) Export Winners, 2) Basic Commodities, and 3) Other Commodities. This agenda which was approved by the Cabinet, was drafted by the Department of Science and Technology in consultation with the various government and private agencies.



In the National Agricultural Research and Extension Agenda (NAREA) 2000 which was formulated by BAR, higher priority is given to basic commodities than to export commodities in consideration of the increasing demand for agricultural products by the fast growing population. (Table 5).

With respect to fisheries, thirty-three (33) products were listed as priorities, which include RPPAP commodities, namely: tuna, milkfish, tilapia, prawn, & roundscad (Table 6).

As in crops and livestock, the priority commodities covered by the STAND (shrimps, prawns, tuna, crabs, carageenan and seaweeds) were included in the National Fishery Research and Extension Agenda (NAFREA) 2000, a separate document for fisheries drafted by BAR in collaboration with PCAMRD for the medium-term 1993-1998. Likewise, priority commodities were categorized into export winners and those with export potential. All the regions considered tilapia as top priority. Tuna, seaweeds, pelagic fishes, and groupers were also given high priority by all regions (except the Cordillera Autonomous Region).

## 2. Comparison of NAREA I with NAREA II

The regions established their commodity priorities by development zones, i.e. uplands, hillylands, and lowland rainfed/irrigated under the land resources. For the

fisheries sector, the development zones were the marine, brackish, and fresh waters. The listing of priorities by development zone is shown in Table 7. Assessing the research prioritization of RPPAP commodities in the upland areas contained in NAREA I (the original version) rice, corn, pineapple, tobacco, cassava and sweet potatoes were prioritized in similar order to the RPPAP results with respect to the maximization of the national and regional benefits. This is indicated by the congruence band (Figure 6a). Sugarcane, chicken and hog from which the biggest national welfare gains could be derived were given medium and low priorities by the regions. Banana, coffee, and coconut which also give substantial gains to the national economy were identified as medium priorities.

There was a slight difference in the setting of commodity priorities in NAREA II (the new version). However, the commodities from which the highest benefits could be expected such as rice, corn, chicken, hog, banana, and coconut were given primary importance by the regions as shown in Figure 6a, reflecting the influence of the RPPAP system. The arrows show the changes in the ranking of commodities from NAREA I to NAREA II. The regions gave equal importance to cattle and carabao considering the need to increase meat and dairy production for the country's food security. Equal importance is given to tomato due to emphasis being given to agri-

processing, in this case, tomato sauce/paste processing. Banana, and coconut were given high priority by the regions in line with the country's objective of enhancing the exportation of these products. Sweet potato was also ranked higher in accordance with the government's corollary objective of ensuring food security.

For the hillyland areas, there was less number of RPPAP commodities identified as priorities in NAREA II, from 17 to 12 (Figure 6b). Deleted from the list of NAREA I priorities are rice, tobacco, tomato, garlic, cotton, and soybean owing to the fact that the growing of these commodities could trigger heavy soil erosion in the hillylands. As in NAREA I, the commodities given paramount importance by the regions in the newly formulated agenda are banana, sweet potato, cattle, carabao, and coffee. Other commodities such as cocoa, corn, and hog were given low priorities in NAREA II. Sweet potato and cassava were elevated in the priority rank as these commodities have been traditionally planted in the area and have been the source of livelihood of poor farmers. Pineapple was given lower priority than in NAREA I since there are private companies which conduct research on this.

In the case of the lowland rainfed/irrigated areas, there was similarity in the identification of priority commodities in NAREA II as in NAREA I except that

sugarcane was added to the list (Figure 6c). In NAREA II, the commodities from which the greatest national benefits are expected were ranked higher compared to that in the original document. As influenced by the RPPAP system, rice, corn, hog, chicken, and sugarcane were given highest priority by the regions.

On the over-all, the regions placed high priority to rice, corn, chicken, hog, banana, roundscad, coffee, and coconut. This prioritization is parallel with that of the RPPAP system, except that sugarcane was not included as high priority (Figure 7). Sugarcane was ranked lower since research on this is solely handled by a government institution and various private companies. Other commodities given high priority by NAREA II are tuna, milkfish, tilapia, cattle, carabao, tomato, sweet potato, and cassava. This deviation from the RPPAP system could be traced to the government's emerging policies governing export enhancement and food security.

Placed under medium priority by the regions are sugarcane, pineapple, prawn, cocoa, soybean, and garlic; jibing with the RPPAP system. Tobacco which is regarded as medium priority by the system is given low priority by the regions as the growing of this crop is suitable only in Regions I & II and its demand is expected to go down due to health hazards associated with smoking.

## 7. FUTURE DIRECTIONS

### 1. Expansion of the RPPAP Model

The RPPAP model covers adequately a number of priority commodities most of which would give considerable national benefits. Looking at the regional perspective, the conduct of research on many of these would give zero benefits considering various parameters. This is generally true with CAR where only four (4) of the commodities covered by RPPAP would give substantial research impact. It is only in Region IV where research on the twenty (20) RPPAP commodities are expected to give substantial benefits owing to the existence of various research institutions in the area, among other factors (Table 8). An additional number of commodities aside from the RPPAP coverage were identified as priorities. The expected impact of research on these could be measured if the model could be expanded to cover other major commodities.

The RPPAP plans to expand to about 20 more commodities to increase its utility in the process of research prioritization. This is necessary in the light of the implementation of the DA's key production area approach for the medium w-term here a list of commodities not included in the RPPAP were identified as priorities. There is also the need to include in the model the discipline levels to support decision - makers in

establishing priorities by researchable areas/ disciplines under each commodity. 2. Institutionalization of Data Collection for some Commodities

The lack of hardware and software at BAS Regional Offices, hampers the collection of accurate and timely data on production, consumption, prices and other pertinent information on agricultural products. There is a need to strengthen the BAS regional capacity to enhance spatial planning procedures, which calls for the provision of the necessary equipment and human resource development at the said offices.

The BAS, with its existing hardware/software will institutionalize the collection of data on commodities of economic importance. These data will include production, consumption and prices. At present, the Bureau prioritizes the gathering of pertinent data on 120 commodities, doing it by phases (I, II and III). BAS's existing system of data collection will be changed to follow the system used in RPPAP. This will facilitate the expansion/improvement of the RPPAP system.

As to the gathering of subjective parameters, the agencies involved in the development of the RPPAP system will be assigned to do the task. BAR, PCARRD, PCAMRD and UPLB will be charged with the collection of data/information on the probability of research success,

ceiling levels of technology adoption, spill-over effects of research and supply and demand elasticities. Other institutions, like the Regional R and D Consortia will be tapped in the collection of subjective data using their respective budgets for the purpose.

### 3. Upgrading of Computer Hardware at the DA Field Offices

The DA Field Offices are now equipped with new computers. If necessary, their hard disks will be upgraded to accommodate the RPPAP computer program which require 40 megabytes memory capacity. The data fed into the computers in updating the regional data will be sent to the DA Computer Service for centralized data banking through telephone.

### 4. Conduct of Trainings

Continuous long-term and short-term trainings for the members of the RPPAP research team and other technical staff of agencies involved in the project will be conducted. This will increase technical capability and ensure the existence of manpower complement for the further development and updating of the RPPAP model. Training funds will be co-shared by the agencies involved. Agencies which implement manpower development program, such as PCARRD, will be tapped for long-term trainings.

On the hands-on training on the use of the RPPAP model, technical staff of involved agencies will further be trained. These will include the encoders at PCARRD, PCAMRD and the DA Field Offices.

**5. Institutionalization of the RPPAP Model at UPLB's Institute of Plant Breeding (IPB)**

The UPLB has been actively involved in facilitating the institutionalization in the Philippine national agricultural research system of the use of the decision-support system, which was developed by the RPPAP, in their research priority setting. It was involved in giving the DA regional research division chiefs, the regional R and D consortia coordinators, and staff of BAR, PCARRD and PCAMRD of some insights on the framework and methodologies adopted in the system, as well as in giving them hands-on practice in the use of computers for research evaluation. Nonetheless, the UPLB itself is yet to institutionalize the said decision support system in its actual research priority setting exercise.

The decision support system can be possibly adopted by the UPLB for its own in-house research evaluation and prioritization. It can also be adopted by the Institute of Plant Breeding (IPB) which is under the aegis of the UPLB College of Agriculture. However, some limitations of the system may become apparent.



Most of the research being funded by the UPLB are basic research. The IPB, on the other hand, undertakes both basic and applied research with the end in view of developing new and improved varieties of almost all crops excluding rice, sugarcane, and coconut. The system, by far, can only readily evaluate 24 commodity research including five poultry and livestock, four fishery commodities, and rice, sugarcane and coconut, among others. The system, therefore needs to include other crops as well. In addition, the system must be expanded also to be able to evaluate basic research. Collaboration with other countries in these areas could be one possible solution to eliminate such limitations on the system.

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FIGURE 1. AN ILLUSTRATION OF MEASUREMENT OF BENEFITS FROM RESEARCH

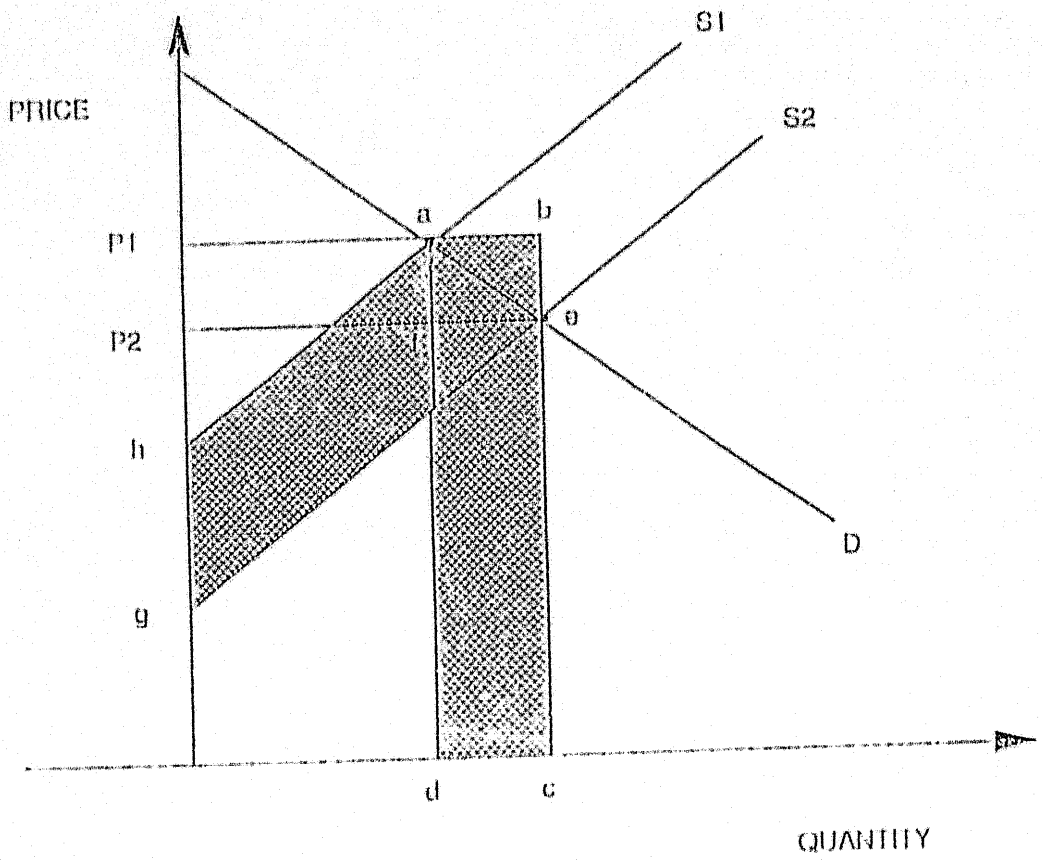


Table 1. Present value and distribution (among regions) of benefits from rice research, Philippines.

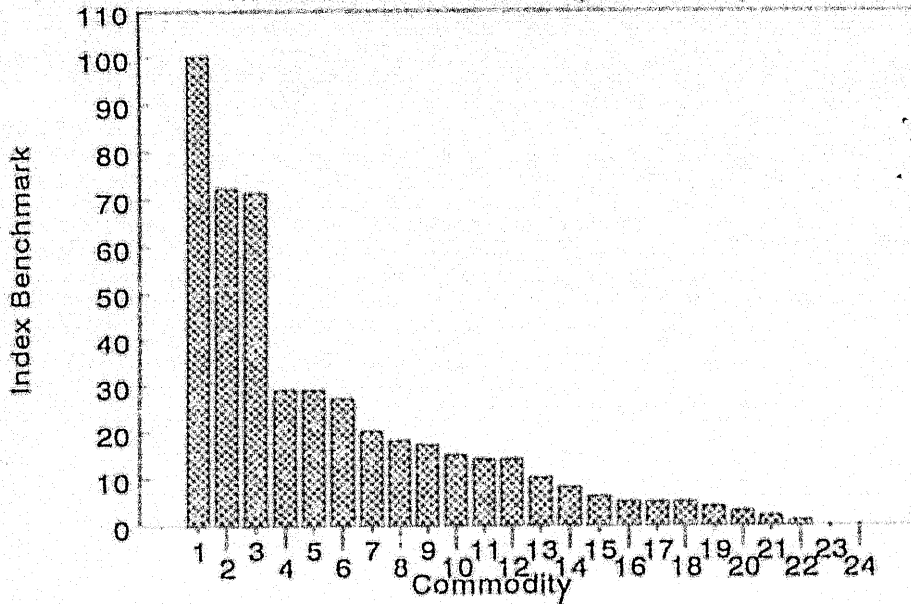
Region Where Research is Undertaken	Total National Benefits MDollar	Regional Benefits MDollar	Car MDollar	Ilocos MDollar	CValley MDollar	CLuzon MDollar	STagalog MDollar	Bicol MDollar	WestVis MDollar	CenVis MDollar	EastVis MDollar	WestMin MDollar	NorthMin MDollar	SouthMin MDollar	CenMin MDollar
Car	7.0	.1	.1	.5	.9	1.6	1.3	.4	1.1	.1	.2	.2	.1	.1	.5
Ilocos	18.5	3.9	.1	3.9	1.9	4.1	3.1	.7	2.4	.3	.4	.3	.2	.3	.3
CValley	21.7	5.8	.1	1.4	5.8	4.3	3.4	.9	2.8	.3	.5	.4	.2	.3	1.2
CLuzon	30.1	12.6	.1	2.0	2.8	12.6	4.5	1.0	3.6	.4	.6	.5	.3	.4	1.3
STagalog	28.0	7.5	.1	2.1	3.1	6.2	7.5	1.2	3.9	.5	.7	.8	.3	.5	1.5
Bicol	19.8	2.7	.1	1.2	2.3	4.0	3.2	2.7	3.0	.3	.6	.5	.3	.4	1.5
WestVis	22.4	7.1	.1	1.4	2.3	4.2	3.3	.9	7.1	.3	.5	.4	.2	.3	1.2
CenVis	18.4	.5	.1	1.4	2.3	4.2	3.3	.9	2.9	.5	.5	.4	.2	.3	1.2
EastVis	17.5	1.7	.1	1.1	2.3	3.9	3.2	1.1	3.0	.3	1.7	.5	.3	.4	1.6
WestMin	14.9	.6	.1	1.0	1.8	3.2	2.6	.9	2.4	.3	.5	.6	.2	.3	1.2
NorthMin	18.9	.8	.1	1.2	2.3	4.0	3.2	1.1	3.0	.3	.6	.6	.8	.4	1.5
SouthMin	13.2	1.4	.9	.8	1.5	2.7	2.1	.7	1.9	.2	.4	.3	.2	1.4	.9
CenMin	20.5	3.3	.1	1.2	2.3	3.9	3.2	1.1	3.0	.3	.6	.6	.3	.4	3.8
Average	22.0	5.7	.1	1.7	2.7	5.6	3.8	1.1	3.5	.3	.6	.4	.3	.4	1.5



Table 3. Commodity research priorities Philippines, based on national average benefits from research (with international spillovers).

Priority Group	Commodity	Absolute Benefits	Relative	Benefits
I	Rice	22.0	100	1
	Sugarcane	15.8	72	1
	Corn	15.6	71	1
	Chicken	6.3	29	3
	Hog	6.3	29	3
II	Banana	5.9	27	4
	Coffee	4.5	20	5
	Roundscad	3.9	18	6
	Coconut	3.8	17	6
III	Pineapple	3.3	15	7
	Tobacco	3.1	14	7
	Tuna	3.1	14	7
	Milkfish	2.3	10	10
IV	Garlic	1.7	8	13
	Prawn	1.3	6	17
	Carabao	1.2	5	18
	Cattle	1.1	5	20
	Tomato	1.0	5	22
V	Tilapia	0.8	4	28
	Cassava	0.7	3	31
	Sweet Potato	0.5	2	44
VI	Cocoa	0.3	1	73
	Cotton	0.1	0	220
	Soybean	0.1	0	220

Figure 2  
Research Benefits Index (Rice = 100)



COMMODITY LEGEND:

Benchmark Case:							
k = 5%			Technology Ad. Lag = 3				
Research Lag = 8			Research Ad. Lag = 4				
Commodity	HIGH PRIORITY			MEDIUM PRIORITY			
	Absolute Benefits	Relative Benefits		Commodity	Absolute Benefits	Relative Benefits	
1- Rice	22.0	100	1	10- Pineapple	3.3	15	7
2- Sugarcane	15.8	72	1	11- Tobacco	3.1	14	7
3- Corn	15.6	71	1	12- Tuna	3.1	14	7
4- Chicken	6.3	29	3	13- Milkfish	2.3	10	10
5- Hog	6.3	29	3	14- Garlic	1.7	8	13
6- Banana	5.9	27	4	15- Prawn	1.3	6	17
7- Coffee	4.5	20	5	16- Carabao	1.2	5	18
8- Roundscad	3.9	18	6	17- Cattle	1.1	5	20
9- Coconut	3.8	17	6	18- Tomato	1.0	5	22
LOW PRIORITY							
19- Tilapia	0.8	4	28	22- Cocoa	0.3	1	73
20- Cassava	0.7	3	31	23- Cotton	0.1	0	220
21- Sweet Potato	0.5	2	44	24- Soybean	0.1	0	220



Table 4. Benefits from research: Tradeoff between national welfare and regional welfare for Southern Mindanao.

Commodities	National Average Benefits (Million \$)	Regional Average Benefits to Southern Mindanao (Million \$)	National Benefits for Research Undertaken in Southern Mindanao (Million \$)	Regional Benefits for Research Undertaken in Southern Mindanao (Million \$)
Rice	22.0	0.4	13.2	1.4
Sugarcane	15.8	0.1	0.8	0.0
Corn	15.6	6.6	18.5	10.4
Hog	6.3	0.1	1.8	0.5
Chicken	6.3	0.0	0.6	0.1
Banana	5.9	3.4	8.6	6.0
Coffee	4.5	1.4	4.8	2.1
Roundscad	3.9	0.1	2.1	0.2
Coconut	3.8	2.1	5.9	4.3
Pineapple	3.3	1.3	3.3	2.1
Tuna	3.1	0.7	3.8	1.4
Tobacco	3.1	0.1	0.0	0.0
Milkfish	2.3	0.1	0.8	0.1
Garlic	1.7	0.1	0.0	0.0
Prawn	1.3	0.0	0.2	0.0
Carabao	1.2	0.0	0.2	0.0
Cattle	1.1	0.1	1.2	0.3
Tomato	1.0	0.0	0.9	0.0
Tilapia	0.8	0.0	0.1	0.0
Cassava	0.7	0.0	0.3	0.0
Sweet Potato	0.5	0.0	0.3	0.1
Cocoa	0.3	0.2	0.4	0.3
Soybean	0.1	0.0	0.1	0.1
Seed Colton	0.1	0.0	0.1	0.0

**Figure 3a**  
**NATIONAL AVERAGE BENEFITS**

S O U T H E R N  M I N D A N A O  R E G I O  N A L  B E N E F I T S		6	L	5	4	M	3	2	H	1
	1							BANANA COCONUT		CORN
	2						PINEAPPLE	COFFEE		
	3						TUNA			RICE
	4	COCOA								
	5				GARLIC CATTLE	TOBACCO MILKFISH		ROUNDSCAD	SUGARCANE HOG	
6	COTTON SOYBEAN	TILAPIA CASSAVA SWEET TOMATO		PRAWN CARABAO TOMATO					CHICKEN	

**Figure 3B**  
**NATIONAL AVERAGE BENEFITS**

S O U T H E R N  M I N D A N A O  R E G I O N A L  B E N E F I T S		6	L	5	4	M	3	2	H	1
	1							BANANA COCONUT		CORN
	2						PINEAPPLE TUNA	COFFEE		RICE
	3									HOG
	4	COCOA			CATTLE			ROUNDSCAD		
	5	SOYBEAN	SWEET POTATO				MILKFISH			CHICKEN
6	COTTON	TILAPIA CASSAVA	PRAWN GARLIC CARABAO TOMATO			TOBACCO			SUGARCANE	

Figure 4. Distribution of Research Expenditure Among RPPAP Commodities

NATIONAL BENEFITS

		6 L	5	4 M	3	2 H	1
R E S E A R C H  E X P E N D I T U R E	1			Carabao Cattle	Tobacco	Coconut	Rice Corn
	2						Hog Sugarcane
	3	Cotton Soybean	Sweet Potato				
	4		Cassava			Banana Coffee	
	5	Cocoa	Tilapia	Tomato			Chicken
	6			Garlic Prawn	Pineapple Tuna Milkfish	Roundscad	

Figure 5. The Decision-Support System for Agricultural Research

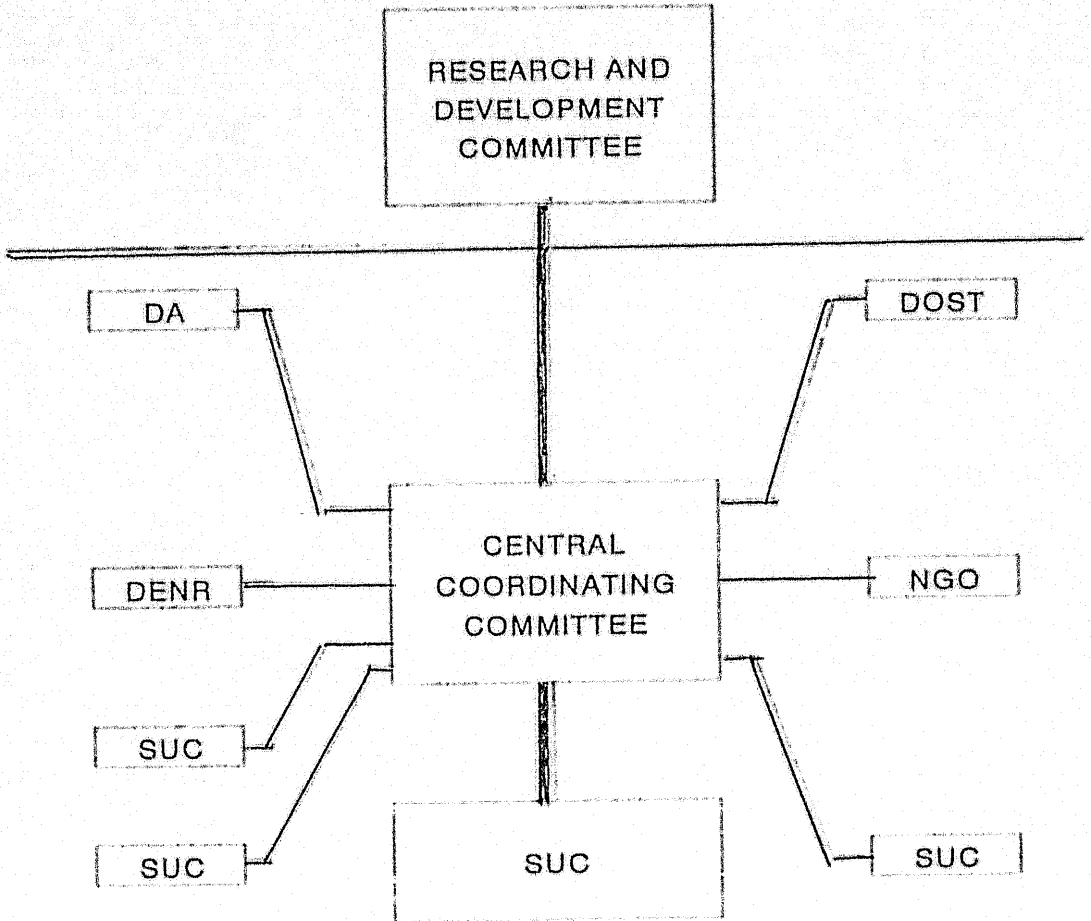


Table 5. National and Regional Priority Commodities

NATIONAL PRIORITY COMMODITIES	REGIONAL PRIORITIES												CAR
	1	2	3	4	5	6	7	8	9	10	11	12	
<b>I. Basic Commodities</b>													
<b>A. Crops Sector</b>													
1. Cereals													
1.1 Rice	x	x	x	x	x	x	x	x	x	x	x	x	x
1.2 Corn	x	x	x	x	x	x	x	x	x	x	x	x	x
2. Fruit Crops													
2.1 Citrus	x	x	x	x	x	x		x		x	x	x	x
2.2 Watermelon	x	x	x	x								x	
3. Vegetables													
3.1 Tomato	x	x	x	x	x	x	x	x		x	x		x
4. Rootcrops													
4.1 Sweet Potato	x	x	x	x	x		x	x		x			x
4.2 Cassava	x	x	x	x	x		x	x		x			
5. Legumes													
5.1 Mungbean	x	x	x	x		x	x	x	x			x	x
5.2 Peanut	x	x	x	x		x	x	x	x				x
5.3 Soybean	x		x				x						x
5.4 Cowpea				x			x						x
6. Fiber Crops													
6.1 Cotton	x										x		
7. Multi-Purpose Trees			x	x	x	x			x		x	x	
<b>B. Animal Sector</b>													
1. Livestock													
1.1 Cattle	x	x	x	x	x	x	x	x	x	x	x	x	x
1.2 Swine	x	x	x	x	x	x	x	x	x	x	x		x
1.3 Carabao	x	x	x	x	x	x	x	x	x	x	x		x
1.4 Goat	x	x	x	x	x	x	x	x	x	x	x	x	x
1.5 Sheep	x	x	x		x		x	x	x	x		x	x
2. Poultry													
2.1 Chicken	x	x	x	x	x	x	x	x	x	x	x	x	x
2.2 Duck		x			x	x	x				x		
<b>II. Export Commodities</b>													
<b>A. Crops Sector</b>													
1. Fruit Crops													
1.1 Mango	x	x	x	x	x	x	x		x	x	x	x	
1.2 Banana		x		x	x		x		x	x	x	x	x
1.3 Pineapple		x		x	x	x							
1.4 Papaya					x				x				
1.5 Durian										x	x	x	
1.6 Cashew	x		x	x		x				x	x	x	
1.7 Pili					x	x				x			
2. Plantation Crops													
2.1 Sugarcane			x		x	x				x			
2.2 Coconut		x		x	x		x			x	x		
2.3 Rubber								x		x	x	x	
2.4 Castorbeans			x										
2.5 Coffee	x	x		x	x				x	x	x		x
2.6 Cacao	x	x			x					x	x		
2.7 Tobacco	x	x											
3. Rootcrops													
3.1 Yam	x	x	x										x
4. Ornamentals				x	x			x		x	x		x
5. Fiber Crops													
5.1 Abaca					x			x	x		x		
6. Bamboo				x	x	x			x		x		

Table 6. REGIONAL PRIORITIES - RAFREA OUTPUT

PRIORITY COMMODITIES	CAR	R E G I O N S											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<b>A. Export Winners</b>													
1. Tuna	-	x	x	x	x	x	x	x	x	x	x	x	x
2. Seaweeds	-	x	x	x	x	x	x	x	x	x	x	x	x
- Eucheuma													
- Gracilaria													
- Sargassum													
3. Shrimps	-	x	-	x	-	x	x	-	-	x	-	-	-
4. Crabs													
- blue crab	-	-	-	x	x	x	x	x	x	x	x	x	-
- mud crab	-	-	x	x	-	-	x	-	x	-	-	x	-
<b>B. With Export Potential</b>													
<b>MARINE</b>													
1. pelagic fishes	-	x	x	x	x	x	x	x	x	x	x	x	x
- blue & black marlin													
- mackerels													
- round scad													
- sardines													
2. Cephalopods	-	x	x	-	-	-	x	x	x	x	x	x	x
3. Seaweeds													
4. Lobster													
<b>AQUACULTURE</b>													
1. Milkfish	-	x	-	x	x	x	x	x	x	x	x	x	x
2. Tilapia	x	x	x	x	x	x	x	x	x	x	x	x	x
3. Grouper	-	x	x	x	x	x	x	x	x	x	x	x	x
4. Seabass	-	-	-	x	x	x	x	-	-	x	x	x	x
5. Abalone	-	-	-	-	-	x	-	x	x	x	-	-	-
6. Grand clam	-	x	-	-	x	-	-	x	x	x	-	-	-
7. Carp	x	x	x	x	x	x	-	x	-	-	x	x	x
8. Mudcrab	x	x	x	x	-	x	x	-	-	-	-	-	-
9. Catfish	-	x	x	x	x	x	x	-	-	-	-	-	-
10. Mudfish	-	-	x	-	-	x	x	-	-	x	-	-	x

Table 7. RPPAP Commodities Identified  
by the Regions by Development Zone

I. Land Resources

Upland		Hillyland		Lowland Rainfed/Irrigated	
Commodities	No. of Regions Reporting	Commodities	No. of Regions Reporting	Commodities	No. of Regions Reporting
Chicken	13	Banana	9	Rice	13
Cattle	13	Cattle	7	Corn	12
Carabao	12	S.Potato	6	Carabao	11
Corn	12	Carabao	5	Hog	9
Hog	11	Coffee	5	Chicken	8
Rice	10	Coconut	5	Tomato	6
Tomato	9	Cassava	4	S.Potato	6
Coconut	8	Chicken	3	Soybean	6
S.Potato	8	Pineapple	2	Cattle	5
Banana	7	Cocoa	2	Sugarcane	4
Coffee	5	Hog	1	Cassava	3
Pineapple	5	Corn	1	Garlic	3
Cocoa	4	Sugarcane	1	Coconut	2
Cotton	4			Pineapple	2
Soybean	2			Cotton	2
Tobacco	2			Tobacco	2



Table 7. Continued...

II. Fishery Resources

Commodities	No. of Regions Reporting
Tilapia	13
Tuna	12
Roundscad	12
Milkfish	11
Prawn	5

Figure 6 A. COMPARISON OF NAREA I AND NAREA II, UPLAND PRIORITIES

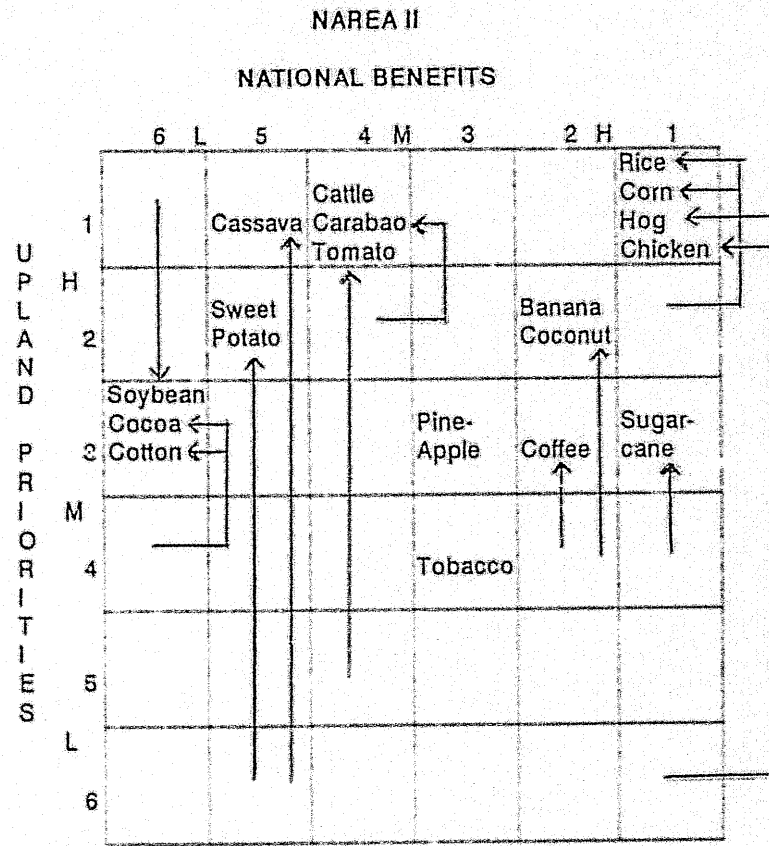
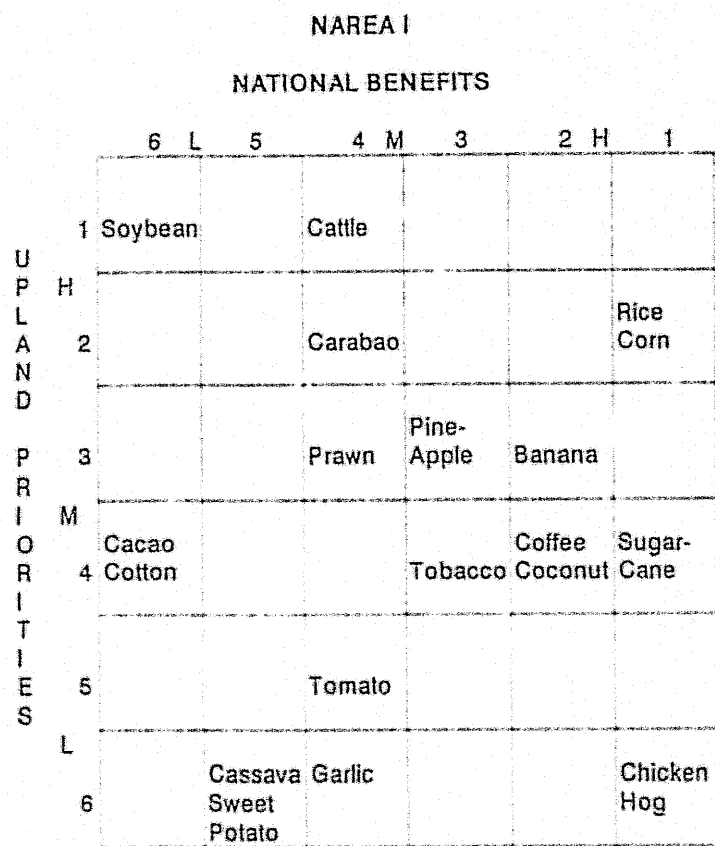


Figure 6 B. COMPARISON OF NAREA I AND NAREA II, HILLYLAND PRIORITIES

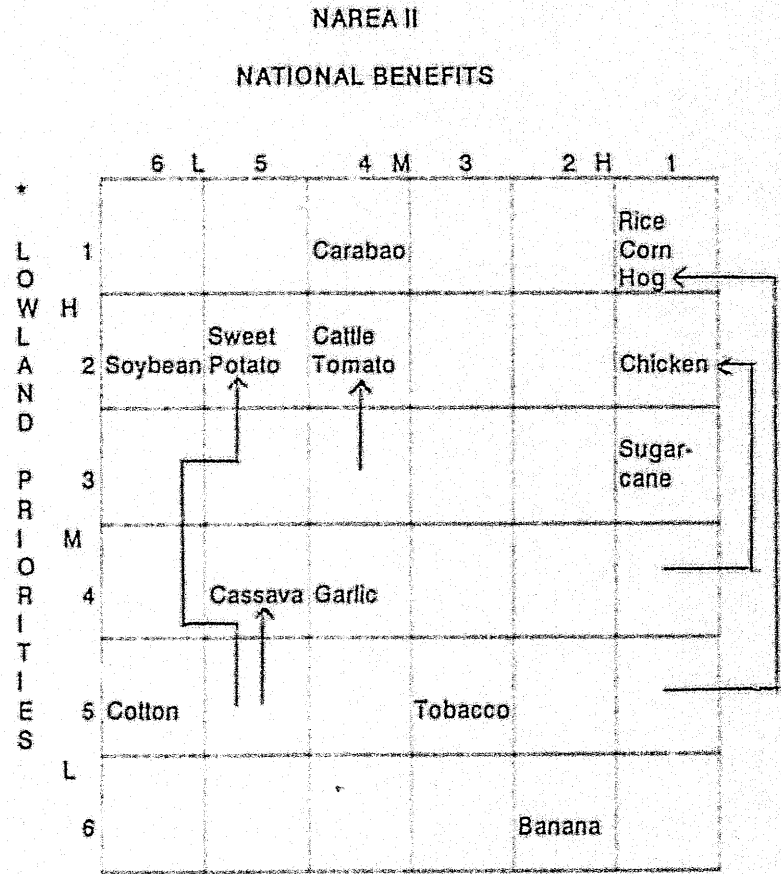
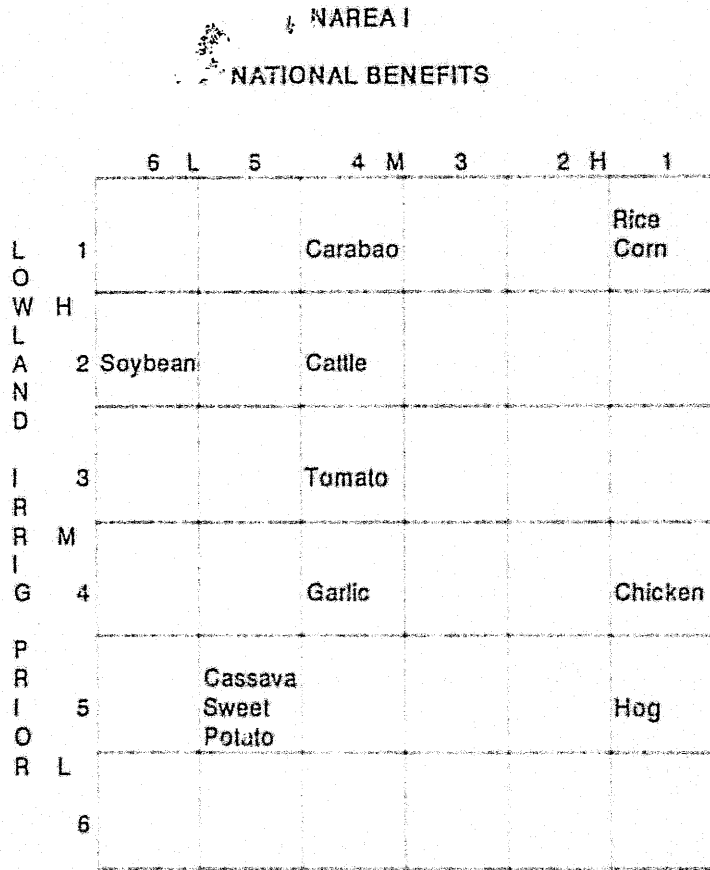
NAREA I  
NATIONAL BENEFITS

		6 L	5	4 M	3	2 H	1
HILLYLAND	1			Cattle	Pine-apple	Banana	
	2	Cocoa Cotton		Carabao	Tobacco		Sugar-cane
	3			Tomato			
PRIORITIES	4						Rice Corn
	5	Soybean					Chicken
	6		Cassava Sweet Potato	Garlic			Hog

NAREA II  
NATIONAL BENEFITS

		6 L	5	4 M	3	2 H	1
HILLYLAND	1						Banana
	2		Sweet Potato	Cattle Carabao			Coffee
	3			Cassava	Pine-apple	Coconut	Chicken
PRIORITIES	4						
	5	Cocoa					
	6						Corn Hog

Figure 6 C. COMPARISON OF NAREA I AND NAREA II, LOWLAND PRIORITIES



\* Include rainfed and irrigated areas.

Figure 7. AGGREGATE REGIONAL PRIORITIES VIS-A-VIS NATIONAL BENEFITS

		NATIONAL BENEFITS								
		6	L	5	4	N	3	2	H	1
A G G R E G A T E  R E G I O N A L  P R I O R I T I E S	1		TILAPIA	CATTLE CARABAO TOMATO		TUNA MILKFISH	BANANA ROUNDSCAD	RICE CORN CHICKEN HOG		
	H		SWEET POTATO CASSAVA					COFFEE COCONUT		
	2	CACAO SOYBEAN			PRAWN	PINEAPPLE			SUGARCANE	
	3				GARLIC					
	M									
	4									
5										
L										
6	COTTON					TOBACCO				

Table 8. RPPAP COMMODITIES IDENTIFIED AS PRIORITIES BY THE REGIONS

COMMODITIES	R E G I O N S													
	CAR	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Rice	x	x	x	x	x	x	x	x	x	x	x	x	x	
Corn	x	x	x	x	x	x	x	x	x	x	x	x	x	
Sugarcane				x		x	x				x			
Hog	x 0	x	x	x	x	x	x	x	x	x 0	x	x	x	
Chicken	x 0	x 0	x	x	x	x	x	x	x	x	x 0	x 0	x	
Banana	x 0	x			x	x		x		x	x	x	x	
Coffee	x	x 0	x 0		x	x 0				x 0	x	x		
Roundscad														
Pineapple		x 0			x	x	x 0							
Tobacco		x	x 0											
Tuna														
Coconut		x 0		x 0	x				x		x	x		
Milkfish														
Garlic		x	x 0		x									
Prawn														
Carabao	x 0	x 0	x	x	x	x	x	x 0	x 0	x	x	x 0	x	
Cattle	x	x	x	x	x	x	x	x	x	x	x	x	x	
Tomato	x 0	x	x 0	x	x	x 0	x	x 0	x 0		x	x	0	
Tilapia														
Cassava		x 0	x	x 0	x 0	x 0	x		x 0	x	x			
Sweet Potato		x	x 0	x 0	x 0	x 0	x		x 0	x	x	0		
Cocoa		x	x			x					x	x	0.2	
Soybean	x	x		x				x						
Cotton		x										x		

0 - Denotes zero benefits