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The CGPRT Feed Crops Supply/Demand and Potential/Constraints for their Expansion in South Asia

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Prospect of Feed Crops to Support the Livestock Revolution in South Asia: Framework of the Study Project

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Background

Accompanying the gigantic surge in global cereal production during the 1971-1995 period, there has been an inconspicuous revolution in the global livestock system and through its subsystem of production, consumption, and impact on economic growth. In developing countries, there was a dramatic rise in consumption of animal-origin food products. It was a result of demand changes as caused by changes in the diets of billions of people in the region, through population growth, urbanization, and income growth. It is in line with Bennett's Law prediction in the economic theory of consumption that suggested that as income grows, the dietary pattern becomes more diversified with better quality (higher price) of food staples. This desire is inherent among most populations of the world. This general phenomenon creates three stylish archetypical consumption bundles according to the level of income per capita. The first bundle occurs at lower per capita income levels where grains dominate. The second bundle occurs at mid-range per capita income levels where animal (livestock and fish) products dominate, followed by grains. The third bundle occurs at higher per capita income levels, where animal products prevail followed by other food products, then horticulture and vegetable products, and finally, grains. In other words, demand for animal products increases while demand for grains as food decreases as per capita income grows.

The stylish path of dietary change explains why demand for livestock and fish products in Asian developing countries has been increasing rapidly in recent years. While per capita consumption of cereals increased by only 0.8 per cent per year, consumption per capita of milk, meat and fish increased by 2.4, 4.9 and 3.1 per cent per year, respectively (Delgado *et al.*, 1997). For developing countries as a whole, total meat consumption grew 5.4 per cent per year and total milk consumption grew 3.1 per cent in the period 1982 to 1994. In India, total meat consumption grew 3.6 per cent per year, while in the rest of South Asia it grew by 4.8 per cent during the same period (FAO, 1998; Delgado *et al.*, 1999). The dramatic increases in the total consumption of animal food products throughout developing countries are caused by rapid population growth coupled with increases in per capita income that result in more diversified food staples.

As meat demand increases, feed grain utilization also increases because feed grains are raw materials for animal feed. This provides a new market opportunity for CGPRT crops. Feed grain utilization per capita has been increasing rapidly at 3.4 per cent per year. It should also be noted that the Asian total population is still growing at around 1.5 per cent per year. As a whole, demand for feed grains (indirect demand) is increasing by around 5 per cent per year, whereas total demand for direct consumption of cereals is increasing by around 2.3 per cent per year. Accordingly, total demand for those cereals, which are used both for human consumption and

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feed, especially maize, sorghum and millet, could increase by around 6 per cent per year. A large difference in the growth rates implies a rapid change of demand structure of those commodities toward more for feed and less for direct human consumption. In fact, maize has been mostly used for feed in many Asian countries.

In addition to demand induced factors, technological changes also contribute to the rapid expansion of demand for animal feed. Increasing land scarcity reduces pasture land availability and hence induces gradual change in livestock farming systems from extensive - out of barn systems, in which the animals are not provided with manufactured feeds, to intensive - inside barn systems, in which animals are fed with manufactured feeds. The same is also true for fish farming. Intensive fish farming has been increasing as a response to increasing scarcity of both natural fish stocks and ponds. Intensification of livestock and fish farming is a major source of increasing demand for feeds in Asian countries.

Another technological factor that induces demand for manufactured feeds is the adoption of modern breeding lines in livestock and fish farming. The modern breeding line animals require manufactured feeds in an intensive within barn or cage farming system. It should also be noted that intensive farming with manufactured feeds and modern breeding lines, is extremely important to improve product quality. In other words, technological change is also a response to meet changes in demand patterns for livestock and fish products.

Animal feeds are dominated by coarse grains, pulses, roots and tubers or the products of these CGPRT crops. CGPRT products are generally either income inelastic or have negative income elasticity. This implies that direct demand for CGPRT products declines with increases in per capita income. This is why CGPRT product prices and market opportunities generally decline over time. The low price and declining demand are the two inherent causes of persistent stagnation or marginalization of most CGPRT farming. This is also the main reason why CGPRT farming is generally dominated by subsistence farmers in Asia. The rapidly emerging demand for feed crops is, therefore, beneficial to reverse the secular marginalization trend of CGPRT farming. It creates a strong demand-pull for the rapid expansion of CGPRT production in many Asian countries.

Increasing demand and prices of CGPRT products would enhance farm household welfare. It would induce commercialization of CGPRT farming and would also facilitate farm diversification, which has the potential to increase and stabilize farm incomes. Rapid expansion of CGPRT farming would create employment and contribute to the development of the rural economy. The rapidly growing livestock industry, supported by domestic feed crop farming and the processing industry, has long been considered to be the most appropriate path of agricultural diversification towards a balanced structural change of the whole economy of most Asian developing countries.

The ample opportunity to expand feed crop farming, however, may create a policy dilemma for some governments. With limited resources, land and water in particular, expanding CGPRT farming may result in a reduction in main staple food production. Some governments may consider this opportunity as a threat to national food security. In some countries, development of feed crop farming may be constrained by various policies, which have been in place to expand food crop farming. Supporting infrastructures may also be insufficient to fully tap the great opportunity for enhancing feed crop farming. In short, it is extremely important to elucidate the real opportunities, constraints and policy options for developing feed crop farming in Asian developing countries through comprehensive research.

Objectives

The general objectives of this project are to elucidate and analyze the potential, weaknesses, opportunities, constraints and policy options for the development of feed crop farming in South Asian developing countries in balance with the rapid development of the livestock and fish culture industry in Asia. More specifically, the objectives may be further broken down:

(i)   To analyze historical dynamics and future trends of demand and supply for feed crop products.

(ii) To evaluate potential, weaknesses, opportunities and constraints for expanding feed crop farming in the participating countries.

(iii) To propose possible cooperation schemes for trade and development of feed crops/products among Asian countries, and

(iv) To formulate policy options to promote sustainable development of feed crop farming in the participating countries.

Subject of study

The main subjects of the project are as follows:

1. Feed crop production and supply and its determinants.
2. Feed crop consumption and demand and its determinants.
3. Feed crop imports and exports and their determinants.
4. The development potential and constraints of feed crops with emphasis placed on CGPRT crops.

Intended impacts and results

1. The project will result in a clearer understanding of the dynamics and future trends of demand and supply for feed crop products in the participating countries.
2. Clearer understanding will be gained on potential, weaknesses, opportunities and constraints for expanding feed crop farming in the participating countries.
3. The results of this study may be a valuable reference for setting up a regional cooperation scheme among ESCAP member countries, and
4. The strategies and policy options formulated through this project will be valuable for choosing operational strategies to promote the sustainable development of feed crop farming in the participating countries.

Basic concepts and methodological framework

In view of preserving comparison among participating countries, the study adopts the same concept and develops the same analysis tools of econometrics, utilizing time series data. The analysis is further complemented with management analysis, devised to delve further into the econometric results.

Feed

Feed is the range of food or feeding stuffs available to an animal. Feeding stuffs is one of the range of potential feeds available to farm livestock. Amongst these would be fresh forages, conserved forages (e.g. hay or silage), concentrates and succulent feeds. Feed can also be classified as: conventional feedstuffs and non-conventional feedstuffs. Conventional feedstuffs are feedstuffs that have been traditionally used for decades or even centuries. They are normally abundant and are purposely cultivated to support animal production. The examples are maize, rice, sorghum, wheat, barley, cassava, fishmeal, and copra meal. Non-conventional feedstuffs are defined as by-products derived from the industry due to processing of the main products and those feeds which have not been traditionally used in animal feeding and/or not normally used in commercially produced rations for livestock, respectively.

Concentrate

Concentrate is animal feeding stuffs, which have a high feed value relative to their volume. It is a low-fiber, high-energy feed that is concentrated by a factory-blended source of nutrients needed to increase the nutritional adequacy of feed supplements.

Feed crops

Feed crops are the crops that are utilized as fresh or processed for feeding animals.

Supply and demand of feed crops

Since the study is interested in investigating the prospects of feed crop development, it is important to establish empirically the impact of price mechanisms and other determinants such as technological factors, population and income in the production and consumption of feed crops. In addition, it is equally crucial to evaluate whether the effort is feasible from a managerial point of view, as commodity development programs entail complicated decision-making in the production, marketing, and processing stages. The study will be conducted by utilizing standard economic theory of supply and demand, complemented with information from farmer and crop growers' groups in the framework of SWOT analysis.

Total supply of a commodity in particular, is basically a summation of domestic production with some imports and its stock in the previous year, as depicted in Figure 1.

Figure 1. Supply of and demand for feed crops
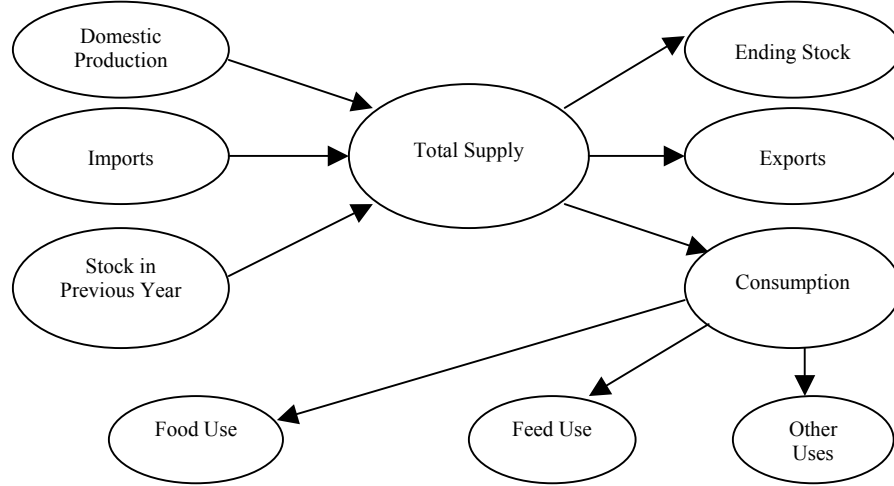
The total supply is then used for consumption, some exports, and some to be stocked at the end of the year. Total consumption is made up from food use by humans, feed to animals (livestock and fish), and other uses.

Model formulation

The model used to generate parameters of equations is based on a system of supply and demand relationships. The system is closed in equilibrium, where total supply equals total demand in a particular country. This is adopted and modified from the World Food Model (WFM) and IMPACT model proposed respectively by Yanagishima (2002), Rosegrant *et al*. (1995), and Rosegrant (1999).

Domestic production

Crop production is assumed as the product of estimated harvested area and yield response functions. Harvested area is specified as a function of crop's own price, the price of other competing crops, and a trend growth factor:

$$AH_{it} = \alpha_i PP_{it}^{\varepsilon_{ii}} \prod_j \left(PP_{jt}^{\varepsilon_{ij}} \right) \left(1 + g_{it} \right) \tag{1}$$

For $_{i,j}$ = All cereals included in the model

Yield is a function of the commodity prices, the prices of some inputs (such as fertilizer and labour), and a trend growth factor reflecting technology improvements:

$$YH_{it} = \beta_i PP_{it}^{\varepsilon_{ii}} \prod_k PI_{kt}^{\varepsilon_{jk}} \left(1 + g_{it} \right) \tag{2}$$

Hence production is:

$$QH_{it} = AH_{it} \times YH_{it} \qquad (3)$$

Where
AH	=	crop area
YH	=	crop yield
QH	=	quantity produced
PP	=	producer price
PI	=	price of factor or input k
i, j	=	commodity index
t	=	time index
g	=	growth rate
ε	=	price elasticity
α, β	=	area and yield intercepts

Total demand

Total use of a commodity is the sum of food, feed and other uses

$$QC_{it} = QF_{it} + QL_{it} + QE_{it} \qquad (4)$$

For food use

$$QF_{it} = \gamma_i PC_{it}^{\varepsilon_{ii}} \prod_j \left(PC_{jt}^{\varepsilon_{ij}} \right) \times (INC_t)^{\eta_i} POP_t \qquad (5)$$

Where

$$INC_t = INC_{t-1} \times (1 + g_t) \text{ and} \qquad (6)$$
$$POP_t = POP_{t-1} \times (1 + g_t)$$

Demand for feed

Other than milled rice:

$$QL_{it} = \gamma_{i\prod_j} PP_{jt}^{\varepsilon_{ij}} G.AC_t (1 + g_{it}), \text{ where } G.AC_t = \Sigma_m w_m QH_{it} \qquad (7)$$

for m	=	all meats in the model and milk and
w's	=	use of feed cereal per unit of meat

Milled rice:

$$QL_t = \gamma \prod_j PP_{jt}^{\varepsilon_j} R.QH_t \left(1 + g_{it}\right) \tag{8}$$

for j = all the cereals considered in the model

Demand for other uses

$$QE_{it} = \gamma_i \left(QF_{it} + QL_{it}\right)^{\alpha_i} QH_{it}^{\delta_i} \left(1 + g_{it}\right) \tag{9}$$

for i = all the cereals included in the model

Ending stock

For a net importing country,

$$ES_{it} = a_i \left(QC_{it} / PC_{it}\right)^{\alpha} \tag{10}$$

For a net exporting country,

$$ES_{it} = b_i \left(QH_{it} / PP_{it}\right)^{\beta} \tag{11}$$

Where QC = total demand
QF = demand for food
QL = demand for feed
QE = demand for other uses
PC = consumer price
INC = per capita income
POP = total population
GAC = basic feed requirement of cereals
RQH = rice production
ES = ending stock

Trade equation
Import and export equations are subject to the country's net trade position. Gross imports for a net importing country and gross exports for a net exporting country are determined on the basis of commodity balances, while alternate specifications are used to compute the "minor" flows-gross imports for a net exporting country and gross exports for a net importing country.

Gross imports
For a net importing country, imports are required to balance the domestic market,

$$M_{it} = QC_{it} + ES_{it} - QH_{it} + X_{it} - ES_{it-1}.$$

For a net exporting country, imports are the larger level of a demand specified minimum access (MQ) or an amount related to total (QC).

$$M_{it} = Max\left(MQ_{it,}QC_{it}\right)^{\alpha} \tag{12}$$

or M_{it} maybe estimated as $M_{it} = a_0 QC_{it}^{\alpha_1}\left(PW_{it}/PP_{it}\right)^{\alpha_2} INC_t^{\eta}$

α_i, η = elasticities of import demand with respect to total consumption, prices, and income

Gross exports

For a net exporting country, exports are the exportable surplus remaining after domestic demand has been satisfied,

$$X_{it} = QH_{it} + ES_{it-1} + M_{it} - QC_{it} - ES_{it} \tag{13}$$

For a net importing country, exports are linked to the change in world price relative to domestic price,

$$X_{it} = b_0 QH_{it}^{\beta_1}\left(PW_{it}/PP_{it}\right)^{\beta_2} INC_t^{\eta} \tag{14}$$

Where   M   =   import volume
   X   =   export volume
   PW   =   world price
   MQ   =   specified minimum access level under the Uruguay Round
   β_i, η =   elasticities of export supply with respect to total production, price and income

Equilibrium
   Total supply   = total demand

$$QH_{it} + ES_{it-1} + M_{it} = QC_{it} + ES_{it} + X_{it} \tag{15}$$

Future trends in production and consumption:

The supply and demand models estimated previously, produce estimated elasticity that might be employed to forecast changes in production and consumption in the future. By further investigating the general form of functions,

$$Y = f(X_1, X_2, X_3, \ldots\ldots, X_n) \tag{16}$$

Where   Y   =   dependent variable
   X_i =   Explanatory or pre-determined variable; i = 1, …….., n

Then it is possible to obtain changes in Y, which is caused by changes in each of the explanatory variables and the elasticity with respect to each of these variables. This is shown through equation (17):

$$dY = \varepsilon_1 dX_1 + \varepsilon_2 dX_2 + \varepsilon_3 dX_3 + ... + \varepsilon_n dX_n \qquad (17)$$

Where ε_i =   the elasticity of each of the independent variables with respect to Y
in the equation being considered,

dY =   Percentage change in Y
dX_i =   Percentage change in the exogenous variable i

By using formulae 17, the change in supply and demand could be estimated by combining a point elasticity estimate with a forecast of the change in the explanatory variable.

Planning strategy

Solely technical matters do not only determine the expansion of technology and its adoption as shown in area and production increases. Often it is also curtailed by management problems at the farms, the market and processing industry, and the administrative levels. Each decision maker, at every level, should have a common goal as to how the performance of an organization can be improved to guarantee the successful achievement of production and agroindustrial development of feed crops. The question being faced is why is the business that he is involved in stagnant, given the tendency of mounting competition? Whenever a number of alternatives are under consideration in the planning process, a very careful analysis of the external and internal dimensions of influence is vital. Every important strategic decision should be subjected to an analysis, whereby attention should be given to aspects such as:

Whether the decision can be executed with the existing condition?
What opportunities are available now and in the foreseeable future?
What are the threats from competitors, regulatory bodies, technological changes, or shifts in customer preferences?
What are the unique strengths and internal abilities and how should they be used as leverage in developing competitive advantage?
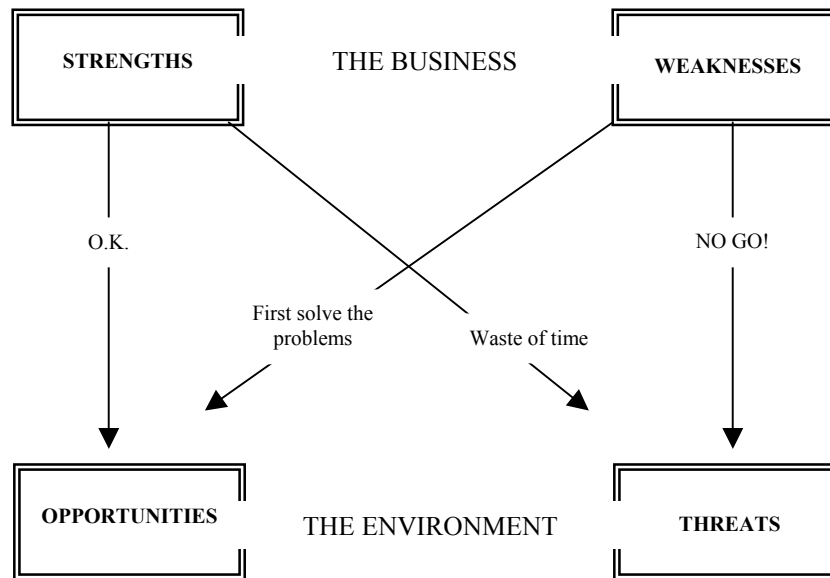What are the weaknesses, and how can they be improved?

This can be identified and analyzed in SWOT (strengths, weaknesses, opportunities, and threats) analysis. The analysis can be applied to each stage of decision-making: production, marketing, or processing.

SWOT analysis is a management tool that should be used by management on a regular basis. The analysis is a simple but very effective analytical method for an organization to measure its own *Strengths and Weaknesses* and to identify, in the target environment, the characteristics of that environment that can be classified as either *Threats or Opportunities*.

All elements associated with an activity have to be analyzed carefully and the decision maker will rate them as either a strength or weakness, or a threat or opportunity. While working on the analysis, the decision maker will find out that it is often not easy to label an element to each of the groups.

The strategic judgment of SWOT analysis is what it is really all about and makes it possible to judge whether a decision maker will be able to expand current production, or that first, solutions have to be found for a number of problem areas. The analyst will place the business and the environment in one "frame" and draw lines between the four squares:

Figure 2. Decision-making through SWOT analysis

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┌─────────────┐                                    ┌─────────────┐
│  STRENGTHS  │      THE BUSINESS                  │  WEAKNESSES │
└─────────────┘                                    └─────────────┘

      O.K.                                              NO GO!

            First solve the
              problems          Waste of time


┌──────────────┐                                   ┌─────────────┐
│ OPPORTUNITIES│      THE ENVIRONMENT             │   THREATS   │
└──────────────┘                                   └─────────────┘
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If the majority of the strengths of the business correspond with the opportunities of the market, then the decision maker will not find too many problems on his way. He can start developing an entry strategy.

If the list of weaknesses is very long and the list of strengths too long, the list of environmental strengths will be very long as well. The business should not get involved with expanding production of the commodities being analyzed.

If however, the strengths of the market correspond with the weaknesses of the business or if, due to the weaknesses of business the list of threats is too long, the company will first have to work on improvements in the organization before becoming involved with expanding its activities. Whilst finding solutions for the weaknesses of the business, the list of weaknesses will become shorter, the list of strengths will become longer and automatically, a lot of the threats in the environment will become opportunities.

If the weaknesses can not be solved, the business will have to decide not to get involved in production expansion, or they may have to look for other commodities or activities where the situation can be completely different. A new analysis will have to be undertaken in this case.

With the SWOT analysis in hand and the proper conclusions drawn, the analyst is now ready to take a justified decision and develop a strategy that should lead to successful product expansion.

Participating countries and organization and implementation

The participants in this project are India, Nepal, Pakistan and Sri Lanka, which are among the low-income group of ESCAP member countries in the South Asia subregion. The four countries neighbour one another and hence, could take the advantage of regional cooperation for the development of CGPRT crops. As proposed, this study is conducted mainly in upland semi-arid agro-ecological areas, which are the focus area of the CGPRT Centre.

The project is implemented in collaboration with partner institutes of those participating countries, where the CGPRT Centre develops country study guidelines in cooperation with the regional advisor, as a resource person for the project. The Centre is also responsible for the coordination of planning and implementing the project and in disseminating the findings. The total duration of the project is one year and a half, starting from July 2001 to December 2002. The project activities consist of three elements: (i) Country study, (ii) Workshop, and (iii) Publication and dissemination.

The country studies are conducted by the respective national experts based on the guidelines prepared by the Centre in close consultation with the regional advisor. The guidelines set the scope, concepts, and method of the country studies and the project schedule. The national experts are requested to produce draft reports of country studies and present them in the regional workshop. Then they shall finalize the country reports by accommodating all relevant and valid suggestions and criticism raised at the workshop to produce final reports for publication. The final reports should also include executive summaries. From the materials contained in the country reports, complemented by other sources, an integrated report is prepared by the Centre in cooperation with the regional advisor. Publication and dissemination of the reports is completed by the Centre. As part of the dissemination, in addition to the regional workshop, where selected policy-makers and researchers are invited, the national experts are also requested to present the findings of their country studies in their own countries.

The organization of the project was as follows:

Overall Coordinator and Supervisor:	Dr Nobuyoshi Maeno, Director, CGPRT Centre
Team Leader:	Dr Budiman Hutabarat, Program Leader, Research and Development, CGPRT Centre
Regional Advisor:	Dr Sivali Sirimevan Ekayana Ranawana, Professor, Livestock and Avian Sciences, Wayamba University, Gonawila, Sri Lanka
National Experts:	
India:	Dr Prem Shankar Pathak, Indian Grassland and Fodder Research Institute, Jhansi, India
Nepal:	Dr Bekha Lal Maharjan, Nepal Agricultural Research Council, Patan, Nepal
Pakistan:	Dr Abdul Ghaffar Khan, Animal Nutrition, Animal Science Institute, National Agricultural Research Centre, Islamabad, Pakistan
Sri Lanka:	Mr Kulugammana Ellapitagedara Karunatilake, Agro Enterprise Development and Information Service (AgEDIS), Department of Agriculture, Paradeniya, Sri Lanka

Prior to the implementation of the project, the coordination pre-planning meeting involving the regional advisor and the team leader along with the director of the Centre was held at the Centre on 27-28 August 2001 to discuss agendas as follows:

(i)   Brief review by the director of CGPRT Centre.
(ii)   Review of the project objective.
(iii) Technical guidelines for country studies.
(iv)   Report outline.
(v)   Planning meeting, and
(vi)   Other matters.

The team leader and regional advisor are then to refine the results of the pre-planning meeting. These revised materials are used and discussed later in the planning meeting in the forms of:

(i) Report of the preplanning meeting that contains tentative references to the planning meeting, schedule of the country study, outline of country and integrated reports.
(ii) General reference of the workplan.
(iii) Basic concepts and analytical framework.

This was discussed further in more detail, later at the planning meeting that was conducted at the Centre on 27-28 September 2001. All the national experts, the regional advisor and team leader along with the director of the Centre were present at the meeting. The regional advisor presented the overview of the project that includes the background and justification, schedule of tasks and the proposed outline of country reports. The team leader explained about conceptual framework and model formulation for empirical estimation, and the national experts were asked to finalize their workplan of the country study and start the country study in October 2001.

Upon completion of writing the country study report, the regional workshop was conducted at the Centre on 3-4 September 2002, to critically review the reports and to seek comments and suggestions for improving the quality of the country reports. Based on recommendations from the collaboration of institutions in the respective countries, the Center accepted the nominations of commentators to the country reports. The names of commentators are as follows:

(i) Dr Narsingh Narain Singh, Directorate of Maize Research, Indian Agricultural Research Institute (IARI), New Delhi, India.
(ii) Dr Shambu Bahadur Panday, Nepal Agricultural Research Council (NARC), Kathmandu, Nepal.
(iii) Dr Abdul Majeed Haqqani, National Agricultural Research Council (NARC), Islamabad, Pakistan.
(iv) Mr Hemachandra Samaratunga, Other Field Crops Research and Development Institute, Department of Agriculture, Paradeniya, Sri Lanka.

The commentators were also participants in the workshop and presented their comment papers.

Report outputs from the project

Three types of publication are produced from the research project: (i) country reports, (ii) an integrated report, and (iii) proceedings of the workshop. The country reports bear the same titles except for the name of the country as follows:

1. Prospects of Feed Crops in India: The Role of CGPRT Crops by Prem Shankar Pathak (Working Paper No. 64).
2. Prospects of Feed Crops in Nepal: The Role of CGPRT Crops by Bekha Lal Maharjan (Working Paper No. 65).
3. Prospects of Feed Crops in Pakistan: The Role of CGPRT Crops by Abdul Ghaffar Khan (Working Paper No. 66).
4. Prospects of Feed Crops in Sri Lanka: The Role of CGPRT Crops by Kulugammana Ellapitagedara Karunatilake (Working Paper No. 67).
5. Prospects of Feed Crops in South Asian Countries: The Role of CGPRT Crops by Budiman Hutabarat and Sivali Sirimevan Ekayana Ranawana (Working Paper No. 68).
6. The CGPRT Feed Crops Supply/Demand and Potential/Constraints for their Expansion in South Asia by Budiman Hutabarat (CGPRT Monograph No. 42).

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