Economic and Social Commission for Asia and the Pacific

CGPRT Centre WORKING PAPER No. 68

Prospects of Feed Crops in South Asia: An Integrated Report

Budiman Hutabarat
Sivali Ranawana

United Nations

The CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UNESCAP.

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Prospects of Feed Crops in South Asia: An Integrated Report

"CGPRT Centre Works Towards Reducing Poverty Through Enhancing Sustainable Agriculture in Asia and the Pacific Region"

WORKING PAPER 68

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Foreword

The research project "Prospects of Feed Crops in South Asia" started in July 2001 and was officially completed in December 2002.

The idea to formulate the project was initiated by Dr. Haruo Inagaki, Dr. Pantjar Simatupang, and Dr. Muhammad Chowdhury during their tenure at the UNESCAP CGPRT Centre as respectively the Director, the Program Leader of Research and Development, and a member of the professional staff, based on their discussions with many persons from different sectors and countries in South Asia. From all discussions it was clear that CGPRT crops have an important contribution to play not only for traditional human consumption but also industrial raw materials and feed to support the livestock sector. From these value-added products, it is expected that the growers' income could be improved if proper government policies are implemented and private sector involvement is sought. This is the main thrust for undertaking the current project.

Four countries in the South Asia region namely, India, Nepal, Pakistan, and Sri Lanka were involved in the project. The four countries were chosen to represent the region in terms of economic and agroclimatological diversity. The main activity included in the project was the undertaking of a country study by the national researchers. The reports of the country studies were published separately for individual countries in the Centre's working paper series.

This integrated report aims firstly, to compile the country reports of the four participating countries, and secondly, provide consolidated discussions on strategies and policies to develop feed crops in the region. I sincerely hope that this integrated report, together with the country reports, will contribute to the further improvement of feed and feed crop development in the participating countries as well as in those countries that have similar conditions.

I am grateful to Prof. Sivali S. Ranawana, Professor of Livestock and Avian Sciences, Wayamba University, Gonawila, Sri Lanka for his devoted services as the Regional Advisor of the project and his contribution to this Working Paper and its publication. My gratitude is extended to Dr. Budiman Hutabarat, a research economist at the Indonesian Center for Agro-Socio Economic Research and Development (ICASERD) and the former Program Leader, Research and Development, UNESCAP CGPRT Centre, who coordinated the project as the Project Leader and compiled this integrated report. My thanks go to Mr. Matthew L. Burrows for his dutiful editing services throughout the publication of the reports of the project.

Finally, I would like to express my sincere appreciation to the Government of Japan for its generous support in funding the project.

October 2003

Nobuyoshi Maeno
Director
CGPRT Centre

Acknowledgements

The authors wish to express their profound gratitude to Dr Haruo Inagaki, the former Director or the CGPRT Centre, who initially conceived and promoted this project and Dr. Nobuyoshi Maeno, the current Director of the Centre, who gave us guidance, assistance and support in implementing the study. This report brings together the findings of a research study carried out by four distinguished scientists from India, Nepal, Pakistan, and Sri Lanka, namely, Dr. Pathak, Dr. Maharjan, Dr. Khan and Mr. Karunatilake and would obviously not be possible without their contributions. To each of them we acknowledge our appreciation. The opportunity to work part-time at the CGPRT Centre was granted by Dr. Tahlim Sudaryanto, the former Director of ICASERD (Indonesian Center for Agro-Socio Economic Research and Development) and Dr. Joko Budianto, the Director General of IAARD (Indonesian Agency for Agricultural Research and Development). The first author is indebted to both of them for their ready willingness.

We must also thank Mr. Matthew L. Burrows who edited this paper as well as all the reports produced from this project. The staff at the CGPRT Centre, especially Ms. Babay Putra and Ms. Agustina Mardyanti, who assisted us in many ways, deserve our special thanks.

Perhaps most important are the many farmers, administrators and businessmen in their respective countries who gave their time and ideas and responded positively during the surveys and studies. We wish to record our thanks and wish them success in their own activities.

October 2003

Budiman Hutabarat, Program Leader
Sivali Ranawana, Regional Advisor
CGPRT Centre

Executive Summary

This study, entitled "Prospects of Feed Crops in South Asia" was conceived as a result of concerns regarding the impact of the rapid growth in the consumption of meat and milk in the region on the availability of animal feedstuffs required to increase animal production. It has been noted that relatively slow growth in feed crop production is leading to deficits in animal feeds resulting in increasing imports of the basic feed ingredients or of animal products to South Asia. The general objectives of this project, therefore, were to examine and analyze the issues and policy options needed to develop feed crop farming in South Asian countries in relation to the rapid development of the livestock and aquaculture sectors. More specifically, the objectives could be described as shown below:

1. To analyze historical dynamics and future trends of demand and supply for feed crop products.
2. To evaluate potentials, weaknesses, opportunities and constraints for expanding feed crop farming in the participating countries.
3. To propose possible cooperation schemes for trade and development of feed crops/products among Asian countries.
4. To formulate policy options to promote sustainable development of feed crop farming in the participating countries.

Since we were interested in investigating the prospects for feed crop development it was important to establish empirically the impact of price mechanisms and other determinants such as technological factors, population and income on the production and consumption of feed crops. Together with that, it was equally important to get an idea of whether the effort was feasible from a management point of view, since programs to develop commodities entail complex decision making in the course of production, marketing and processing. This part of the study was conducted utilizing standard economic theories of supply and demand, complemented by the management planning tool of SWOT analysis.

This project was undertaken during the period from July 2001 to December 2002 through a collaborative study with partner institutes in India, Nepal, Pakistan, and Sri Lanka. One distinguished national researcher from each of these countries undertook the task of carrying out the study in their respective country and preparing country reports. They are:

- Dr. Prem S. Pathak, Indian Grassland and Fodder Research Institute, Jhansi, India.
- Dr. Bekha L. Maharjan, Nepal Agricultural Research Council, Patan, Nepal.
- Dr. Abdul Ghaffar Khan, Animal Nutritionist, Animal Science Institute, National Agricultural Research Centre, Islamabad, Pakistan.
- Mr. K.E. Karunatilake, Agro Enterprise Development and Information Service (AgEDIS), Department of Agriculture, Peradeniya, Sri Lanka.

This Working Paper has been compiled using the information generated by the individual country studies and by complementing them with other relevant information to give a regional perspective to the issues and prospects.

Livestock farming is an essential component of agricultural systems in these countries and contributes between 10 per cent (Sri Lanka) and 45 per cent (Pakistan) to total agricultural production. Although milk and milk products have traditionally been the major source of animal protein in the South Asian diet and the demand continues to increase, the consumption of meat, in particular chicken, has shown huge increases in recent years. Governments in the region are already facing the challenge of increasing the production of milk and meat to satisfy this demand and for this purpose will need to increase the productivity of the large numbers of livestock in the region.

All four countries studied have overall deficits of animal feedstuffs, both roughages and concentrates, since production has not been able to keep pace with the rapidly rising demand. The growth in the livestock sector is primarily in the poultry sector and much of the demand for feed arises for the two key ingredients – maize and soybean meal – needed to prepare broiler and layer rations. In order to increase the yields of dairy cows, however, feeds higher in energy and protein are needed and, therefore, a growing demand for high quality feed ingredients can be expected from this sector.

In India, Pakistan and across the South Asian region, unlike in the West, coarse cereals are used for human consumption as well as for animal feeding. Their cultivation is also an important source of income and employment to millions of rural farmers. Maize, sorghum and a range of millets are used in South Asian countries but of these, as in other parts of the world, maize has now become the most important of the cereal grains for animal feeding.

Since the pig industry is relatively small and ruminants are usually supplemented with straight feeds, most of the commercial feed mills in the region supply the expanding poultry sector. The number and capacity of such commercial mills are adequate or even excessive and the majority are operating at between 50 and 70 per cent of their installed capacity. Many of these feed manufacturers are integrated with companies that supply other inputs as well to the purchasers and processors of eggs and chicken. These large enterprises are usually located close to urban centres and have good infrastructure.

Much of the feed supply for ruminants, in contrast, still originates from natural forages and crop residues, which do not compete as food for human consumption. As the available grazing lands have dwindled and the genetic potential of animals has improved, farmers need to use nutrient dense manufactured feeds to supplement their dairy cattle.

All countries in this study have a variety of farmer price support policies for cereal grains but which, in reality, are only effective in the case of wheat and rice with the prices of coarse grains being left largely to market forces. In this sense the demand for these crops is independent of and may even be discouraged by these pricing policies.

Projections show that in all countries there will be an increasing demand for feed and feed crops resulting in a possible growing deficit in the supply of feed ingredients in the next decade. In India, the demand for coarse cereal crops, both food and feed, is expected to increase but the accompanying growth in production will be in the order of 47 per cent to 64 per cent of the demand. The demand for concentrate feeds will, over the next ten years, be at an annual rate of 2.69 per cent. Although, in terms of actual volume, demand will be highest for cattle and buffalo followed by poultry, the fastest growth rate of demand is first poultry (5.74 per cent), followed by pig (4.07 per cent) and buffalo (2.41 per cent).

Maize, soybean, and most of the other coarse cereals in the South Asian region have traditionally been cultivated by smallholder farmers on marginal lands under rainfed conditions. Examples are Nepal, where maize is largely cultivated in the hills by small farmers, and Sri Lanka where it was grown only in the non-irrigable areas during the "maha" (wet) season by small-scale farmers

In general, the measures taken to support farm gate prices of coarse grains and other CGPRT crops have not had the desired results. In India and Pakistan, the support prices for coarse cereals have had a negligible impact on their production. Moreover, distribution of subsidized food grains in the food-deficit districts with a view to stabilize prices has in the past created more problems than price control.

All countries are likely to experience positive growth rates in coarse grain production in the coming decade. Maize production is expected to increase between 1 and 3 per cent per annum in all countries except India.

The studies show these countries will be able to overcome some of the shortages in animal products and feedstuffs through co-operation in trade not only for coarse grains and their by-products but even for animal products. Such trade will help each of these countries to focus

on the commodity in which it has a competitive advantage. Sri Lanka is hoping to benefit from the trade co-operation and liberalization they have adopted as policy but Nepal, Pakistan and India may face difficulties in adjusting to the liberalization and globalization of trade. India will be confronted by competition from other countries that produce coarse grains. Sri Lanka and Nepal stand to gain from the regional preferential trade agreement (SAPTA).

Collaboration in research and development among the countries studied also has a great potential to increase the production of feed crops for mutual benefit. Such a program could deal with technological aspects of developing new varieties using genetic material available in the region and then sharing these more productive strains. Research and development should also extend to better utilization of root and tubers as feed crops in the region. The animal feed industry and other related private sector firms should be encouraged to participate through suitable incentives.

The most serious concerns relating to feed crops in the region could be summarized as follows:

(i) Demand for CGPRT crops as feed ingredients in each participating country will increase faster than domestic supply. The gap between demand and supply will be more significant in Sri Lanka and Nepal and less in India and Pakistan.

(ii) The expansion of CGPRT feed crops is constrained by factors such as undeveloped markets, slow output from research, and a lack of support for farmers, price incentives and transparent policies.

Some of the measures that governments can take immediately are (i) facilitate the development of contract procurement between farmers and feed processors thus ensuring a market and a fair price, (ii) promote farming in production blocks by farmer organizations to exploit economies of scale through increasing productivity and market efficiency, and maintaining quality, (iii) greater investment in the development of High Yielding Varieties possessing resistance to drought and insect-pests, (iv) invite the private sector to be involved in the research and development effort as a stakeholder, particularly in areas such as variety development and grain quality improvement, and (v) establish a program of minimum support price on par with wheat and rice, which is truly effective in increasing production.

There is clearly scope and a need for enhancing regional cooperation in technology and trade where: (i) India and Pakistan could share their research findings on production and processing technologies of CGPRT feed crops with their neighbouring countries and (ii) each country will have the opportunity to exploit its comparative advantage within the framework of the regional trade association of SAPTA (South Asian Preferential Trade Arrangement) where Nepal, for example, could concentrate on producing more high-value horticultural products in the hills, rather than oilseeds or other CGPRT crops that can be exchanged with the produce grown in India. Sri Lanka could focus on producing industrial, cash or medicinal crops, rather than soybean. Such complementary arrangements will have mutual benefits not only in the case of feed crops but throughout all of agriculture.

The studies carried out in each country have identified strengths, weaknesses, opportunities and threats relating to the expansion of feed crop farming.

Since each country has its own natural endowments and government policies within a historical setting specific to each of them, it is difficult to make generalizations that apply across the board. Nevertheless, this study was able to identify some strategies and policies that hold promise in increasing feed crop production which are identified in the Conclusions and Recommendations of this paper.

1. Introduction

1.1 Background and justification

It is generally recognized that the demand for foods of animal origin increases as the dietary pattern becomes more diverse owing to income growth and changes in lifestyle. In developing countries of Asia, this dietary change has been partly responsible for the huge increase in demand for livestock and fish products in recent years. While per capita consumption of cereals increased by only 0.8 per cent per annum in these countries, consumption per capita of milk, meat and fish increased by 2.4, 4.9 and 3.1 per cent per annum respectively. For developing countries as a whole, total meat consumption grew at 5.4 per cent per annum and total milk consumption grew 3.1 per cent during the period 1982 to 1994. In India, total meat consumption grew at 3.6 per cent per annum, while in the rest of South Asia the corresponding increase was 4.8 per cent per annum for the same period. As a derived demand of the increase in animal production, livestock and fish farming in particular, feed grain utilization per capita has also increased rapidly at an annual rate of 3.4 per cent. Another factor contributing to this growth in demand for feed grains is the increase in the human population. In the last decade the total population of Asia grew at around 1.5 per cent per annum. In response to this, the total demand for direct consumption of cereals increased by around 2.3 per cent per annum whereas the demand for feed grains (indirect demand) rose by around 5 per cent per annum. Accordingly, total demand for those cereals, especially maize, sorghum and millet, which are used both for human consumption and feed, may have increased by around 6 per cent per annum. The disparity in these growth rates implies that a rapid change in the demand structure of these commodities has taken place, towards more for feed and less for direct human consumption. The example of maize shows that, in fact, maize is now being used primarily for feed in many Asian countries.

Increasing demand for feeds, manufactured feeds in particular, has also been induced by the change in livestock farming systems from extensive out-of-barn systems to intensive penned/caged/housed systems due firstly to decreases in pasture lands available for grazing and forage production and secondly, to the introduction of modern breeding lines, which require standardized quality feeds to maintain their high levels of productivity. The same is true for aquaculture.

Concentrate feeds for animals are mainly produced from coarse grains, pulses, roots and tuber crops (CGPRT crops), or the by-products resulting from the processing of these CGPRT commodities. These feed crops are grown, in general, by small-scale subsistence farmers in marginal and remote areas on less favorable land such as sloping upland or drought-prone areas in many Asian countries. The rapid growth in demand for feed in these countries provides an opportunity to induce the expansion and commercialization of these crops, and thereby contribute to the improvement of the farm economy and rural development, and eventually to poverty alleviation. It must be remembered, however, that expansion of feed crop farming may compete with that of other staple food crops for the limited land and water resources available.

A related problem is that some crops used in modern animal feeds, particularly broiler chickens, are also consumed by humans thus setting up direct competition. It is clear, therefore, that the development and marketing of feeds and feed crops in developing countries of Asia have many social and economic implications.

1.2 Objectives

The overall objective of this project is to examine the current situation with respect to the demand and supply of feed crops in countries of South Asia in relation to the rapid increase in demand for meat, milk and eggs and evaluate the prospects for meeting the projected demand in the coming decade. This objective can be expressed more specifically as follows:

1. To analyze historical dynamics and future trends of demand and supply for feed crops.
2. To evaluate potentials, weaknesses, opportunities and constraints for expanding feed crop farming in the participating countries.
3. To formulate policy options to promote the sustainable development of feed crop farming in the participating countries.
4. To propose possible cooperation schemes for trade and development of feed crops/products among Asian countries.

1.3 Analytical approach

1.3.1 Definitions

A wide variety of materials derived from plants, animals and non-living materials are fed to domestic animals in the modern world. Some general terms used in relation to animal feedstuffs are given below:

- Roughages: Plant vegetative material usually containing high fiber and low energy such as grasses, legumes and straws, which are usually fed to herbivores.
- Concentrates: Materials from plants and animals which are relatively high in energy and protein that are usually fed to monogastric animals and to ruminants only as supplements.
- Straight feeds: Single ingredients fed direct such as grains and oilcakes.
- Compound feeds: Mixtures of ingredients formulated to give a compound feed of a desired energy and protein content.

Feeds and feed crops

In this report, the term feeds is applied to any of the range of materials which are fed to animals. Many of the roughages fed to animals - straws and stovers - are the residue from the cropping of legume seeds or grains. Some roughages however, such as grasses and legumes are cultivated specifically for animal feeding. Similarly, many concentrate ingredients are by-products of post harvest processing of seeds and grains. Examples are the oilseed meals which are the residue following oil extraction of oilseeds such as soya or coconut and the brans arising from the milling of cereals. On the other hand, some cereals and seeds are purposely cultivated to support animal production. Cereals are also cultivated for human consumption. All crops that eventually become an animal feed, either directly or as a by-product, can be considered as a feed crop. This report, however, deals primarily with the CGPRT crops – coarse cereals, oilseeds and root crops – that produce some of the most important concentrate ingredients used in animal feeds in Asia.

1.3.2 Analytical framework

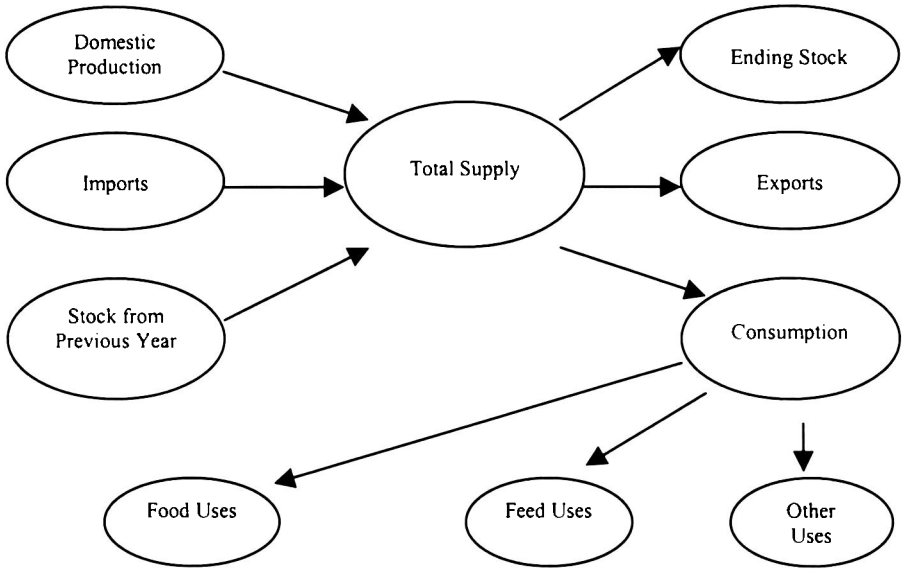
Since it was proposed to investigate the prospects for feed crop development it was important to establish empirically the impact of prices and other determinants such as technological factors, population and income on the production and consumption of feed crops. It was equally crucial to evaluate whether the goals achievable as commodity development programs would entail making complicated decisions relating to production, marketing and

processing. The study was conducted by utilizing standard economic theories of supply and demand, complemented by the management planning tool of SWOT analysis.

Supply and demand for a feed crop

Total supply of a commodity is basically a summation of domestic production with some imports and stock from the previous year as depicted in Figure 1.1. Total supply can then be described as consumption, exports and a balance stock at the end of the year. Total consumption includes food consumption by humans, feed to animals (livestock and fish) and uses for other purposes. The complete model is presented in Appendix 1.

Figure 1.1 Supply of and demand for feed crops



Planning strategy

Although new technologies and their adoption often result in increases in cultivated area and production, these parameters are not solely determined by technical matters. Often it is also curtailed by factors such as management problems on the farms, the market and processing industry, and the various administrative levels. It is important that every decision maker at each level should have a common goal as to how the overall performance of the organization can be improved to guarantee success in the production and agro-industrial development of feed crops. 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 conditions?
- ☑ 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 in developing competitive advantage?
- ☑ What are the weaknesses, and how can these be overcome?

This can be identified and analyzed in a **SWOT (strengths, weaknesses, opportunities and threats)** analysis. The analysis, when applied at each stage of decision-making (production, marketing, or processing) will show four possible outcomes:

1. If the majority of the strengths of the business correspond with the opportunities of the market, than the decision maker will not find too many problems on their way. An entry strategy can be developed.
2. If the list of weaknesses is very long and the list of strengths too long, then the list with environmental strengths will be very long as well. The business should not get involved in expanding production of the commodities being analyzed.
3. If, however, the strengths of the market correspond with the weaknesses of the business or if, due to the weaknesses of the business the list of threats is too long, than the analyst will first have to work on improvements in the organization before becoming involved with expanding activities. In finding solutions for the weaknesses of the business the list with weaknesses will become shorter and the list with strengths will become longer and automatically a lot of threats in the environment will become opportunities.
4. If the weaknesses can not be resolved, then 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 made in that 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.

1.4 Implementation

The study was carried out in collaboration with partner institutes in India, Nepal, Pakistan and Sri Lanka involving several distinguished researchers, namely,

- Dr. Prem S. Pathak, Indian Grassland and Fodder Research Institute, Jhansi, India.
- Dr. Bekha L. Maharjan, Nepal Agricultural Research Council, Patan, Nepal.
- Dr. Abdul G. Khan, Animal Nutrition, Animal Science Institute, National Agricultural Research Centre, Islamabad, Pakistan.
- Mr. K.E. Karunatilake, Agro Enterprise Development and Information Service (AgEDIS), Department of Agriculture, Peradeniya, Sri Lanka.

Each national expert undertook an in-country study that resulted in a country study report. The findings of these studies were discussed at a regional workshop held in Bogor, Indonesia to which some policy-makers, researchers and reviewers from the participating countries were invited to be present. It was expected that their contributions would make the policy recommendations derived from the country study more meaningful, help to disseminate the findings and build a wider audience for the results. The national experts also agreed to disseminate the findings of their country studies in their own countries.

Dr. Sivali Ranawana, Professor, Livestock and Avian Sciences, Wayamba University, Gonawila, Sri Lanka served as the Regional Advisor and Dr. Budiman Hutabarat, the Program Leader, Research and Development, UNESCAP CGPRT Centre acted as the Project Leader. Dr Nobuyoshi Maeno, Director, UNESCAP CGPRT Centre was in charge of overall coordination and supervision.

The project commenced officially in July 2001 and a coordination and pre-planning meeting involving the Regional Advisor, the Team Leader along with the Director of the Centre was held at the Centre on 27-28 August 2001. At this meeting the basic concepts, objectives of the project, the analytical framework for the country studies, the report outline and general reference of the workplan as described in the project document were discussed, refined and

finalized. These were then presented to the national experts at a planning meeting held at the Centre on 27-28 September 2001. The country studies commenced thereafter in October, 2001.

The regional workshop, held to critically review the country study reports and seek out comments and suggestions for improving their quality, was conducted at the Centre on 3-4 September, 2002. This meeting included the participation of experts from each of the countries under the study, who reviewed the reports and made their independent comments.

1.5 Organization of the integrated report

The integrated report is presented in eight chapters. Chapter 1 explains briefly the framework of the project and its implementation, followed by Chapter 2 that describes the general economic background of the South Asian region. The situation with respect to feed crops, feeds and the animal production sector in the participating countries are summarized in Chapter 3, succeeded by the demand for and supply of feed crops in Chapter 4 and 5 respectively. Chapter 6 examines the attempts being made by the countries to bridge the demand and supply gap.

Chapter 7 contains the conclusions and summarized recommendations suggested in the country reports.

2. General and Socio-Economic Features

2.1 Population

The population of the four countries under study; India, Nepal, Pakistan and Sri Lanka make up 90 per cent of the population of the region, which is nearly 1.3 billion and expected to increase to between 1.6 and 1.7 billion by the year 2010. They also comprise nearly a third of the population of the entire UNESCAP region countries of 3.62 billion. Of the SAARC member countries population in 1998, India's share is over 76 per cent, Pakistan's over 10 per cent, Nepal and Sri Lanka each have nearly 2 per cent. During the period of 1988-1998, Pakistan's population grew at the fastest rate of 2.49 per cent, followed by Nepal at 2.32 per cent, India at 1.96 per cent and Sri Lanka at 1.24 per cent per annum (Table 2.1). Of the UNESCAP member countries population in 1998, India made up nearly 27 per cent, Pakistan 3.63 per cent, Nepal and Sri Lanka each less than 1 per cent.

More than half of the one billion poor in the word live in this region (Devendra *et al.*, 2000) and it is estimated that nearly half the people live below the poverty line. Moreover, particularly in India, there is a very high percentage of rural poor. The alleviation of poverty among these people has been given high priority by all governments of these countries. About 57 per cent of the population of these countries and a very high proportion of the rural population are dependant on agriculture, including livestock, as their chief livelihood. It is also significant that a very large proportion of this population is associated with raising livestock.

2.2 General economy

Among the participating countries, India had the highest Gross Domestic Product (GDP) in 1998 followed by Pakistan, Sri Lanka and Nepal (see Table 2.1). On a per capita basis, however, the order changes with Sri Lanka first followed by Pakistan, India and Nepal. Nepal can be considered to have the smallest economy on both counts. India's GDP grew fastest among the countries involved, followed by Sri Lanka, Pakistan and Nepal on the basis of local currency but in dollar terms Sri Lanka shows the highest rate, followed by Pakistan, India and Nepal. This is partly due to the fact that the exchange rate of India's rupees grew faster than those of other currencies. It must be noted, however, that all currencies have dropped against the US dollar although the rates of change are different among the different currencies (Table 2.1).

Table 2.1 Value (in 1998) and growth rates (1988-1998) of selected indicators in participating countries

			India		Nepal		Pakistan		Sri Lanka	
		Units	Value	Growth rates (%/yr)	Value	Growth rates (%/yr)	Value	Growth rates (%/yr)	Value	Growth rates (%/yr)
Human population		millions	971.0	2.0	21.8	2.3	131.5	2.5	18.8	1.2
Employment	Total	1,000	28,166.0	0.9	na	na	36,361.0	2.4	5,946.0	0.2
	Share(%)[1]		2.9				27.7		31.7	
	Agr.	1,000	1,434.0	0.3	na	na	17,182.0	1.6	2,472.3	-0.9
	Share(%)[2]		60.0				47.3		41.6	
GDP (in local currency)	Total	billions	17,626.1	16.1	300.8	14.7	2,677.7	15.4	912.8	15.5
	Agr.	billions	4,693.4	15.4	112.5	11.9	677.5	16.8	192.7	14.4
	Share(%)[3]		26.6		37.4		25.3		21.1	
Exchange rate		(Rupees/ US$)	42.5	11.6	67.7	10.9	45.9	9.8	67.8	7.6
Total GDP	in US$	billions	414.9	5.1	4.4	4.4	58.4	5.4	13.5	7.6
Per capita GDP	in US$		427.3	3.1	203.5	2.0	443.8	2.9	717.5	6.4
Agriculture GDP	in US$	billions	110.5	4.3	1.7	2.0	14.8	6.8	2.8	6.7
CPI		1990=100	217.7	10.0	212.1	9.9	221.9	10.5	226.5	12.0
Lending rate		%	13.5	-1.7	14.0	1.3	na	na	6.0	-4.2
Production index	Food	1989/91=100	120.9	2.7	119.6	2.7	144.4	4.8	113.3	1.5
	Cereal	1989/91=100	115.8	2.1	111.6	2.3	132.7	3.8	115.6	2.0
	Industry	1990=100*	159.6	6.4	192.0	6.4	133.9	3.8	na	9.6****
Production[4]	Cereals	billion mt	229.1	2.2	6.4	2.3	27.0	3.8	2.6	1.9
	Co.Grains	1,000 mt	31,063.3	1.5	1,667.8	2.9	2,184.9	2.7	34.8	-0.9
	Maize	1,000 mt	10,880.2	3.2	1,343.4	2.6	1,611.3	0.8	30.3	-0.1
	Barley	1,000 mt	1,559.7	1.2	35.8	4.9	153.8	5.0	0.0	0.0
	Millet	1,000 mt	10,404.6	1.5	288.7	4.9	193.3	5.5	4.4	-4.2
	Pulses	1,000 mt	14,492.9	1.7	206.7	2.8	1,081.1	6.8	28.6	-4.7
	Soybean	1,000 mt	6,799.2	18.1	15.9	3.3	8.6	36.5	0.6	-0.6
	Roots and tuber crops	1,000 mt	28,056.2	2.4	1,129.3	4.7	1,607.9	8.3	353.0	-6.5
	Cassava	1,000 mt	6,348.2	2.5	0.0	0.0	0.0	0.0	252.8	-6.0
Animal population	Cattle	millions	212.1	0.6	7.0	1.0	21.2	2.4	1.6	-0.9
	Pigs	millions	16.0	3.8	0.8	4.0	na	0.0	0.1	-2.1
	Goats	millions	121.4	0.9	6.1	1.6	44.2	2.8	0.5	0.5
	Chickens	millions	375.0	2.9	15.8	5.2	223.0	14.4	9.6	1.1
Nominal catch	Inland waters	1000 mt	650.2	6.3	12.0	7.1	163.5	4.9	29.9	4.0
Imports	All	10^6 US$	42,648.0	9.5	1,434.0	12.9	9,308.0	3.9	6,319.0	11.1
	SAARC	10^6 US$	495.0	32.0	454.0	32.5	225.0	12.1	758.0	18.3
Exports	All	10^6 US$	36,624.0	11.0	444.0	8.0	8,433.0	5.7	4,673.0	12.6
	SAARC	10^6 US$	2,054.0	20.9	162.0	54.9	415.0	14.0	113.0	3.1
BoP of merchandize***	Imports	10^9 US$	-44.8	8.9	-1.2	7.8	na	4.6	-5.3	-35.3
	Exports	10^9 US$	34.1	10.0	0.5	11.0	na	6.8	4.8	12.7

na = not available.

* Except in Nepal, 1986/87 = 100.

** Cassava in Sri Lanka, barley in others.

*** BoP = Balance of payment.

**** For the period 1988-1997.

[1] With respect to total human population.

[2] With respect to total employment.

[3] With respect to total GDP.

[4] Source: FAO (2002).

Source: UNESCAP (various issues).

Values for the agricultural GDP are shown in Table 2.1. It can be seen that India's GDP was by far the largest followed by Pakistan, Sri Lanka and Nepal, but that Nepal's agricultural sector contributes most to its total GDP when compared to the others with Sri Lanka, at 21.1 per cent, being the lowest. Despite generating fewer employment opportunities, the agricultural sector in India still offers substantial income for its population. In all countries, the agricultural sector's GDP grew at a healthy rate with the growth being highest in Pakistan. The growth of the agricultural GDP, however, was slower than the overall growth in their economies, with the exception being Pakistan.

The Consumer Price Indices (CPI) ranged from 212.0 in Nepal to 227.0 in Sri Lanka showing that levels of prices in each country more than doubled during the period 1990 to 1998. The closeness of the CPI between the countries suggests a considerable amount of integration among the economic sectors of those countries which is worth examining. The levels of CPI in India at 217.7 and in Nepal at 212.1 with corresponding growth rates of 10 and 9.9 per cent per annum, demonstrates that the economies of these two countries are closely linked. In the capital markets, there seems to be a wide disparity among the countries. As the table shows, the interest rate level in India and Nepal is almost the same but that in Sri Lanka it is only 6.0 per cent per annum. While the interest rate in India and Sri Lanka shows a declining trend, it tends to increase in Nepal.

2.3 Agricultural sector

Food production has been increasing in all the countries studied (Table 2.1). The highest rates of production are evident in India and Pakistan for all food items as well as cereals. The industrial production indices, in contrast, were highest in Nepal (252), with India (159.6) and Pakistan (133.9) following taking 1990 as the base.

Food and cereal production in Pakistan in the period of 1988-1998 grew faster than those of the other countries, whilst Sri Lanka showed the smallest rates. The annual growth rates of food production in descending order are 4.8 in Pakistan, 2.7 in Nepal, 2.7 in India and 1.5 per cent in Sri Lanka, and those of cereal production are 3.8 in Pakistan, 2.3 in Nepal, 2.1 in India and 2.0 in Sri Lanka. On the contrary, industrial production in Sri Lanka showed the highest rate of growth compared with those of the other countries at 9.67 per cent, down to 6.42 per cent in India, 6.35 per cent in Nepal, and 3.78 per cent per annum in Pakistan. It appears that during the period of 1988-1998, Sri Lanka diversified its economy placing more emphasis on industrial growth than on agricultural growth, while Pakistan followed the opposite path being more interested in agricultural production than in industrial production.

With its huge agricultural land area, India controls around 78 and 90 per cent of cereal and coarse grain area cultivated respectively in the South Asian region (Table 2.2), Pakistan has almost 10 and 6 per cent, Nepal has over 2.5 and 3 per cent, while Sri Lanka appears to have only a negligible area for both coarse grains and cereals. The same observation also applies to the production of the two commodity groups. Amounting to around 19 and 11 per cent of the world's cereals and coarse grain area cultivated and around 14 and 3 per cent of the world's production of the two commodities.

Of the total area of maize cultivated in South Asia, India contributed 77.0 per cent, producing 10.9 million metric tons on average between 1997-1999; Pakistan had 12.0 per cent, producing 1.6 million metric tons; Nepal 10.0 per cent, producing in 1.3 million metric tons; and Sri Lanka only 0.4 per cent with production at 30 thousand metric tons. Overall, the area under maize in South Asia is less than 6 per cent of that in the world and production is only 2 per cent. Barley is grown in India, Pakistan and Nepal with, once again, India being dominant. India contributes 80 per cent of the area under barley producing 1.6 million metric tons; Pakistan 15.0 per cent, producing in 154 thousand metric tons; and Nepal 3.5 per cent, producing 36 thousand metric tons. The region's contribution to the world's barley area and production is less than 2 per cent.

In contrast to maize and barley, South Asia, with nearly 40 per cent of the world's millet area and production, is a major traditional producer of these cereals. The majority (94 per cent) is grown in India, with production at 10.4 million metric tons. The corresponding figures for Pakistan, Nepal and Sri Lanka are 3.0 per cent and 193 thousand metric tons, 2.0 per cent and 289 thousand metric tons and 1 per cent and 4 thousand metric tons respectively.

Nearly all the soybean cultivated and produced (average value from 1997-1999) in the region is from India with negligible amounts from the other countries. South Asia's share in the world's area harvested and produced is very small, only around 9 per cent and 4 per cent respectively. It appears that cassava is grown only in India and Sri Lanka in the region and of this, India produces 96 per cent and Sri Lanka 4 per cent. The total area cultivated in the region is less than 2 per cent of the world's total and total production is only around 4 per cent of the world's total production.

Pakistan recorded the highest growth rate in the production of cereals, at 3.8 per cent per annum, followed by Nepal at 2.3 per cent, India at 2.2 per cent and Sri Lanka at 1.9 per cent (see Table 2.1). However, for coarse grains Nepal leads having a growth rate of 2.9 per cent, followed by Pakistan at 2.7 per cent. India's coarse grain production increased at only 1.5 per cent per annum, Sri Lanka had a declining trend at -0.9 per cent per annum.

The growth in maize production is largest in India, at 3.2 per cent, followed by Nepal at 2.6 per cent, and Pakistan at 0.8 per cent per annum. Pakistan and Nepal experienced high growth in barley production at 5 per cent each, India had 1.2 per cent per annum. In terms of millet, Nepal also records the highest rate of growth at 5.5 per cent, followed by Pakistan at 4.9 per cent and India at 1.5 per cent per annum. For pulses that include soybean, Pakistan showed the highest production growth, at a remarkable rate of 6.8 per cent for pulses and 36.5 per cent for soybean. India also achieved a remarkable growth rate in soybean production at 18.1 per cent. For tuber crops, the highest rate was for Pakistan at 8.3 per cent per annum, followed by Nepal at 4.7 per cent and India at 2.4 per cent.

Sri Lanka shows a negative trend for almost all commodities, except cereals, which probably reflects the growth in rice production. The growth in production of Sri Lanka's millets, pulses, soybean, tuber crops, and cassava were all negative with rates at -4.2, -4.7, -0.6, -6.5, and -6.0 per cent per annum respectively. This should be of concern to the Sri Lankan government, especially since cassava is a potential substitute for energy sources to its growing livestock population.

Any increases in CGPRT or primary crop production ultimately ends up being consumed by the growing human and livestock population. The cattle population is huge in India, 212.1 million heads in 1998 compared to 21.2 million in Pakistan, 7.0 million in Nepal and only 1.6 million in Sri Lanka. These populations show increasing trends in Pakistan, Nepal and India but a declining rate in Sri Lanka. The cattle population of Pakistan enjoys the highest rate of growth, 2.4 per cent, followed by Nepal, 1.1 per cent and India at 0.6 per cent. India also has the largest goat population of 121.4 million heads with Pakistan 44.2 million heads, Nepal 6.1 million heads and Sri Lanka 0.5 heads million (1998 statistics). The rate of growth of the goat population is highest in Pakistan at 2.8 per cent with Nepal 1.6 per cent, India 0.9 per cent and Sri Lanka 0.5 per cent per annum. With regard to swine, again India has a sizable population, 16.0 million heads in 1998, Nepal 0.8 million heads and Sri Lanka 76,000 with increases of 4.0 per cent in Nepal, 3.8 per cent in India, but Sri Lanka's shrank at 2.1 per cent during the 1988-1998 period. In the case of chicken, India has 375.0 million birds, Pakistan 223.0 million birds, Nepal 15.8 million birds and Sri Lanka 9.6 million birds. These populations increased at the highest rate in Pakistan 14.4 per cent, followed by Nepal 5.2 per cent, India 2.9 per cent and Sri Lanka 1.1 per cent per annum during the period of 1988-1998.

Table 2.2 Area harvested and production of selected CGPRT crops in South Asia (average 1997-1999)

Region/Country	Crop	Area harvested (ha)		Production (mt)	
		Value	Share (%)*	Value	Share (%)*
South Asia	Cereals	129,014,744	18.89	297,851,501	14.27
	Coarse grain	33,105,194	10.67	35,115,893	3.90
	Maize	8,033,044	5.76	13,948,494	2.32
	Barley	1,001,956	1.74	1,760,044	1.27
	Millet	13,466,867	36.94	10,953,961	38.50
	Soybean	6,186,453	8.85	6,825,634	4.43
	Cassava	292,272	1.78	6,601,088	3.98
India	Cereals	101,040,167	78.32	229,066,837	76.93
	Coarse grain	29,923,300	90.39	31,063,333	88.46
	Maize	6,202,567	77.21	10,880,233	78.00
	Barley	802,667	80.11	1,559,733	88.62
	Millet	12,700,500	94.32	10,404,567	94.99
	Soybean	6,155,167	99.49	6,799,200	99.61
	Cassava	262,800	89.92	6,348,233	96.15
Nepal	Cereals	3,257,408	2.53	6,404,116	2.15
	Coarse grain	1,095,144	3.31	1,667,826	4.75
	Maize	798,450	9.94	1,343,363	9.63
	Barley	34,564	3.45	35,803	2.04
	Millet	262,130	1.95	288,660	2.64
	Soybean	21,757	0.35	15,924	0.23
	Cassava	0	0.00	0	0.00
Pakistan	Cereals	12,541,600	9.72	26,999,872	9.06
	Coarse grain	1,891,633	5.71	2,184,933	6.22
	Maize	952,300	11.86	1,611,333	11.55
	Barley	150,667	15.04	153,833	8.73
	Millet	411,867	3.05	193,267	1.76
	Soybean	6,876	0.11	8,604	0.13
	Cassava	0	0.00	0	0.00
Sri Lanka	Cereals	811,553	0.63	2,634,730	0.88
	Coarse grain	34,526	0.10	34,826	0.10
	Maize	28,155	0.35	30,344	0.22
	Barley	0	0.00	0	0.00
	Millet	6,207	0.05	4,347	0.04
	Soybean	653	0.01	606	0.01
	Cassava	29,463	10.08	252,814	3.85

* For South Asia, share is with respect to the world's total, for a single country, share is with respect to South Asian region.

Source: FAO (2002).

Apart from the livestock sector, the burgeoning of inland aquaculture in the region is expected to aggravate the demand for CGPRT crops. The production of inland water fisheries in all countries at present is not yet substantial. India nets the highest catches, amounting to 650,200 metric tons; Pakistan 163,500 metric tons, Nepal 12,000 metric tons and Sri Lanka 29,900 metric tons. This production shows an increasing trend for the period of 1988-1998 in all countries, Nepal's rate being highest at 7.07 per cent, followed by India at 6.28 per cent, Pakistan 4.91 per cent and finally Sri Lanka at 4.01 per cent per annum. The positive growth of inland water fishery production helps establish this sector as a potential user or consumer of feed products in years to come. In many countries in Asia and the Pacific region this sector has shown tremendous development in recent years and could even compete with humans and livestock for feeds if the feed crops and sector are not given due attention.

2.4 Trade

2.4.1 Aggregate trade

The value of total imports paid in 1998 by India was US$ 42,648 billion, Pakistan US$ 9,308 billion, Sri Lanka US$ 6,319 billion and Nepal US$ 1,434 billion. The proportions expended within the SAARC region by each of these countries amounts to 1.2 per cent, 2.4 per cent, 12.0 per cent and 31.7 per cent for India, Pakistan, Sri Lanka and Nepal respectively. The import values have a tendency to rise and the growth rates of imports within the SAARC region are always larger than those of total imports. For instance, total imports of Nepal for the period 1988-1998 increased at 12.9 per cent per annum, but imports from SAARC countries grew at 32.5 per cent per annum. This is an encouraging sign that trade within the region is growing. As expected, the share of Nepal's imports from the SAARC region is larger than those of other countries because it is a landlocked country and surrounded by high mountains to its northern border.

For the same period, the value of total exports by India, Pakistan, Sri Lanka and Nepal were respectively US$ 36,624 billion, US$ 8,433 billion, US$ 4,673 billion and US$ 444 billion. Of these amounts, each country collected 5.6 per cent, 4.9 per cent, 2.4 per cent and 36.5 per cent respectively from the SAARC region. The export values have also tended to rise and the growth rates of exports to countries within the SAARC region are always larger than those of total exports, except for Sri Lanka. For instance, total exports from Nepal during the period 1988-1998 increased at 8.0 per cent per annum but that of exports to other SAARC countries increased at 54.9 per cent per annum. In contrast, Sri Lanka's total exports grew at 12.6 per cent per annum but exports to other SAARC countries only increased at 3.1 per cent per annum. As in the case of imports, Nepal's SAARC exports exceed those of other countries due to its natural setting. From this observation, it can be concluded that there is an increasing trend for trade within the SAARC region. Nepal has taken advantage of this, presumably with its close neighbour, India. If this trend continues, hopefully facilitated and encouraged by the SAARC and SAPTA initiatives, each country should be able to assess its strengths and weaknesses in its agriculture sector and develop complementary programs.

2.4.2 Agricultural products

Figures in Table 2.3 show that agricultural and derived products show a tendency towards more active trading by each of the countries studied. Unfortunately, the extent of regional trade and its growth between these countries cannot be determined due to the lack of trade statistics. In 1998, the South Asian region was able to export nearly 7 million metric tons of cereals but at the same time it purchased over 7.8 million metric tons of cereals from the world market, therefore, the region is a net importer of cereals. This situation could be reversed if each country in the region felt the need to develop its own domestic cereal production. There is reason for optimism in this regard since the growth in the volume of exports of cereals was 32.3 per cent per annum between 1988-1998, which is more than 5 times larger than the imports for the same period.

Among the countries being considered, it can be seen that Pakistan, Sri Lanka and Nepal were net importers of cereals in 1998, whereas India was a net exporter. Pakistan was actually able to sell around 28.0 per cent of the region's total exports but at the same time it also had to import over 30.0 per cent of the region's total imports. Imports of cereals in this country grew at a much faster rate than the exports. The cereal imports to Sri Lanka, which did not export any cereals, at 1.2 million metric tons, were huge amounting to over 15.0 per cent of the region's total import volume.

Table 2.3 Quantity and values of exports and imports of selected CGPRT crops in 1998 and their annual growth rates (1988-1998) in South Asia

		Quantity (mt)				Value ($)			
Country	Crops	Export	Growth rates (%/year)	Import	Growth rates (%/year)	Export	Growth rates (%/year)	Import	Growth rates (%/year)
South Asia	Cereals	6,988,592	32.3	7,804,093	5.8	2,085,759	24.2	1,224,043	9.7
	Pulses	143,696	23.8	1,049,481	5.1	70,418	21.3	365,720	5.1
	Maize	2,093	977.4	118,301	8.6	452	467.4	18,101	11.8
	Cassava	43,575	764.9	95,560	14.7	2,481	237.2	4,227	16.3
	Bran+millings	20,811	-9.5	28,998	15.2	1,451.00	-9.6	1,719.00	18.8
	Feeding stuffs	3,570,193	9.6	375,222	23.8	487,345	9.4	118,680	28.2
	Oilseeds	3,465,168	11.0	257,816	35.0	468,866	9.8	58,157	27.9
India	Cereals	4,981,251	63.1	1,821,156	1,671.2	1,511,095	36.8	282,723	938.9
	Pulses	103,922	37.2	628,786	6.7	53,538	30.0	190,343	6.6
	Maize	2,063	nv	1,440	nv	446	nv	203	nv
	Cassava	40,590	4,529.8	0	nv	1,853	689.4	0	nv
	Bran+millings	2,133	310.6	26,623	nv	397	323.4	1,085	nv
	Feeding stuffs	3,524,279	11.5	53,020	6.5	482,731	10.2	14,424	31.7
	Oilseeds	3,438,489	11.2	9,554	7.8	466,219	9.9	541	6.9
Nepal	Cereals	9,919	1,927.2	24,439	99.6	1,840	1,876.1	6,093	147.7
	Pulses	37,867	22.9	5,198	63.6	16,095	27.6	1,261	56.1
	Maize	0	nv	310	nv	0	nv	44	nv
	Cassava	0	nv	0	nv	0	nv	0	nv
	Bran+millings	17,600	6.5	0	nv	973	2.0	0	nv
	Feeding stuffs	43,100	1.9	670	68.5	3,634	3.1	140	23.2
	Oilseeds	25,500	7.8	670	10.0	1,833	7.3	140	7.2
Pakistan	Cereals	1,975,631	10.5	2,527,375	36.2	569,228	9.2	357,789	39.0
	Pulses	1,827	79.1	187,902	25.3	738	36.9	65,812	30.3
	Maize	30	nv	2,046	nv	6	nv	2,535	nv
	Cassava	110	nv	5,840	6.1	9	nv	384	8.4
	Bran+millings	906	-0.4	0	nv	66	5.6	0	nv
	Feeding stuffs	1,382	-1.8	174,424	667.7	103	19.4	39,962	194.1
	Oilseeds	0	nv	171,296	nv	0	nv	38,569	nv
Sri Lanka	Cereals	2,741	606.7	1,188,706	3.6	1,412	147.3	183,979	5.5
	Pulses	22	371.1	118,734	38.4	32	88.3	51,132	45.0
	Maize	0	nv	106,537	36.2	0	nv	14,096	35.4
	Cassava	2,875	89.3	22,550	32.4	619	93.7	1,312	33.0
	Bran + millings	50	nv	1,329	323.9	5	nv	307	187.2
	Feeding stuffs	1,280	-0.6	105,309	20.2	864	-1.5	35,734	18.2
	Oilseeds	1,149	nv	69,427	26.8	811	nv	15,473	14.8

nv = not valid, division by 0.
Source: FAO (2002).

India, being a net exporter of cereals, was able to trade nearly 5 million metric tons, around 71.0 per cent of the region's total exports. At the same time, it had to purchase over 1.8 million metric tons of cereal, nearly 23 per cent of the region's total imports. The growth rate of such imports is huge, 1,671.2 per cent per annum, when compared to the growth of exports (63.1 per cent) during the 1988-1998 period. However, India only began to import cereals recently and its imports therefore, start at a lower base level.

With regard to pulses, the region falls into the net importer category, as all large countries being studied were net importers. The region was only able to export 143,696 metric tons but had to purchase over 1 million metric tons in 1998. The total export volume increased at 23.8 per cent per annum and the total import volume grew at 5.1 per cent per annum. Nepal was the only net exporter country. India imported most of the pulses in the region, around a 60 per cent share, Pakistan 18 per cent, Sri Lanka 11 per cent and Nepal less than 1 per cent. While the rates of export growth in India, Pakistan and Sri Lanka tend to be larger than those of import growth in these countries, the rate of growth of exports in Nepal is smaller than that of imports.

Examination of specific crops that are commonly utilized as raw materials in the feed industry gives different results. The region was a net importer of maize and its total export

volume (118,301 metric tons) is insignificant, although there is a tendency for this to increase. India, Nepal and Pakistan presently do not trade much in maize but in contrast, Sri Lanka, which does not export maize, accounts for around 90 per cent of the region's total maize imports. Trade in Cassava was around 150,000 metric tons, exports making up 44,000 metric tons and imports over 95,000 metric tons. India was the major cassava exporter and did not import at all in 1998 whilst Sri Lanka was the main importer; Nepal and Pakistan were not involved in the trade.

2.4.3 Feedstuffs

The situation is quite different with regard to specific animal feedstuffs such as brans, oilseed cakes, fish and meat meals and feed additives, 86 of which are traded in the international market. Although the region is a net exporter of feedstuffs with nearly 3.6 million metric tons of exports and less than half a million metric tons of imports, much of these exports can be attributed to soybean meal exports from India. Nepal also exports small amounts but both Pakistan and Sri Lanka are net importers. India's export volume grew at a higher rate than that of India's imports, whereas the reverse is true for Nepal. Import volumes tend to grow in both Sri Lanka and Pakistan.

Overall trade in commodities such as cakes, meals of soybean and other pulses or oilseeds was around 3.5 million metric tons of exports and around 260,000 metric tons of imports. With regard to other feedstuffs including brans and other milling by-products, the region was a net importer despite some exports. The amount of trade is relatively small with India being the major importer of this product at around 92 per cent of the region's total and Nepal the key exporter, with its share at about 85 per cent of the region's total.

In summary, the region as a whole is a net importer of cereals, pulses, maize, cassava, bran and other milling by-products and a net exporter of feedingstuffs such as oilseed cakes and meals, and other vegetable oil residues. Sri Lanka is a net importer of all products considered, namely cereals, pulses and maize, cassava, and feedingstuffs. Its import volumes of these commodities are comparatively very large. India is a net exporter of cereals, feedingstuffs or oilseed cakes and meals, and other vegetable oil residues, but a net importer of pulses. Pakistan is a net importer of cereals, pulses, feedingstuffs or oilseed cakes and meals. Nepal is a net importer of cereals, but although it exports pulses, bran and other milling by-products, feedingstuffs or oilseed cakes and meals, and other vegetable oil residues, the volumes are small.

2.5 Commodity balance sheets

The Food and Agriculture Organization of the United Nations uses available data to construct commodity balance sheets for many countries around the world (FAO, 1991 and 2002). FAO calculates balances by adding the quantity imported to the total quantity of foods produced after adjusting to changes in stock during the reference period. Total utilization is categorized into the quantity exported, used for feed, used for seed, for processing and human consumption (FAO 1991 and 2002). However, through the calculation of data on the tabulated sheets provided in the statistical database, it seems that total supply and total utilization figures are not as defined above, but rather total supply is the total supply as defined above minus the quantity exported and the total utilization figures are the total utilization figures defined, excluding exports. The analysis that follows adopts the former definitions. An analysis of the origin of supply as well as commodity utilization in the South Asian region is presented below. Utilization for seed, waste and other uses have not been included as these are still insignificant in the region.

2.5.1 Origins

Domestic production

India is a mass producer of cereals, starchy root crops, pulses and vegetables compared with the other countries in the region. Taking a three-year average (1997-1999), total supply of cereals in Bangladesh, India, Nepal, Pakistan, and Sri Lanka are shown in Table 2.4. India's domestic production percentage for cereals is in excess of 100 per cent because the value of changing in stocks is large and negative or because India exports cereals in a volume that is higher than it imports, making total supply is less than domestic production.

Table 2.4 Total supply, domestic production, imports and exports of primary food crops in South Asian countries (average 1997-1999)*

Country		Cereals		Starchy roots		Pulses		Vegetables	
		1,000 mt	% of total supply**	1,000 mt	% of total supply	1,000 mt	% of total supply	1,000 mt	% of total supply
Bangladesh	Total supply	24,839.77	100	2,377.41	100	616.21	100	1,674.49	100
	Domestic production	22,377.64	90.09	2,336.51	98.28	475.09	77.1	1,638.66	97.18
	Imports	2,852.96	11.49	40.9	1.72	141.12	22.9	43.91	2.60
	Exports	0.24	0	0	0	0	0	8.08	0.48
India	Total supply	175,533.1	100	2,8819.5	100	14,665.71	100	57,723.23	100
	Domestic production	185,762.6	103.84	28,887.43	99.97	14,008.57	94.66	58,102.09	99.97
	Imports	1,727.63	0.97	2.11	0.01	789.39	5.33	16.5	0.03
	Exports	3,362.68	1.88	53.38	0.18	132.25	0.89	395.36	0.68
Nepal	Total supply	5,280.77	100	1,111.07	100	175.74	100	1,421.46	100
	Domestic production	5,177.61	97.57	1,108.62	99.78	205.77	95.93	1,371.37	96.45
	Imports	40.39	0.76	2.51	0.23	10.74	5.01	50.44	3.55
	Exports	25.58	0.48	0.06	0.01	38.76	18.07	0.35	0.02
Pakistan	Total supply	24,585.3	100	1,765.7	100	1,229.24	100	4,544.19	100
	Domestic production	24,641.75	93.22	1,818.52	99.12	1,071.75	86.44	4,496.9	97.73
	Imports	2,762.83	10.45	15.93	0.87	164.81	13.29	104.24	2.27
	Exports	1,848.69	6.99	68.75	3.75	10.65	0.86	56.95	1.24
Sri Lanka	Total supply	2,911.5	100	481.38	100	147.52	100	727.55	100
	Domestic production	1,766.54	60.61	342.07	70.26	28.01	18.99	617.99	83.60
	Imports	1,241.38	42.59	144.61	29.70	119.56	81.02	121.24	16.40
	Exports	3.13	0.11	5.38	1.11	0.05	0.03	11.68	1.58

* Changing in stocks not included.
** The percentage value may be higher than 100 per cent due to large and negative value of changing in stocks.
Source: FAO (2002).

A similar situation can be witnessed with respect to starchy roots. Pakistan's exports are greater in quantity than its imports and consequently total supply is in excess of total domestic production. In terms of total supply, Nepal was able to export more than it imports.

Imports

The contribution of imports to total supply varies among the countries considered. In India and Nepal, imports of cereals are an insignificant element of total supply, while in Bangladesh, Pakistan and Sri Lanka imports constitute around 12, 11 and 43 per cent respectively. Starchy root imports are comparatively quite substantial in Sri Lanka, amounting to 30 per cent of the total supply but only minor in Bangladesh (less than 2 per cent) and even less in India, Nepal and Pakistan. With regard to vegetables, three countries documented import contributions in the range of 2 to 4 per cent, that is Pakistan, Bangladesh and Nepal, with nearly 17 per cent in Sri Lanka but India's vegetable imports are significant.

Exports

Exports make domestic production unavailable to be used domestically. Pakistan and India's cereal exports are respectively nearly 2 and 7 per cent of their total supply, while Nepal, Sri Lanka and Bangladesh's are negligible. For starchy roots, Pakistan and Sri Lanka export

some of their production amounting to nearly 4 and 1 per cent of their total supply respectively. Only Nepal recorded significant exports of its pulses equivalent to 18 per cent of total domestic supply. Pakistan and Sri Lanka recorded some exports of vegetables amounting to less than 2 per cent of the total domestic supply.

2.5.2 Utilization

Feed

As can be seen from Table 2.5, the pattern of crop utilization as feed is different from country to country in the South Asia sub-region. To a larger extent, ranging from 3 to 5 per cent of total supply, Sri Lanka, Pakistan, and Nepal use their total supply of cereals to feed the livestock and to a lesser extent, below 1 per cent, Bangladesh and India. This signifies the relative importance of cereals for human consumption rather than for animal feed in Bangladesh and India.

Table 2.5 Utilization of primary food crops in South Asian countries (average 1997-1999)*

		Cereals		Starchy roots		Pulses		Vegetables	
Country		1,000 mt	% of total supply	1,000 mt	% of total supply	1,000 mt	% of total supply	1,000 mt	% of total supply
Bangladesh	Feed (1,000 mt)	3.85	0.02	0	0	1.56	0.25	0.01	0
	Processed food (1,000 mt)	0	0	0	0	0	0	0	0
	Food (1,000 mt)	23,238.27	93.55	1,922.07	80.85	577.44	93.71	1,520.9	90.20
India	Feed (1,000 mt)	1,742.95	0.97	0	0	1,291.18	8.73	0	0
	Processed food (1,000 mt)	85.01	0.05	0	0	0	0	0.01	0
	Food (1,000 mt)	156,470.4	87.46	22,804.65	78.92	12,138.16	82.03	54,034.68	92.97
Nepal	Feed (1,000 mt)	256.99	4.84	0	0	0	0	0	0
	Processed food (1,000 mt)	3.75	0.07	0	0	0	0	0	0
	Food (1,000 mt)	4,157.69	78.35	830.42	74.74	156.98	73.18	1,279.28	89.98
Pakistan	Feed (1,000 mt)	1,048.31	3.97	0	0	176.33	14.22	0	0
	Processed food (1,000 mt)	3.95	0.01	0	0	0	0	0	0
	Food (1,000 mt)	21,163.69	80.06	1,515.68	82.61	864.96	69.76	4,373.84	95.05
Sri Lanka	Feed (1,000 mt)	82.53	2.83	75.55	15.52	0	0	0	0
	Processed food (1,000 mt)	3.59	0.12	0	0	0	0	0	0
	Food (1,000 mt)	2,625.78	90.19	356.16	73.16	142.19	96.35	628	84.96

* Export shares included in Table 2.4 but those of others' not included.
Source: FAO (2002).

While no other countries were noted to utilize starchy roots as feed, Sri Lanka used around 16 per cent of its total supply as animal feed. It appears that in other countries of the region, starchy root crops were used entirely for human consumption.

Pulses were used to some extent for feeding animals in India and Pakistan but not in any of the other countries. The table also shows that no country in the sub-region uses vegetables to feed the livestock. This is understandable as vegetables normally fetch higher prices than the CGPRT crops do because they are exclusively used for human consumption. However, their by-products and waste might be fed to livestock.

The current level of low utilization of CGPRT crops for animal feeding suggests one or more of the following interpretations:

(1) Animals may be fed with alternate products than those that belong to the CGPRT crop group.
(2) The feed milling industry has not developed to utilize these crops.
(3) Animals are not scientifically or optimally fed.
(4) The available feedstuffs are exclusively obtained from imports. An analysis of the countries' own situation would be an opportunity for each country to explore its strengths and weaknesses and comparative advantages.

Processing

It can be seen from the table that the processing of CGPRT crops, aside from feed milling, has not developed in the region to any great extent. Moreover, the processing of these crops is only recorded for cereals and for only for a small proportion of the total production.

Food

Not surprisingly, the major portion of cereals, including coarse cereals, starchy roots, pulses and vegetable supplies in the region are used mainly as food for human consumption. This can be expected in a region in which the human population is high and alternative uses of CGPRT crops are still undeveloped. As tabulated on the food balance sheet, around 78 to 94 per cent of cereals, 73 to 83 per cent of starchy roots, 70 to 97 per cent of pulses, and 84 to 95 per cent of vegetables of the total supply are consumed as human food in the sub-region (FAO).

3. Review of Current Status

Livestock are an essential component of the rural economy of all countries in South Asia, in particular India, Nepal and Pakistan and to a lesser degree Sri Lanka. Milk and milk products have traditionally contributed the major portion of animal protein in South Asian diets but in recent years the consumption of meat from chickens has increased dramatically. Ruminant meat consumption is significant in Pakistan but the consumption of pig meat is negligible when compared to countries of East Asia. Despite its tangible contribution, importance and complex role in the economic development and food security in these countries, the potential of the livestock sector to raise the nutritional and economic standards of the people has not been fully exploited.

3.1 Livestock production

The livestock population in India is the largest among the various countries of Asia and the Pacific. India produced 68.6 million metric tons of milk, 28.2 billion eggs, 44,300 tons of wool and 4.14 million metric tons of meat in 1992 (Taneja, 1999). In Nepal, total meat production was 194,258 metric tons in the year 2000-2001. The production of livestock in India is primarily on smallholdings characterized by low input - low output systems, although commercial intensive systems have developed not only for poultry but also for dairying with crossbred cattle and buffalo. Around 80 per cent of the livestock farms are marginal, small and medium holdings having 53 per cent of the operated area with the majority of the owners below the poverty line. Average herd size per farm is 3.7 heads of cattle and buffalo. A third of small ruminants are reared under nomadic conditions (with an average herd size of 40 sheep and 20 goats) and the balance on smallholdings with a smaller numbers of animals. Pig production is mostly practiced under scavenging systems by the weaker section of the society but poultry production is reasonably organized. Nearly 50 per cent of poultry meat and 56 per cent of the eggs are now produced under intensive production systems.

In Nepal, urban demand for milk around Kathmandu, Hetauda, Biratnagar, Pokhara and others is supplied by commercial dairy processing units but milk cooperatives (about 1000 in number) collect and supply milk in the twenty-nine districts of the country. Other dairy products including ghee (clarified butter), butter, cheese, yogurt and ice cream are also produced both at the domestic level and in processing units. Ghee produced in western and mid-western Nepal is exported to nearby Indian towns of Lucknow and Kanpur where the Nepali; ghee is popular among consumers there.

In 2000, the livestock sector in Sri Lanka contributed 2 per cent to the total GDP, largely from the poultry sector with broiler meat and eggs contributing 44 per cent and 26 per cent respectively. The other meats namely, mutton, pork and beef, share the balance of 19 per cent with milk production at about 11 per cent. Poultry farming, especially broiler meat production, is a well-established agribusiness seen around the cities. Broilers are reared under intensive deep litter systems using commercial compound feeds. In the case of layers, however, despite an increasing trend towards intensification, about 15 to 30 per cent of total egg production still originates from extensively managed village flocks. Goat meat and beef are produced largely from animals raised by farmers in extensive grazing and browsing systems and milk mainly from mixed, crop-livestock smallholdings. The economic contribution of swine production is minor, has shown little growth and remains a small sector with pigs still being raised under scavenging systems in many areas. Three reasons have been identified for the low pig production: (i) Pig meat is not popular among most sections of the population, (ii) commercial

pig production is uneconomic at the prevailing prices of feeds, (iii) growing concerns over problems of environmental pollution generated by the pig farms. The potential for increasing swine meat production using available local feed resources in smallholder, semi-intensive production systems, however, is substantial. The cattle population is largely represented by local or indigenous animals, reared under extensive conditions in the rural areas. It provides beef for the urban market and draught power for paddy cultivation. There are good prospects for dairy buffalo production in the future. For this purpose, the relatively small numbers of exotic river-type buffalo, mainly confined to state breeding farms at present, should be used to improve the indigenous swamp animals whose milk production is low.

During the period of 1990-1991 to 2000-2001, there was a consistent and rapid growth in the production of livestock products, such as milk, meat and eggs in Nepal. The growth rate of meat, milk and egg production was 2.89 per cent, 2.83 per cent and 3.39 per cent per annum respectively for the period of 1990 to 2001. The production growth rate of buffalo milk was 2.58 per cent, whereas that of cow milk was 3.06 per cent per annum. When the market is oversupplied by milk, normally during winter, dairy processing units in urban areas declare milk holidays twice a week, but in times of shortage the demand has to be met by imports. A local breed of hen can lay about 67 to 112 eggs per annum compared to 200 and 250 eggs per year from crossbreeds and hybrids. The productivity of local birds is genetically inferior in egg and meat production compared to improved breeds. The live weight of local birds is 619 grams, whereas the live weight of crossbreeds ranges from 1,575 grams to 1,948 grams in the cases of Austrohite and New Hampshire breeds. The growth rates and trends of livestock populations during the past two decades have been nearly static in the case of cattle, goat, sheep and pig, with declining trends for draught buffalo. The production of chicken meat has recorded a phenomenal increase, with a growth rate of 170 per cent during the period of 1987 to 1997. The pig population in the country has always remained less than 100,000 and hence, its contribution to per capita consumption is negligible. Present estimates do not suggest any appreciable increase in the pig population within the next few years.

As in India, Nepal and Pakistan, buffaloes are also milked in some areas of Sri Lanka for the preparation of a curd, a very popular food. For this reason, the use of dairy-type (river breeds) buffalo cows is increasing on many parts of the island, particularly in the peri-urban area wet zones in which a ready and lucrative market for the buffalo curd is available. It is estimated that the production of milk increased from 0.225 million tons in 1988 to 0.341 million tons in 1998, but during this same period imports of milk powder increased from 40.1 million to 53.6 million kg. This clearly shows that local production cannot match the increasing demand, even though consumption is still below international levels. This shortfall can be expected to become further aggravated unless major issues such as the lack of suitable land to grow good quality forage, shortages of economical feed supplements and inefficiencies in the marketing system are addressed and resolved.

In the region, Pakistan easily ranks first in the consumption of foods of animal origin with levels of per capita intake comparable to those in the West. Milk, beef, mutton, poultry meat, and egg production in Pakistan showed overall average growth rates of 4.18 per cent, 4.18 per cent, 4.28 per cent, 26 per cent, and 8.07 per cent, per annum respectively during the 1981-2000 period (Khan, 2003). In spite of the reasonable growth rate in milk production, Pakistan still imports milk and milk products, spending considerable amounts of foreign exchange due to the high demand; during 1995-2000 alone, the cost was around Rs. 1,063.21 million per annum. Beef is commonly obtained from buffalo and cattle primarily as by-products of dairy activities, sheep and goats produce mutton. Feedlot fattening to systematically increase beef and mutton production has not yet developed and production is based on conventional production systems. The ruminants obtain most of their nutrients from grazing green and dry fodder with minimal supplementation of feed concentrates. The significant increase in poultry meat production was achieved by the use of hybrid broiler strains, coupled with balanced feeding, proper management and health care as in other parts of the world.

3.2 Livestock product consumption

On the consumption side, the overall growth rates in per capita milk, beef, mutton, poultry meat, and egg consumption in Pakistan were 2.06 per cent, 2.08 per cent, 0.70 per cent, 14.5 per cent, and 6.12 per cent per annum respectively for the period of 1981 to 2000. In Nepal, it is estimated that per capita consumption of milk, meat and eggs is 58 liters of milk (of which 70 per cent is buffalo milk and 30 per cent cow milk), 10 kg of meat (65 per cent buffalo meat, 20 per cent goat meat and 7 per cent poultry meat), and 25 eggs in 2000-2001. The total annual consumption for processed milk and milk products is estimated to be 240 thousand tons of milk equivalent, which consists of urban household demand (45 per cent), institutional demand (30 per cent), export demand (8 per cent), and others (17 per cent). Milk product demand, as well as other animal product demand is believed to be growing due to the influx of tourists to the country. Butter, cheese, tea-whitener, baby foods and a quantity of skim-milk powder (SMP) are imported to complement the domestic production. Buffalo meat accounts for 65 per cent of the total domestic meat consumption, followed by goat and castrated goat constituting about 25 per cent of the meat supply in Nepal. The demand for buffalo meat is particularly strong among the Newar community in Kathmandu valley, Hetauda, Pokhara, Narayanghat and other hill towns and a considerable number of buffaloes are regularly imported for this purpose. Goat meat is equally popular irrespective of caste. Another source of meat as well as eggs is from chickens. At the same time, Nepal also exported 36,348 heads of buffalo, 47,266 goats, 33,169 poultry birds, 141,986 liters of milk and 7,197,000 units of eggs to India. The possibility of exporting yak cheese to neighbouring countries is being considered. A higher level of milk production is required to meet the increasing demand for milk and milk products in the coming decade up to 2010.

The consumption of beef in Sri Lanka increased from 16,000 to 24,000 metric tons between 1994 and 1998. Although the slaughter of buffalo is officially banned, the declining use of buffalo for paddy field work has made them uneconomical to raise and illegal slaughter, leading to a reduction in numbers, is no doubt taking place. The annual per capita consumption of chicken meat has surged from 600 g to 2,540 g, or 323 per cent during the ten-year period from 1987 to 1997 and in 2000 stood at just over 3 kg, an increase of about 18 per cent in three years. Further increases in production are expected in the future and the industry appears to be able to respond to additional demand for chicken meat. The per capita egg availability in Sri Lanka increased from 50 in 1987 to 54 in 1997 and to 60 in 2000, but still remains low when compared to consumption levels in developed countries or even to some of the developing countries in the region. The slight increase in the layer sector was partly reflected in the marginal increases in egg consumption over the years, in contrast to the massive growth seen in broiler meat production. However, eggs still remain the cheapest animal protein source when calculated as Rupees per unit of protein.

From the previous discussion it is clear that all the countries being analyzed have deficits of one or more animal products and that the growth in production has not been able to match the growth in consumption. The likely reasons are that supporting raw materials and ingredients such as feed crops are not adequate to meet the needs of the milling factories, that the production growth in the livestock sector is almost exclusively in the poultry sector, and since the elements governing production such as the genetic make up of animals and the natural feed resources are fixed while that of consumption is flexible. India, however, is confident that the increasing demand for milk and milk products of the growing population could be matched by the expected rise in milk yield (Pathak, 2003).

The projected deficits in animal products will have to be met by higher productivity through breeding and feeding and the adequate provision of feedstuffs of high quality. Production of eggs and chicken meat can meet part of this increased requirement but the meat of other species will need to be developed as well.

3.3 Aquaculture and inland fisheries

Aquaculture resources are usually classified into three categories:

1. Fresh water, in inland and seasonal reservoirs, tanks and ponds.
2. Brackish water, in deep lagoons, coastal areas and estuaries.
3. Marine, in seawater as an exclusive economic zone.

World production of aquaculture reached 42.77 million tons in 2000, an increase of 8.9 per cent over the previous year and is currently valued at US$ 65 billion. Aquaculture now encompasses nearly 200 species. In contrast to terrestrial farm animal species, much less practical information exists concerning dietary nutrient requirements (Pathak, 2003). Fish production is a dynamic market with an average growth rate of 10 per cent per annum, depending upon the country and species. China is currently the worlds largest producer.

Endowed with a coastline of 1,311 km, India exported 440,473 tons of seafood, worth US$ 1.4 billion in 2000/01 and this is expected to increase to US$ 2.5 billion by 2005-2006. This development is from an initial level of 15,732 tons, worth Rs 39 million in 1961-62. In terms of Indian seafood exports, cultured shrimp accounts for 76 per cent of the total shrimp exports and 53 per cent of the total exports of marine products. Frozen shrimp accounts for 25.4 per cent by volume and 69.6 per cent by value of the total exports of marine products. The shrimp farming industry picked up in 1980, dropping off by 1990 but has again started picking up since then.

As in India, Pakistan is endowed with large marine and inland fishery resources and yet the sector contributes only about 1 per cent to GDP. Fish provides not only a source of protein to the ever-increasing population, but is an important source of foreign exchange earnings as well. The sector is also an important employer, employing 0.4 million people, or about 1 per cent of the total national labor force. Total fish production in 1990-1999 was 654,500 metric tons, of which about 474,000 metric tons was marine fish and 179,800 metric tons was inland fish. The foreign exchange earned from the sector amounted to US$ 89.8 million.

In Sri Lanka, total fish production has increased from 183,990 metric tons to 304,380 metric tons in the last decade. Inland and aquaculture fish production in Sri Lanka provides only about 10-12 per cent of the total production. It comes mainly from seasonal water bodies and reservoirs/tanks. However, aquaculture practices are not yet well developed in the country, except for shrimps. Shrimp production is mainly found in the Puttalam district (a coastal district) and has on occasion been affected drastically by disease. However, shrimp (prawn) farming is a very popular activity in northwestern coastal areas and its produce is largely exported. Shrimp and ornamental fish production is carried out intensively in Sri Lanka. However, as there are no substantial commercial aquacultural practices developed in the country, the growing of fish for consumption has not yet developed. The National Aquaculture Development Authority (NAQDA), which has the mandate to develop inland aquaculture, commenced activities relatively recently and already has a few breeding stations.

Aquaculture is a relatively new activity in Pakistan established just twenty years ago and its contribution to overall fish production is still insignificant. It has shown a dramatic change in the past 20 years or so, however, and is developing as a promising industry now. More people are investing in fish farming and the marginally productive lands, in particular, are being increasingly put to this use. The technology of fish production has improved over the passage of time, though at a slower pace. Despite all positive trends in the fish farming sector, there is not yet a great need for tapping the aquaculture resources in a manner that uses of all the possible resources available. Marine and coastal aquaculture has yet to gear up and there is an immense need for providing a knowledge base and other infrastructure facilities to uplift these sub-sectors. It is estimated that 20 per cent of overall inland fish production comes from aquaculture, whereas the overall contribution of inland fisheries to total fish produced in Pakistan is over 25 per cent. Capture fisheries are dominated by the Indus River system, which

starts from the mountains of northern Pakistan and is joined by four large rivers flowing through the extent of Punjab and finally draining into the Arabian Sea in Sind province. The fish fauna of the Indus River system in its northern part is of cold-water type, while the greater middle and southern part of the system represents warm-water fishery zones. The catches from inland rivers and reservoirs account for more than 80 per cent of the total inland fish production, however they continue to decline. The major reasons for this development are: (i) The pressure of intensive fishing combined with the more difficult access to the flood plains for the migrating brood stock and young fishes due to canalization and damming. (ii) The influence of extrinsic factors. The riverine fishery management system depends on the enforcement of regulatory laws by provincial fishery departments pertaining to restrictions on the size of fish caught and the observance of closed seasons for fishing.

During the past four decades, there have been six large man-made reservoirs created through the construction of dams and barrages over the rivers in Pakistan providing about a 0.25 million ha area for fish production. In addition to this, there are also several small dam reservoirs. The fish production system is mostly based on the exploitation of natural food present in the water bodies and its augmentation by fertilization. The carrying capacity of these ponds, therefore, is directly proportional to the availability of natural food in that system.

For Pakistan, the organic manure available is ample and a cheap source of fertilizer, as traditionally farmers keep their own herd of cattle for milking and invariably all farmers provide their farmyard manure for fish farming. Improvements in the use of fertilizers both in quality as well as in quantity have been further fortified, but in rare cases the farm uses supplementary feed (mainly composed of rice polish and oil seed cakes). These practices have shown improvements in fish production on a per unit area basis. Based on the results of gradual improvement in production due to the use of quality fertilizer and supplementary feeding, a range of farmers started working for more nutritious pellet feed. Some farmers use pellet feed, particularly during the fattening period prior to marketing, which may last for 2-3 months. These pellet feeds are made at the farmyard by using mechanized meat-mincing machines. Some are already using high protein diets containing fish meal. The cutting point, however, is that the feeds are not commercially available because feed costs are expensive for preparing cheap and balanced fish feed. As far as the availability of feed is concerned, most of the major feed ingredients are abundantly available in Pakistan, including fish meal. Recently, the country has seen imports of soybean meal and cake for use in poultry feed; the same could be used for fish culture as well if needed. There is a need to prepare commercial fish feed according to fish weight and size and their physiological needs. To obtain proper weight gain, floating feeds should also be introduced. In India, fish feed rations contain soymeal and full fat soya as a substitute for fish meal. It is difficult to quantify the production of fish feed, however, since it is mostly carried out in an informal manner.

The use of manufactured feed in the fisheries sector is still confined to commercial aquaculture, especially shrimp, or prawn, farming. The use of commercial pelleted feeds for other species of inland fish is still uncommon in the region. At present, there is no significant demand for feed crops from the aquaculture sector and, although there is some use of oilseed meals in aquaculture, there is little competition with the livestock industry

3.4 Utilization of feed crops and feed ingredients

While most of the coarse cereals in developed countries are used for cattle feed and some of the cereals like barley are processed for beer, in India, Pakistan and across the South Asia region, these crops are grown primarily for human consumption and as source of income and employment to millions of poor farmers. Maize, sorghum and millets are the major components of the coarse cereals in India and Pakistan.

Maize remains the most important of the cereal grains used for animal feeding in Asia as well as much of the world. This is also true in the South Asia region. Although Asia produces

large amounts of rice as well as some wheat, these grains cannot compete with maize in terms of nutritive quality and cost for animal feeding. It is rich in energy, low in fiber and palatable with few problems regarding digestion or mixing into feeds. For these and other reasons, it is the cereal of choice, particularly for the rapidly expanding poultry feed sector. The demand for maize is therefore high, and can be expected to increase in the future. At the same time, production of other cereal grains such as sorghum and millet have not shown a significant increase. Tubers and yams have the potential to at least partly replace maize as an energy source but the cost of producing them is still very high and precludes their inclusion in animal feeds. India produces 15.6 per cent of total world cereal production, of which about 2 per cent is utilized for feed. Maize occupies 26 per cent of the area and contributes 41 per cent in terms of production of the three coarse cereals; maize, sorghum and pearl millet. Production is mainly located in three major states, Karnataka, Bihar and Uttar Pradesh. From a yield point of view Andra Pradesh, Karnataka and Punjab are the best producing areas. It is cultivated in both the kharif (rainy season) and rabi (dry season) with maximum area in the kharif, but highest yields in the rabi (Singh 2001). Of the total consumption, about 40 per cent is used by the poultry sector, 36 per cent as human food, and 12 per cent as livestock feed. Actually, in total, more than half the maize is used for animal feed.

As in other countries, the most commonly used cereal grain in poultry and animal feed in Nepal is maize with groundnut or soybean meal being the oilseed meal of choice. Other ingredients such as rice and wheat bran that are locally available are also used to some extent. For cattle feed, the common ingredients used are mustard cake and rice bran. Feed supplements including minerals, vitamins, amino acids and antimicrobial agents are mostly imported from India. Maize constitutes around 40 per cent of the poultry feeds and the total requirement amounts to 277 thousand metric tons or 67.5 per cent of the total feed ingredients required for livestock. The protein sources constitute about 27.5 per cent of which soybean contributes 10.7 per cent, and minerals and vitamins constitute about 5 per cent of the total feed ingredients.

Sorghum is also an important cereal crop in India because it is grown and consumed by rural people and also used as a raw material for industrial products as well as for feed. The kharif sorghum is an important traditional crop on mixed-farms under the dryland ecosystem of Indian agriculture. With the hybrid technological package available for sorghum now, the rainfed areas have become potentially productive in this crop. Barley is a crop useful for not only livestock and poultry feed but also food, fodder and malt breweries. It is considered the crop most suited to dry climates, poor quality irrigation, drought conditions, poor fertility and saline - sodic soil conditions. However, barley along with other coarse cereals like pearl millet, ragi and others has lost much ground in India to wheat and other commercial crops during the course of the "green" revolution. The cultivation of barley is considered a marginal affair, normally undertaken by poor farmers whose land holdings are small with low productivity, mostly in the states of Rajasthan, Haryana, Andra Pradesh and Uttar Pradesh.

In Pakistan, around 20 per cent of a poultry ration consists of maize. However, when the maize price increases, the poultry growers substitute maize with other cheaper cereal grains or their by-products (Alvi, 2002 quoted by Khan, 2003). Wheat is also used in poultry rations and in commercial dairy farming systems, but at levels not exceeding 15 per cent of the total volume, whilst sorghum is used at less than 5 per cent of the ration. Millet is not usually fed to poultry on commercial farms, but is commonly used on traditional poultry and livestock farms. In fact, nearly 50 per cent of the millet available ends up being used in animal feeds. Milled rice is not included in livestock or poultry rations, but its by-products such as rice polish, rice bran and rice tips are all utilized either by commercial poultry rations or in livestock feeding.

A typical poultry feed formulation in Sri Lanka will have cereals (mostly maize), cereal by-products, fats and oils, animal or plant protein sources, vitamin or minerals or additives. The main source of protein supplement in poultry feed is soybean in the form of soybean meal that is imported from abroad as soybean oil extraction is currently not carried out domestically. There is a small quantity of soybean produced internally but only for human consumption. Tubers and

yams may have the potential to at least partly substitute maize as an energy source but production costs under Sri Lankan conditions are too high, impeding inclusion in animal feeds. At current market prices, poultry and pig rations that are made with cassava as the energy source cost about 4 to 5 times higher than that of maize and presently all cassava produced in Sri Lanka is consumed by the human population. Therefore, its potential use as an animal feed in Sri Lanka will not materialize in the near future.

3.5 Past growth in the consumption and production of feed ingredients and feed crops

The growth rates for consumption of feed and feed crops, and production in the four countries are summarized in Table 3.1. The table shows that Nepal has a higher rate of growth relative to India for total feed consumption. This corresponds with a higher growth rate of animal populations in Nepal (Table 2.1). On a single commodity basis, Table 3.1 also shows that demand for maize in Nepal increases at a higher rate than that of Pakistan (4.08 per cent for Nepal and 3.45 per cent for Pakistan). In Pakistan, the overall growth rates of wheat, millet, and sorghum used as feed ingredients during the last twenty years (1981-2000) were about 3.41 per cent, 2.11 per cent and 0.31 per cent respectively.

The growth in annual production of total cereals in India, from 1961 to 1999 was 2.82 per cent, trailing behind the population and income growth. The growth was mainly from wheat and rice, while coarse cereals, except maize, declined. Growth rates of millet and sorghum were 0.46 per cent and 0.23 per cent respectively, while that of barley was negative (-1.96 per cent) and maize was 2.28 per cent. This is far less than the rate in Nepal but greater than that of Sri Lanka. In Pakistan, millet had a negative trend (-2.12) and sorghum's growth rate is comparable to that of India but that of maize was greater. In Sri Lanka, local production of maize gradually decreased until 1999 but increased thereafter. This trend has resulted in a consistent increase in imports of seeds. Besides, a significant quantity of maize is harvested as green cobs for human consumption, amounting to around 25-50 per cent of total production, which further reduces the availability of local maize for animal feeding. A higher growth rate was attained by Sri Lanka in terms of soybean production, but this is still only half of the Nepali growth rate.

The increase in total cereal production in India was due to a dramatic increase in yields given by high-yielding varieties, especially wheat and rice. As a result, the area under rice and wheat has increased, while that of coarse cereals, with the exception of maize, have declined. The area under kharif sorghum has declined from 11.52 m ha (1970) to 4.76 m ha (1996) due to changes in cropping patterns and crop diversion to oil seeds, pulses, cottons and so on, which has been driven by economics. (Rana *et al.*, 2001). The area under barley has declined precipitously from 3.4 million ha in 1967-68 to 1.8 million ha in 1990, and further dropped to 0.85 million ha after 1990. Likewise, the production level has also dropped from 3.5 million tons (in 1967-68) to 1.63 million tons in 1990 and is presently 1.5 million tons.

Table 3.1 Past growth rates for the consumption and production of feed and feed crops in selected South Asian countries (in per cent per annum)

Country	Crop	Consumption	Production
India	Feed	2.62	
Nepal		3.24	
Pakistan			
Sri Lanka			
India	Maize		2.28
Nepal		4.08	3.79
Pakistan		3.45	2.91
Sri Lanka			0.32
India	Soybean		
Nepal			4.83
Pakistan			
Sri Lanka			2.45
India	Sorghum		0.23
Nepal			
Pakistan		0.31	0.22
Sri Lanka			
India	Millet		0.46
Nepal			
Pakistan		2.11	-2.12
Sri Lanka			
India	Barley		-1.96
Nepal			
Pakistan			
Sri Lanka			
India	Wheat		
Nepal			
Pakistan		3.41	3.00
Sri Lanka			

Source: Pathak (2003) for India; Maharjan (2003) for Nepal; Khan (2003) for Pakistan; and Karunatilake (2003) for Sri Lanka.

3.6 Feed processing industries

The number of feed processing units and their available capacity in the four countries is more than adequate and appears even excessive. As a result, many of the processing industries are operating at between only 50 and 70 per cent of their installed capacity. In Pakistan, the average percentage of real production capacity is 51 per cent, in India 60 per cent, and in Nepal between 60 and 70 per cent. A similar situation is found in Sri Lanka, which utilized only 80 per cent of capacity. The reasons for inadequate capacity utilization were mainly due to the insufficient supply of feed raw materials and ingredients, a lack of proper maintenance of operation plants and the irregular supply of electricity, among others. At present, there are 18 large feed millers, about 7,100 unregistered feed plants, and plenty of self-mixing units across India. Nepal had 154 feed mills in 1999-2000 producing about 65 per cent of the total feed requirement. Most of these feed industries are small processing units, producing less than 300 metric tons a year. However, there are 20-25 processing industries, which can produce more than 10,000 metric tons of feed annually.

Of the 150 commercial feed companies in Pakistan, with a production capacity of about 2,700 thousand tons, more than 90 per cent are involved in the production of poultry feed. The number of units has increased nearly nine-fold within two decades and the total production capacity has multiplied more than nine-fold from its level in 1976. For large and small ruminants, there are only 10-15 commercial ruminant feed producers, in spite of the large ruminant population. For poultry feed, the millers increased production to 1,290 thousand tons in 1996, at a 30 per cent growth rate per annum from 1976 to 1996. In Sri Lanka there are only a few large feed processors belonging to the private sector and they dominate the feed industry. These few companies in Sri Lanka produce 70 per cent of the annual production (Ranawana, 1999). They co-exist with numerous traditional self-made ration producers, owned by the cooperative societies or individual farmers, who carry out some feed mixing mostly for their own farms. These self-mixing producers are resource poor, small-scale rural individuals and most of them have to depend on importers of ingredients such as maize and soybean meal for their requirement.

The feed processing units are often vertically integrated, providing various kinds of inputs and services such as hatcheries, veterinary supplies, other livestock inputs, health and output marketing services and other support services. The large commercial feed processing mills are usually located in areas with good or excellent infrastructure, and in close proximity to their users, that is poultry farms. With this kind of arrangement, it would not be surprising to learn that the millers are ultimately the price setters for the feed and associated inputs and outputs to which the growers are locked in.

In Nepal, the millers are scattered in Kathmandu Valley and other urban areas such as Chitwan, Pokhara, Biratnagar, which can supply about 65 per cent of the feed requirement. In the hills, the units are generally smaller, with a less than 300 metric ton capacity, and operate to serve small poultry farms in the area. The major feed manufacturers usually distribute their products through small dealers and about 5 per cent of the feed is directly supplied to commercial livestock and poultry enterprises. Three large millers in Sri Lanka absorb around 70 per cent of the maize requirement and almost all milling facilities are located in three districts namely Colombo, Gampaha and Kurunegala, where the poultry industry is dominant. In Pakistan, feed mills are primarily concentrated in Punjab and Sindh provinces, producing layer feeds, broiler feeds and breeder feeds. The feeds produced are sold either directly to farmers, commercial livestock and poultry farms or through their sales agents or dealers. The dealers provide their clients with veterinary services, input and output marketing services and credit arrangements for livestock raising purposes.

4. Demand for Feed and Feed Crops

The roughages used for ruminant feeding in the region include low-quality materials such as crop residues and natural grasses as well as cultivated green forages such as improved grasses and tree fodders which are of a much better quality. The cereal residues such as straw and stovers are an important feed resource in India and Pakistan, particularly for draught animals. Dairy cattle, dairy buffalo and goats are also supplemented with concentrates containing cereal brans, legume hulls and a variety of oilseed cakes which have moderate amounts of protein. The higher producing cows may be fed with some coarse cereals such as sorghum or millet together with urea and minerals. Cereals such as maize and the high-protein supplements such as soybean meal and groundnut meal are fed to intensively raised poultry for chicken meat and egg production.

Increasing animal numbers in the region places a greater demand on all these feed resources and the supply is considered inadequate in India at present for all feed resources (Pathak, 2003) even for the low-quality roughages. The primary strategy to increase milk and meat production from ruminants in the region is to improve their genetic potential but these improved animals need higher quality forages and supplements to realize to their potential. This will result in a greater demand for coarse cereals and higher quality protein supplements even for ruminants. The urgent demand will come, however, from the rapidly expanding poultry sector. The modern chicken, in particular the broilers and their parents, demands feed of the highest quality which can only be satisfied by the use of ingredients such as maize and soybean meal and the demand for these and their substitutes can be expected to increase rapidly. It can be seen, therefore, that with increases in milk, meat and egg production in the region, we can expect a greatly increased demand for coarse cereals and good quality protein oilseed meals. The demand for such materials in the four countries is examined in this chapter.

4.1 Structure and nature of consumption

4.1.1 Types of feed resources

Although the livestock sector is considered an important part of Indian agriculture, it still depends to a great extent upon feedstuffs available locally on the smallholdings and only a small proportion of the livestock population are fed a properly compounded and balanced feed as per their requirements. Sheep and goat are generally maintained on grazing and browsing systems and with almost no concentrates being fed. The improved hybrid types, estimated to be around 26 per cent of the total population, are given some concentrates but others including the large numbers of local cattle are given food waste and perhaps some bran. It is estimated that 35 per cent of poultry in India are found in the rural sector where again they are fed on different kinds of residues.

A similar situation exists in other countries of the region. In Nepal, the inadequate feed resources, both qualitatively and quantitatively, have been considered as one of the major constraints to livestock resource management and increased animal production. At present, most of the feed supply for ruminants comes from rangelands, pastures and crop residues, which do not compete with human consumption. However, because of the declining grazing resources on the one hand, and the growing demand for livestock products on the other, there has been a change to high-nutrient density manufactured feeds. If the manufactured feed prices increase, farmers reduce their use and substitute crop

residues, fodder and forages to save on the costs of production. The population of improved poultry breeds raised intensively is estimated at 50 per cent of the total poultry population.

As in India, feed crops in Pakistan are not grown to feed animals but are cultivated primarily to meet human dietary needs. Wheat, maize, sorghum, millet and barley are the cereal crops which are grown for human dietary needs but are also used as components of animal feed. Even before the development of the commercial poultry feed industry, these cereal grains were fed to livestock and rural poultry. However, with the advancement of the poultry industry, the feed grains are being used more systematically as feed ingredients in commercially prepared rations, especially for poultry. Maize grain is usually used up to 20 per cent in poultry rations. When maize prices increase, however, other cereal grains or by-products (Alvi, 2002) are often substituted. Wheat is also used in poultry rations and on commercial dairy farms. The use of wheat in poultry rations is limited to around 15 per cent because it has some adverse effects. Sorghum is also used in commercial poultry feed but its inclusion level usually does not exceed 5 per cent. Millets are not usually fed to commercial poultry but are commonly used for rural poultry and other livestock. Although milled rice is not incorporated in livestock and poultry rations, its by-products such as rice polish, rice bran and rice tips are all utilized in both commercial poultry and livestock rations.

Natural pasture and browse are the main feed resources available for ruminants in Sri Lanka, but at a diminishing rate, in the dry and intermediate zones of the country as shrub jungles and savannas and in the valleys and hills as grasslands. Even in the more populated areas, fallow paddy lands, railway embankments, riverbanks, dry water reservoirs, roadsides and uncultivated terrain are important sources of natural pasture. These forages are estimated to contribute more than 90 per cent to total roughage use by ruminants in the country. Farm grown pasture and fodder is estimated to be less than 10 per cent of the total roughage production in the country. Most farmers are reluctant to grow improved pasture and fodder grass due to the relatively low returns for milk. Tree fodders like *Gliricidia sepium*, *Erythrina variegata* and *Lencaena leucocephala* and agro-industrial by-products mainly from rice and coconut industries also play an important role in ruminant feeding. Annual coconut *poonac* production is used mainly for mixing in cattle and pig feeds. With the prevailing low milk prices received by dairy farmers, it is not economically feasible to give good-quality compound feeds to their cows, particularly those containing cereals. As a result the farmers make their own compound feed mixture, typically based on coconut *poonac* and rice by-products, and therefore milk production remains low.

In general, it can be seen that most of the feed supply for ruminants in the South Asian region still originates from natural forage resources: rangelands, pastures and crop residues, which do not compete with human consumption. As open grazing lands have dwindled and demand for livestock products has mounted, the supplementation of high calorie and nutrient dense manufactured feeds has begun in some areas.

4.1.2 Share of feed crops in animal feeds

Nearly two thirds of poultry production in Sri Lanka takes place in intensive systems and the balance is village chickens reared under extensive or scavenging systems. Other poultry species like, duck, turkey, guinea fowl and quail are found in negligible numbers although there is now a program to develop duck farming. Nearly 70 per cent of the raw materials required for compound poultry feed production are imported and the local ingredients used are only rice by-products (rice bran and polish, broken rice) and coconut oil meal in limited amounts. Overall, less than 50 per cent of the total rice bran and polish produced is used in animal feeding mainly due to the variability in quality of the product in the market. Utilization of industrial by-products and other non-conventional feed resources for compound feed production in poultry feeding is minimal. Pig fatteners are mainly fed swill or by-products mixed with swill, except in a few breeder operations, where compound

feeds are used. Only a small quantity of fish and shrimp feed is produced currently in the country and the main requirement is imported. Most of the feed mills lack the facilities and technology required for the production of fish, particularly shrimp, feeds. This situation is not expected to change in the immediate future. Nearly two thirds of total maize feed demand is stratified by three companies that produce poultry feeds. There are, however, a few thousand persons who purchase the grain and soybean meal from importers to produce their own poultry feed. Presently, soybean meal usage is 20 to 30 per cent in broiler feed and 15 to 20 per cent in layer feed.

In India, maize is used for poultry feed (40 per cent), human food (36 per cent), cattle feed (12 per cent), starch (10 per cent) and seed (2 per cent). Its use in poultry feeds approaches 50 per cent since it is the major component of poultry feed. Overall, maize and sorghum continue to be dominant grains among the coarse cereals for monogastric animals, and the demand is expected to rise rapidly.

The share of total grains (maize, wheat and sorghum excluding millet) in commercial poultry rations varied from 27 to 72 per cent during the period of 1981 to 2000 in Pakistan. Nearly all the sorghum produced was utilized in poultry rations. Maize, wheat and millet are also used for dairy animals and the casual feeding practiced for small ruminants. During the same period, the percentage of total grains (maize, wheat, sorghum and millet) utilized in ruminant feeds was in the range of 28 to 73 per cent.

Commercial feed is fed mainly to dairy cattle and poultry raised for milk, meat and egg purposes in Nepal. The percentage of feed demand is 42 per cent for poultry and 58 per cent for cattle and other animals. The number of improved cattle is rising quickly in the central, eastern and western regions of the country and farmers treat the improved cattle as important assets by feeding quality feed to their milk cattle. The annual growth in demand for livestock feeds is rising at a rate of 3.24 per cent per annum, which varies from 2.77 per cent in the case of feed for milk animals, 3.17 per cent in the case of feed for meat production and to 4.25 in the case of feed for egg production from poultry birds. For the small-scale poultry and dairy farmers that are scattered nationwide, their feed demand is met by local feed dealers who also act as veterinary agent suppliers of day old chicks, buyers of poultry birds and eggs, and cooperatives that collect milk from farmers and supply feeds in the case of dairy farms. Since maize and soybean are consumed locally as a staple diet by the local population, their marketable surplus is very much limited.

4.2 Response to government policies and market forces

The prices of feeds or feedstuffs are determined through the interaction of demand and supply of feed crops or feedstuffs. On the supply side, as the prices of their major components like maize, oil cakes and oil meals have been increasing in all countries in the region, so too have the prices of feeds and feedstuffs. Secondly, all countries included in this study apply price support policies on cereal grains in many forms but it is only effective for wheat and rice, leaving coarse grains to the markets. Thirdly, the feed processing industries are usually competitive and whose product price is determined by their market over which the government has little or no control. Fourthly, entry to and exit from the industry is free, and at present almost all the industries in the respective countries operate below their installed capacities. All these factors lead to higher product prices.

On the demand side, a positive trend is that demand for the concentrate feeds induces an equivalent trend in their prices but domestic prices to some extent are also governed by the market prices from neighbouring countries, as happens between India and Nepal, or in general on the cost of ingredients that have to be imported from other countries, like minerals and vitamins.

In Pakistan, prices of major agricultural commodities are subject to two mechanisms; the floor prices, which are normally set through the support price mechanism

and the ceiling prices, built through government interventions on trade. Under this mechanism, ten commodities are included in the support price system: wheat, rice, gram, sugarcane, cottons, sunflower, soybean, canola, onion and potato. For other commodities, supply and demand forces dictate their prices. A comparison of consumer price behaviour of wheat, maize, sorghum and millet suggested that during the last twenty years the average consumer price of millet was at an all time high followed by maize, sorghum and wheat. The wheat consumer price is lowest because the subsidy given by the government has driven its price down, while those of all other cereal grains have progressively increased during the last twenty years. It is interesting to note that the main factor influencing feed demand for wheat and maize is the acceleration of poultry production in the country. The results show that when milk production in the country increased sorghum, millet and wheat use as feed also increased.

Table 4.1 Estimated demand elasticities of maize in selected countries of South Asia

Country	Elasticity of demand with respect to				
	Food		Feed		
	Income	Price[1]	Price[2]	Meat[3]	Eggs
India	-0.038	0.112	0.097	-0.027	-0.106
Nepal	0.256	-0.073	0.305	1.247	-0.024
Pakistan	-0.63	-0.06	-0.093	0.107	0.366
Sri Lanka	1.6	-0.19	na	0.52	0.35

na = not available.
[1] Producer price of maize in India, ratio of maize to rice and wheat price in Nepal.
[2] Producer price of maize in India, ratio of maize to rice and wheat price in Nepal and Pakistan.
[3] It is all meat production, except in Pakistan and Sri Lanka only poultry meat production.

Table 4.2 Estimated price and income demand elasticities of wheat, millet, sorghum, barley and ragi in selected countries of South Asia

Country	Elasticity of demand with respect to				
	Food		Feed		
	Income	Price[1]	Price[2]	Meat[3]	Eggs
Wheat					
Pakistan	0.01	-0.23	-0.081	0.010	0.564
Millet					
India	-0.212	0.320	-0.126	0.009	-0.394
Pakistan	2.042	-0.652	-0.346	-0.204	0.184
Sorghum					
India	-0.356	-1.301	-1.781	0.004	2.181
Pakistan	0.300	0.335	-0.104	0.142	0.419
Barley					
India	-0.438	0.191	1.706	0.005	-2.910
Soybean[5]					
Nepal	0.464	-0.491	na	na	na

na=not available.
[1] Producer price of crop in India and of wheat and millet in Pakistan, and price ratios of sorghum to millet in sorghum model of Pakistan.
[2] Producer price of crop in India and of millet in Pakistan, and price ratios of wheat to sorghum and of sorghum to millet in wheat and sorghum model respectively in Pakistan.
[3] All meat production, except in Pakistan only poultry meat production.
[4] Egg production, except in Pakistan sorghum model milk production.
[5] Total soybean demand in Nepal.

As can be seen from Table 4.1, the price and quantity elasticities of demand for maize for feed manufacture are as expected, that is, as maize prices increase the demand for feed slows and as poultry meat and egg production increase, the demand for maize as feed rises. For other crops, the price elasticities are also as expected in Pakistan (Table 4.2).

In a somewhat different manner, the various existing pricing policies on CGPRT crops in Sri Lanka are designed not only to ensure an adequate income for the producers, but at the same time prevent its damaging effects on the sustainability of processing

industries, by occasionally changing the policies to respond to new developments in the feed and feed crop market. In Table 4.1, the demand elasticities for maize as feed with respect to meat and egg production are also positive as in Pakistan, which implies that as meat or egg production soar, the demand for maize as feed will rise.

In India, despite the existence of procurement price policies, the real prices of coarse cereals were stagnant after the mid seventies but that of rice and wheat declined further. This can be explained by the low or negative growth of coarse cereal production and the high growth of rice and wheat production in the last thirty years. With little growth in coarse cereals, the prices are maintained at a level that keeps pace with demand, or the demand adjusts to prices of rice and wheat, but a very high growth has led to the decline in its real prices. As a result, the gap between coarse cereals and wheat and rice prices could be narrowed gradually, while keeping coarse cereal prices still below that of wheat and rice.

In the case of India, the prices of feed or feedstuffs are dictated by the prices of its major component like oil meals and these have been increasing steadily. Its consequence to livestock production is that for most of the small dairy farmers who can not afford to purchase expensive concentrates, they could substitute them with their home-made rations containing higher coarse cereal proportions, as most of these cereals are cheaper. In the empirical model, this is shown by all signs in the maize feed demand model, which are not in conformity with the expectation (Table 4.1). However, for millet and sorghum (Table 4.2), the signs of price are as expected.

For Nepal, the range of price policy options is actually very limited due to the open border with its neighbouring countries. Sharing a 500-mile long border with India through which the free movement of commodities flourishes, Indian market forces largely determine Nepal's prices for most agricultural commodities. On the other hand, Nepal can export as well as import any quantities to and from India without a significant effect on Indian prices. Given these conditions, Nepal has not surprisingly tended to formulate policies that could capitalize on opportunities offered by Indian markets, rather than establishing price policies of its own. In the empirical model, the maize price with a positive sign and egg production with negative sign are in conflict with expectations, but meat production gives a positive sign as expected (Table 4.1).

The two feed crops affecting the prices of compound feeds in Nepal are maize and soybean and their prices have consistently increased by 19.53 per cent and 9.17 per cent respectively during the period of 1990/1991 to 1999/2000. Likewise, the feed processing industries are competitive but operating below capacity. Their product prices are subject to the market prices across the border that are generally higher by 15 to 20 per cent, due to the transport costs. As a result, a positive trend in prices for major concentrate feeds is observed. This trend is also reinforced by the increase in domestic demand. Prices of starter and grower feeds for egg layers and cattle feed prices rose respectively by 15 per cent, 13 per cent and 17 per cent annually during the period 1990/1991 to 1999/2000.

4.3 Projections up to the year 2010

Application of the relevant formulae generated by the trends show that the demand for feed and feed crops in all countries will increase in the next decade and will probably result in increasing deficits of feeds or concentrates. The demand for coarse cereal crops in India is expected to increase due to the higher growth in food and feed consumption compared to the low growth in production, to the order of 47 per cent to 64 per cent of total domestic production. The present level of requirement of animal feeds, estimated at 117.44 million tons for all species of livestock including poultry is increasing at a rate of 2.62 per cent per annum. The present level of production is estimated at 41.96 million tons giving a deficit of 64.27 per cent, and this gap is likely to grow. Calculations based on standard feeding practices and requirements for different species of livestock show that total demand

for concentrate feeds will grow over the next ten years. It is noteworthy that the maximum demand is for cattle feed followed by buffalo and poultry, but the fastest rate of growth is for poultry (5.74 per cent), pigs (4.07 per cent) and buffalo (2.41 per cent). Although some of these calculations may be hypothetical, as in the case of ruminants, which are not actually fed according to requirements, still it is obvious that this demand will keep increasing in view of the emphasis on cross-bred herds and the increase in the potential of the dairy sector in the future. The increased demand for poultry and pig production is clear. If translated into actual feed crop demand, it may be estimated that the demand for each member of the coarse cereal group should increase at least at the same rate of the total feed demand which is 2.69 per cent per annum.

In the estimates made by Pathak (2003), contrary to expectations, only the demand for sorghum (jowar)'s has a positive sign, at 0.20 per cent per annum, while those for maize, pearl millet (bajra), barley and ragi are projected to reduce by -0.68 per cent, -0.61 per cent, -2.25 per cent and -0.08 per cent per annum. In other words the demand for coarse grains as feed is expected to decline with the exception of sorghum demand (Table 4.3). These conflicting results could be due to Pathak (2003) using different assumptions in the estimation models.

In Nepal, the rate of feed consumption increased at an annual rate of 3.24 per cent during the period of 1995 to 2000 along with the feed demand for milk, meat and egg production which grew at 2.77 per cent, 3.17 per cent and 4.25 per cent respectively. The experience has been that local feed production fell short of the rising demand by livestock farmers and many of them in the Tarai were compelled to buy feeds from India. Indian manufactured feeds were also preferred because they are easily available, given the open border situation, and cheaper. The poultry sector has shown a rapid increase in demand for feeds and this is expected to continue. The demand for cattle feed is also increasing along the milk-production pockets, as more and more dairy cattle are stall-fed and require higher amounts of feed for improved milk production. It is expected that with the increase in numbers of improved exotic breeds of cattle and poultry that are replacing local breeds and the apparent trend towards more intensive systems using manufactured feeds, the demand for commercial feeds will further increase in the country. This will result in an increased demand for feed and feed crops. It was estimated that milk, meat and egg production will increase by 3.00 per cent, 2.95 per cent, and 4.20 per cent respectively in the period of 2001-2010 and reach levels of 1.47 million, 250,000 and 710,000 metric tons. To reach these production levels, it is projected that 874,000 metric tons of commercial animal feed should be available (see Appendix 2).

With the current level of feed production at 410,316 metric tons (in 2000) there is a need to accelerate feed production in the country by developing the production of feed crops, in particular maize and soybean that are important feed crops in poultry feed. The contribution of maize and soybean to poultry rations is 40 to 45 per cent and 10 to 15 per cent respectively. Maize and soybean are also used at the rate of 10 per cent and 2 per cent in cattle feed. It was estimated that in 1999-2000, about 210,000 metric tons of maize and 17,000 metric tons of soybean meal were used by the feed manufacturers. Maize demand is expected to rise at 5.00 per cent per annum for the period of 2001 to 2010, amounting to 342 thousand metric tons in 2010. By assuming that per capita income increases by 2.00 per cent per annum, real prices of soybean are held constant and the demand for soybean as feed follows the same response as total demand, the feed demand for soybean will grow by 0.93 per cent per annum, amounting to 18,817 metric tons in 2010.

In Nepal, the demand for total feed will increase from 653,100 metric tons in 2001 to 871,000 metric tons in 2010, or an increase in 3.29 per cent per annum. This is slightly lower than the estimate by Maharjan, 2003. The increased demand for feed crops cannot be fulfilled with the summer rain-fed production from the hills and mountains alone but will

also have to come from the Tarai irrigated lands where these crops can be expanded as a winter crop.

Table 4.3 Growth rate projection and volume of feed and feed crop consumption and production in selected countries of South Asia, 2005 and 2010 (in metric tons)

		Growth rate projection in 2000-2010 (per cent/yr)		2000		2005		2010	
Crop	Country	Consumption	Production	Consumption	Production	Consumption	Production	Consumption	Production
	India	2.69				123,678,000		141,359,000	
	Nepal	3.29				742,000		874,000	
Feed	Pakistan	2.53		976,000		1,016,000		1,242,000	
	Sri Lanka								
	India	-0.68	0.24			4,078,470	12,822,500	4,012,510	12,770,500
	Nepal	5.00	3.00	210,000	1,445,000	268,018	1,675,151	342,065	1,941,958
Maize	Pakistan	3.34	2.60	363,000	1,652,000	409,000	1,801,000	498,000	2,083,000
	Sri Lanka	13.00	1.08			187,210	32,650	344,920	34,450
	India								
	Nepal	0.93	3.65		17,301	17,374	20,607	17,756	24,872
Soybean	Pakistan								
	Sri Lanka	6.54				113,597			
	India	0.20	1.58			129,272	8,055,999	130,437	8,608,490
	Nepal								
Sorghum	Pakistan	-0.51	0.34	11,000	215,000	11,000	249,000	11,000	261,000
	Sri Lanka								
	India	-0.61	-1.56			128,500	10,620,670	125,000	11,168,140
	Nepal								
Millet	Pakistan		-0.75	78,000	156,000	90,400	169,000	88,700	159,000
	Sri Lanka								
	India	-2.25	-0.11			92,760	1,483,540	83,730	1,445,610
	Nepal								
Barley	Pakistan								
	Sri Lanka								
	India	-0.08	-0.08			116,975	2,339,529	116,743	2,334,864
	Nepal								
Ragi	Pakistan								
	Sri Lanka								
	India								
	Nepal								
Wheat	Pakistan	4.47	3.03	527,000	21,081,000	523,000	23,123,000	654,000	27,097,000
	Sri Lanka								

Source: Pathak (2003) for India; Maharjan (2003) for Nepal; Khan (2003) for Pakistan; and Karunatilake (2003) for Sri Lanka.

The positive growth rate in feed demand is also projected in Sri Lanka. The increase in demand for feed will come primarily from the poultry sector which is serviced by the large feed manufacturers. Feed production for dairy and other animals which are often given straight feeds is comparatively low. Maize demand for the livestock industry in Sri Lanka is projected to increase from 114,820 metric tons to 344,920 metric tons during the coming decade. The rate of growth in maize demand for feed is nearly 13.0 per cent per

annum. This is nearly a three-fold increase over the demand in 2000. Accordingly, the demand for human consumption is projected to increase from 68,100 metric tons to 168,260 metric tons, or at 10.57 per cent per annum. Compared to human consumption, the growth rate of livestock production demand for maize is higher. If this trend continues, there should be a sharp expansion in the poultry production sector. On the whole, these results indicate that there will be noticeable demand for both human consumption and the livestock feed industry. Karunatilake (2003) predicted that local maize production could only meet about 17 per cent of the total demand. All of the soybean meal and 80 per cent of the maize required by the domestic feed millers is now imported.

The continuing growth in the feed industries will increase the demand for oilseed meals. The demand from feed millers for soybean meal will grow at a rate of around 6.54 per cent per annum. Although there was reasonable growth in local soybean production, at 2.45 per cent per annum between 1990-2000, this was mainly used for food products and in any case, as there was little oil extraction being carried out, the meal was not available for animal feeding. The demand for roots and tuber crops for animal feed will probably be insignificant as most of it is used for human consumption.

The consumption of wheat as feed for livestock and poultry in Pakistan which was 216,000 tons in 1981, increased to 527,000 tons in 2000, giving an overall growth rate of 3.41 per cent per annum. However, the share of wheat used for feed out of total wheat consumption remained the same at 2 per cent throughout the last two decades. Maize use as feed has grown from 189,000 tons in 1981 to 363,000 tons in 2000, or at 3.45 per cent. The share of maize used for feed from total maize consumption has increased at a much higher rate than those for other uses, from 19-20 per cent during 1981-95 to 22 per cent during the last 5 years. The use of sorghum as feed has been stagnant during the last twenty years, at around 11,000 tons and its share as feed in the total consumption of sorghum remained at 5 per cent in that period. In the case of millet, its use in the feed industry has gradually declined, from 107,000 tons in 1981 to only 78,000 tons in 2000, even though about half of total production has been used for animal feeding throughout the last twenty years.

In Pakistan, therefore, based on the absolute quantities of grains used, wheat is the most predominant grain consumed as feed, followed by maize, millet and sorghum. The overall growth rate in the consumption of these grains in poultry and livestock feeding was 2.53 per cent. In the coming decade, total consumption of wheat for feed is projected at 523 thousand tons in 2005 and 654 thousand tons in 2010, or a growth rate of 4.47 per cent per annum. Total consumption of maize for feed is projected at 405 thousand tons in 2005 and 489 thousand tons in 2010, which is 3.34 per cent growth per annum. Total consumption of sorghum for feed is projected at 10.8 thousand tons in 2005 and 10.5 thousand tons in 2010, at a negative rate of -0.51 per cent. Total consumption of millet for feed will be 90.4 thousand tons in 2005 and 88.7 thousand tons in 2010.

5. Supply of Feed and Feed Crops

In the South Asian region, CGPRT crops including feed crops, are grown in a variety of production systems that can range from smallholder mixed farms to larger-scale commercial enterprises. The supply of inputs needed by farmers as well as the marketing systems can be equally complex from small village-level sales to contractual arrangements. The large-scale cultivators usually have a close association and collaboration with the feed manufacturers, and at times they may even be vertically integrated. This chapter examines the supply characteristics of feeds and feed crops in the participating countries.

5.1 Production structure and characteristics

Maize was traditionally grown in Sri Lanka during the maha (wet) season as a rainfed crop, but with the expansion and rapid development of the poultry feed industry and the popularity of green cobs as snacks, greater demand was created for maize in the late eighties. Today, maize is considered the second most important cereal food crop grown and the government has promoted the cultivation of maize as an irrigated crop on low-lying paddy fields in the dry and intermediate zones during the yala (dry) season. Maize is now grown on smallholdings throughout the country, regardless of season (yala and maha) for sale as green cobs. This maize is grown by about 250,000 farmer families directly engaged in the cultivation of "other" field crops such as coarse grains, pulses, oil crops and condiments. There are still, however, about 60,000-75,000 farm families engaging in rainfed maize cultivation in the traditional manner who have an average farm size of one to one and half acres. It can be seen that most of the maize in Sri Lanka is grown on smallholdings with only a few farmers engaged in large-scale maize cultivation on 5 to 10 ha. Most of the private sector companies and investors are engaged mainly in the purchase of maize although some of them, with state incentives, have begun providing inputs such as seeds, particularly hybrid maize seeds. Although most of the maize is purchased for feed, a few food producers also purchase quality maize at higher prices to produce nutritional supplements for pregnant women, mothers and children. These purchasers are not involved in the cultivation of maize but only in collecting raw materials including maize, soybean, green gram and other pulses for blended foods from local growers through contract arrangements.

Soybean is also grown both in *maha* and *yala* seasons but not on a large scale. In the past, much of the local soybean production was purchased by a state-owned company which extracted oil and produced soybean meal for the animal feed industry. At present, however, there are no soya oil extraction plants in Sri Lanka and the entire requirement of soybean meal is imported by feed manufacturers, primarily from India. Any soybean grown in Sri Lanka is used by food processors.

The production of maize in Nepal is mainly concentrated in the hills and grown as a subsistence crop by small farmers but is considered the second most important staple food crop in the county. Upland maize is cultivated under rainfed conditions and mostly on marginal land alternating with millet. In the Tarai, which accounts for 20 per cent of the area, there is an as yet untapped potential for winter and spring maize. Mustard is grown after maize in the hills while soybean, as a major summer legume crop, is commonly intercropped with maize. Maize has shown little if any improvement in its productivity over the last few decades due mainly to the use of poor varieties and the depletion of soil fertility on the sloping lands in the hills.

The local maize and other feed crop products with some imported grains are crushed by nearly 200 units of feed manufacturers, located mainly in Kathmandu Valley. Around 20 to 30

units are large-scale feed plants able to produce about 10,000 metric tons per annum and there is an unknown number of medium-scale units producing 500 to 700 metric tons per annum.

In Pakistan, it is estimated that the small (< 2.0 ha), medium (2 ha to 10 ha) and large farms (>10 ha) respectively contributed 16.0, 55.0 and 29.0 per cent of the 14,476 thousand tons of wheat produced in 1990. The corresponding figures for maize production (1,104 thousand tons) on small, medium and large farms were 41.0, 47.0 and 12.0 per cent, sorghum 10.0, 53.0 and 36.0 per cent and millets 10.0, 52.0 and 37.0 per cent. The total number of agricultural farms in Pakistan was 5,071 thousand in 1990. Of these, 4,183 thousand farms (82.5 per cent) were involved in wheat production and 1,067 thousand farms (21 per cent) grew maize.

5.2 Response to government policies and market forces

As discussed in Chapter 4, price policies are typically intended to ensure an adequate income for the producers and at the same time incentives for new crop growers ensuring the sustenance of existing processing industries. In reality, the pricing policies that exist in these countries are only supportive of rice and wheat production. In India, the procurement and support prices for coarse cereals have little impact on their production. In addition, the growers of coarse cereals face prices that are much more unstable than those of wheat, rice, oil seeds, pulses and cotton. For instance, the variability in millet price was 35.56 per cent compared to 14.66 for oil seeds, 25.09 for cotton and 25.06 per cent for wheat. Somewhat surprisingly, the domestic prices, except for millet, are also much higher than the world prices.

In an effort to improve domestic coarse grain competitiveness, the Indian government has initiated a comprehensive program with components such as the production of a nucleus of breeder and foundation seeds, front line demonstrations on improved production technologies, integrated pest management (IPM) and incentives to farmers to use certified seeds of hybrid and improved varieties. For sorghum, there is a wide range of high-yielding varieties available to meet the requirement of food, fodder, feed and industrial uses. There are even some types specifically bred as forages. Some improved technological production packages have been developed for different agro-climatic regions or sorghum-based cropping systems through sustained research over the years. Another important technology introduced was a community drier that was invented to control grain mould in sorghum. Eco-friendly IPM measures were also formulated and introduced to farmers.

In Pakistan, the objectives of a Price Support Policy for selected agricultural crops is to: (1) Safeguard the interest of the farmers in the post harvest period when prices of a farm commodity tends to fall. (2) Raise the production of crops through, for instance, price intervention, particularly those which are either exported or meant for import substitution. (3) Stabilize the prices of farm commodities. These policies are implemented for wheat, rice, gram, sugarcane, cottons, sunflower, soybean, canola, onion and potato. The support prices are determined on the basis of a number of factors: the cost of production, domestic demand, supply and stock position, export or import parity price, fertilizer and the commodity price parity, comparative advantage of crops, real price of the commodity, impact of the suggested prices on other sectors of the economy and the cost of living and changes in the purchasing power of the farmers. The policies have been very effective for crops like wheat, rice and cotton and to some extent for sugarcane in the past, but less so far CGPRT crops.

The government also provides credit to farmers through banks, especially through the Agricultural Development Bank of Pakistan. The response to market development was very encouraging in the case of wheat, where by giving a support price of Rs 7.50 per kg of wheat grain farmers produced a surplus in the span of one year (2000). The government also facilitated the procurement of wheat through public sector institutions which made arrangements to export the excess production. There were some problems encountered, however, by the smallholders and deprived segments of the farming community in selling their wheat to the public sector institutions in areas where notables were dominant. The support package for wheat worked out

by the government includes provisions of wheat flour to consumers at a subsidized price by rationing the supply to the flourmills. In contrast to wheat, maize production and marketing is independent of government control and its supply and demand is left to market forces. Market development has little influence on sorghum and millet production as proper marketing channels have not developed for these crops.

The government support programs in Nepal for livestock feed ingredients such as maize, soybean and others are not yet pronounced. Similarly, the distribution of subsidized food grains in food-deficit districts with a view to stabilize prices in the past appears to have created more problems than price controls. These effects are related to the fact that Nepal's tiny market is closely linked with the giant Indian market. With the freely convertible exchange rates against the Indian rupee and the rationing of foreign exchange, Nepal in effect takes its prices from the Indian market. It seems impossible to alter this market connection by whatever means. Although, on occasion, there are regulatory measures imposed to control price and quality of feeds, this is carried out more as a policing activity than to facilitate feed producing and consuming entities. These mechanisms are not effective for livestock products.

In order to protect the local producers of some major crops, the Sri Lankan government has implemented various pricing policies to create a favorable environment that ensures adequate income for the producers. These measures have been taken in relation to the CGPRT crops, (known in Sri Lanka as "other" field crops), due to their importance from an economic, social and political point of view. These policies have occasionally been changed in response to new developments on behalf of both consumers and producers. A price support scheme was implemented for green gram, black gram and groundnut through floor prices or producer prices. The farm gate or wholesale price of soybean prevailing in the country is unlikely to have any effect on soybean demand or consumption by the animal feed manufacturers. However, the international market or CIF price may have a substantial influence on it. Together with the price policies, the government also launched, in the early eighties, crop diversification programs in the new areas brought under cultivation under a huge river basin development project known as the "Mahaweli Development Project". The producer (farmer) was also given access to credit at subsidized interest rates. At present, this scheme is being mainly implemented for rice, maize and onions.

The government has tried to help maize farmers by introducing floor prices, producer prices and tax schemes. At one stage, the state even became directly involved in maize marketing and importation, but gradually abandoned them when the open economic policy was introduced. The government now attempts to control maize prices through tariffs. For example, all import taxes for maize were removed in March 2002 to give an incentive to feed millers but were reinstated in August 2002. At present, under the value added tax system in operation for all kinds of businesses, 20 per cent is charged for imported maize as a value added tax. The farm gate price of maize has gone up by 178 per cent during the last decade as a consequence of the surge in demand for maize due to the rapid expansion of the poultry sector. Apart from this, fluctuations in import prices and difficulties placed in the way of importers due to the latest policies imposed by the government of Sri Lanka and by trading partner countries have also contributed to the maize price hike.

The government has also enacted and enforced an animal feed law since 1986 designed to regulate the feed manufacturing sector. It seeks to protect the farmer by ensuring standards and protect the genuine manufacturer from unscrupulous competition. The large and medium-scale feed millers are able to meet the quality standards, but the cottage (self-mixing) producers often cannot. However, the law is being implemented in a manner that allows these operations to function but raise their standards within as short a period as possible.

Empirical estimates made in the current study of the impact of prices on the supply or production of feed crops are shown in Tables 5.1 and 5.2.

Table 5.1 Estimated supply elasticities of maize in selected countries of South Asia

Country	Elasticity of supply with respect to				
	Area		Yield		
	Own price[1]	Price[2]	Own price[3]	Urea price[4]	Other price[5]
India	0.085	na	0.362	-0.308	na
Nepal	-0.037	na	na	0.453	na
Pakistan	0.109	-0.061	0.122	-0.010	na
Sri Lanka	0.240	-0.270	0.190	-0.052	-0.35

na = not available.
[1] Producer price of maize in India, Pakistan and Sri Lanka, ratio of maize to rice price in Nepal.
[2] Producer price of sugarcane in Pakistan and of soybean in Sri Lanka.
[3] Producer price of maize in India, Pakistan and Sri Lanka, ratio of maize to rice price in Nepal.
[4] Ratio of urea to maize price in Nepal.
[5] Soybean price in Sri Lanka.

Table 5.2 Estimated supply elasticities of wheat, millet, sorghum, barley and soybean in selected countries of South Asia

Country	Elasticity of supply with respect to			
	Area		Yield	
	Own price[1]	Price[2]	Own price[3]	Urea price[4]
Wheat				
Pakistan	0.310	-0.15	0.040	-0.009
Millet				
India	-0.272	na	0.624	-0.022
Pakistan	1.715	-0.094	1.679	-0.118
Sorghum				
India	-0.394	na	0.497	-0.161
Pakistan	0.110	-0.225	na	-0.010
Barley				
India	na	na	0.225	-0.730
Soybean[5]				
Nepal	-0.090	na	na	na

na = not available.
[1] Producer price of crop in India and Pakistan, ratio of crop price to CPI in Nepal.
[2] Producer price of sugarcane for wheat, sorghum for millet, and millet for sorghum in Pakistan.
[3] Producer price of crop in India, and Pakistan.
[4] Producer price of sugarcane for wheat, sorghum for millet, and millet for sorghum in Pakistan.
[5] Soybean production in Nepal.

The elasticity of the area under maize to its own price shows positive signs, except in Nepal, which implies that as maize prices increase the area allocated to maize expands in India, Pakistan, and Sri Lanka. However, as other crop prices rise the area cultivated with maize declines. This is shown by the negative elasticities of the sugarcane price in Pakistan and the soybean price in Sri Lanka. With regard to yield, the own-price and urea-price elasticities are also in line with expectations, all positive and all negative respectively with the exception of Nepal with positive elasticity for urea price. The price elasticity of other crops in the yield model also gives the expected sign. These all indicate that as maize, urea or alternative crop prices increase, maize yield increases or declines accordingly (Table 5.1).

For other crops, the price elasticities of area under the crop are only as expected for Pakistan wheat, millet and sorghum (Table 5.2). It means that when the price of a crop rises or the other crop price declines, the area devoted to the crop will get larger or smaller respectively. The same observation is confirmed in the yield model, which implies that as the price of a crop or urea rise the crop's own yield will adjust accordingly.

5.3 Projections to 2010

Other than for a few crops in India which are in decline, all four countries are expected to experience positive growth rates in coarse grain production in the coming decade. Maize

production will increase by around 1 to 3 per cent per annum except in India (Table 4.3). Although Indian maize production grew by 2.33 per cent per annum in the eighties and 2.92 per cent per annum in the nineties, in the coming decade its growth rate is expected to decrease to 0.24 per cent per annum. Sorghum (jowar) is projected to grow at 1.58 per cent per annum in India, while barley and ragi production are expected to decline by 0.11 per cent and 0.08 per cent per annum respectively. Barley production itself has shown an alarming decline from 3.5 million metric tons in 1967-1968 to 1.63 million metric tons in 1990, and 1.5 million metric tons in 2000-2001. It is evident that a serious attempt should be initiated to arrest these trends and to accelerate the existing growth rates. Such an effort will be crucial for India when faced with increasing demand for maize and other coarse cereals from poultry and dairy feed manufacturers on the one hand and external pressures from trade liberalization on the other.

In Sri Lanka, past data shows that the average growth of maize production was 0.32 per cent per annum between 1990-2000 and the anticipated growth of production for the period 2001-2010 is estimated at 1.08 per cent per annum, reaching around 34,450 metric tons in 2010 (see Appendix 2). Domestic production of soybean has fluctuated considerably and no patterns could be discerned (Karunatilake, 2003). The overall average growth rate of 2.45 per cent per annum during the period 1990-2000 will not be sustained over the next decade and Sri Lanka has resigned herself to importing most if not all her soybean meal requirement for the growing poultry industry. Production of potatoes, sweet potatoes, kiriala and innala (two native yams) is expected to increase by 2.25 per cent, 2.61 per cent, 14.32 per cent and 15.48 per cent per annum respectively up to the year 2005. It is clear that as in India, if there is no immediate effort to boost domestic production, maize imports will increase rapidly to meet the demand from the poultry sector and that most of this will be imported from outside the region.

Maize production in Nepal is projected to increase from 1,488,350 metric tons in 2001 to 1,942,000 metric tons in 2010, an increase of 3.00 per cent per annum. Soybean production in 1999 was at 16,780 metric tons and will increase to 24,872 metric tons by 2010, a growth rate of 3.65 per cent per annum. There appears to be little possibility of further expanding the area under cultivation or of improving the productivity of these areas. There is also competition in the use of maize for food or feed in Nepal, and the increased maize production will only be available to the feed processors if there is a concomitant increase in the production of paddy for human consumption. This can be achieved by improving infrastructure in the hill areas, where rice is preferred over maize as the staple.

Wheat production in Pakistan, which was 11.48 million tons in 1981, increased to 21.08 million tons in 2000 giving a growth rate of 3.00 per cent during the last twenty years. This is an overall growth rate calculated by taking the average of a five-year period's growth (see Khan, 2003). Maize production in 1981was 970,000 tons and increased to 1.65 million tons by 2000 at a rate of 2.91 per cent per annum. Sorghum production, which was 230,000 in 1981, declined to 221,000 tons in 2000 but gave a positive overall growth rate of 0.22 per cent (Table 4.3) because the positive growth rates calculated for a five-year period were greater than the negative rates in absolute terms. Millet production declined from 214,000 tons in 1981 to 156,000 tons in 2000 (negative 2.12 per cent). Within the next decade (2001-2010), wheat production is projected to grow at a rate of 3.03 per cent per annum or by 35 per cent in total, giving 23.1 million tons in 2005 and 27.1 million tons in 2010. The growth rate of maize production is estimated at 2.60 per cent per annum or about 27.00 per cent from 2001 to 2010, amounting to 1.8 million tons and 2.1 million tons for 2005 and 2010 respectively. Sorghum production will only grow at 0.34 per cent per annum, giving 249,000 metric tons and 261,000 metric tons for 2005 and 2010 respectively and millet production is expected to continue to decrease at -0.75 per cent per annum, giving 169,000 and 159,000 metric tons for 2005 and 2010 respectively.

6. Measures to Meet Excess Demand

From the discussions in the previous chapters it is clear that all four countries in this study will be faced with growing shortfalls in the supply of feedstuffs needed to support the growth of their livestock sectors. All countries are optimistic, however, that they will be able to resolve the problem or bring the shortfall to manageable proportions and that they can do so by deploying agricultural resources through productivity improvements, technological innovation and formulating appropriate research and development policies. They realize also that at the same time they may have to turn to the international market.

Other than Nepal, the countries studied seem to feel that the government should take the lead in attempts to increase the supply of feed ingredients and that it cannot be left to market forces alone. This role for the public sector is best illustrated by the Pakistani government that has launched a plan according to which the agricultural sector would grow by 5 per cent per annum through 2010 by increasing crop area and improving crop productivity. The government will encourage the private sector to participate primarily in the provision of inputs to the farmers such as seeds, balanced and compound fertilizers, herbicides, weedicides and so on. A separate program known as corporate farming to boost grain production has also been formulated for the private sector. In Sri Lanka, the government has traditionally produced even the seed but these activities are being transferred to private companies.

Nepal (Maharjan, 2003) feels that the government should only play the role of a facilitator rather taking on an active role, particularly in the changing environment of globalization and general liberalization.

India is optimistic that substantial inroads can be made into the deficits with the inclusion of non-conventional feedstuffs of agro industrial and forest origin concentrates, estimated at 11.02 million tons in 1990-91 (Pathak, 2003). Khan (2003) also maintains that the projected future shortfall of maize in Pakistan could be resolved with the widespread adoption of hybrid maize. In Sri Lanka, (Karunatilake, 2003) changes in government priorities particularly in relation to land use, may be necessary to expand area and introduce new technologies if they are to increase maize production.

6.1 Production technology

The problem of coarse grain shortages to support increased livestock performance in India could be eased, Pathak (2002) argues, by better use of other grains like wheat and broken rice for feeding their productive animals. Moreover, considering that 35 per cent of poultry and the majority of dairy production are located in rural areas, some of the nutritional deficits could be met from domestic sources such as tapioca, turnip, carrots and kitchen waste available at the level of smallholdings. On the institutional side, India has the advantage of strong research and development organizations which can be expected to produce the necessary technological innovations and breakthroughs.

The Indian Council of Agricultural Research (ICAR), unique in the region and perhaps in Asia, has a number of research institutions and personnel which can address the many technological problems associated with these crops. They include the Directorate of Maize Research, National Research Centre for Sorghum, All India Coordinated Research Program (AICRP) on Barley Improvement, AICRP on Sorghum Improvement, AIC Small Millets Improvement Project, AICRP on Maize, AICRP on Pearl Millet and the AICRP on Under Utilized Crops. The All India coordinated programs use the facilities of the ICAR available throughout India. Besides these institutes, both the central government and the state

governments have programs (Directorates) for minor millet development. These crops are also researched at the State Agricultural Universities which come under the general purview of the ICAR. Finally, the Zonal Agricultural research stations under the State Agricultural Universities also provide region specific research backup on these crops.

The prospects for expanding feed crop production, maize in particular, in Nepal are considered very good. Some of the measures that need to be taken are, firstly, promoting appropriate varieties of maize, supporting the private entrepreneurs and traders to establish collection centres, encouraging contract procurement of maize from farmers, providing credit to farmers in advance and developing storage and marketing facilities near production pockets. Secondly, grow winter maize in the Tarai areas instead of crops such as wheat, mungbeans and other legumes that are mainly exported and thirdly, to grow feed crops such as oilseed, soybean, millet or other crops along with maize in hill valleys and on small-scale farms. In order to achieve this, the government should provide technological support to expand local maize and feed crop production by giving due attention to research, development and extension related to these crops. The state sector should also appreciate and recognize the potential contribution from the private sector in the feed, poultry meat and milk production areas, especially in terms of research and development. As the private sector is unwilling to invest in long-term research and development endeavors, the government should facilitate and encourage them by designing appropriate incentive packages.

In Sri Lanka, the government should invest in research and development of technological packages for feed crops, particularly maize to promote higher productivity which in turn would lead to larger areas being cultivated with this crop. The package should include production technologies, and marketing, storage and processing facilities for any given production system. To expand the area under cultivation, the government has already taken steps to promote maize cultivation in the yala season in well-drained paddy fields and an appropriate technological package for productivity improvements has been identified. The Department of Agriculture has developed a hybrid variety at the Field Crop Research and Development Institute (FCRDI) which will be released soon. The government has also stipulated a new Seed Act to regulate matters pertaining to seed production and under this, the private sector will be offered incentives and facilities to engage in seed production and multiplication programs. The Department of Agriculture shows leadership to increase productivity and acts as a facilitator for the activities of the private sector, NGOs and farmer organizations.

The government has gradually withdrawn its involvement in agricultural marketing and encourages the private sector by adopting open economic policies, with the exception that it is sometimes compelled to intervene and purchase agricultural commodities in order to protect farmers. The state agricultural extension services have been devolved from the central to the provincial administration. The forward sales contract concept introduced by the Central Bank of Sri Lanka has also helped to create a favorable environment to expand maize acreage as well as productivity. Moreover, the facilities given by the Bureau of Investment (BOI) such as long-term leases have attracted foreign investors interested in large-scale maize cultivation using new improved technologies. These measures are expected to lead to substantial increases in maize production.

In Pakistan, research and development activities have been directed towards variety improvement, provision of quality seeds of improved varieties to farmers and restructuring the technology transfer programs. The PARC (Pakistan Agricultural Research Council) is actively engaged in revitalizing its Technology Transfer Program in collaboration with the provinces, where emphasis will be placed on the provision of information regarding the improved technology packages for the production of grain crops. Research and development efforts of the PARC for ruminant feed development and its leadership role have led to the establishment of small to medium scale ruminant feed mills. The trend in Pakistan among dairy farmers to utilize commercial feeds for dairy animals is increasing year by year.

As part of the attempts to produce better production technologies the Agricultural Prices Commission and the Agricultural and Livestock Marketing Authority of Pakistan have jointly implemented research and development projects on the imperfections of the marketing system and the development of strategies for future improvement. Placing higher priority on grain crop research in the country would also strengthen the Commodity Research Programs in the provinces. However, there is also a need for restructuring the national agricultural research system.

Reforms in the irrigation sector have resulted in the promulgation of enabling laws for the establishment of Irrigation and Drainage Authorities at the provincial level, Area Water Boards at the Canal Command level and Farmers' Organizations at the distributaries canal level. The Farmers' Organization is envisaged to be the vehicle for the development of irrigated agriculture. The devolution model adopted in Pakistan, which gives more discretionary power to the district government, would also provide effective backward and forward linkages between research and extension institutions in the provinces. The staff of the line departments like agriculture and livestock are placed under the district executive officer for agriculture. Similar structural reforms are expected in agriculture and livestock sectors in the future.

The National and Provincial Rural Support Programs in the country have also started motivating the farmers, landless families and women and organizing them into Village and Women Organizations. These organizations are now in place in a large part of the country with their saving and credit programs. The credit program is directed especially for resource-poor farmers because instead of the usual financial collateral, the program allows and initiates social and community-based collateral. This is one of the most successful programs among the resource-poor farmers, even though the interest rates are relatively high - to the order of 18 per cent - but the access to the credit is easy. Additionally, these programs are successful in linking the community organizers with the research and training institutions in the agricultural and livestock sectors. Some of the organizations have already entered into adaptive research for the multiplication and distribution of certified seeds to fellow members. These linkages and community-based organizations in the future could provide a parallel system of extension, which is more effective than the current public sector extension system.

Research and development programs of PARC have also resulted in the development of urea molasses block industries for ruminants with special reference to grain-fed livestock. Now there are varieties of recipes/formulas for livestock feeds including the urea molasses blocks to cater the needs of any target ruminant feeding system.

6.2 Co-operation and liberalization of trade

The advantages of co-operation in trade through export and import activities of feedstuffs is clearly apparent among the countries under consideration and in general within the South Asian region. This is apparent from the discussion in Chapter 2, especially for coarse grains. Trade possibilities are not limited only to those commodities but extend to animal products as well. If animal products are traded among the countries, then it can be expected to create additional demand for feed crops in the exporting countries. The sustainability of the trade flows will be dictated by the country's comparative advantage. The comparative advantage can be assessed and exercised through international trade agreements, since there is no country in the world that could claim itself free of support from the government.

Domestic trade policies in these four countries would be significantly affected through the upcoming international trade agreements and transit agreements (particularly for landlocked countries) such as the WTO (World Trade Organization) and the SAPTA (South Asian Preferential Trading Arrangement). According to standard thinking, trade would be beneficial for two parties if it could lead to the efficient use of scarce resources. As the WTO and the SAPTA or SAARC are still evolving, it would be impossible to accurately predict the impact of agricultural trade liberalization on the agricultural or any other sector. The challenge is to

convert the impact of these agreements to expected benefits. This aspect has not been fully evaluated or discussed in any of the research papers on which this consolidated report is based. Maharjan (2003) recognizes the close link between his country and India, which naturally lends ways and trade opportunities between the two. Karunatilake (2003) also notes the crucial role of soybean imports on the feed industry operation in Sri Lanka. Both authors present a brief discussion on the impact of the WTO agreement to their own agricultural/livestock sectors and the policy measures needed in anticipation of trade liberalization. Karunatilake (2003) argues that Sri Lanka would reap extensive benefits from trade co-operation and liberalization, while Maharjan, Khan, and Pathak hold that their agricultural/livestock sectors would find it difficult to adjust to the globalization of trade. India will be confronted by competition from other countries producing coarse grains cheaper than they can. Karunatilake and Maharjan both see the regional preferential agreements as being advantageous to their countries.

Pathak (2003) reports that India exported sorghum and pearl millet consistently over the years, whereas in the case of maize, barley, ragi and other millets, exports only picked up after 1993,1995, 1992 and 1992 respectively. Even though the coarse cereals exported constitute only a small proportion of total exports, in absolute terms it has shown an impressive record of growth over the years. Moreover, these items form an important part of the regional trade that India has with its neighbours and in fact, the solvent extracted soybean meal was included in the top 10 products exported to Pakistan and Sri Lanka in 1995-1996 (Mukherji, 1998). With regard to the impacts of the WTO implementation process, Pathak argues that Indian coarse cereals would face stiff competition from other countries that actually produce these crops under government subsidies. Chand (1997) also noted that if the present restrictions on quantity were removed, the imports of sugar and edible oils would possibly increase. But of course, if subsidies are removed or brought down, India may regain its comparative advantage. India should, therefore, be actively negotiating under WTO rules with countries exporting coarse cereals for agreement to continue the reduction of subsidies given by them to their farmers. If India still does not have competitive advantage, even at the least level of subsidy, the research institutes will have to seek new technologies and farming systems in the form of more productive varieties that can fit better into the agroecological zones in which coarse cereals are cultivated. Farmers will otherwise, Pathak (2003) argues, be left with less profitable crops, farmers with a marketable surplus will not be able to sell and they may all be reduced to the level of subsistence farmers due to the adverse effects of globalization. However, Chand (1997) quoting Parikh et al (1995) holds that agriculture and trade liberalization would improve social welfare, particularly of the rural and urban poor.

Commodity trading across her land borders is essential for a country such as Nepal. As a landlocked country ranked as one of the least developed, Nepal has no access to sea lanes for trade with the outside world. Its trade has to rely on treaties with its giant neighbours, India and China. Ghee produced in western and mid-western Nepal is exported to the nearby Indian towns of Lucknow and Kanpur where the Nepali ghee is often preferred by local consumers. During the winter (flush season), when the milk supply exceeds the demand, the dairy processing units in the urban areas abide milk holidays twice a week. However, in times of milk shortages, the demand is met through imports of dairy products like butter, cheese, tea-whitener, baby foods and a quantity of skim-milk powder (SMP). As Nepal is a very popular tourist destination, the demand for milk and milk products is also expected to increase due to the rise in urban centres and the increase in the influx of tourists. There is also a possibility of exporting yak cheese to neighbouring countries. Goats are imported on an increasing scale every year from India and China. To meet the growing requirement of animal products, Nepal imported about 382,454 heads of buffalo, 465,506 heads of goat and 1,703,220 units of poultry bird, 929,276 liters of milk and 2,792,000 units of eggs in 1998-99. Similarly, exports from Nepal included 36,348 heads of buffalo, 47,266 of goat, 33,169 poultry, 141,986 liters of milk and 7,197,000 units of eggs to India. Lentils from Nepal were included in the 10 most important products imported by India.

In the past, trade with China was not significant and was also only on a state-to-state basis. This compelled Nepal to trade mainly with India both on a state and private basis, but unfortunately Nepalese products have only limited access in those markets due to protectionist and restrictive policies adopted by the countries. At home, the demand for products is also weak because of predominantly low-income consumers and geographically scattered markets. For that reason, although Nepal has the potential to increase production, the prospects for finding suitable markets for any surpluses are, at present, small.

Anticipating the globalization in agricultural trade, the government in Sri Lanka introduced open economic policies in the late eighties, following which the trade in many food crops was liberalized. By implementing trade liberalization policies, the government expects to increase local production of selected crops and in turn assure the sustainability of local agro-based industries such as the feed industry by ensuring a continuous supply of raw materials at affordable prices. Maize and soybean meal imports are permitted for the animal feed industry, but rice imports were allowed only when local production failed to meet domestic demand. From the experience gained so far, it seems that on balance, trade liberalization has been in favor of the Sri Lankan economy because the government has also taken some steps to protect local producers by introducing tariffs for important cash crops. With trade liberalization, new technology such as new seed varieties including hybrid maize could be brought into the country in addition to proper equipment for seed cleaning, sorting, grading, packing and testing as well as modern micro-irrigation components.

As the local production of maize falls short of the national requirement, the best option for Sri Lanka is to source the balance from the region while at the same time continuing with efforts to increase local production. At present, almost the total requirement of soybean meal is imported from India. Since this country produces large surpluses and Sri Lanka does not extract oil from soybeans, it makes sense to continue to import from India. The shortage of cereals for poultry as well as for dairy feeds may have to be sourced from outside the region until such time as Sri Lanka is able to meet its needs. Sourcing feed ingredients from within the region is advantageous since the trade can be included in the free trade and preferential trade agreements being arranged within the SAARC countries. It is estimated that the production of milk increased from 0.225 million tons in 1988 to 0.341 million tons in 1998, but during this same period the import of milk powder increased from 40.1 million to 53.6 million kg.

In Pakistan, the introduction of import restrictions through tariff and non-tariff measures permitted under WTO rules would provide the opportunity for the country to produce crops not only to meet the domestic requirement but also export when the prices are competitive. However, at present, Pakistan will have to import grains to meet the shortfall. At the same time, Pakistan has placed a ceiling binding of 100-150 per cent on agricultural items in its offer on agriculture submitted to the WTO. It was necessary because agriculture plays an important role in the economy and Pakistan is a net food importing country. Significant amounts of foreign exchange are earned from exports of raw and base products from agriculture. In spite of the reasonable growth rate in milk production, because of the high level of consumption, Pakistan is still importing milk and milk products. Edible oils, grains, pulses, and flour, tea and coffee are also imported by spending large sums in foreign exchanges (Akhtar, 2000 and Khan, 2003).

In anticipation of a new trade order, Nepal has tried to convert itself from a high tariff import regime to a liberal one, with tariff rates reduced and simplified, ever since the restoration of democracy in 1990 and the recent announcement of liberalized economic policies. Subsidies have been reduced or eliminated in agricultural inputs and outputs. As a consequence, the Nepal feed industry will be exposed to direct competition from India and other neighbouring countries. Nepal has not yet signed an accord with the WTO up to now. If they do join the WTO in the near future, Nepal could possibly benefit from the arbitration procedures available under WTO rules to settle problems peculiar to landlocked countries. Some of the advantages include the fact that Nepal will have the legal right to transship goods through India using any convenient port of entry or point of exit. Through the years Nepal has suffered from, the dumping of

subsidized goods being produced in surplus by neighbouring countries. In essence, Nepali products were competing not with the rival producers but with the national treasuries of richer countries. Under the WTO trading arrangement this will be minimized in the future. Nepal can gain benefits from exporting not only cereals, but also high value crops, off-season vegetables and fruits, medicinal plants and herbs, legumes and pulses, which can all be exported to other countries after the subsidy on these commodities is removed by other trading partners.

Another important right to Nepal under the WTO is the freedom of transit. In the absence of these rights, Nepal's access to the sea is governed by the Trade and Transit Treaty with India, which stipulated the use of the Calcutta port since 1960, which is a congested shallow seaport in the region and unable to handle large vessels for bulk transportation. The other benefit is that the New World Trading Order would open up new trading opportunities based on the principles of comparative advantage. Despite its least developed country status, local production of goods and crops would still have to compete with imports at world market prices. Besides, the provision of sanitary and phytosanitary measures (SPS) applied to developing countries sometimes would be considered as a disincentive measure for them to have access to markets in developed countries, although from the importing countries standpoint it is just a precaution to protect against human, animal and plant life or health. In summary, once Nepal becomes a member of the WTO, the country may face difficulties unless Nepal improves the quality, efficiency and cost competitiveness in feed and feed crop production. As the transport of ingredients is bulky and transport systems are rudimentary, Nepal may have to face the problem of higher marketing costs as well.

To reap the benefits from the new international trade, Nepal should be active in total quality improvement and product promotion and try to reduce marketing costs. Nepal as an active member of the South Asian Association for Regional Cooperation (SAARC) can also benefit from the SAARC Preferential Trading Arrangement (SAPTA) as a trading block with its members. In that sense Nepal should probably try to capitalize on the opportunities offered by this forum.

6.3 Regional co-operation in research and development

Many of the technical problems in increasing the productivity of their feed crops identified by the countries of the South Asian region are very similar. In this situation, the authors feel that there is a strong case for collaborative research among scientists of the four countries. This will enable them to share and pool resources of personnel and equipment and direct them towards a common goal. Enhancement of feed crop production, product development and the utilization of root and tuber crops for animal feed could be included in such a program. The participation of the animal feed industry and other related private firms should be encouraged.

With their relatively large economic size and diverse agriculture, India and Pakistan could share their research findings with neighbouring countries on planting and processing technologies on the ubiquitous CGPRT and feed crops, such as cassava, sweet potato, oilseed, and millet. India with its large research base is in a good position to assist other countries of the region with new varieties and technologies for mutual benefit. There is also a need to establish regional networks on agricultural research, information and extension. The bilateral arrangement for collaboration in agricultural research and development currently active between the Indian ICAR and its Sri Lanka counterpart, the Council for Agricultural Research (CARP) could serve as a mode for regional collaboration. The Memorandum of Understanding under this arrangement allows for the exchange of germplasm, exchange of scientists and experts as well for formal training.

The studies under the current project show clearly that the demand for feed ingredients from several CGPRT crops will increase and that at the same time, the supply is either declining, stagnant or increasing only moderately. This will lead to increasing shortfalls of these

commodities. The choices available to these countries are either to increase domestic production by deploying resources, resort to imports or follow a combination of the two. The final decision will depend on the principle of comparative or competitive advantage and considerations of food security. It must be remembered that the international market these countries face today is an "artificial" market where many, if not all the surpluses sold are not produced with truly comparative advantage in those countries because of all kinds of government support programs.

In view of the liberalization of trade there is a need to strengthen the regional trade agreement SAPTA so that each country cultivates crops that have a competitive advantage and are therefore complementary. Nepal, for example, could concentrate on producing more high-value horticultural products in their alpine regions, rather than oilseeds and other CGPRT crops that are grown in India.

6.4 Results of SWOT analysis on feed crop production in South Asia

The strengths, weaknesses, opportunities, and threats of feed crops and feed development in each country have been identified by the researchers. Some of the common elements of those attributes are listed below. Some of the factors recognized as strengths include the availability of cultivatable areas and high-yielding varieties (particularly maize), promotion of feed crop farming as a means of agricultural diversification and lowering production costs. In India and Pakistan, the export potential to their neighbours is a strength and in Sri Lanka the involvement of the private sector in large-scale cultivation is identified as a strength. The fact that producers are subsistence farmers with fragmented landholdings, the lack of a support price or effective marketing systems for feed crops, unavailability of drought-resistant high-yield varieties, cost of hybrid seeds, poor harvest and post-harvest handling, lack of systematic research and threats to the natural environment are identified as weaknesses. Potential deterioration of natural resources caused by maize cultivation in the hill country of Nepal and root and tuber crop cultivation in the hill country of Sri Lanka may also be taken as weaknesses in the respective countries. The moves towards intensive livestock farming, the growing demand for animal products, government policies to encourage agricultural diversification, growing private sector involvement, trade liberalization and regional economic cooperation are listed as opportunities. The traditional systems of rearing livestock, low production from feed factories, poor physical and market infrastructure to collect and distribute harvests, growing competition from foreign countries, and lack of regulation to control feed quality, are elements identified as threats (Table 6.1).

Table 6.1 SWOT analysis for feed and feed crop development in South Asia

STRENGTHS	• Large area available under rainfed, drylands or highlands as well as lowlands that could be put into use during the dry season (in Sri Lanka), and summer and winter in India, Nepal (in the Tarai region), and Pakistan. • Helping to promote the acceleration of agricultural diversification. • Water productivity of feed crops is higher. • Input use such as fertilizers, herbicides or weedicides, pesticides, and so on is less. • New hybrids of maize with high-yield potential are available. • Production costs are lower and they have potential to increase cropping intensity and above all productivity.
WEAKNESSES	• Landholdings are fragmented and the number of small farmers is increasing. • Policy and price support for feed crops excluding wheat and rice is lacking. • Effective marketing and processing systems for feed crops is lacking. In Sri Lanka, soybean-processing facilities are not available. • Policy support for feed manufacture is not appropriate. • Harvest and post-harvest handling at the farm level is inadequate. • Competition for area use from commercial crops is mounting. • Availability of improved feed crop seeds in quantity and on time at an affordable price, except wheat and hybrid maize is of concern. • Productivity of feed crops is low. • Farm growers are at the subsistence level. • Access to credit and other input facilities is lacking. • Drought resistant varieties, particularly sorghum and millet in Pakistan, are not available. • Technological improvements on feed crops, especially in drought-prone areas are slow. • Research, extension and farmer linkages are weak. • Feed crop production zoning is non-existent. • Potential attacks from wild animals on cultivation.
OPPORTUNITIES	• Trend towards intensive livestock raising. • Availability of grazing and pasture grounds is decreasing. • Livestock population is large and its growth rate is high. • Growing demand for livestock products, such as milk and monogastric meat as against food grains. • Concern over quality productive animals is growing. • Role of the business community is increasing. • Export promotion of livestock products is in place, especially in India. • Interference of government in input and output pricing is minimal. • Open border facilitates trade and transit treaties, particularly between India and Nepal. • Foreign market is huge. • The WTO gains its implementation. • Climate is favorable and water is available to grow feed crops in both the winter and summer cropping seasons, especially in India, Nepal, and Pakistan. • Government policy encourages crop diversification. • World market prices continue to increase. In Sri Lanka it is also magnified by devaluation of Sri Lankan rupee against US$. • Human food industry is expanding. • Consumers prefer local products.
THREATS	• Livestock rearing is mainly in households subsidiary to farming. • The real production capacity of feed industries is low. • Locations of feed industries are too concentrated. • Poor market infrastructure in the producing areas. • Control over feed quality and product development is poor. • Feed manufacturers are unorganized. • Improvements in livestock productivity are slow compared to world averages. • Costs of raw materials for feed production continue to rise. • Government policies keep changing. • Products of foreign countries compete with those of local. • Market prices of livestock products tend to increase.

7. Conclusions and Recommendations

Agriculture is the primary livelihood of people in the South Asian region and livestock farming is an essential component of agricultural systems in these countries. The contribution of livestock to agriculture in South Asian countries ranges from nearly 40 per cent in Pakistan to 10 per cent in Sri Lanka. Milk and milk products have traditionally been the major source of animal protein in the South Asian diet in contrast to those of East Asia. The demand for milk continues to increase in these countries due not only to increases in population but rapid increases in per capita consumption. A recent phenomenon in these countries is the huge increase in the consumption of meat, in particular chicken. This phenomenon has been observed in other developing countries as well and has been referred to as the "livestock revolution" and will no doubt pose a major challenge to governments in the region. Although the countries in South Asia have very large and increasing populations of animals, in particular ruminants, their productivity is low and they have not been fully exploited. The chief constraint to increasing production from these animals is acknowledged to be the availability of feed resources.

All countries in the South Asian region have overall deficits of animal feedstuffs, the main reason being that production has not been able to keep pace with the rapidly growing demand. Apart from the shortfall of roughages for ruminants, the availability of supporting raw materials and ingredients are not sufficient to meet the needs of the feed manufacturers. The growth in the livestock sector is primarily in the poultry sector and much of the demand for feed arises for preparing broiler and layer rations. The growth in the poultry sector is expected to continue and any deficits of key ingredients such as maize and soybean meal will, therefore, increase.

In India, Pakistan and across the South Asian region, coarse cereals are not confined to animal feed alone as in the West, but are cultivated mainly for human food. Their cultivation is also an important source of income and employment to millions of rural farmers. Maize, sorghum and a range of millets are used in South Asian countries but of these, maize remains the most important of the cereal grains for animal feeding.

Since the pig industries are very small and ruminants are usually supplemented with straight feeds, most of the commercial feed mills in the region have grown to supply the expanding poultry sector. The number and capacity of such commercial mills are adequate or even excessive so that the processing industries in all countries are operating at between 50 and 70 per cent of their installed capacity. Many of these feed manufacturers are linked to companies that also supply other inputs such as chicks and drugs as well as to the purchasers and processors of eggs and chicken. The entire system is, therefore, integrated and often vertically integrated within the same private sector company. These large enterprises are usually located close to urban centres with good infrastructure and in close proximity to their users, the poultry farms.

Most of the feed supply for ruminants in South Asia still originates from natural forage resources – rangelands and natural pastures – as well as crop residues, which are not consumed by people. As open grazing lands have dwindled, the genetic quality of animals has improved and the demand for livestock products has increased, farmers are compelled to use nutrient dense manufactured feeds to supplement their dairy cattle.

All countries in this study have farmer price support policies for cereal grains which take many forms. In reality, however, these appear to be only effective in the case of wheat and rice and coarse grains are by and large left to the markets. In this sense the demand for these crops is independent of or may even be discouraged by these policies.

Projections based on current trends show that in all countries there will be an increasing demand for feed and feed crops resulting in a possibly growing deficit in the supply of feed

ingredients within the next decade. In India, the demand for coarse cereal crops is expected to increase due to the growth in consumption for both food and feed; the accompanying growth in production will be less, in the order of 47 per cent to 64 per cent of total domestic demand. The total demand for concentrate feed shows a growing trend over the next ten years at a rate of 2.69 per cent annually. It is noteworthy that in terms of volume, the maximum demand is for cattle followed by buffalo and then poultry but the fastest rate of growth for feed demand is primarily for poultry (5.74 per cent), followed by pig (4.07 per cent) and buffalo (2.41 per cent).

Maize, soybean, and most of the other coarse cereals in South Asia have traditionally been cultivated by millions of smallholder, often subsistence, farmers, under rainfed conditions commonly on marginal lands. In Nepal, maize although the second most important staple food crop is largely cultivated in the hills by small farmers. In Sri Lanka, the situation was similar with maize being grown only in the non-irrigable areas during the maha (wet) season by small-scale farmers.

The measures taken to support farm gate prices of coarse grains and other CGPRT crops in the countries studied have not been effective and have not achieved their intended objectives. In India and Pakistan, the support prices for coarse cereals have had a negligible impact on their production. The Nepali government's programs to support the supply of livestock feed ingredient crops have not yet been clearly defined. Similarly the distribution of subsidized food grains in the food-deficit districts with a view to stabilize prices has in the past created more problems than price controls.

Other than for a few crops in India, all countries are likely to experience positive growth rates in coarse grain production in the coming decade.

It is very clear that cooperation in trade not only for coarse grains and their by-products but even for animal products will result in mutual benefits to all countries in the South Asian region. Such trade will help ameliorate some of the expected deficits in animal feeds and animal foods since each of these countries can then focus on the commodity in which it has competitive advantage. Sri Lanka is hoping to benefit from the trade co-operation and liberalization they have adopted as policy while Nepal, Pakistan, and India may face difficulties in adjusting to the globalization of trade. India will be confronted by competition from other countries that produce coarse grains. Sri Lanka and Nepal stand to gain from the regional preferential trade agreement (SAPTA).

Collaborative research and development programs among the countries studied have great potential to increase the production of feed crops and are particularly important in view of the declining trend of public research funding worldwide. Such a program could deal with technological aspects of developing new varieties using genetic material available in the region and then sharing these more productive strains together with the technical packages for their successful cultivation. Research and Development should also extend to the use of root and tubers as feed crops in the region. The participation of the animal feed industry and other related private sector firms in the research and development endeavor should be ensured through suitable incentives.

The most serious concerns relating to feed crops in the region are that:

(i) The demand for CGPRT crops as feed in each participating country will increase faster than its domestic supply. The gap between demand and supply will be more significant in Sri Lanka and Nepal and less in India and Pakistan.

(ii) The expansion of CGPRT feed crops is constrained by factors such as undeveloped markets, slow output from research and a lack of support for farmers, price incentives and transparent policies.

The immediate programs required in light of this are:

(i) The government should facilitate the development of contract procurement between farmers and feed processors thus ensuring a market and a fair price.

(ii) The government should also promote farming organizations in production blocks to exploit economies of scale through increasing productivity and market efficiency and maintaining quality.
(iii) The public sector should apply greater investment in the development of High Yielding Varieties possessing resistance to drought and insect-pests.
(iv) The private sector should also be invited to become involved in collaborative research on many areas such as variety development and grain quality improvement.
(v) The government should establish a program of minimum support price on par with wheat and rice, which is truly effective in increasing production.

There is clearly scope and a need for enhancing regional cooperation in technology and trade: (i) Where India and Pakistan could share their research findings on production and processing technologies of CGPRT feed crops with neighbouring countries. This could be implemented as a SAARC activity to establish regional networks on agricultural information and extension. (ii) Each country will have the opportunity to exploit its comparative advantage within the framework of the regional trade association of SAPTA (South Asian Preferential Trade Arrangement). In view of the liberalization of trade there is also a pressing need to capitalize on the regional trade association of SAPTA, where Nepal, for example, could concentrate on producing more high-valued horticultural products in the hills, rather than oilseeds or other CGPRT crops that can be exchanged with the produce grown in India, and Sri Lanka on producing industrial, cash or medicinal crops, rather than soybean. Such complementary arrangements will have mutual benefits not only in the case of feed crops but throughout agriculture.

The studies carried out in each country have identified their strengths, weaknesses, opportunities and threats relating to the expansion of feed crop farming. The strengths identified were the availability of suitable areas, availability of some high-yielding varieties (particularly maize), government policies to promote agricultural diversification and low production costs. For India and Pakistan, the potential for export is a considered strength and in Sri Lanka the involvement of the private sector in large-scale cultivation is considered an important element.

The fact that many farmers are at the subsistence level with fragmented landholdings was considered a weakness together with the lack of effective price support, ready markets, drought-resistant high-yielding seeds as well as the high cost of hybrid seeds, poor undeveloped facilities for harvest and post-harvest handling and the undesirable effects on the natural environment. The latter is a problem particularly in the hill country of Nepal and Sri Lanka.

The move towards intensive livestock farming with higher producing animals and quality feeds, the growing demand for animal products, government policies to encourage agricultural diversification, growing private sector involvement, and the trade liberalization and regional co-operation have been listed as opportunities. Opportunities specific to Sri Lanka are the cottage level feed mixers, the positive government intervention in facilitating large-scale cultivation of maize and the imposition of import tariffs for maize.

The elements identified as threats namely are the problems in changing traditional methods of livestock raising, the low productivity of feed factories, the poor infrastructure for collection, storage and transportation of harvests, lack of control over quality of feed ingredients and processed feeds and the increasing competition from countries outside the region.

Since each country has its own natural endowments and government policies within a historical setting specific to each of them, it is difficult to make generalizations that apply across the board. Such an effort is made more complicated as several feed crops with their own characteristics are involved. Nevertheless, this study was able to identify some strategies and policies that hold promise in increasing feed crop production and these are shown below:

7.1 General recommendations

i. Promotion of feed crops for feed and for other uses and the promotion of diversification from rice and wheat cultivation.

ii. Encouraging contractual farming for CGPRT crops with feed processing industries and cultivate in consolidated land blocks.

iii. Expansion of feed crops to suitable areas and seasons outside their traditional systems not hitherto attempted. Examples are, lowland irrigated cultivation during the dry season (in Sri Lanka) and summer and winter in India, Nepal (in the Tarai region) and Pakistan. There is also a possibility for increasing cropping intensity through inter or relay-cropping.

iv. Increasing investment in research and development of these crops, in particular the development of high-yielding varieties that are resistant to drought and insect-pests to further reduce their cost of production. Research and development is also required on post-harvest handling and processing with the participation of the private sector.

v. Trade negotiations and cooperation at the regional level to ensure that a complementary arrangement is arrived at and at the same time gradually make adjustments to the agricultural and industrial sectors to guarantee competitiveness.

vi. The public and private sector should cooperate to produce quality seeds and make them available to the farming community at reasonable prices and take measures including timely inputs to narrow the gap between the farmers' yield and the potential yield of variety seeds developed at research stations.

vii. Strong linkages need to be developed between researchers and extension personnel on a regular and sustainable basis.

viii. A well-planned farmer education program should be developed to introduce new technology and provide other services. The extension service should identify the high potential areas for feed crops, especially maize, and initially concentrate efforts in these areas before expanding to larger areas. The private sector must also be encouraged to establish its own commodity-based extension services.

7.2 Specific recommendations

India

i. Promote coarse cereal production for feed and other uses and the government should establish a program of minimum support price for coarse cereals on par with wheat and rice.

ii. Public research institutes must work towards improving sorghum productivity.

iii. All stakeholders should support the agenda of diversifying agriculture.

iv. As some of these crops are also consumed by people, the supply of these coarse cereals should be provided at subsidized rates to Below Poverty Line (BPL) families to ensure them access to food.

v. Support prices for coarse grains would be desirable to maintain the interest of farmers. At the same time the organized marketing of animal products is essential.

vi. Import restrictions through tariffs, when required, to safeguard the interest of coarse cereal growers in the country are important when looking to a sustainable level of production of these crops.

vii. Proper execution of market intervention mechanisms in consonance with administered market support prices (MSP) in respect of coarse cereals on par with wheat, rice, pulses, oil seeds, cotton and jute is a must to provide a better market and also promote its production growth by the farmers.

viii. Sorghum: Large-scale popularization of inter-cropping of sorghum with pulses/oilseeds through incentives under development programs including appropriate market intervention for the procurement of sorghum at administered prices should be ensured on par with wheat and rice; assured production of quality seeds of public bred sorghum cultivars; and effective quality control of sorghum seeds sold in the market.

ix. Maize: Maize should be accorded special status by de-linking it from other coarse cereals for strategic development; minimum support price of maize should be made more remunerative; food subsidy on maize should also be provided like for wheat and rice; and the promotion of the cultivation of Quality Protein Maize (QPM) and single cross maize hybrids.

Nepal

i. As Nepal is ecologically divided into two regions, the Tarai and the mountain (hill) areas, the government should also promote winter maize and soybean in the Tarai and to develop oilseeds, millet and other crops on the hill farms.

ii. The government should also monitor the developments in technology, products and prices so that the local farmers can benefit from Indian market trends, feedstuffs and feed crop inflows and prices.

iii. Another available alternative is to develop oilseeds, millets and other crops on the hill farms, which will require additional collaborative efforts from the government and research and development centres like the CGPRT Centre.

Pakistan

i. A more continuous and coordinated effort should be made for the development of high yielding, disease and drought resistant varieties of feed crops.

ii. There is a need to expand access to production loans and to strengthen the linkage of farm-producers and users of improved seeds with the patronage of government agencies. There is also a need to launch a program of breed improvement and availability of balanced feed and feeding systems.

iii. There is a need to expand production loans to a wider potential of farm customers and provide credit to farmers for storing their agricultural produce until it can fetch reasonable prices.

iv. There is a need to expand production of improved seeds through progressive seed growers, who would then supply their seeds to their fellow farmers.

v. Establishment of proper storage facilities by the private sector to ensure the maximum procurement of grains and subsequent supply to the consumers.

vi. The ruminant sector is still operating on the conventional system and needs to be commercialized. To increase livestock productivity, there is need to establish financially strong feed mills to provide balanced feed and technical know how to the farming communities.

Sri Lanka

i. To protect local raw material producers and feed millers, it is recommended that the present tax structure for maize imports be continued until the expected levels of local production are achieved within 3 to 5 years time.

ii. The production and distribution of potential hybrid varieties should be given to the private sector to reduce costs and delays.

iii. Promote the organization farmers into production blocks to increase productivity, arrange marketing through forward contracts, maintain the quality of products, have a well planned farmer education program with the help of extension services and other relevant agencies.

iv. Small-scale as well as medium-scale processing equipment must be popularized among growers and private sector manufacturers must be encouraged to produce such machinery.

v. Due to the high level of dependency on imported raw materials, mainly maize, the possibilities must be exploited to use other available local raw materials in the agricultural sector, which are either unutilized or under-utilized including feedstuffs such as rubber seed meal, fruit seeds, tea refuse, fish waste, jackfruit seeds and abattoir waste.

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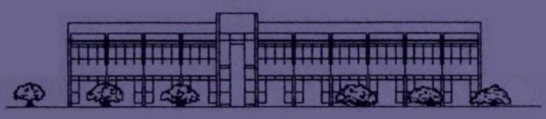

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