Economic and Social Commission for Asia and the Pacific

CAPSA WORKING PAPER No. 88

Identification of Pulling Factors for Enhancing the Sustainable Development of Agriculture with Special Reference to Maize in India

R.P. Singh
Ranjit Kumar
N.P. Singh

United Nations
ESCAP

UNESCAP-CAPSA

The Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific (CAPSA) is a subsidiary body of UNESCAP. It was established as 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) in 1981 and was renamed CAPSA in 2004.

Objectives

CAPSA promotes a more supportive policy environment in member countries to enhance the living conditions of rural poor populations in disadvantaged areas, particularly those who rely on secondary crop agriculture for their livelihood, and to promote research and development related to agriculture to alleviate poverty in the Asian and Pacific region.

Functions

1. Co-ordination of socio-economic and policy research on secondary crops.
2. Networking and partnership with other international organizations and key stakeholders.
3. Research and analysis of trends and opportunities with regard to improving the economic status of rural populations.
4. Production, packaging and dissemination of information and successful practices on poverty reduction.
5. Dissemination of information and good practices on poverty reduction measures.
6. Training of national personnel, particularly national scientists and policy analysts.
7. Advisory Services.

CAPSA Working Papers currently available:

Working Paper No. 87 *Secondary Crops Based Farming Systems and Their Integration with Processing and Marketing in Bangladesh*
by Jahangir Alam

Working Paper No. 86 *Enhancing Sustainable Development of Diverse Agriculture in Viet Nam*
by Dao The Anh, Le Duc Thinh and Vu Trong Binh

Working Paper No. 85 *Enhancing the Sustainable Development of Diverse Agriculture Through CGPRT Crops in Myanmar: Current Status of CGPRT Crop Agriculture and Identification of its Development Constraints*
by Aung Kyi

Working Paper No. 84 *Status and Prospects of Feed Crops in Thailand*
by Chamras Rojanasaroj, Siriporn Wonlertprayoon, Pachara Krittaphol, Wareeporn Phojeen, Panee Pattamawipak and Sopapan Ninragsa

Working Paper No. 83 *Enhancing Sustainable Development of Diverse Agriculture in Sri Lanka*
by A.R.M. Mahrouf

Working Paper No. 82 *Enhancing Sustainable Development of Diverse Agriculture in India*
by R.P. Singh, N.P. Singh and Ranjit Kumar

Working Paper No. 81 *The Status and Prospect of Feed Crops in Indonesia*
by Dewa K.S. Swastika, Made O.A. Manikmas, Bambang Sayaka and Ketut Kariyasa

(Continued on inside back cover)

Identification of Pulling Factors for Enhancing the Sustainable Development of Agriculture with Special Reference to Maize in India

"UNESCAP-CAPSA: Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific"

WORKING PAPER 88

Identification of Pulling Factors for Enhancing the Sustainable Development of Agriculture with Special Reference to Maize in India

R.P. Singh
Ranjit Kumar
N.P. Singh

UNESCAP-CAPSA
Centre for Alleviation of Poverty
through Secondary Crops' Development
in Asia and the Pacific

Table of Contents

List of Tables

List of Box

Page

List of Abbreviations

AGMARK	:	Agricultural Grading And Marketing Act
BPL	:	Below Poverty Line
BCR	:	Benefit Cost Ratio
CCA	:	Cultivable Command Area
CDS	:	Center for Development Studies
CES	:	Constant Elasticity of Substitution
CGPRT	:	Coarse Grains, Pulses, Roots and Tubers
DMI	:	Directorate of Marketing and Inspection
DSCR	:	Debt Service Coverage Ratio
FCI	:	Food Corporation of India
FHP	:	Farm Harvest Price
GCA	:	Gross Cropped Area
GDP	:	Gross Domestic Product
GIA	:	Gross Irrigated Area
GQ	:	Golden Quadrilateral
GR	:	Green Revolution
HA	:	Hectare
HYV	:	High Yielding Varieties
INR	:	Indian Rupee
IPM	:	Integrated Pest Management
IRR	:	Internal Rate of Return
IT	:	Information Technology
M. Ha	:	Million Hectares
MPCE	:	Monthly Per Capita Expenditure
MSP	:	Minimum Support Price
MT	:	Million Tons
NABARD	:	National Bank for Agricultural and Rural Development
NATP	:	National Agricultural Technology Project
NGO	:	Non-Government Organization
NH	:	National Highway
NHDP	:	National Highway Development Project
NIA	:	Net Irrigated Area
NIAM	:	National Institute of Agricultural Marketing
NPW	:	Net Present Worth
NSA	:	Net Sown Area
NSDP	:	Net State Domestic Product
NSSO	:	National Sample Survey Organization
PDS	:	Public Distribution System
PWD	:	Public Works Department
QPM	:	Quality Protein Maize
RBI	:	Reserve Bank of India
SPS	:	Sanitary and Phytosanitary Standards
T&V	:	Training & Visit
T/Ha	:	Tons/Hectare
TCIL	:	Telecommunications Consultants India Ltd.
TPD	:	Tons Per Day

UT	:	Union Territory
WFPR	:	Work Force Participation Rates
WHP	:	Wholesale Price
WTO	:	World Trade Organization

Foreword

Most Asian countries succeeded in multiplying major cereal production through the '*Green Revolution*'. This was made possible by the introduction of high yielding varieties and policy support which promoted the construction of irrigation facilities and the use of modern inputs such as chemical fertilizers and pesticides. Recently however, the growth in productivity of major cereals has reached a plateau. Agricultural diversification has a number of positive effects: among others, food security, risk mitigation, labour absorption and conservation of biodiversity. It is crucial to be aware of the driving forces and constraints to agricultural diversification to formulate policy options which realize the coexistence of sustainable agricultural development and poverty reduction in rural areas.

Responding to this vital need, UNESCAP-CAPSA conducted a three-year research project, "Identification of Pulling Factors for Enhancing the Sustainable Development of Diverse Agriculture in Selected Asian Countries (AGRIDIV)", from April 2003, in collaboration with eight participating countries, Bangladesh, India, Indonesia, Lao People's Democratic Republic, Myanmar, Sri Lanka, Thailand and Viet Nam.

It is my pleasure to publish "**Identification of Pulling Factors for Enhancing the Sustainable Development of Agriculture with Special Reference to Maize in India**" as a result of the second phase of the Indian country study of the project. This volume presents rural surveys and case studies to collect primary data to support policy recommendations to realize poverty alleviation through agricultural diversification.

I thank Dr. R.P. Singh for his effort. Continuous support from the Indian Agricultural Research Institute (IARI) is highly appreciated. Prof. Hitoshi Yonekura, Graduate School of Agricultural Science, Tohoku University, Mr. Tomohide Sugino and Dr. Parulian Hutagaol provided useful guidance at every stage of the study as Regional Advisor, Project Leader and Associate Project Leader respectively. I extend thanks to Mr. Matthew Burrows for his editing.

Finally I would like to express my sincere appreciation to the Japanese Government for its financial support of the project.

November 2005

J.W. Taco Bottema
Director
UNESCAP-CAPSA

Acknowledgements

The authors take this opportunity to place on record their sincere thanks to Dr. Mangala Rai, Secretary, DARE and Director General, ICAR for allowing us to conduct this study in collaboration with UNESCAP-CAPSA, Bogor, Indonesia. Our most humble and sincere thanks are to Dr. S. Nagarajan, Director and Dr. B.S. Parmar, Joint Director (Research), IARI for their encouragement and consistent support during this study.

Dr. J.W.T Bottema, Director, UNESCAP-CAPSA, Bogor, Indonesia deserves special thanks for providing an opportunity to collaborate and work with CAPSA. We are grateful to Mr. Tomohide Sugino, Project Leader, AGRIDIV project for providing all the necessary support to execute this study. We are equally indebted to Dr. M.P. Hutagaol, Associate Project Leader for reviewing the project findings. We are extremely grateful to the learned referee, who has given useful comments on the earlier draft of the study. Last, but not the least, we are equally thankful to all those who have helped directly or indirectly to enable me to produce this report.

R.P. Singh, Ranjit Kumar
and N.P. Singh
IARI, New Delhi

Executive Summary

India, since independence, has followed a policy of self-sufficiency in food production and undergone remarkable transformation. This may aptly be attributed to the sustained needs to feed the burgeoning population in the past, backed by the technological revolution largely referred to as the '*Green Revolution*'. The growth in agricultural production since the 1960s has come from a sustained rising trend in yields, with slight increases in area and thereby production. The conducive government initiatives in creating irrigation infrastructure, input delivery systems, and investment in agricultural research and extension services coupled with conducive price policy support has resulted in the transformation of the country from a perennial food importer to its current position of net exporter of rice and many other agricultural commodities, defying many predictions.

However, these transformations in Indian agriculture were biased towards finer cereals, mostly produced in favourable production environments, and have castled their ramifications on the coarse cereals, pulses, and oilseeds, predominantly grown in rainfed and marginal production areas, comprising nearly 70 per cent of the arable land in the country. This resulted in a sharp decline in the acreage of this sector, leaving just maize as an exception where an area of nearly 0.8 million hectares was added. In contrast, growth in agricultural production has slowed significantly in recent years. In the face of declining growth in agricultural productivity and the likely increases in future food demand, the potential sources of growth lie squarely on coarse grains particularly maize, which is now gaining commercial crop status due to its diversified end uses as food, feed and industrial uses.

It is in this context that five traditionally important maize growing states of India, namely, Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh were selected for study. These states account for almost 40 per cent of the total area under maize cultivation. Maize is one of the most important crops grown in the region next to fine cereals. Unemployment rates were found to be lower in rural areas of the study domain though the poverty was more rural in nature mainly due to disguised unemployment in the region. There were wide variations in incidence of poverty across the states selected for study. Infrastructural bottlenecks remained the major challenge before planners in fighting rural poverty and creating gainful employment for the growing workforce. As such, there is no provision for infrastructural development relevant specifically to CGPRT farming and industry. The agricultural development indicators were positive only for Punjab among the selected states.

Over exploitation of water, increasing use of fertilizers and injudicious cropping patterns in the post green revolution period have threatened sustainable production in some regions, especially the state of Punjab. The ramifications in the form of a depleted water table and the unsustainable level of balance of groundwater potential in states like Punjab and Rajasthan is quite evident. In contrast, CGPRT crops were found to be much more efficient users of water than other crops, but they still occupy only a minor share in the crop mix acreage.

The per capita operational holdings were much higher than that of the state average in most of the sampled households. The majority of the farmers were small farmers who cultivated mainly for the purpose of augmenting farm income and self-consumption. Maize cultivation as such is less labour intensive compared to other crops like paddy and wheat. However, labour utilization depends on its opportunity cost. Variations in labour use across the farms and cultivators also depended on worker-family size ratio. Though the farm yield increased with the cultivation of hybrid and composite varieties, still in many states such as Uttar Pradesh and Rajasthan, the farmers preferred to grow local or traditional varieties. This is true especially in cases where maize is used for home consumption.

It terms of the cost composition, expenditure on human labour was highest. The costs incurred on hybrid varieties were higher compared to that on local varieties but the revenue associated with the yield were also very high. Diversification in favour of maize production was mainly to reduce the risk associated with the yield and price fluctuations of other crops. This also had implications on employment generation and income augmentation. The majority of farmers across all categories fell under the 'low adoption' category that approximated to 54 per cent. In Bihar, Madhya Pradesh and Rajasthan more than 70-80 per cent were cultivating either the local variety or were not applying the recommended level. A look at input use efficiency indicated that the average technical efficiency among selected farmers was 61 per cent. Besides technology adoption bottlenecks, the institutional constraints identified were a lack of transportation facilities, insufficient supply of power, non-availability of quality seeds, shortage of fertilizer and untimely credit availability.

At the macro level, maize invariably gained substantial importance as feed and fodder. At present, India faces a 61 per cent net deficit in green fodder and 64 per cent in feeds, representing the scope for increasing the demand for maize as animal feed. Assessment of the marketing system showed that marketing and distribution channels depend on the type of market where the maize is being produced and marketed. In rural markets, with infrastructure not being so well developed, farmers depend mainly on traders and middlemen for marketing their products. The majority of the produce is sold in the local market in the absence any of agro-processing industry in the region.

Past agricultural price policies in India have been biased towards fine cereals compared to coarse cereals and support price increases have always favoured fine cereals, especially since the mid sixties. Credit support lacks accessibility and timely availability to small farmers. Current food diversification policies are aimed at increasing human consumption of coarse grains. Increases in income level have led to a shift away from consumption of coarse cereals. Growth in agricultural production has slowed significantly in recent years. In the face of declining growth in agricultural productivity and likely increases in future food demand, the potential sources of growth lie squarely on coarse grains, particularly maize, which is now gaining the status of a commercial crop due to its diversified end uses. Therefore, the crop deserves special attention.

Policy reforms brought about during the late 1980s started to encourage private investment in maize R&D and have provided wider options to the farmers for selecting cultivars. However, the neglect of the marginal production environment by both public and private sectors is a matter of great concern and policy makers should evolve the national maize R&D strategy. Although the adoption of high-yielding varieties of maize has been a key element to bring technological breakthroughs in the maize sector in the country, the maize growers in marginal production environments have not yet realized the benefits of technological advances in maize production. Keeping this in mind, policies should be aimed at interlinking the technological, economic and institutional support to the farmers of these areas.

Under the changing global scenario, economic policies need to be directed towards improving the trade competitiveness of maize vis-à-vis other crops. Besides, reduction in per unit cost of maize through increased productivity, improvements in market functionaries and infrastructure development to reduce the transaction costs are prerequisites to make Indian maize globally competitive, providing needed impetus for the effective canalizing of the produce to the various post-harvest uses in the form of setting up widespread mini or small-scale enterprises, even in the hinterlands. This will not only give incentives to the producers by way of commensurate prices, but will also smoothen the marketing and disposal of the produce.

The above policy options directed towards maize, grown predominantly in the resource poor and heavily populated regions, will aide in alleviating poverty and generate employment in maize-based agro industry. This will also bridge the widespread inequities in the region apart from arresting the degradation of resources arising from monocropping in the region.

1. Introduction

1.1 Findings of First Phase study

Agricultural growth in the past has been sufficient to move India from a severe food crisis to a state of aggregate food surplus today. Most of the development in agriculture has taken place in irrigated regions bypassing rainfed marginal environments. The rainfed regions are mostly dominated by CGPRT crops, i.e. coarse grains, pulses, roots and tubers. Barring maize and potato, CGPRT crops are loosing ground against the finer cereals, and the cash and commercial crops. Moreover, some of the coarse grains and pulses are nutritionally superior and increased productivity of this group will provide additional nutritional security.

Although the country has gained momentum in its economic fundamentals, the impact of development planning on the economic welfare of the people has not been equitable in the past. Due to an increasing total labour force and persistent marginalization of holdings, the number of landless labourers is on the rise and has grown to approximately 94 million and the average size of holdings fell to 1.41 hectares in 1999-2000 (GOI, 2003).

Recently, diversification has received some attention from all quarters. During the last three decades, the extent of diversification has been largely in favour of fine cereals and commercial crops, which has cast a shadow on coarse grains. The acreage under coarse grains has been taken away by more remunerative crops. Among the major states, Gujarat was observed to be highly diversified, while Uttar Pradesh to be the least diversified state in terms of cropping pattern. The Simpson Index (SID) for the country as a whole rose over the last two decades signifying the government's thrust towards diversification.

The share of coarse cereals and pulses in the gross cropped area (GCA) has come down to about 15 and 11 per cent respectively. Maharashtra, Rajasthan, Karnataka, Madhya Pradesh (MP), Uttar Pradesh (UP), Andhra Pradesh (AP) and Gujarat together occupy more than 80 per cent of the total area under CGPRT crops in the country. Maize and chickpea have shown robust growth in production during the post-GR period. Pulses are facing great difficulty in expanding acreage mainly due to highly unstable yield performance. Only 12-13 per cent of cultivated area under CGPRT crops receives irrigation. Potato being a cash crop has almost 100 per cent irrigated area. During the last three decades, the drop in per capita consumption of coarse cereals is almost two thirds. CGPRT crops contributed 12 per cent of the total consumption basket in rural areas and only 8 per cent in urban areas. In many states, farm harvest price (FHP) was higher than wholesale price (WHP), which shows the fragile market behaviour of these commodities in the market due to low demand as well as inter-state trade. Further, minimum support prices for these crops do not have much relevance in the country. Thus, this study calls for a level playing field to be provided to CGPRT crops for equitable growth in Indian agriculture and diversification of the rural economy should receive higher priority to meet the twin objective of eradicating poverty and unemployment.

1.2 Research issues

Indian agriculture is highly diversified both in terms of the production environment and activities. However, despite a rapid increase in livestock production, the crop sector still contributes 75 per cent to the total value of agricultural output. Overall agricultural achievements in the country are impressive, with increased per capita food production and accumulating food stocks. Despite these successes, the country faces a few major unfinished agendas. First, success in reducing poverty and malnutrition, most of which is located in rural

areas, particularly in north and eastern parts of the country, is a continuing challenge. Secondly, sustainable management and the use of natural resources is a growing challenge with depletion of groundwater, agrochemical pollution, and land degradation due to water-logging, salinity, soil erosion, and deterioration of soil fertility. These all attract the attention of researchers and policy makers to reorient production and policy strategies towards more nutritive food production which also has less negative externalities on the local environments.

1.3 Study objectives

1. Identify and prioritize constraints and accelerators of agricultural diversification and promotion of selected promising CGPRT crops, i.e. maize.
2. Status and prospects for increasing the consumption of selected CGPRT products.
3. Prospects of selected CGPRT crops and their value addition under economic globalization. Role of public and private sectors.
4. Agricultural diversification and its impact on the rural economy, welfare and environment.
5. Analysis of government policies, institutional arrangements and local factors that determine the use of selected CGPRT crops for agricultural processing.
6. Strategic policies for the sustainable development of diversified agriculture.

1.4 Scope of the study

- The study focus is on crops, which have multiple uses and vast potential in terms of productivity enhancement. Among all the CGPRT crops, maize holds special status being used as animal feed, industrial raw materials as well as being the staple food of a large proportion of the population in India.
- The project will result in a better understanding of the dynamics and future trends of maize production, its utilization and its role in future goals of achieving farm diversification.
- The potential, weaknesses, opportunities and constraints for expanding maize based cropping patterns in India will be clearly understood.
- It will help in formulating strategies and policy options for the development and promotion of sustainable farming options in India.

2. Conceptual Framework and Methodology

2.1 Conceptual framework

The central hypothesis of this study is that the opportunities and constraints for the sustainable development of agriculture depend upon the comparative advantages that exist in a particular location. For example, opportunities for the development of high-value perishable commodities, such as horticultural crops or dairy, are likely to be greatest in areas with relatively high market access and agricultural potential. In such areas, investment in appropriate forms of infrastructure (e.g. irrigation, roads), human capital, and institutions may yield high social returns and facilitate a process of sustainable development. Diversification is an integral part of the process of structural transformation of an economy. Within agriculture and particularly within the crop mix, the so called 'superior cereals' like wheat and rice progress faster compared to the 'inferior cereals' (e.g. sorghum, pearl millet or minor cereals). However, the factors prompting diversification and with the speed at which the changes occur vary in different situations. Where the natural resources and agro-climatic conditions do not support the high-value crops, diversification of the production system towards CGPRT crops would provide better sources of livelihood. Since many CGPRT crops have several industrial uses, the development of synergy between crop production and industry would further boost the income and employment generation conditions for the rural poor.

2.1.1 Rationale for diversification

Diversification of Indian agriculture is taking place as the area under commercial crops, has more than doubled since the 1960s. Among the food crops the area under superior cereals, i.e. wheat and rice, is increasing and that under the inferior cereals is declining. There are four major points which argue for agricultural diversification: (i) it is imperative to increase the income in the smallholdings; (ii) the need for fuller employment in the farm households; (iii) stabilization of farm income over the seasons; and (iv) conservation and enhancement of natural resources.

Keeping in mind the dominance of the marginal and small farmers in terms of their numbers as well as their small operational holdings (they operate about 40 per cent of the cultivated land area with operational holdings of less than 1.5 ha), the poverty of a large number of rural households could be eradicated with just the introduction of high-value crops on these holdings (Vyas, 1996). There is the equally important consideration of fuller employment for the rural workforce. To ensure fuller employment to the existing and growing labour force in the countryside there is a need to have more labour intensive enterprises. On both these counts, some CGPRT crops like sorghum, maize, and pulses, fit very well into the picture. These crops have a very high potential of diversified uses and if the necessary parastatals for value addition are created in rural areas, the income and employment scenario would significantly improve.

Furthermore, most CGPRT crops demand less inputs; they require less fertilizer, irrigation water and other agro-chemicals required for the cultivation of other high-value crops or fine cereals. The high doses of these inputs have created havoc in many parts of the country in terms of soil salinity, increasing resistance of pests to the chemicals, and damage to beneficial insects like natural pollinators. Thus, providing sufficient space to CGPRT crops would have long-term positive effects on the environment. The case for an accelerated pace of diversification is quite strong to meet the objectives of higher income and employment, stabilization of incomes and conservation of natural resources. This can only be achieved if

concerted efforts are made on three fronts: technological development, economic reforms and institutional change.

2.2 Research methodology

2.2.1 Selection of crops

Maize has purposively been selected for the study because of its widespread acceptability among all the CGPRT crops. In India, maize is emerging as the third most important crop after rice and wheat. The significance of maize as a source of a large number of industrial products besides its uses as human food and animal feed additionally make it an emerging cereal crop of increasing importance. Structural changes in consumption patterns coupled with rising per capita income, continue to boost demand for livestock and poultry products which, in turn, lead to increases in the demand for maize as feed. At the global level, the demand for maize is undoubtedly going to increase. India has competitive advantage in maize production in the international market with the nominal protection coefficient remaining below one (Chand, 1999). Maize is grown on about 7.45 million hectares of land in the country with an average grain yield of 1,983 kg/ha.

2.2.2 Selection of research sites

Maize was traditionally grown in the regions of the Indo-Gangetic Plains of India. However, over the years, the yield of this crop remained stagnant and the cultivated area in some states even declined. For this study, five states namely, Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh have been selected (Table 2.1). From each selected state, the three largest maize growing districts were purposively selected. From each district, two blocks and from each block, a cluster of 2-3 villages were randomly selected. From each cluster, 50 maize growers were randomly selected. Moreover, the information for the study was heavily drawn from the data collected in an NATP project, "Technological Change and Production Performance in Maize-based Irrigated Agro-ecosystem: The Interplay of Economic, Technological and Institutional Factors" recently completed at IARI, New Delhi. The specific information required for the study was collected using PRA technique for the study.

2.2.3 Selection of respondents

As discussed earlier, from each of the selected districts of the five traditional maize growing states, 100 maize growing farmers were randomly selected irrespective of their landholdings. The only criteria for selection was that the farmer had been cultivating maize for at least the previous two years. Therefore, the total sample size for the study was 1,500 farmers.

2.2.4 Timeframe of the study

The study mainly pertains to the agricultural year 2004-2005. The primary data at the farm level from the selected five states was collected during this period. Except in Bihar, maize is grown in most selected states during the rainy season. In Bihar, winter maize is also very popular and in fact more rewarding than the rainy season crop. Therefore, the information regarding maize production has been collected for both the specific period in Bihar and for the rainy season in other states.

Table 2.1 Sample design for farm survey in maize growing states of India

State	District	Block	No. of sample farmers
Bihar	Begusarai	Begusarai, Barauni	100
	Vaishali	Patepur, Goraul	100
	Samastipur	Jitwarpur, Bibhutipur	100
Madhya Pradesh	Chindwara	Chindwara, Chourai	100
	Shahdol	Sohagpur, Pushparajgarh	100
	Mandsaur	Sitamau, Garoth	100
Punjab	Jalandhar	Adampur, Bhogpur	100
	Hoshiarpur	Hoshiarpur I, Hoshiarpur II	100
	Patiala	Dera Bassi, Rajpura	100
Rajasthan	Banswara	Banswara, Ghatol	100
	Chittorgarh	Chittorgarh, Kapasan	100
	Bhilwara	Bhilwara, Mandalgarh	100
Uttar Pradesh	Bulandsahar	Skiandrabad, Danpur	100
	Baharaich	Fakhapur, Tejwapur	100
	Jaunpur	Dharmapur, Bakhsa	100
Total			1 500

2.2.5 Methods of analysis

The results of the study are mainly based on tabular analysis using simple statistical methods like arithmetic mean and standard deviation. However, to know the adoption pattern of improved technologies and the efficiency level of the maize producers, the technology adoption index and technical efficiency have been estimated.

Adoption index

The technology adoption index is a catch-all measure of technology adoption practices of the farmers. The technology adoption practices include area under high yielding varieties (HYVs), appropriateness of irrigation level and dosage of fertilizers. The technology adoption index has been computed as follows:

$$TAI_i = \frac{1}{5}\left[\frac{AH_i}{CA_i} + \frac{NA_i}{NR_i} + \frac{PA_i}{PR_i} + \frac{IA_i}{IR_i} + \frac{KA_i}{KR_i}\right] \times 100$$

Where;

i = Number of farmers, say 1,2,3, …, n.
TAI_i = Technology Adoption Index of i^{th} farmer
AH_i = Area under modern maize varieties (ha)
CA_i = Total area of maize (ha)
NA_i = Quantity of nitrogen applied for maize (kg/ha)
NR_i = Recommended dose of nitrogen of maize crop (kg/ha)
PA_i = Quantity of phosphorous applied for maize (kg/ha)
PR_i = Recommended dose of phosphorous of maize crop (kg/ha)
IA_i = Actual number of irrigations applied
IR_i = Recommended number of irrigations
KA_i = Actual amount of potash applied for maize (kg/ha)
KR_i = Recommended amount of potash applied for maize (kg/ha)

The index was used to analyse the adoption level of maize growing farmers.

Estimation of technical efficiency- frontier production function

Stochastic frontier production function is being widely used to estimate technical efficiency (Russel and Young, 1983). The stochastic frontier production function is as follows:

$$Y_i = f(x_i ; \beta_i) \exp(v_i - u_i)$$

Where;

Y_i is the possible production level of the i^{th} firm, $f(x_i ; \beta_i)$ is the suitable functional form (e.g. Cobb-Douglas, CES or Translog) of the vector of inputs (X_i) and vector of unknown parameters β_i. v_i is distributed randomly and a symmetrical, two-sided error term, $v \sim N(0, \sigma_v^2)$, captures the effects of random shocks outside the farmers control, i.e. observation and measurement error, and other statistical noise. Thus, v allows the frontier to vary across farms, or over time for the same farm, and therefore the frontier is stochastic. u_i is a distributed half-normal, one-sided error term, $u \sim N(0, \sigma_u^2)$, that captures deviations from the frontier due to inequality. Both u_i and v_i are independent of each other. The technical efficiency (TE) of an individual farm is defined as the ratio of the observed output (Y_i) to the corresponding frontier output f(.), conditional on the levels of inputs used on farm. Thus,

$$TE = Y_i / f(x_i ; \beta_i) = \exp(v_i - u_i)$$

Note that $(v_i - u_i)$ is zero when the farm produces the potential output (full TE) and is greater than zero when production is below the frontier (less than full TE). Mean technical efficiency is measured by taking the average of the efficiency of all the sample households.

2.3 Measurement of technical efficiency

2.3.1 Specification of the model

The stochastic frontier production function has been specified as follows:

$$\ln y_i = \beta_{i1} + \beta_{i2} \ln L + \beta_{i3} \ln F + \beta_{i4} K + v_i - u_i \qquad i = 1, 2 \ldots n$$

Where;

y_i = Yield of maize in the i^{th} farm (q/ha)
L = Human labour use in maize crop (man days per ha)
F = Quantity of fertilizer (N + P + K) used (kilograms/ha) on the maize crop
K = Capital which includes overhead expenditure on animal and machine labour, seeds and pesticides (INR/ha)
$v_i - u_i$ = The random error term
n = Number of farms growing maize

The maximum likelihood estimation (MLE) method was used to provide estimates of the stochastic frontier production function equation.

3. Profiles of the Study Site, the Respondents and Their Households

3.1 Profiles of the study site

3.1.1 Geographic and administrative settings

Five states namely Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh have been selected for the study. These are traditional maize growing states in India. In terms of geographical area as well as population, some of these states like Madhya Pradesh, Rajasthan and Uttar Pradesh are the largest states in the country in one or another way. These five states have more than one-third of the total number of districts in the country (Table 3.1).

Table 3.1 Geographical and administrative settings of maize growing states in India

States	Geographical area (sq km)	Number of administrative districts	Total population in millions
Bihar	94 163 (2.86)	37	82 879 (8.07)
Madhya Pradesh	308 000 (9.37)	45	60 385 (5.88)
Punjab	50 362 (1.53)	17	24 289 (2.37)
Rajasthan	342 239 (10.41)	32	56 473 (5.50)
Uttar Pradesh	238 566 (7.26)	70	166 053 (16.17)
India	**3 287 263 (100)**	**629**	**1 027.015 (100)**

Source: India, 2003.
Figures within parentheses are percentage of India.

The five selected states played very important roles in addressing the food security concerns in the country. Currently, Uttar Pradesh and Punjab are the first and second largest food grain producing states in the country with a contribution of about 21 and 14 per cent respectively in total food grain production (Agricultural Statistics at a Glance, 2004). Similarly, Madhya Pradesh is the largest maize as well as pulse producing state in the country. The state accounts for about 15 per cent of total maize and 20 per cent of total pulse production in India. Bihar has the largest area under winter maize and the growth has been phenomenal. Rajasthan is the third largest oilseed producing state with the highest production of rapeseed and mustard.

It may be observed from Table 3.2 that three out of the five selected states have significant net sown area (NSA) as well as gross cropped area (GCA). These three states are Madhya Pradesh, Rajasthan and Uttar Pradesh, each of which has about 11-12 per cent of NSA and 10-13 per cent of GCA of the country. Punjab has only 3 per cent of NSA while Bihar has 5 per cent. GCA in these two states is also of the same order. Oppositely, there is a huge difference in irrigated area, which varies from above 90 per cent of GCA in Punjab and about 70 per cent of GCA in Uttar Pradesh to merely 19 per cent in Madhya Pradesh.

Table 3.2 Land use statistics of selected maize growing states in India (thousand hectares)

Particulars	Bihar		Madhya Pradesh		Punjab		Rajasthan		Uttar Pradesh		India	
	1992-1993	1999-2000	1992-1993	1999-2000	1992-1993	1999-2000	1992-1993	1999-2000	1992-1993	1999-2000	1992-1993	1999-00
Forested land	2 949	1 930	8 217	8 613	287	305	2 394	2 580	1 690	1 714	68 067	69 024
Land not available for cultivation	3 171	3 440	3 388	3 200	488	394	4 376	4 305	3 048	3 025	41 161	42 407
Other uncultivated land excluding fallows	786	771	3 067	2 843	34	46	7 140	6 716	1 104	968	29 609	28 486
Fallow land	3 261	2 734	1 191	1 024	85	49	3 404	5 148	1 928	1 692	23 559	24 906
Net sown area	7 162	7 437	14 871	15 070	4 139	4 238	16 939	15 509	16 476	16 801	142 509	141 231
Gross cropped area	9 356	9 979	18 268	20 419	7 552	8 240	20 167	19 286	24 400	24 903	185 487	189 740
Area under food grains [a]	63.15	40.89	53.34	61.30	75.36	75.92	63.65	56.75	79.49	80.36	66.39	64.88
Area under non-food grains [a]	16.08	59.86	46.66	38.70	24.64	24.08	36.35	43.25	20.52	19.64	33.61	35.12
Net irrigated area [a]	35.75	36.90	20.34	27.72	51.13	48.59	22.17	29.10	46.40	50.96	27.12	30.17
Gross irrigated area [a]	43.18	47.62	20.99	18.46	94.58	90.86	27.20	35.95	65.56	70.98	35.99	40.23

Source: Centre for Monitoring Indian Economy, 2004.
[a] Figures are in per cent of Gross Cropped Area.

Table 3.3 Demographic features of selected maize growing states of India

State	Population density, 2001 (No. of persons/sq km)	Population (%)				Literacy [a] (%)		Workforce (%)		
		Rural		Urban						
		Male	Female	Male	Female	Rural	Urban	Cultivator	Agricultural labourers	Others
Bihar	880	46.47	43.06	5.60	4.87	33.83	67.89	38.42	42.08	19.50
Madhya Pradesh	196	39.59	37.99	11.79	10.64	35.87	70.81	58.28	25.77	15.95
Punjab	482	35.00	31.06	18.37	15.57	52.77	72.08	23.76	16.97	59.27
Rajasthan	165	39.66	36.96	12.37	11.01	30.37	65.33	55.37	10.63	34.00
Uttar Pradesh	689	41.66	36.81	10.44	11.09	36.66	61.00	53.27	18.93	27.80
India	324	37.11	35.10	14.62	13.17	44.70	73.10	31.70	26.70	41.60

Source: Statistical Abstract of Various States, 2001-2002.
[a] Census of India, 1991 n.a. = not available.

3.1.2 Demographic profile

Demographic features of the selected states are given in Table 3.3. It was observed that the population density in Bihar, Uttar Pradesh and Punjab is much higher than the country average of 324 persons per sq km. While in the other two states, the density is sparse. In India, more than 70 per cent of the total population still resides in rural areas. In Bihar state, the share of rural population even exceeds 89 per cent followed by 78.47 per cent in Uttar Pradesh, 77.58 per cent in Madhya Pradesh, 76.62 per cent in Rajasthan and 66 per cent in Punjab.

Literacy and education are reasonably good indicators of development in a society. Since the literacy rate is more meaningful if the sub-population in the age group zero to six is excluded from the total population, it was decided in 1991 to use the term literacy rate for the population relating to seven years and above. The literacy rate for the country as a whole as of 2001 (Census, 2001) is 65.38 per cent for the population aged seven years and over. The corresponding figures for males and females are 75.85 and 54.16 per cent respectively. Thus, three quarters of the male and more than half of the female population aged seven years and above are literate in the country today. India has continued its inexorable march towards improving its literacy rate by recording a jump of 13.17 per cent from 52.21 in 1991 to 65.38 in 2001. The rural-urban divide continues to be wide. As is evident from Table 3.3, the literacy rate in rural areas of all the selected states were almost half of the literacy rate in urban areas. This creates significant disadvantages to the rural populace.

3.1.3 Economic profile

Per capita income is, if not solely, one of the most important indicators of economic development for any economy. In this context, the Indian economy has grown well over the years. It can be seen from Table 3.4a that per capita income in all selected states, except Punjab, has remained below the Indian average. Nevertheless, it has increased in all states, except in Bihar, 10 times over the last two decades. There have been regional disparities in terms of economic development across the states. Growth in per capita income varied from 6.96 per cent in Bihar to 12.30 per cent per annum in Rajasthan.

Table 3.4a Growth in per capita income in terms of NSDP in selected states

State	Per capita income at current prices (INR/annum)				Growth rate, % per annum (1990-2001)
	1980-1981	1990-1991	1995-1996	2001-2002	
Bihar	917	2 665	3 041	5 445	6.96
Madhya Pradesh	1 358	4 049	7 809	12 027	11.18
Punjab	2 674	8 318	15 471	25 248	10.63
Rajasthan	1 222	4 191	8 467	13 738	12.30
Uttar Pradesh	1 278	3 590	6 331	9 753	9.92
All India [a]	1 741	5 365	10 149	17 823	12.08

Source: Economic Survey, 2004-2005.
[a] Per capita Net National Product.

Distribution of population across different monthly per capita expenditure (MPCE) gives an idea about income distribution in a society. To ascertain the economic development of the people, it is necessary to investigate how the gains of economic growth have been distributed. Per capita household expenditure collated from the 55th Round of the National Sample Survey (NSS) explains clearly the trend and pattern of expenditure behaviour as income increases in the selected states. It may be ascertained from Table 3.4b that at a state level, the percentage of persons in the rural sector below the MPCE level of INR 255 ranged from 0 per cent in Punjab to 19 per cent in Madhya Pradesh. For the urban sector the percentage of persons below INR 350 is high in Bihar (26 per cent), UP (19 per cent) and Madhya Pradesh (16 per cent) and low in Punjab (3 per cent) and Rajasthan (5.7 per cent). The percentage of the population with MPCE in rural areas exceeding INR 775 ranged from 3 per cent (Bihar) to 33 per cent (Punjab). The figure in the

high MPCE group exceeding INR 1,500 in the urban sector is maximum in Punjab (11 per cent) and lowest in Bihar (4 per cent). However, the range of variation in the urban sector was much narrower.

Table 3.4b Distribution of population across different monthly expenditure (Percentage of population)

MPCE / State	Rural		Urban	
	< INR 255	> INR 775	< INR 350	> INR 1 500
Bihar	16.3	2.7	26.4	4.0
Madhya Pradesh	19.3	4.6	16.3	4.9
Punjab	0.6	33.4	2.9	10.5
Rajasthan	2.2	11.6	5.7	7.5
Uttar Pradesh	9.5	7.9	18.7	5.8
All India	10.2	10.0	10.2	10.0

Source: NSSO, 1999-2000.

Agriculture has been the mainstay of the Indian economy for many years and still provides livelihoods for a large proportion of the rural population in the country. Although the contribution of this sector (primary) has grown over the years, its share in the national economy has declined. This is mainly due to faster growth in secondary and tertiary sectors. Among the selected states, sectoral changes are more prominent in Bihar, Punjab and Uttar Pradesh (Table 3.4c). In Bihar, the share of agriculture in NSDP has declined to below 30 per cent and that of manufacturing and trade, hotels and restaurants have marginally increased. This may be due to the low priority given to the agricultural sector in the state and therefore, a lot of the workforce are leaving agricultural operations and moving to other states/cities in search of better job opportunities. Among all the selected states, agriculture is most prominent in Punjab, which contributes more than 40 per cent to the NSDP.

Table 3.4c Share of different sectors in the Net State Domestic Product (NSDP) of selected states in India at current prices (Percentage)

Sector	Bihar		MP		Punjab		Rajasthan		UP	
	1993-1994	1999-2000	1993-1994	1998-1999	1993-1994	1998-1999	1993-1994	1999-2000	1993-1994	1999-2000
Agricultural	38.01	29.65	36.28	33.11	47.93	42.92	33.02	33.59	40.1	35.74
Forestry and logging	2.17	1.55	2.92	2.86	0.14	0.23	1.98	1.67	1.8	1.2
Fishing	1.34	1.62	0.19	0.38	0.19	0.29	0.11	0.07	0.43	0.33
Mining and quarrying	6.15	3.62	4.05	3.3	0.01	0.01	1.93	2.13	0.67	0.75
Manufacturing	11.28	13.73	13.56	14.76	14.45	13.22	11.18	7.35	12.91	15.26
Construction	4.34	3.87	5.5	6.19	4.65	6.24	9.75	10.32	4.73	5.23
Electricity, gas and water supply	0.91	1.06	2.32	2.03	0.9	1.66	2.32	1.58	1.51	2.08
Transport, storage and communication	3.86	5.45	4.64	5.2	2.45	3.52	4.22	5.56	4.27	4.34
Trade, hotels and restaurants	13.83	17.44	13.07	12.96	13.12	11.42	14.39	12.8	14.12	15.47
Banking and insurance	2.48	4.01	2.3	3.5	3.49	5.29	3.22	4.21	2.88	3.74
Real estate, ownership of dwellings and business services	2.62	2.45	5.82	5.05	4.19	3.17	6.23	4.31	5.81	3.76
Public administration	5.64	5.82	3.34	3.69	3.86	5.26	3.9	5.82	4.22	4.88
Other services	7.37	9.73	6.01	6.97	4.62	6.78	7.73	10.6	6.56	7.23
State domestic product (INR million)	100 (342 016)	100 (627 589)	100 (466 469)	100 (789 463)	100 (270 766)	100 (479 002)	100 (290 603)	100 (586 497)	100 (777 850)	100 (1 646 296)
State per capita income (INR)	**3 810**	**6 328**	**6 645**	**10 147**	**12 714**	**20 463**	**6 200**	**11 030**	**5 258**	**9 765**

Source: Central Statistical Organization.

3.1.4 Agricultural profile

The agro-climatic features of any region provide a general perception about the suitability of that region for crop production. This includes information about annual rainfall, temperature, topography and soil type. In this context, the states under study look, agriculturally, one of the most fertile regions in the country. Most of these states are endowed with highly productive alluvial/ loamy soils, rich in groundwater and/or surface irrigation water, and favourable climatic conditions (Table 3.5). With the topography of these states being plains, there is less probability of natural resource degradation through natural processes like wind erosion and water erosion.

Table 3.5 Agro-climatic features of the selected states in India

District	Average Rainfall (mm)	Temp. range (0^0 C)		Topography	Soil type and texture
		Kharif (July-Oct.)	Rabi (Nov.-Apr.)		
Bihar	1 284	27- 42	6-34	Plains	Alluvial, sandy loam
Madhya Pradesh	800	16-46	4-34	Undulating, Plains	Loamy to clayey, sandy loam
Punjab	497	34-45	4-35	Undulating, Plains	Loamy sand, sandy loam, calcareous and clay loam
Rajasthan	825	21-35	8-35	Plains, Hilly	Sandy loam to clay loam
Uttar Pradesh	1 057	28-39	29-34	Plains	Alluvial, sandy loam, calcareous, clay loam

Source: Statistical Abstract of the selected states.
Note: Kharif - Rainy Season, Rabi - Winter Season.

The population density in states like Bihar and Uttar Pradesh are too high, and besides the large dependency of the rural population on agriculture, the number of landholdings in these states is too high. This has resulted in an uneconomically small size of holding (less than 1 ha) compared to other developing/developed countries. The national average holding size is also very small, *viz.* 1.41 hectares (Table 3.6). Similarly, although these states have favourable agro-climatic conditions, except in Punjab, cropping intensity is low with a national average of 134 per cent. Maize occupies about 2-6 per cent of the total cropped area in these states.

Fertilizer consumption (N+P+K) in India has grown over the years but still remains low compared to other countries. Fertilizer consumption per hectare in India is less than 100 kg, it is 271 kg in China, 110 kg in USA and 104 kg is the world average (Fertilizer Statistics, 2002-2003). Across selected states there is huge variability in fertilizer consumption as farmers of Punjab apply 177 kg/ha of N+P+K, while it is as low as 39 and 46 kg/ha in Rajasthan and Madhya Pradesh respectively.

Irrigation has played a very important role in agricultural transformation in the country. This is why there has always been emphasis on irrigation projects in the plans of the past. However, recently, such focused attention has been diverted and slowly but surely support from the public sector in this area is declining, which can easily be felt from the increasing dependency on groundwater for irrigation. Even in states like Bihar, where there is enough surface water, more than 42 per cent of the net sown area is irrigated by groundwater, which is as high as 64 per cent in Punjab. Such trends have resulted in long-term repercussions in terms of water shortages in rural areas for just drinking purposes for 3-4 months each year. At the national level, 26 per cent of net cultivated area is irrigated by groundwater and 15 per cent by surface water.

During the past three and half decades, 29 million hectares of land have been added to the gross cropped area (GCA) of the country (Table 3.7a) which is a gain of almost 18 per cent. However, this gain has not benefited all crops equally. In fact, most of the millets and pulses have been pushed aside. The major gainers in this transformation were wheat, rice, oilseeds, horticultural crops and maize to some extent. The area under maize has grown marginally, by 0.35 per cent (Table 3.7b). In many traditional growing states, the area under this crop has

eventually declined. Another major concern is the declining GCA in Bihar state, which needs to be seriously looked into.

Table 3.6 General profile of agriculture in the selected states in India

State	No. of landholdings (million no.)	Average size of holding (ha)	Total cropped area (million ha)	Cropping intensity (%)	Fertilizer consumption (kg/ha)	Percentage of net sown area irrigated	
						Surface water	Groundwater
Bihar [a]	18.91	0.79	17.63	152	98.40	19.90	42.20
Madhya Pradesh	9.60	2.30	20.53	136	46.33	7.52	30.04
Punjab	0.21	2.03	7.94	188	177.18	30.58	63.90
Rajasthan	5.36	3.96	18.14	124	39.27	10.94	25.25
Uttar Pradesh [b]	20.07	0.90	26.88	149	118.16	17.95	50.64
India	115.58	1.41	189.74	134	95.23	14.66	25.87

Source: Statistical Abstract of Various States, 2001-2002.
[a] Statistical Abstracts Bihar, 1991.
[b] Statistical Abstract Uttar Pradesh, 1996.

Table 3.7a Changes in area under different crops during 1966-1968 to 1999-2000 in selected states (thousand hectares)

States	Maize	Rice	Wheat	Other millets	Barley	Pulses	Oilseeds	Fruits and vegetables	GCA
Bihar	-93	151	512	-74	-117	-128	-11	84	(-) 61
MP	291	313	743	-1 561	-105	302	-518	110	6 151
Punjab	-391	2 015	1 076	-148	-111	-382	-268	66	2 543
Rajasthan	213	31	797	-309	-509	-2 989	1 299	69	5 240
UP	-505	1 555	3 495	-734	-933	-1 100	194	559	3 745
India	572	6 102	7 364	-13 165	-2 055	-2 436	6 290	4 254	29 320

Source: Centre for Monitoring Indian Economy, Agriculture, February 2004.

Table 3.7b Changes in share of different crops in gross cropped area during 1966-1968 to 1999-2000 in selected states (Percentage)

States	Maize	Rice	Wheat	Other millets	Barley	Pulses	Oilseeds	Fruits and vegetables	GCA
Bihar	-0.85	1.38	4.67	-0.67	-1.07	-1.17	-0.10	0.76	(-) 0.59
MP	1.38	1.49	3.53	-7.42	-0.50	1.44	-2.46	0.53	31.86
Punjab	-6.46	33.27	17.75	-2.44	-1.83	-6.31	-4.43	1.08	47.98
Rajasthan	1.26	0.18	4.71	-1.82	-3.01	-17.66	7.68	0.40	33.90
UP	-2.20	6.77	15.22	-3.20	-4.06	-4.79	0.84	2.43	16.73
India	0.35	3.69	4.45	-7.96	-1.24	-1.47	3.80	2.57	18.29

Source: Centre for Monitoring Indian Economy, Agriculture, February 2004.

3.1.5 Extent of unemployment and poverty in selected maize growing states of India, 1999-2000

The National Sample Survey Organization (NSSO) carries out all-India household surveys on employment and unemployment with a large sample usually once every five years. The sixth such survey was conducted in the 55th Round (July 1999-June 2000). The previous five quinquennial surveys were conducted during the 27th (October 1972-September 1973), the 32nd (July 1977-June 1978), the 38th (January-December 1983), the 43rd (July 1987-June 1988) and the 50th (July 1993-June 1994) rounds. The estimates of employment and unemployment are measured in terms of 3 basic approaches, namely Usual Status, Current Weekly Status and Current Daily Status. In this study we mainly refer to 'usual status' approach for studying the unemployment scenario.

Box 3.1 National Sample Survey Organization

The National Sample Survey Organization collects data on the characteristics of Labour Force (Employed and Unemployed) through various rounds of the NSSO. Since 1972-1973 the survey on employment - unemployment has become a part of the quinquennial programme of NSSO surveys.

The persons surveyed are classified into various activity categories on the basis of activities pursued during certain specified reference periods as Usual Status, Current Weekly Status and Current Daily Status. These are defined as under:

a) Usual Status: A person is considered working or employed if the person was engaged for a relatively longer period in any one or more work related (economic) activity during the reference period of 365 days preceding the date of survey.

b) Current Weekly Status: A person is considered working or employed if the person was engaged for at least one hour on any one day on any work related (economic) activity during the reference period of seven days preceding the date of survey.

c) Current Daily Status: A person is considered working for the entire day if he had worked four hours or more on any day of the reference week preceding the date of survey.

The persons surveyed are also classified into different activity categories on the basis of time spent: If a person spent relatively more time during the preceding 365 days in an activity it is considered as the Principal Usual Status activity of the person. If a person who is a non-worker but pursued some economic activity in a subsidiary capacity is called Subsidiary Status employed. The Principal Status and Subsidiary Status activities form the Usual Status activity of a person.

To study the regional disparities in the usual status work force participation rates (WFPR), the estimates based on the 55th Round results on usual status worker-population ratios in terms of 'principal status' and also 'principal as well as the subsidiary status taken together' are presented in Table 3.8. It can be observed that not much change occurs in the employment scenario for male persons over the years in rural or urban areas.

Table 3.8 Persons employed according to usual status in India (Percentage of workforce)

Round	Rural			Urban			All		
(Year)	M	F	P	M	F	P	M	F	P
55th round (1999-2000)	53.1	29.9	41.7	51.8	13.9	33.7	52.7	25.9	39.7
50th round (1993-1994)	55.3	32.8	44.4	52.1	15.5	34.7	54.5	28.6	42.0
43rd round (1987-1988)	53.9	32.3	43.4	50.6	15.2	33.7	53.1	28.5	41.2
38th round (1983)	54.7	34.0	44.5	51.2	15.1	34.0	53.8	21.6	42.0

Source: NSSO reports of various rounds.
M= Male, F= Female, P= Person.

There was a slight decline in population growth between the periods 1983-1993/1994 and 1993/1994-1999/2000 from 2.0 per cent per annum to 1.9 per cent (Table 3.9). Though growth of output in the economy accelerated between these two periods: from 5.2 per cent gross domestic product (GDP) growth to 6.7 per cent, the pace of employment growth slowed from 2.7 per cent to 1.07 per cent. There has been a rise in unemployment across the country. The situation is particularly grim in rural areas, where employment growth has collapsed following cut backs on rural development expenditure.

The Tenth Plan visualizes that even with as high growth as 8 per cent, the objective of providing employment opportunities to all additional labour force will not be achieved; as the growth in labour force has always remained higher than the growth in workforce. This may add to the base period stock unemployment of 34.85 million and will give an unemployment rate of 9.79 per cent at the end of the Tenth Plan, an increase from 9.21 per cent at the base. This arises largely due to the near jobless growth characteristic in many sectors of the economy, especially in the organized sector, and a growing capital intensity in many of the organized sectors and even in some of the unorganized sectors including small-scale industries.

Table 3.9 Employment and unemployment scenario in India on CDS basis

	Persons (million)			Growth per annum (%)	
	1983	1993-1994	1999-2000	1983 to 1993-1994	1993-1994 to 1999-2000
All India					
Population	718.20	894.01	1003.97	2.00	1.95
Labour force	261.33	335.97	363.33	2.43	1.31
Workforce	239.57	315.84	336.75	2.70	1.07
No. of unemployed	21.76	20.13	26.58	-0.08	4.74
	(8.3)	(5.99)	(7.32)		
Rural					
Population	546.61	658.83	727.50	1.79	1.67
Labour force	204.18	255.38	270.39	2.15	0.96
Workforce	187.92	241.04	250.89	2.40	0.67
No. of unemployed	16.26	14.34	19.50	-1.19	5.26
	(7.96)	(5.61)	(7.21)		
Urban					
Population	171.59	234.98	276.47	3.04	2.74
Labour force	57.15	80.60	92.95	3.33	2.40
Workforce	51.64	74.80	85.84	3.59	2.32
No. of unemployed	5.51	5.80	7.11	0.49	3.45
	(9.64)	(7.19)	(7.65)		

Source: Tenth Five-Year Plan.
Figures within parentheses are the unemployment rate in percentage.

Detailed analysis of the unemployment rate in the selected states revealed that the overall unemployment rates are not too high but the urban unemployment rates are much higher than that of rural areas (Tables 3.10a and b). This is mainly due to widespread disguised unemployment in the agricultural sector in rural areas, where labour productivity tends to be zero or negative. It is also noteworthy that the unemployment rate in rural Punjab, which is considered to be an agriculturally developed state, is very high followed by rural Bihar, which is economically the poorest state. In urban areas, the unemployment rate was found to be the highest in Bihar state followed by Uttar Pradesh state.

Table 3.10a Unemployment rate on CDS basis in selected states, 1999-2000 (Percentage of labour force)

States	Rural			Urban		
	Male	Female	All	Male	Female	All
Bihar	7.20	6.20	7.00	8.70	13.50	9.30
Madhya Pradesh	4.00	3.50	3.80	7.20	5.70	7.00
Punjab	4.20	1.70	3.70	4.80	5.30	4.90
Rajasthan	3.30	1.90	2.80	4.70	3.50	4.50
Uttar Pradesh	4.00	2.10	3.60	6.30	5.00	6.20
India	**7.20**	**7.00**	**7.20**	**7.30**	**9.40**	**7.70**

Source: NSS Report No. 458: Employment and Unemployment Situation in India, 1999-2000.

The situation is much more grim for youth of age group 15-29 years. There are sharp variations in the unemployment rate of youth across states. Against the all India average of 14.7 per cent unemployment among the urban male youth in 1999-2000, it is much higher in Bihar (24.0) and slightly higher in Madhya Pradesh (14.9) while Punjab and Rajasthan have 8 to 9 per cent unemployment. In rural areas in all the selected states except Bihar, the unemployment rate for male as well as female youth has been reported very low compared to the national average.

Table 3.10b Unemployment rate among the youth (15-29 years age) on CDS basis in selected states, 1999-2000

(Percentage of labour force)

States	Rural			Urban		
	Male	Female	All	Male	Female	All
Bihar	11.5	8.8	11.0	24.0	28.0	24.4
Madhya Pradesh	5.4	4.0	4.9	14.9	12.3	14.6
Punjab	8.0	3.6	7.0	8.9	13.9	9.5
Rajasthan	5.0	3.3	4.4	8.4	10.4	8.8
Uttar Pradesh	6.8	2.0	6.1	12.4	12.7	12.5
India	**11.1**	**10.6**	**11.0**	**14.7**	**19.1**	**15.4**

Source: NSSO.

The Planning Commission estimates incidence of poverty on the basis of the large-scale quinquennial Sample Survey on Household Consumer Expenditure conducted by the National Sample Survey Organization (NSSO). The concept of the poverty line is based on the average calorie requirement norm recommended by the nutrition expert group (ICMR) and the age-sex occupational structure of the population. The average calorie norms are 2,400 calories per capita per day for rural areas and 2,100 calories per capita per day for urban areas.

As per its estimate, there was a significant decline in the proportion of people living below the poverty line (BPL) between 1973-1974 and 1999-2000 from 54.88 per cent to 26.1 per cent, and in terms of the absolute number of poor from 328.9 million to 260.3 million. In spite of the impressive decline in poverty in the country as a whole, there are wide variations in the incidence of poverty between states and the rural-urban divide (Table 3.11). The Tenth Plan (2002-2007) has set a target of reducing the poverty ratio by five percentage points to 19.3 per cent by 2007 and by 15 percentage points by 2012. The targets for rural and urban poverty in 2007 are 21.1 per cent and 15.1 per cent respectively.

Table 3.11 Percentage of population below the poverty line (Percentage of population)

State	Rural			Urban			Combined		
	1973-1974	1993-1994	1999-2000	1973-1974	1993-1994	1999-2000	1973-1974	1993-1994	1999-2000
Bihar	62.99	58.21	44.30	52.96	34.50	32.91	61.91	54.96	42.60
Madhya Pradesh	62.66	40.64	37.06	57.65	48.38	38.44	61.78	42.52	37.43
Punjab	28.21	11.95	6.35	27.96	11.35	5.75	28.15	11.77	6.16
Rajasthan	44.76	26.46	13.74	52.13	30.49	19.85	46.14	27.41	15.28
Uttar Pradesh	56.53	42.28	31.22	60.09	35.39	30.89	57.07	40.85	31.15
India	**56.44**	**37.27**	**27.09**	**49.01**	**32.36**	**23.62**	**54.88**	**35.97**	**26.10**

Source: Planning Commission.

As has already been discussed, the unemployment rate is lower in rural areas than in urban areas, while the poverty is more rural in nature. This is true for most of the states because the selected states' economies are mainly based on agriculture and agriculture supports large population living in rural areas. In other words, large populations in rural areas are involved in agricultural activities at every level of economic earning due to the disguised unemployment. That is why, although employment figures look healthy for rural areas, populations below the poverty line are still at alarming proportions.

3.1.6 Extent of environmental problems

Given the fact that technologies today are applied on a massive scale and the interventions in ecosystems are substantial, many times they result in major environmental problems. Irrigation was the cradle where HYV seeds and fertilizer consumption thrived, bringing about the green revolution in Indian agriculture during the late 1960s and 1970s. Since the advent of the green revolution in India, crop yield in irrigated areas has increased substantially and so, the productivity of irrigation water. However, only a few crops consumed most of the irrigation water across the regions. Rice, wheat and sugarcane together cover two-thirds of the GIA of the country. Keeping in mind the water requirement and grain yield, it was found that CGPRT crops were more efficient users of water (Table 3.12). Although research focused on water productivity is relatively new, the gap between the available knowledge to increase water productivity and its beneficial application appears quite large.

Due to injudicious cropping patterns, there has been a serious imbalance in the groundwater profile in a few states. As most of the water bodies, which happened to be common property resources in the past, came under the plough, the chances of recharging the groundwater reduced. Furthermore, the inadequate development of surface irrigation provisions led to increases in the farmers' dependency on groundwater for irrigation. These together have resulted in an unsustainable balance of groundwater potential in states like Punjab and Rajasthan, among the selected states (Table 3.13).

Table 3.12 Water requirement of various agricultural crops

Crop	Water requirement (mm)	Grain yield (kg/ha)	WUE (kg/ha mm)
Rice	2 000	6 000	3.0
Wheat	280	3 534	12.6
Sorghum	500	4 500	9.0
Pearl millet	500	4 000	8.0
Maize	625	5 000	8.0
Groundnut	506	4 680	9.2
Finger millet	310	4 137	13.4

Source: http:/www.ikisan.com/links/ap_irrigations.html.

Table 3.13 Groundwater resources and irrigation potential of selected maize growing states in India

(m.ha.m./year)

State	Total replenishable groundwater resources	Available groundwater resources for irrigation	Net draft	Balance groundwater potential available for exploration
Bihar	3.35	2.85	0.55	2.30
Madhya Pradesh	5.09	4.33	0.72	3.61
Punjab	1.87	1.68	1.58	0.10
Rajasthan	1.27	1.07	0.54	0.53
Uttar Pradesh	8.38	7.12	2.68	4.44
India	**43.19**	**7.09**	**11.52**	**24.58**

Source: CGWB, 2000. Bihar includes Jharkhand, MP includes Chhattishgarh and UP includes Uttaranchal.
Note: m.ha.m = million hectares meters.

The seriousness of the issue is validated in Table 3.14, which shows that 52 per cent of the blocks in Punjab and 18 per cent of the blocks in Rajasthan come under the 'over-exploited' category. The regions/blocks are categorized as over-exploited where groundwater utilization is more than 100 per cent of replenishable groundwater and as 'dark' where groundwater utilization is more than 85 per cent but less than 100 per cent of replenishable groundwater.

Table 3.14 Categorization of blocks as over-exploited and dark in the selected maize growing states in India

State	Number of districts	Number of blocks	Number of blocks			
			Over-exploited		Dark	
			No.	%	No.	%
Bihar	42	585	-	-	-	0.17
Madhya Pradesh	45	459	-	-	3	0.65
Punjab	12	118	62	52.54	8	6.78
Rajasthan	30	236	45	18.07	11	4.66
Uttar Pradesh	63	895	19	2.12	22	2.46

Source: CGWB, 2000.

The groundwater problems, the faulty cropping patterns and poor irrigation practices have also lead to another serious environmental problem i.e. degradation of land. About 74 million hectares of land in India come under water eroded degraded land, out of which, about 13 million hectares are in Madhya Pradesh alone (Table 3.15). Wind erosion is the major problem in Rajasthan state, which has one of the largest deserts, the 'Thar Desert', in Asia.

Table 3.15 Area under degraded land in selected maize growing states in India (million ha)

State	Forest degraded area	Non forest degraded area			
		Saline and alkaline	Wind eroded	Water eroded	Total
Uttar Pradesh	1.43	1.30	-	5.34	6.64
Bihar	1.57	0.00	-	3.89	3.90
Madhya Pradesh	7.19	0.24	-	12.71	12.95
Punjab	0.08	0.69	-	0.46	1.15
Rajasthan	1.93	0.73	10.62	6.66	18.01
India	35.89	7.16	12.93	73.60	93.69

Source: Compendium of Environmental Statistics, 2002.

3.1.7 Condition of public infrastructure relevant to CGPRT farming and industry

Infrastructural bottlenecks remain to be major challenges facing developing countries in the fight against rural poverty and creating gainful employment for the growing workforce. As such, there is no provision for infrastructural development relevant specifically to CGPRT farming and industry. However, the growth in general infrastructure in the selected maize growing states has wider implications. For overall agricultural development, a few parameters like road density, villages electrified, provision of irrigation and credit disbursement need to be looked into.

Among the selected states, Punjab looks comfortable in all respects mentioned above (Table 3.16). In terms of road density and electrification of villages, which are the backbone of economic development, Bihar is way behind the other states. Similarly, mechanization of agriculture has not made much headway in Bihar, Madhya Pradesh and Rajasthan, which can be seen from the table that the number of tractors per thousand of gross cropped area is too low compared to Punjab and Uttar Pradesh. Increased dependency on groundwater for irrigation has fuelled the growth of pump-sets in almost all the states. Its density is still low in Bihar.

Table 3.16 Infrastructural facilities in selected maize growing states in India

State	Road density (km/100 sq km)	Villages electrified (%)	No. of regulated markets (per 1 000 ha GCA)[a]	No. of tractors (per 1 000 ha GCA)[a]	No. of pumpsets (per 10 000 ha of operated area)[a]	No. of bank branches[b] (per 1 000 GCA)
Bihar	46.44	63.9	0.081	9	27	0.362
Madhya Pradesh	47.59	89.0	0.030	13	64	0.173
Punjab	109	100.0	0.082	51	92	0.319
Rajasthan	20.52	78.8	0.021	4	32	0.176
Uttar Pradesh	67.94	75.9	0.026	25	33	0.335
India	76.84	84.3	0.038	14	66	0.359

Source: Statistical Abstract of Various States, 2001-2002.
Note: [a] Data for 1999-2000.
[b] Data for 2002.

3.2 Profiles of the respondents and their households

3.2.1 The respondents' profile

As discussed earlier, 300 farmer households were selected for the study from each of the five traditional maize growing states. It can be observed from Table 3.17 that the average age of the respondent farmers in most of the selected states was late forties. More than half of the sample farmers were illiterate in Rajasthan followed by Uttar Pradesh. More than two-thirds of farmers in Bihar were either illiterate or educated up to a primary level. In Punjab, more than fifty per cent of the sample farmers were well educated; above secondary level.

3.17 Distribution of respondent farmers according to age and education group (Percentage)

Particulars	Bihar	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh
N	300	300	300	300	300
Avg. age (years)	49.44	47.42	50.46	43.38	48.23
Age group					
Below 30 years	4.33	10.00	7.33	19.33	10.33
30 to 45 years	39.67	38.00	33.33	41.33	39.67
Above 45 years	56.00	52.00	59.33	39.33	50.00
Education group					
Illiterate	31.67	17.33	20.00	61.33	44.33
Primary	32.00	47.33	24.00	19.00	14.67
Secondary	17.67	29.00	47.33	11.67	25.67
Higher	18.67	6.33	8.67	8.00	15.33

Source: Field Survey, 2004.

In all these states, agriculture in general and crop production in particular is the main occupation of the households. In rural areas, more than three-quarters of the population depends on agriculture in most of the states for their livelihood (Table 3.18). However, in urban areas, manufacturing and service sectors like trade, hotels and restaurants provide livelihoods to the majority of the population.

Table 3.18 Distribution of usually working persons in the principal status by broad industry division in selected states (Percentage)

State	Rural				Urban			
	Agri	Manu	Tra and Ho	Others	Agri	Manu	Tra and Ho	Others
Bihar	80.0	6.1	4.6	9.3	9.7	17.8	29.8	42.7
Madhya Pradesh	87.0	3.8	2.8	6.4	15.2	17.9	26.3	40.6
Punjab	62.7	7.9	8.0	21.4	6.1	23.8	30.2	39.9
Rajasthan	75.0	4.8	3.9	16.3	9.1	21.3	22.6	47
Uttar Pradesh	73.8	8.4	5.9	11.9	7.9	25.1	30.3	36.7
India	75.1	7.4	5.4	12.1	7.9	22.6	27.0	42.5

Source: NSS Report No. 458: Employment and Unemployment Situation in India, 1999-2000.
Agri- Agriculture; Manu- Manufacturing; Tra and Ho- Trade and hotels.

3.2.2 The households' profile

Average family size in rural areas appears to be large in the selected states. In the sample households, average family size is about seven members in Madhya Pradesh, Punjab and Rajasthan, while more than nine in Bihar and Uttar Pradesh (Table 3.19). Out of this, a little less than 50 per cent of family members join the farm workforce; most of them were adult male members.

Per capita income in the selected states was calculated by dividing the total family income by the total number of family members. It can be observed from Table 3.20 that the per capita income varies from INR 3,268 in Bihar to INR 10,463 per annum in Punjab. The major source of income in all these states remains crop production. Jobs in public/private sectors and

business contributed very little to the average annual per capita income of these households. Other sources of employment included dairying, rural artisan and construction work.

Table 3.19 Details of the family structure across the selected states in India (Number per household)

Particulars	Bihar	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh
Male adult	3.46	2.42	2.35	2.12	3.34
Female adult	2.57	2.20	2.22	2.05	2.95
Children	3.95	2.05	2.10	2.53	2.91
Total family size	9.98	6.67	6.67	6.70	9.20
Farm worker male	2.96 (61.03)	1.71 (64.04)	1.69 (65.4)	1.83 (50.14)	1.89 (65.85)
Farm worker female	1.89 (38.97)	0.96 (35.96)	0.89 (34.6)	1.82 (49.86)	0.98 (34.15)
Total workers	4.85	2.67	2.58	3.65	2.87
Share of worker to family size (%)	48.60	40.03	38.70	54.48	31.20

Source: Field Survey, 2004.
Figure within parentheses are in percentage.

Table 3.20 Details of family income in the selected states in India

Particulars	Bihar	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh
Annual income per capita (INR)	3 268	7 141	10 463	6 348	7 659
Sources of family income (%)					
Agriculture	65.0	58.0	67.5	57.6	62.7
Service	7.5	10.0	8.0	9.5	7.9
Business	7.2	6.6	9.7	11.3	8.0
Others	20.3	25.4	14.8	21.6	21.4

Source: Field Survey, 2004.

3.3 Concluding summary

In the post green revolution period agricultural diversification has gained substantial importance mainly due to its role in increasing agricultural income and addressing poverty related issues. It is in this respect that sorghum, maize and pulses (CGPRT crops) fit very well into the picture as these crops have high potential for diversified uses. CGPRT crops are less input demanding, resulting in positive long-term effects on the environment, addressing the sustainability issue.

Five states of India - Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh were chosen for the study mainly on the basis of acreage under maize. These states account for almost one-third of the area in total maize cultivation. Maize is one of the most important crops grown by the cultivators in the region, next to fine cereals. Cultivation of maize in the rainy season is more popular than the winter season, except in Bihar where winter maize is becoming more popular day by day.

Unemployment issues in rural as well as urban areas remain one of the major concerns in many of these states. It was observed from NSSO statistics that there has not been much change in the employment scenario over the years (1983-2000) in rural and urban areas. In urban areas, the unemployment rate was found to be highest in Bihar followed by Uttar Pradesh. India's national average rate of unemployment among urban male youths was 14.7 per cent in 1999-2000. It was much higher in Bihar (24.0) and a little higher in Madhya Pradesh (14.9) while Punjab and Rajasthan had only 8 to 9 per cent unemployment. Unemployment rates were lower in rural areas though the poverty was more rural in nature mainly due to disguised unemployment in the region.

The Planning Commission's estimate of poverty based on average calorie norms showed that the proportion of people living below the poverty line declined substantially to 26.1 per cent in 1999-2000. There were wide variations in incidence of poverty across the states. The current

target is to reduce rural and urban poverty in 2007 to 21.1 per cent and 15.1 per cent respectively.

Over exploitation of water, increasing use of fertilizers and injudicious cropping patterns during the post green revolution period have threatened sustainable production in some regions. The increased rate of depletion of groundwater in a few states has resulted in an unsustainable balance of groundwater potential in states like Punjab and Rajasthan. Apart from environmental degradation, the increasing use of fertilizers to enhance yield and production has had adverse repercussions on sustainable production. On the other hand, CGPRT crops were found to be much more efficient users of water than other crops.

Infrastructural bottlenecks remain a major challenge facing developing countries in fighting rural poverty and creating gainful employment for the growing workforce. As such, there is no provision for infrastructural development relevant specifically to CGPRT farming and industry. For overall agricultural development, a few parameters like road density, villages electrified, provision of irrigation and credit disbursement were analyzed and it was found that these indicators were positive only for Punjab among the selected states.

The socio-economic profile of the farmers-respondents showed that more than half of the sample farmers were illiterate in Rajasthan followed by Uttar Pradesh. Average family size in the rural areas was found to be large in the selected states. Out of these, a little less than 50 per cent of family members joined the farm workforce. The variations in per capita income between states were quite large such that the per capita income varied from Rs 3,268 in Bihar to Rs 10,463 per annum in Punjab. Agriculture still remains the major source for providing income and livelihoods for more than half of the respondent- households.

4. Analysis of CGPRT Farming System

4.1 Average size of farm operation

Per capita operational holding gives an idea about the assets of the farmers. From Table 4.1 it can be seen that in the maize growing belts of selected states, the per capita operational holding was much higher compared to the state average holding. It was the highest in Punjab state (4.21 ha) compared to the state average of 3.79 hectares. In Bihar, average operational holding was 2.86 hectares (state average = 0.75 hectares), in Madhya Pradesh it was 3.11 hectares (state average = 2.28 hectares); in Rajasthan it was 2.11 hectares (state average = 3.96 hectares) and in Uttar Pradesh average operational holding was 1.52 hectares against the state average holding of 0.86 hectares.

Table 4.1 Operational holdings and extent of irrigation of sample farmers in selected states of India (hectares)

Status	Bihar	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh
Irrigated area	2.53	1.71	4.17	1.72	1.52
	(88.46)	(54.70)	(98.97)	(81.52)	(100.00)
Non-irrigated area	0.33	1.40	0.04	0.39	-
	(11.54)	(45.30)	(1.03)	(18.48)	
Total operational area	2.86	3.11	4.21	2.11	1.52
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Source: Field Survey, 2004.
Figures in parentheses show percentage of area.

The distribution of sample households across the farm-size categories is given in Table 4.2, which shows that the majority of maize growing farmers are small-scale farmers in the selected states, whose numbers were the largest in Uttar Pradesh followed by Rajasthan. Except in Punjab and Madhya Pradesh, large-scale farmers do not participate significantly in maize production. During the winter season, significant numbers of large-scale farmers cultivate maize in Bihar too. Overall, 55 per cent of the maize growers came under the small category, 27 per cent under medium and 18 per cent farmers came under the large farm size category.

Table 4.2 Distribution of sample farmers' farm size (Percentage of total)

State	Small (< 2 ha)	Medium (2-4 ha)	Large (> 4 ha)	Total
Bihar	45.67	38.00	16.33	100 (300)
Madhya Pradesh	48.00	27.67	24.33	100 (300)
Punjab	39.33	30.67	30.00	100 (300)
Rajasthan	63.33	24.67	12.00	100 (300)
Uttar Pradesh	79.33	13.33	7.33	100 (300)
Overall	55.13	26.87	18.00	100 (1 500)

Source: Field Survey, 2004.
Figures within parentheses are the total no. of sample households.

4.2 Patterns of cultivation

The study clearly suggests that with developments in maize technology, farmers opt for maize to augment family income and employment. In all the selected states, small farmers allocated more acreage to this crop in comparison to other categories of farmers (Table 4.3). It varied from around 21 per cent of cropped area in Uttar Pradesh to as high as 40 per cent in Rajasthan. This could be due to the fact that maize is cultivated by the small farmers not only

for sale but also for home consumption. In most of the cases, maize is taken as the sole crop and in some cases, mixed with potato cultivation.

Table 4.3 Share of maize in the cropping pattern of selected farmers (Percentage)

State	Small	Medium	Large	Overall
Bihar	24.57	12.28	7.84	14.90
	(0.61)	(1.34)	(1.69)	(1.45)
Madhya Pradesh	23. 44	20. 60	17. 20	19. 77
	(0.58)	(1.06)	(1.54)	(0.95)
Punjab	27.35	19.64	13.45	16.23
	(0.66)	(1.07)	(2.61)	(1.37)
Rajasthan	40.12	37.56	33.18	37.58
	(0.67)	(1.48)	(2.85)	(1.15)
Uttar Pradesh	21.23	16.42	13.19	18.06
	(0.38)	(0.89)	(1.52)	(0.54)

Source: Field Survey, 2004.
Figures within parentheses are maize area in hectares per farm.

Although maize is more profitable than its competing crops, farmers face problems in selling during a year of bumper harvest. This situation restricts farmers to grow maize on a smaller scale. The area under HYV in the country has increased from a mere 7 per cent during 1967-1971 to 54 per cent during 1992-1996. However, the irrigated maize area in the country has increased marginally, from 16 per cent during 1967-1971 to 21 per cent in 1992-1996. Even this positive shift in HYV area has not been even in all growing states (Table 4.4). Among the selected states, the farmers of Punjab, Madhya Pradesh and Bihar (during *rabi* season) cultivated mainly hybrid maize, while those of Rajasthan and Bihar (during *kharif* season) were found reluctant to do the same. In fact, in Uttar Pradesh, local cultivars like *Jaunpuri* performed better than many of the composite and hybrids with less inputs and care. In the case of Rajasthan, maize is mainly cultivated for domestic consumption, for which composite/hybrid is not preferred. That is why the adoption of improved cultivars in these two states is less. Furthermore, maize has made inroads during the winter season in a big way in Bihar state alone, where the temperature doesn't fall much during the season and therefore the yield of the wheat crop is affected. In some parts of Uttar Pradesh and Rajasthan also, maize cultivation during the winter season has been reported but on a very small-scale.

Table 4.4 Distribution of maize area under different types of cultivars on selected farms in selected states of India (Percentage)

State	Maize area per farm (ha)	Local	Improved cultivars		
			Composite	Hybrid	Total
Bihar- *kharif*	1.50	49.83	42.02	8.15	50.17
Bihar- *rabi*	1.35	Nil	26.52	73.48	100.00
Madhya Pradesh	0.94	12.75	19.15	68.10	87.25
Punjab	1.37	7.60	4.80	87.60	92.40
Rajasthan	1.19	61.34	3.36	35.29	38.65
Uttar Pradesh	0.54	75.93	3.70	20.37	24.07

Source: Field Survey, 2004.

4.3 Labour use

Maize cultivation, in general, is not considered very labour intensive. The labour utilization in different states are presented in Table 4.5. From the table, it is evident that labour utilization is greater in states where the opportunity cost of agricultural labour is less. Labour use in maize cultivation varied from 32 man days per hectare in Punjab to as high as 112 man days in Rajasthan. There is not much variation in labour use across farms and across the cultivars, which can be seen from the standard deviation given in the table. It appears to be very

interesting that the labour use in maize cultivation varies greatly. It depends on the workers to family size ratio and the priority of the family for that crop. Since in Rajasthan, both aspects are favourable to maize, labour use is too high.

Table 4.5 Labour use in maize cultivation in selected states

State	Human labour (man days/ha)	Standard deviation
Bihar (rainy)	57.30	17.57
Bihar (winter)	65.31	18.23
Madhya Pradesh	79.42	21.67
Punjab	32.58	16.18
Rajasthan	112.33	27.67
Uttar Pradesh	81.48	32.54

Source: Field Survey, 2004.

4.4 Farm productivity

Improvements in yield and therefore, reductions in the unit cost of production of the crop are the most common impact indicator to measure efficiency at farm level. It was found that maize yield increased significantly with the adoption of composite/hybrid varieties of maize in all the selected states (Table 4.6). There was a huge variation in yield realized by the farmers even with the same type of cultivars. For example, in Bihar during the winter season, a few farmers harvested grain yield to the tune of 7 tons per hectare with average yield of 6 tons per hectare.

Table 4.6 Grain yield of maize crop realized by sample farmers in selected states of India (Tons/ha)

State	Rainy season			Winter season	
	Traditional	Composite	Hybrid	Composite	Hybrid
Bihar	1.92	2.29	4.15	4.98	6.01
Madhya Pradesh	1.54	2.72	3.81	N.C.	N.C.
Punjab	1.97	3.25	3.63	N.C.	N.C.
Rajasthan	1.60	2.58	3.83	N.C.	3.97
Uttar Pradesh	2.36	N.C.	4.32	N.C.	5.20

Source: Field Survey, 2004.
N.C.= Not cultivated.

4.5 Cost-revenue structures and farm profitability

Improvement in yield is only one aspect of the impact of improved technologies. Improved technologies push the yield frontier by utilizing either more inputs or by utilizing the resources more efficiently. In the case of maize, increases in yield due to the composite/hybrid variety went hand in hand with increases in the cost of cultivation (Table 4.7). For example, the farmers who spent nearly INR 6,000 in Bihar on cultivating one hectare of traditional maize during the rainy season (*Kharif)*, had to spend about INR 17,000 to cultivate hybrid maize during the winter season (*Rabi)*.

Expenditure on fertilizer, irrigation, plant protection measures and seeds mainly contribute to the additional cost of cultivation. Irrigation costs were a major expenditure after human as well as machine labour costs in maize cultivation during the winter season, as the crop requires 4-6 irrigations during this season. While in the case of rainy season maize, farmers give a maximum of up to 2-3 irrigations. Secondly, the farmers apply very low chemical fertilizer (11-80 kg N, 0-40 kg P and 0-25 kg K) in the case of traditional *kharif* maize, but this increased tremendously for hybrid *kharif* (50-128 kg N, 25-55 kg P and 18-33 kg K) and hybrid *rabi* (98-110 kg N, 22-62 kg P and 26-55 kg K).

Table 4.7 Cost of cultivation of different cultivars of maize in selected states in India (INR/ha)

State	*Kharif* maize			*Rabi* maize	
	Traditional	Composite	Hybrid	Composite	Hybrid
Cost of cultivation					
Bihar	5 849	5 773	6 531	12 929	16 932
Madhya Pradesh	5 625	8 604	10 546	N.C.	N.C.
Punjab	6 427	8 009	8 956	N.C.	N.C.
Rajasthan	9 506	10 212	12 881	N.C.	17 070
Uttar Pradesh	8 601	N.C.	12 295	N.C.	12 857
Total return					
Bihar	9 676	11 555	14 778	24 504	29 446
Madhya Pradesh	6 889	12 076	16 917	N.C.	N.C.
Punjab	13 035	17 934	19 637	N.C.	N.C.
Rajasthan	10 841	16 538	22 895	N.C.	24 722
Uttar Pradesh	11 915	N.C.	22 217	N.C.	27 989
Net income					
Bihar	3 823	5 781	8 248	11 573	12 514
Madhya Pradesh	1 264	3 472	6 371	N.C.	N.C.
Punjab	6 608	9 925	10 682	N.C.	N.C.
Rajasthan	1 335	6 326	10 014	N.C.	7 652
Uttar Pradesh	3 314	N.C.	9 922	N.C.	15 132

Source: Field Survey, 2004.
N.C.= Not cultivated.

Similarly, the farmers have to buy new seeds every year from the market in the case of hybrid seeds, while they can use their own seeds for the traditional variety. These all add extra burdens to the resource-poor farmers in particular. Moreover, due to proportionately very high yield from the improvement in varietal technology, although the cost of cultivation increased, net profit is significantly higher from composite as well as hybrid cultivars.

4.6 Role of diversified farming system in risk mitigation

Diversification is often considered as an important farm management strategy to combat risk. Production risk on a diversified farm is reduced, as different crop enterprises have different degrees of resistance to adverse situations. This is true at the micro level for subsistence farming where different types of crops are grown together on a farm. However, with commercialization of agriculture, market induced price risk increases. Secondly, the relevance of diversification of Indian agriculture has grown manifold under the current economic scenario.

Agricultural diversification is a process of broadening and strengthening the income sources of rural households. Diversification at farm level can be of two types: horizontal, within the farm production unit; or vertical, involving off-farm activities like storing, and processing. The regional dimension of agricultural diversification includes individual diversification - diversified within respective farms and, regional diversification- specialized in individual farms but diversified in the region.

Diversification is needed for three reasons: i) improving the efficiency of resource use, which is hitherto underutilized; ii) risk reduction as different crop enterprises have different degrees of resistance to adverse situations; and iii) responding to changes in demand. Diversification is also a key strategy for poverty reduction as it ensures gainful employment for a large population year round. Actually, maize cultivation in the winter season in Bihar state is one example of risk reduction by diversifying the crop portfolio. In eastern states, temperatures do not fall much during the winter season, which is one of the most essential factors for setting bold grains in wheat. This has lead to lower wheat yields and compelled farmers to opt for alternatives. On the other hand, maize requires very low temperatures and if assured irrigation and recommended fertilizer are given, it gives better returns to the farmers. However, market risk, price fluctuation and not an assured market. restrict the farmers to cultivate maize only on a limited scale.

The major premise behind the crop diversification strategy is that the economic performance of the crop sector is intimately linked to the underlying cropping pattern. Although small farmers do display their characteristic tendency of cereal-based specialization, large rainfed farms also share this feature. Under this condition, efforts to diversify these groups towards horticultural crops, despite being able to enhance their income, could reduce food output and undermine self-consumption initiatives. In fact, resource endowment (irrigation and land quality) and self-consumption initiatives seem to outplay strict economic criteria for crop choice or diversification.

4.7 Potential and constraints in farming operations

4.7.1 Technological adoption

The agro-climatic conditions and natural resource endowments of the region under study provide great potential for agricultural development. Adoption of HYVs is only one aspect of achieving higher yields. There are other factors which influence the yield per unit area of any crop. Adoption of new technology means using the entire package of practices for the cultivation of improved varieties of maize. An adoption index was calculated for individual farmers, which included the adoption of improved varieties, adoption of recommended doses of chemical fertilizers, and amount of irrigation. It was observed that the majority of farmers, across all the categories still fell under the category of 'low adoption'.

The study revealed that the majority of farmers (54 per cent) were low adopters of modern technologies while 26 per cent fell under the category of 'high adoption' (Table 4.8). The trend was more serious in the case of small and medium farmers, which supported the common belief that "modern technologies bypass the small farmers". But it would seem that technological adoption was also not very widespread even among the resource rich farmers/large farmers. This clearly shows large scope for yield improvements of this crop across all the states.

Table 4.8 Distribution of sample farmers across different adoption levels (Percentage)

Adoption level	Small (< 2 ha)	Medium (2-4 ha)	Large (> 4 ha)	Overall
Low adoption (0-33 %)	55.08	52.36	43.32	54.22
Medium adoption (34-66 %)	21.89	17.12	17.45	19.45
High adoption (67-100 %)	23.03	30.52	39.23	26.33
Total sample size	827	403	270	1 500

Source: Field Survey, 2004.

The trend was very similar across all the selected states (Table 4.9). In Bihar, Madhya Pradesh and Rajasthan the majority of farmers (more than 70-80 per cent) were cultivating either the local variety or were not applying the recommended doses of fertilizer or irrigation.

Table 4.9 Distribution of sample farmers by adoption level by state (Percentage)

State	Low adoption (0-33 %)	Medium adoption (34-66 %)	High adoption (67-100 %)
Bihar	87.20	12.80	Nil
Madhya Pradesh	97.00	3.00	Nil
Punjab	7.00	13.00	80.00
Rajasthan	73.00	24.33	2.67
Uttar Pradesh	2.83	48.67	49.00
Overall	54.22	19.45	26.33

Source: Field Survey, 2004.

Adoption of any technology can be likened to a vehicle having four wheels: institutions, infrastructure, and technology transfer and policy, with technology working as the driver. When all the wheels have an optimum level of air, pressing the accelerator will increase the speed of the vehicle to the desired speed. Less air in even one wheel would limit the speed, irrespective of how good the driver is. This is true for maize technology too. The absence of appropriate institutional arrangements/infrastructure have been found to hinder the speed of technological adoption in the selected states

4.7.2 Technical efficiency

Out of the 1,500 sample farms, around 85 farmers did not apply chemical fertilizers to their crop and were growing only traditional cultivars of maize. These farmers were cultivating maize either for domestic consumption purposes or the marketed surplus was very low. Therefore, only the remaining 1,415 farms were considered for the estimation of technical efficiency. The dependent variable included in the model was the output of the maize crop. The inputs included human labour, fertilizer used and capital, which consisted of overhead expenditure on seeds, plant protection chemicals, animal and machine labour and are given in Table 4.10.

Table 4.10 Estimates of frontier production function

Parameter	Coefficients		
	Large	Medium	Small
Constant	0.275	1.560	1.665
Landholding (ha)	-0.020	-0.128	0.001
Human labour (man days)	0.089 [a]	-0.083 [b]	-0.055 [b]
Value of Seeds (INR)	0.546 [a]	0.383 [a]	0.325 [a]
Qty of NPK (kg)	0.037 [a]	0.043 [a]	0.058 [a]
Value of irrigation (INR)	0.007 [b]	0.013 [b]	0.013 [a]
Lambda	2.282	2.603	2.589
Sigma	0.550	0.653	0.625
No. of observations	364	324	727
Log likelihood function	-154.267	0.055	0.051
Variance (σ^2_v)	0.049	0.055	0.051
Variance (σ^2_u)	0.254	0.371	0.340
Mean technical efficiency (%)	63.4	60.1	60.4

Source: Estimated from Field Survey, 2004.
[a] and [b] indicate significance level at 1 and 5 per cent probability level respectively.

As expected, the coefficients of human labour, seeds, fertilizer use and irrigation were significant in all the three categories of farm, namely large, medium and small. However, in the case of labour, there is a significant decrease in its value. As we know, the frontier parameters indicate the maximum possible contribution of each input to output, when the inputs are utilized efficiently following the best practice techniques.

Technical efficiency of sample farms in maize production

Technical efficiency is the ability of the farm to achieve maximum possible output with the available resources. The distribution of farms under the efficiency categories is given in Table 4.11. The minimum technical efficiency was 26 per cent and the mean technical efficiency was 93 per cent. The maximum number of farms came under the 60-80 per cent technical efficiency category. The mean technical efficiency of 61.5 per cent indicated that on average the sample farms operated 39 per cent below the frontier output levels. The study implied that the maize output of the “average farmer” could be increased by 39 per cent by adopting the technology followed by the “best practice” farmers.

Table 4.11 Distribution of maize growers under different levels of technical efficiency

Efficiency levels (%)	Percentage of farmers		
	Large	Medium	Small
N	**364**	**324**	**727**
<40	13.14	16.68	19.82
40-50	9.07	11.42	6.27
50-60	11.26	10.18	9.04
60-70	22.53	26.24	26.53
70-80	23.90	22.53	23.04
80-90	18.41	12.04	14.29
>90	1.65	0.93	1.02

Source: Estimated from Field Survey, 2004.

There were, however, technological constraints behind such responses of farmers. The lack of assured irrigation, unavailability of quality seeds and their exorbitant price were the major constraints which inhibited the farmers from their adoption (Table 4.12). The farmers of relatively poor states like Bihar and M.P. expressed that high costs were the main reason for poor technological adoption. In Punjab and Rajasthan, unawareness of the recommendations was the main reason, while farmers of U.P. and some in Punjab opined that recommendations for the region were not accurate.

High irrigation charges were the main bottleneck in Bihar and U.P. for the underutilization of technology, while in the cases of M.P. and Rajasthan, the non-availability of irrigation sources when needed was the main reason. Unsatisfactory irrigation facilities were the major problem in Rajasthan and it is astonishing to note that 58 per cent of the farmers in Punjab also expressed this as a constraint.

Table 4.12 Technological constraints faced by maize farmers in selected states of India (Percentage of farmers [a])

State	Reasons for not adopting HYV			Reasons for not applying recommended level of fertilizer		
	Unfit for hhld. cons.	Seed not avail.	Expv.	Expv.	Reco. not proper	Not aware
Bihar	20.15	25.35	35.80	88.36	10.28	-
M.P.	30.35	45.65	45.15	75.33	7.00	17.33
Punjab	15.25	21.25	25.45	-	31.30	48.00
Rajasthan	38.55	40.64	50.40	6.33	22.67	70.67
U. P.	35.20	55.80	50.45	6.00	57.67	33.00

Source: Derived from Field Survey, 2004.

Note: hhld.= Household; cons.= Consumption; Avail.= available; Expv.= Expensive; Reco.= Recommendation.

[a] Percentage of farmers is the percentage of farmers related to the respective constraints, and NOT of total sample farmers.

Institutional constraints presented in Table 4.13 are not constraints to only maize production, but are true for all crops in the study area. It is a well known fact that good transportation facilities are key to the economic development of a region. About 50 per cent of the farmers in states like Bihar and Rajasthan have not had have their villages connected with metallic roads to the market places. The insufficient and irregular supply of electricity was also a major concern in these states. Untimely credit availability was another constraint in the rural areas of Bihar and U.P. Kisan Credit Card (KCC) [1/] was reported to be a nightmare for the farmers of the selected states in general. Poor marketing was a great disappointment for the maize growers.

[1/] Government of India launched the Kisan Credit Card (KCC) Scheme in 1998-1999. It aims at providing crop loans to farmers in a flexible and cost effective manner. The scheme is being implemented in all the states and union territories by all Commercial Banks, Regional Rural Banks, State Cooperative Banks and Primary Agricultural Cooperative Societies (Economic Survey, 2004-2005). As of 30th September 2004, cumulative issue of the Kisan Credit Card (Kisan stands for farmers) amounted to 43.56 million. The highest number of KCC were issued by Cooperative Banks (25.85 million), followed by Commercial Banks (13.24 million) and Regional Rural Banks (4.46 million).

Table 4.13 Institutional constraints to the cultivation of maize perceived by the farmers in selected states of India

(Percentage of farmers [a])

State	Poor connectivity of village to market	Electricity problem		Unsatisfactory irrigation facilities	Credit availability		
		Insuffi-cient	Untimely		Inade-quate	Un-timely	Unaware of KCC [b]
Bihar	46.3	73.3	81.0	20.7	43.0	77.0	42.7
M.P.	4.3	66.0	95.0	36.7	14.3	9.0	40.0
Punjab	n.a.	60.3	66.7	58.0	10.0	10.0	31.0
Rajasthan	50.0	100.0	100.0	100.0	n.a.	n.a.	6.3
U. P.	28.0	39.3	67.7	15.7	30.3	73.3	31.7

Source: Derived from Field Survey, 2004.

Note: [a] Percentage of farmers is the percentage of farmers related to the respective constraints, and NOT of total sample farmers.

[b] KCC means Kisan Credit Cards, n.a. = not available

A grading facility is not available and graded produce does not fetch a higher price, therefore farmers do not opt for grading. Farmers can receive a higher price for the same produce during the lean season but the lack of storage facilities renders this opportunity unviable.

4.8 Concluding summary

In the preceding section, average size of farm and the type of crops grown by type of farmer, pattern of cultivation, labour use and farm productivity have been discussed. In a quantitative assessment with extensive statistical tools, discussions on cost and revenue structures along with the technical efficiency and the level of adoption for the selected sample were estimated.

It was found that for the selected sample of farmers, the size of per capita operational holdings was higher than that of the state average. The majority of maize growing farmers were small-scale farmers who cultivated mainly for the purpose of augmenting farm income and self-consumption. Maize cultivation intercropped with potato during the *kharif* season was also practiced by many farmers. Maize cultivation as such is less labour intensive compared to other crops like paddy and wheat. However, labour utilization depends on its opportunity cost. Variations in labour use across the farms and cultivators depended on the worker to family size ratio. Farm yield has increased with the cultivation of hybrid and composite varieties, but still in many states such as Uttar Pradesh and Rajasthan, farmers prefer to grow local or traditional varieties. This is true especially in cases where maize is used for home consumption.

The main components of the cost structure were human labour, fertilizers, irrigation, plant protection measures and seeds. Of them, the major expenditure incurred was human labour. The costs incurred on hybrid varieties were higher compared to that of local varieties but the revenue associated with the yield was also very high. Diversification in favour of maize production was mainly to reduce the risks associated with the yield and price fluctuations of other crops. This also has implications on employment generation and income augmentation.

Adoption as a whole package, with recommended levels of fertilizer application, seed application and the amount of irrigation, was studied. It was observed that the majority of farmers across all categories fell under the 'low adoption' category (54 per cent). In Bihar, Madhya Pradesh and Rajasthan more than 70-80 per cent of the sample farmers were cultivating either the local variety or were not applying recommended levels. Average technical efficiency among selected farmers was 61 per cent. About 39 per cent of farms operated below the frontier output levels. In addition to the technology adoption bottlenecks, the institutional constraints identified were a lack of transportation facilities, insufficient supply of power, non-availability of quality seeds, shortage of fertilizer and untimely credit availability.

5. Analysis of the Maize Marketing System

5.1 Forms of products traded and distribution channels

Agricultural marketing includes the movement of agricultural produce from farms where it is produced to consumers or processors. The agricultural market in India today is dominated by rural primary markets that meet local demand, secondary markets that service distant demand and wholesale markets that gather large amounts of produce from different sources for the retailers in the country. With a view to keep pace with the need to handle increasing agricultural production, the number of regulated markets has also been increasing. There were 7,161 regulated markets in the country as of March 2001 (Govt. of India, 2001). The basic objective of market regulation is to regulate trade practices, increase market efficiency through reductions in market charges, eliminate intermediaries and protect the interests of the producers and sellers.

Domestic demand for maize continues to be largely driven by the evolution of traditional markets (e.g. feed and food markets), as well as by industrial uses and the development of alternative uses for maize. Given relatively high income elasticity of feed demand, traditional markets are expected to grow at a faster rate. There are many types of maize varieties, such as flint corn, dent corn, sweetcorn, popcorn, flour corn and waxy corn. This classification is based on the nature and distribution of starch in the endosperm.

About 50 per cent of the maize grown in India is used as animal feed and the rest is subjected to processing for food or chemicals (Singh *et al.,* 2003). Three major processes, *viz.* dry milling, wet milling and alkali processing are the methods followed for producing maize products. The end products of these processing methods vary and serve as raw materials for the further manufacture of processed foods. Accordingly, there are several maize products being traded in the Indian market: maize as grits; flour for food purposes; maize as animal feed; and industrial products like starch, fructose and ethanol.

5.1.1 Marketing channels

Marketing channels are the routes through which the agricultural product moves from the hands of producers to the ultimate consumer. It involves various middlemen who facilitate the flow of goods from the point of production to the points of ultimate consumption. The length of the channel varies from commodity to commodity depending upon the quantity to be moved, the nature of consumer demand, the degree of regional specialization and extent of post-harvest facilities available in the region. Broadly, they are:

1. Farmer → Consumer
2. Farmer → Village trader → Retailer → Consumer
3. Farmer → Village trader → Wholesaler → Retailer → Consumer
4. Farmer → Wholesaler → Feed/Starch industry → Wholesaler → Retailer → Consumer

5.2 Farm gate price

The farm gate prices prevailing in the various selected states during the nineties are depicted in Table 5.1. The farm gate price in 1990-1991 ranged between INR 1,857 in U.P and INR 3,237 in Bihar. Winter maize cultivation in Bihar and Rajasthan and the lack of marketability of produce during the winter season leads to sudden dips in the prices. The traders

and the starch and feed industry located in other states take advantage of this and exploit the farmers in these already poverty stricken states. The trends of farm gate prices remained almost the same with wide variations in the prices amongst various maize producing states.

However, during the latter part of the decade, the differing farm gate prices between states subsided due to the intervention of institutional instruments and market integration. The farm gate price in the state of Punjab remained invariably higher throughout the study period than its counterpart states.

Table 5.1 Farm gate price of maize in selected states (INR/ton)

Year	Bihar	Madhya Pradesh	Punjab	Rajasthan	Uttar Pradesh
1990-1991	2 360	2 320	3 237	2 307	1 857
1991-1992	3 020	3 300	3 150	3 370	2 890
1992-1993	3 210	2 900	3 600	2 840	2 540
1993-1994	2 960	2 850	3 870	2 800	2 930
1994-1995	3 350	4 100	4 185	4 240	3 270
1995-1996	3 630	3 950	4 500	4 080	3 610
1996-1997	3 990	4 350	4 815	4 610	4 080
1997-1998	3 657	4 100	4 658	4 180	4 170

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India.

5.3 Market structure and competition

As in other developing countries, market and road networks in the maize growing regions of India are not well developed. Roads in most maize growing regions are much poorer than the national average and even feeder roads are not well laid out. Markets for food grains in general and maize in particular are very thinly spread throughout the maize growing regions. Most maize production is sold in local village markets where grain prices are 2-8 per cent lower than those in the nearest regulated market. Grain prices in the latter markets are still lower than the government established minimum support price. Farmers continue to sell their produce in the local village market predominantly in a scattered fashion because: (i) when grains are sold outside the village, transportation costs tend to be higher than marginal returns due to price difference, and (ii) farmers tend to sell to local traders, especially if they need to repay a loan they may have taken out to purchases inputs or for consumption purposes. Farmers were of the opinion that there is no other reliable way to sell their produce, as the volume is often very low. A collective effort for transportation and marketing would minimize transportation costs, allow quick product disposal, and fetch higher output prices.

The degree of product diversification in maize is limited to three products only. Since maize is grown in three varietal forms, namely local, composite and hybrid, the availability of grains in the market is generally restricted to these three types. Further, there are no conditions of entry or exit of the players in the market. A well organized flow of market intelligence information exists through the traders who keep track of the prices prevailing in nearby and other inter-state markets, but seldom the benefits are passed on to the farmers. The traders form a cartel kind of situation, and hence the competition is practically negligible. However, due to a lack of favourable government polices, the markets are not integrated and hence the behaviour of the markets varies from state to state and from region to region. The traders take advantage of poor integration and exploit the farmers in times of bumper crop produce by way of reduced prices; even below the minimum support price (MSP) level. The government on the other hand does not have maize in its purview of the Public Distribution System and hence, the prevalence of MSP is insignificant for maize.

5.4 Potential and constraints in the marketing system

The marketing of agricultural commodities is different from the marketing of manufactured commodities because of the special characteristics of the agricultural sector (demand and supply), which have a bearing on marketing. These special characteristics affect the supply and demand of agricultural products in a manner different from that governing the supply and demand of the manufacturing sector, notably: perishability of a product, seasonality of production, bulkiness of produce, variation in quality of products, irregular supply of agricultural products, small size of holdings and scattered production, and increased price spread due to multiple processing function.

An efficient marketing system provides an incentive to farmers to produce more, conveys changing needs of the economy to enable production planning, fosters competition among traders and eliminates exploitation, particularly among the small and marginal farmers. With a view to handle the increasing agricultural production, the number of regulated markets in the country has increased. The basic objective of market regulation is to regulate trade practices and increase market efficiency through the reduction of middlemen and market charges, and protect the interests of producers and sellers. With the mass production/mass marketing system being replaced by customer based/market driven strategies the world over, the need for an effective marketing system in India is of paramount importance, especially in the post-WTO scenario. Technology transfer in the field of agricultural marketing has to be geared up.

The potential of a future marketing system lies in:

1. Product planning;
2. Marketing information system;
3. Futures and contracts markets;
4. Organic food marketing;
5. Grading, standardization and quality assurance;
6. Post-harvest management; and
7. IT application in agricultural marketing.

However, the multiplicity of the legal instruments, state co-ordination, market regulations and multiple trade charges and levies on producers and sellers, the existing agricultural mechanisms have failed to check trading malpractices and have made the agricultural marketing system highly restrictive and inefficient.

5.5 Concluding summary

Maize is used for animal feed, food consumption as well as used as raw materials for industrial purposes. About 50 per cent of the produce is used as animal feed. In industry, it is mainly used for starch, fructose and ethanol. The main processes involved after harvest are dry milling, wet milling and alkali processing. Assessment of the marketing system showed that the marketing and distribution channel and the length of this chain depended on the type of market where the maize is being produced and sent. In the rural market, being not so well developed, farmers have to depend mainly on traders and middlemen for marketing their products. The majority of the produce is sold in the local market in the absence of an agro-processing industry in the locality. A lack of transportation facilities was also cited as a constraint. Most of the maize growing areas had roads in very poor condition. A collective effort of the central and state government would help solve this problem and would allow the quick disposal of produce. This would also result in better price realization by the farmers due to the reduced transportation costs. In fact, traders take advantage of infrastructural bottlenecks to exploit farmers and sometimes even pay them below the minimum support price announced by the government.

6. Analysis of the Industrial Processing Business for Maize

6.1 Types of processed products

Maize has acquired a well-deserved reputation as a staple cereal food. With its high level of carbohydrates, fats, proteins, and some vitamins and minerals, it is nutritious for human consumption. Maize has now been termed a *nutricereal*. The high protein quality of maize in quality protein maize (QPM) varieties is another attraction catching the eyes of scientists, planners, policy makers and extension workers to tackle the problem of protein malnutrition prevalent in the world today. On the other hand, maize at the *baby corn* stage can be considered as a blessing for the people, especially weaning infants, elderly people and patients under stress. Hence, there is an urgent need to exploit the potential of maize for the promotion of good health, especially for the vulnerable segments of society. It will only be possible when maize is utilized in more diversified forms by converting it into a variety of products, through grinding, alkali processing, boiling, cooking and fermenting, such as infant foods, health foods/beverages, nutraceuticals, convenience foods, specialty foods and emergency rations. Maize has many industrial applications, which can make it a profitable crop in the future Indian economy.

Types of maize varieties

There are many types of maize varieties, such as flint corn, dent corn, sweetcorn, popcorn, flour corn and waxy corn. This classification is based on the nature and distribution of starch in the endosperm.

Present scenario of maize utilization

In India, maize is utilized as human food, animal feed and raw materials for industrial products. Approximately, 50 per cent of the total produce is for animal feed, about 40 per cent for human consumption and only 10 per cent for industrial uses. As a human food, traditionally, maize is utilized in the form of *roti*, *sattu*, thick *puris*, *bhuja* and *dalia*. Research institutions are paying utmost attention to value-added products of maize for diversification and popularization, like noodles, improved flour, deep fat-fried products like chips, flakes that can be made into savory or sweet preparations and ready-to-eat flavored flakes to boost maize utilization.

Dry milling

Dry milling is followed by either grinding the whole kernel into flour using roller mills or the grains are subjected to conditioning to a moisture level of 18-24 per cent followed by gravity separation and roller milling. Conditioning toughens the germ and induces swelling of the germ, endosperm and pericarp. When it is passed through a degerminator, the germ and pericarp are separated from the endosperm. The resulting materials form grit meals and flour, which can be used for the manufacture of breakfast cereals, extruded snacks and food mixes.

Table 6.1 Applications and advantages of maize processing

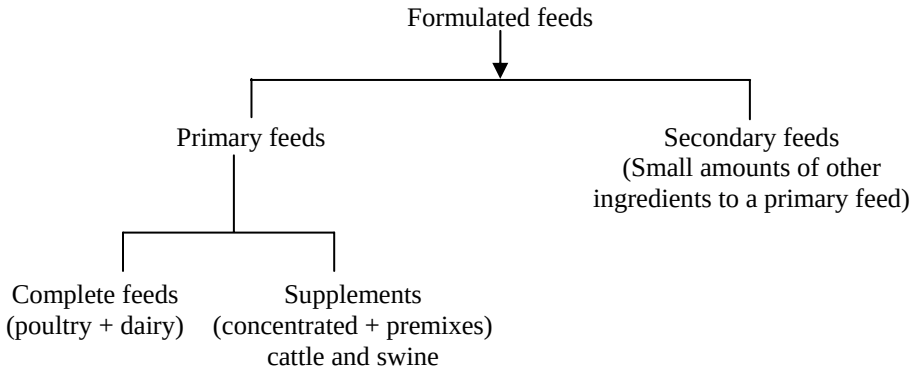
Dry milling		Wet milling		Alkali processing
Fraction	Use	Fraction	Use	
Whole flour:	Ethanol	Corn gluten:	Protein enrichment	Masa: Tortillas,
Grits:	Breakfast cereal	Starch:	Fructose, syrup	Chips, Fabricated foods
Meal:	Extruded snacks	Oil:	Edible oil	
	Food mixer			
Flour:	Food mixes, coatings			
Advantages				
Lower use of energetic fractionation		Higher starch yield		Vitamin
Lower capital cost		Separation of functional components		Niacin availability
Starch manufacture				Improved protein quality

Wet milling

Wet milling involves the adoption of biochemical and chemically induced changes in the maize kernel, which facilitates the mechanical separation of fractions. The kernel is steeped in water with a lower level of SO_2 followed by higher levels of SO_2 and subjected to milling. Protein fraction, starch and maize oil are the major products formed and the protein meal can be used as animal feed.

Recently, a number of nutritional products have appeared from QPM such as weaning food, health food, convenience food and speciality foods. These products are receiving attention from farmers, NGOs and industrialists, however, much needed promotion from governmental organizations is get to come. Some of the industrial products of maize are:

A. Formulated feeds



B. Wet milling products

Cornstarch is the primary product of wet milling. It is recovered in purified form at a yield of 67 to 69 per cent of dry corn substance. It is widely used because it is inexpensive, lacks characteristic flavour and makes a clear paste.

Industrial applications

1. **Unmodified starch**: It is also called milk starch or thick boiling starch. It is the lowest cost industrial starch product. High paste viscosity, strong gel and retrogation are its special properties.
2. **Acid modified cornstarch**: It is used as an adhesive for paper lamination and clay coating. Other uses are as textile warp-size applications (where smooth, strong film coatings are needed to protect the fibers during weaving).
3. **Oxidized starch:** Its paste, if spread in thin layers, dries to a clear adherent continuous film. It is desired for paper, clay coating adhesive, textile warp-size for cotton and rayon, and laundry finishing.

4. **Pre-gelatinized starch:** Has the property of instant solubility and different paste viscosity.

Chemical derivatives:

Heavily cross-bonded cornstarch is used for dusting surgical gloves (after being autoclaved). This starch is not gelatinized but is slowly digested in the body.

i. Hydroxy ethyl acid modified cornstarch;
ii. Hydroxy ethyl starch;
iii. Hydroxy propyl starch (approved by the Food and Drug Adulteration Act);
iv. Cornstarch as amino alkyl and quaternary ammonium;
v. Waxy starch;
vi. Higher amylose starch.

C. Sweetener products

i. Corn syrups;
ii. Dextrose;
iii. High Fructose Corn Syrups (HFCS).

D. Corn oil

Corn oil is commercially produced from corn germ isolated by wet milling or dry milling. It has become a highly desirable vegetable oil because of its bland flavour and high smoke point. Another reason for the popularity of corn oil is its high content of unsaturated fatty acids recognized by medical authorities as a dietary component for reducing blood cholesterol levels.

E. Food products

Cornbread or corn muffins can be made from cornmeal. In Mexico, cornbread is known as *Tothriya*. Another favourite food is cornflakes. The flaking grits are cooked to a rubbery consistency with syrup, malt, salt and flavourings added. After tempering, cooked grits are flattened between large steel rolls followed by toasting in traveling ovens to a golden brown color. Cornflour has been found to be particularly valuable as an ingredient of pancake mixes, baby foods, cookies, biscuits, ice cream cones, ready-to-eat cereals and better breading mixes. Cornflour (fine) is used in the preparation of a thickening agent for soup in most continental food recipes.

F. Other corn foods

Besides many traditional foods from maize like breads, cakes, cornmeal and hominy, maize is important in the preparation of other food products like corncob. An undetermined amount of corncob is used as feed for ruminant animals. The cobs are specially useful for blast polishing and cleaning electrical parts without danger. The free flowing highly absorbent property of corncob granules makes them useful as a carrier for pesticides, fertilizers and vitamins. Finely divided fractions of cob are used in hand soaps, cosmetics and animal litters. Corncob is useful in the extraction of crude petroleum. Thus, maize is a versatile crop full of potential to pay good dividends to farmers, policy makers, planners and scientists.

6.2 Production capacity and its uses

6.2.1 Production capacity

Agro-based industries emerged as the main source of income and employment in India. The important agro-based industries are edible oils and vanaspati, sugar, fermentation, food and

fruit processing, dairy, pulp and paper and starch (maize products). Most agro-based industries fall under the edible oils and vanaspati category followed by sugar, fermentation and food processing.

Table 6.2 Number, capacity and location of maize-based industries

S. No.	Industry segment	Total no. of units	Annual processing/ production capacity	Location
1.	Starch (maize products)	11	0.2 X 10^6 tons	Gujarat, Andhra Pradesh, Uttar Pradesh, Haryana
2.	Feed industry	195	6.0 X 10^6 tons	Karnataka, Andhra Pradesh, Tamilnadu and Maharashtra

Source: Central Pollution Control Board, GOI, CLFMA, Pune, India.

The number of units of starch businesses in the organized sector is only eleven. The annual processing capacity of the starch industry is 200,000 tons. The starch industry is mainly based in Gujarat, Andhra Pradesh, Uttar Pradesh and Haryana states and the feed industry in India has a total installed capacity of 6 million tons comprising of 195 registered units.

6.2.2 Utilization pattern of maize

Farm level

In India, maize is utilized as human food (50 per cent), animal feed (40 per cent) and raw materials (10 per cent) for industrial products. The utilization pattern of maize varies from state to state and according to the size of the farm (Table 6.3). It was found that maize production per farm was highest in Bihar, but a significant proportion of the produce was consumed at the household level, followed by Rajasthan state where maize is one of the staple food crops.

Table 6.3 Utilization pattern of maize on selected farms (Percentage)

Particulars	Bihar	M.P.	Punjab	Rajasthan	U.P.
Food	12.36	4. 80	4.67	15.97	7.83
Feed	15.39	2. 85	4.86	3.07	1.05
Kind payment	9.12	8. 90	4.02	0.30	0.39
Seed	1.49	0. 11	-	1.13	0.65
Loss	1.55	0. 34	0.10	0.28	1.20
Sale	60.09	83. 00	86.35	79.06	88.89
Total production	100.00	100.00	100.00	100.00	100.00
(tons/farm)	(9.13)	(3. 12)	(4.80)	(2.83)	(4.02)

Source: Derived from Field Survey, 2004.

Similarly, maize as feed is used to the tune of 15.39 per cent of total production in Bihar, which is the highest among all the selected states. The farmers of this state, thus, had less marketable surplus maize than other states. In most of the states, around 80 per cent of the total maize produced per farm is sold in the market. The utilization pattern analysis also indicated that *rabi* maize was mainly grown for market, whereas a substantial part of *kharif* maize was used as food and feed.

Household level

A survey was also conducted in Bihar and Uttar Pradesh to find the different ways in which maize was being utilized at a household level, as either food or feed. In Bihar, 82.59 per cent of the maize produced was sold in the market, while 10.29 per cent was used as animal feed and 4.50 per cent as food. In Uttar Pradesh also, most of the maize produced (96.48 per cent) was sold and only 2.27 per cent was retained for food and just 0.15 per cent for animal feed.

To find the utilization pattern of maize in Bihar and Uttar Pradesh, the women of maize growing families were contacted (since women are more informed and resourceful in terms of revealing the utilization at household levels) (Table 6.4). It was understood that in Bihar, 76.5

per cent of the maize kept for feed purposes was used in ground form mixed with other cereals, and the balance was used as pure ground maize. In Uttar Pradesh, whole maize was also fed to animals but only a very small proportion. The majority of the maize was used as feed in ground form with other cereals (79.43 per cent).

Table 6.4 Mode of maize form used as animal feed (Percentage of total maize retained for feed)

Maize forms	Bihar				Uttar Pradesh			
	< 2 ha	2-4 ha	> 4 ha	Overall	< 2 ha	2-4 ha	> 4 ha	Overall
N	112	32	6	150	87	49	14	150
Whole maize	-	-	-	-	4.80	4.55	6.98	4.91
Ground maize	18.5	18.6	33.3	23.5	18.28	13.00	16.63	15.66
Ground maize (mixed with other cereals)	81.5	81.4	66.7	76.5	76.92	82.45	76.39	79.43

Source: Derived from Field Survey, 2004.

The studies (Table 6.5) on human consumption of maize in Bihar revealed that it was being consumed as plain flour (37.19 per cent) in the form of *chapati* or Indian homemade bread, roasted flour (33 per cent) (*sathu* - a ready-to-eat food), dalia (16.15 per cent), roasted cob (9.87 per cent), *chura* or ground form (4.37 per cent), popcorn/*bhuja* (1.81 per cent) and sweetcorn (0.14 per cent). In Uttar Pradesh, maize consumption at home level was in the form of roasted maize (62.66 per cent), popcorn/*bhuja* (21.44 per cent), plain flour (11.27 per cent), roasted flour (2.49 per cent), *chura* (1.42 per cent) and *dalia* (0.72 per cent).

Table 6.5 Maize used for food (Percentage of total maize retained for food)

Maize forms	Bihar				Uttar Pradesh			
	< 2 ha	2-4 ha	> 4 ha	Overall	< 2 ha	2-4 ha	> 4 ha	Overall
Roasted cob	4.6	6.0	19.0	9.9	64.6	60.9	59.4	62.7
Popcorn/ *Bhuja*	0.6	1.8	3.0	1.8	21.8	19.9	25.3	21.4
Chura	6.1	5.0	2.0	4.4	1.7	1.2	0.6	1.4
Dalia	18.6	19.8	10.0	16.1	0.8	0.4	1.4	0.7
Plain flour	39.5	39.0	33.0	37.1	9.2	14.0	11.8	11.3
Roasted flour	30.4	28.2	33.0	30.6	1.9	3.6	1.5	2.5

Source: Derived from Field Survey, 2004.

Macro-level

Maize has a wider range of uses than any other cereal at the macro-level because of its worldwide distribution and lower prices. It can be processed into different products for various end-uses. Traditional or commercial products were found to be based on certain endosperm properties and quality parameters. Quality factors that influence the choice and suitability of maize varieties for various uses included chemical, physical, biochemical, physio-chemical, organoleptic and rheological properties; which can be influenced and altered favourably through breeding and other agronomic practices.

Maize is used as a staple food, animal feed and raw material for industrial products. In developed countries, a larger proportion of maize is used for livestock feeding and as an industrial raw material. The trend of using maize as animal feed has recently picked up in India due to two reasons.

Firstly, increasing per capita income has taken upward swing, which has changed the consumption pattern towards non-vegetarian foods. This requires more animal products and indirectly, demand of animal feed has increased. Secondly, the encroachment of common property resources in rural areas and declining per capita landholding have increased the pressure on agriculture, which has ultimately squeezed pasture land in a big way, forcing domestic livestock to depend mainly on stall feeding.

Maize is used extensively as the main source of calories in animal feeding and feed formulation as maize gives the highest conversion of dry substance to meat, milk and eggs compared to other cereal grains. Maize is a valuable feed grain because it is among the highest in net energy content and lowest in protein and fibre content. It is fed either directly or is dried, milled and compounded with other ingredients, the mixture is then fed or converted into forms preferred by specific animals. By-products of industrial wet and dry milling are also used as feed.

The present level of production of animal products, namely milk, meat, fibre and eggs will have to be augmented in response to growing demand. To meet the demand of increasing numbers of livestock and also their higher productivity, feed resources will have to be augmented. In terms of animal feed, coarse cereals particularly maize, have a major role to play. At present, the country faces a net deficit of 61.1 per cent in green fodder and 64 per cent in feeds (Pathak, 2003).

The Indian feed industry comprises both organized as well as unorganized sectors. The organized sector has around 195 registered manufacturing units under the umbrella of the Compound Livestock Feed Manufacturers Association (CLFMA), producing 2.8 million tons of compound feed despite having an installed capacity of nearly 6.0 million tons. Of the total, just eight manufacturing units control the lion's share (over 50 per cent). Over the years, cattle feed production has remained static but there has been a sharp increase in poultry feed production. Cattle feed production has increased from just 25,000 tons in 1965 to 1.50 million tons in 1995 and further to 1.64 million tons in 2000, registering a growth rate of nearly 8 per cent. However, during the same period, the growth in poultry feed production was to the tune of nearly 36 per cent. It grew from a mere 14,000 tons to 1.26 million to 1.94 million tons (Table 6.6). Even now, the potential of animal feed production is quite high in India. Cattle feed and poultry feed production potential stands at 60 and 9 million tons respectively, which shows that the industry is currently utilizing only 2.6 per cent of cattle feed production and 21.1 per cent of poultry feed production. There exists a huge gap between realized potential and the current level of production (Singh *et al*., 2003).

Table 6.6 Production of compound livestock feed by the organized feed sector in India (Million tons)

Particulars	1965	1975	1985	1995	2000	2001	Growth rate (1965-2001)
Cattle	0.025	0.26	0.75	1.50	1.64	1.65	8.0
Poultry	0.014	0.17	0.41	1.26	1.94	1.94	36.0
Others	-	-	-	0.05	0.03	0.04	Nil
Total	0.039	0.44	1.16	2.81	3.61	3.63	20.0

Source: Various CLFMA publications on production.

According to the National Egg Coordination Committee and Poultry Development and Promotion Council, the Indian poultry industry with a turnover of INR 290 billion annually, is among the worlds leading producers of poultry and is growing at a spectacular rate of 15 per cent per annum. With rapidly growing exports to Europe, Japan, the Middle East and many more, it is the fastest growing industry in the agricultural sector. Annual production of maize is about 12 million tons, out of which nearly 45 per cent is used for animal feed. *Kharif* maize accounts for nearly 90 per cent of maize production while the remainder comes from the recently introduced *rabi* (winter) maize. Pathak (2003) estimated the demand projections for maize at 12.8 mt by 2012. This estimate seems to be based on a conservative assumption of either no growth or negative growth in the demand for maize as food, feed or even processing purposes in the long-term, whereas all countries are expected to show increasing demand for feed.

The total demand for concentrated feed is likely to show a growing trend at a rate of 2.69 per cent annually over the next ten years. The poultry, swine and buffalo sectors are expected to grow by 5.74, 4.07 and 2.41 percent annually, respectively (Hutabarat, 2003). As regards to

corn consumption in 2004, off-take from the poultry sector is expected to be 6.64 mt, the livestock sector 1.39 mt, starch industry 1.10 mt and brewery 60,000 tons (Subramani, 2004). On the other hand, the WTO has its own implications affecting the demand of maize, as global maize demand is expected to increase by 50 per cent within the next two decades. Keeping this in mind, the demand for maize was estimated under two scenarios. Under the first scenario, it was assumed that there would be high growth (8 per cent in the short-run and 5 per cent in the long-run) in maize demand for feed, and under the second scenario, conservative growth (5 per cent in the short-run and 3 per cent in the long-run) was assumed. Table 6.7 reveals that India would need at least 15 mt of maize by 2010 and 16 mt by 2015. This is the scenario under the assumption of a closed economy. If India wishes to tap the international market, it will require much greater maize production. Also observed was that if the area under maize expands as in the past, the yield of this crop should increase to 2.15 t/ha, and if it remains constant yield will have to be improved to 2.31 t/ha to meet domestic demand (Table 6. 7).

Industrial purposes

Industrial uses of maize are categorized under two processes: wet milling and dry milling. Processing basically separates the fractions of the grain into germ, hull and endosperm to produce a wide range of products for various food and non-food uses. In addition to the conventional industrial uses of maize grains, there are many other newer areas with high potential. Entrepreneurs around the globe are turning to an environmentally friendly and bio-degradable form of plastic developed by Cargill Dow from polylactic acid (PLA), a maize-based polymer (Grain News, 2003). The product is being commercially used by companies like Sony, Fujitsu and Wilkinson for making shells of laptop computers and food containers.

Table 6.7 Demand projections of maize in India (Million tons)

Sector	2005-2006		2010-2011		2015-2016	
	Scenario1	Scenario2	Scenario1	Scenario2	Scenario1	Scenario2
Food	3.60	3.60	3.60	3.60	3.60	3.60
Feed	8.96	7.79	9.94	8.20	12.67	9.49
Industrial uses	1.87	1.87	2.07	2.07	2.27	2.27
Seed	0.13	0.13	0.13	0.13	0.14	0.14
Wastage	0.54	0.54	0.54	0.54	0.55	0.55
Total	15.1	13.93	16.28	14.54	19.23	16.05
Area (million ha)	6.95	6.95	7.15	7.15	7.45	7.45
Required yield with area expansion (t/ha)	2.17	2.00	2.28	2.03	2.58	2.15
Required yield with constant area (t/ha)	2.17	2.00	2.34	2.09	2.77	2.31

Source: Estimated from data of CLFMA, Pune.
Scenario-1: Growth in feed expected 8 per cent during 2001-2005, 5 per cent during 2010-2011 and 2015-2016.
Scenario-2: Growth in feed expected 5 per cent during 2001-2005, 3 per cent during 2010-2011 and 2015-2016.

6.3 Cost-revenue structure and business profitability

The maize based industries, namely animal and bird feeds and starch have grown very much, as indicated in Table 6.8. The number of animal and bird feed industries has increased from 301 in 1991-1992 to 377 in 1996-1997. The value of output of animal and bird feed industries was INR 9,397 million in 1991-1992, which increased to INR 24,904 million in 1996-1997. The number of starch producing units in India was 367 in 1991-1992 declining to 278 in 1996-1997. This was due to the closure of many starch producing units, specifically in Madhya Pradesh and Rajasthan state because the price of starch declined in the international market and the high cost of domestic production. However, total starch output increased from INR 3,251 million in 1991-1992 to 5,287 million in 1996-1997. The value of inputs used in animal and bird

feed industries was INR 8,421 million and INR 2,493 million respectively in 1996-1997. The net income from animal and bird feed industries was INR 749 million, rising to INR 1,628 million in 1996-1997. The total value of inputs used in the starch industry was INR 2,810 million in 1991-1992 and INR 4,307 million in 1996-1997. The net income from the starch industry in India was INR 160 million in 1991-1992 and increased to INR 660 million in 1996-1997.

Maize based industry showed potential for employment generation as the number of persons engaged in the animal and bird feed industry and the starch industry increased from 12,997 and 2,910 in 1991-1992 respectively to 18,970 and 8,196 in 1996-1997. The value of output per person engaged in the animal and bird feed industry increased from INR 764,154 in 1991-1992 to INR 1,312,826 in 1996-1997. Further, the net value added increased from INR 895 million to INR 2,164 million during the same period.

Table 6.8 Input-output of processing industries

Particulars	Unit	Animal and bird feeds			Starch		
		1991-1992	1994-1995	1996-1997	1991-1992	1994-1995	1996-1997
Value of output (gross)	INR million	9 397	16 163	24 904	3 251	4 548	5 287
Products (VOP- Non-indl. Services)	INR million	9 233	15 919	22 298	3 187	4 417	5 106
Total inputs	INR million	8 421	13 955	22 493	2 810	3 819	4 307
Total emoluments	INR million	251	447	647	183	233	236
Depreciation	INR million	81	174	247	92	80	86
Profits (PBT)	INR million	458	1 154	881	-59	158	383
Net value added	INR million	895	2 035	2 164	349	649	894
Rent paid	INR million	18	27	52	21	15	14
Interest paid	INR million	128	349	484	168	194	221
Net income	INR million	749	1 659	1 628	160	440	660
Fixed capital (Net Fixed assets)	INR million	720	2 109	3 129	777	1 290	1 377
Working capital	INR million	768	754	1 979	369	534	299
Invested capital (NFA+ Inventories)	INR million	1 742	4 269	6 262	1 580	2 249	2 357
Total persons engaged	Nos.	12 297	15 703	18 970	2 910	11 032	8 196
VOP/invested capital	Times	5.39	3.79	3.98	4.19	2.02	2.24
VOP/persons engaged	INR/person	764 154	1 029 326	1 312 826	272 918	412 219	645 034
Factories	Nos.	301	346	377	367	369	278

Source: Industry: Financial Aggregates and Ratios, CMIE, June 2000, 1 crore equals 10 million.

6.4 Potential and constraints in industrial processing

6.4.1 Potential assessment for maize processing

Maize is one of the important *Kharif* crops of India grown over an area of 6.29 million hectares with annual production of 10.30 million tons. At present, the processing of maize into a value added product is very limited. It is a staple food for local people but its consumption has declined over a period of time. Increased income levels and the PDS support available for rice and wheat by the Government of India have led to less consumption of maize by local people thereby leaving a huge marketed surplus. There is huge potential but it may not be possible to process the entire surplus of maize to value added products immediately as market development takes time.

Table 6.9 Marketed surplus ratio[a] of maize in various states

State	1999-2000	2000-2001	2001-2002
Bihar	55.0	40.8	49.2
Madhya Pradesh	65.9	52.9	61.8
Punjab	n.a.	n.a.	n.a.
Rajasthan	37.5	36.8	42.3
Uttar Pradesh	61.9	78.5	61.4
All India weighted average	67.3	69.1	66.0

Source: Agricultural Statistics at a Glance, 2004.

Note: [a] Marketed surplus is a quantity of the produce, which the producer-farmer actually sells in the market, irrespective of his requirements for family consumption, farm needs and other payments. Marketed surplus ratio is the ratio of marketed surplus and total production of the crop for the household.

n.a. = not available.

Strengths

- Maize production in the country has been growing steadily over the past five years. The anticipated production of maize during 2004-2005 is estimated to be in the range of 11-12 mt.
- Government of India initiative to increase the area of cultivation and production of maize during the 10^{th} Five-Year Plan period and its inclusion under the technology mission has given impetus to maize production in the country.
- Starch manufacturing from maize generates about 1 mt of by-products for every 2 mt of starch produced and these by-products are worth more per metric ton than the maize itself making starch manufacture an economic venture.
- Strong raw material base with total production of 6.0-7.0 lakh mt and 4.0-4.5 lakh mt of market surplus.
- Maize is becoming a cash crop for farmers, as a major part of it is usually sold at the market. Further, there is no substitute for it particularly under rainfed conditions and so the farmers will continue to grow maize.
- Agro and food processing are thrust areas for the Government of India. A special package of incentives is available for processing units established in designated areas.
- Maize starch is a preferred product compared to its substitutes like potato starch and tapioca starch.
- The productivity of maize is already high but can still be raised further. The higher the productivity, the lower the cost of production will be.

Opportunities

- Backward linkages with farmers (contract farming type arrangement) is possible, as maize has become a cash crop.
- Demand for starch is high from varied users like food, pharmaceuticals, textiles, paper and packaging.
- The demand is likely to increase to 18.6 million tons by 2011-2012.
- Great export demand for corn gluten as a poultry feed from Southeast Asian countries.
- More than 75 per cent of total maize imported in the world comes to East Asian or South Asian countries which provides a huge opportunity for India in terms of geographical proximity.
- Substantial subsidies from the government in the form of land, subsidized power and water are available.
- Cornstarch has been identified as one of the ingredients for the manufacture of biodegradable plastic. The demand for cornstarch is expected to increase in future.
- Cornstarch is a substrate in the manufacture of alcohol, which has been identified as an environmentally friendly fuel.

6.4.2 Constraints to industrial processing units

- Competition for maize procurement by the poultry feed industry will limit raw material availability.
- No organized market/single place for bulk procurement. Maize has to be procured from individual farmers or through middlemen/traders, which may hamper the regular availability or may cause price fluctuations.
- Maize is produced mainly in the *Kharif* season and mainly grown under rainfed conditions.
- Stiff competition from other producers within the country.

6.5 Concluding summary

Maize, due to its varied properties, finds multiple uses from domestic consumption to industrial uses; making consumer products, chemical derivatives and clinical derivatives. In India, almost 30 per cent of the crop output is used for domestic and food consumption, 60 per cent is used for animal feed and the final 10 per cent is used for industrial purposes. Maize has helped not only in increasing farm income but also in increasing employment opportunities in urban and peri-urban areas. Various processes like dry milling and wet milling also provide opportunities to add value to maize at various stages and for a variety of purposes. It also provides a base for agro-based industries such as food processing, edible oils and vanaspati ghee. Starch industries are mainly located in Gujarat, Andhra Pradesh, Uttar Pradesh and Haryana with an installed capacity of 6 million tons.

According to the analysis of end uses of maize at the macro level, it showed that maize has gained substantial importance as feed and fodder. At present, India is facing a 61.1 per cent net deficit in green fodder and 64 per cent in animal feeds representing the scope of the increasing demand for maize as animal feed. There is a huge gap between the realized potential and current level of production of the industry. With the growing demand of feed, the number of units in the feed industry is also growing but at a slow pace. Maize based industries show substantial potential in employment generation and income augmentation for unskilled labourers.

7. Analysis of Institutional Support

7.1 Economic policies

7.1.1 Price support programme

During 2003-2004, there was a noticeable improvement in the production performance of Indian agriculture. According to the 2nd Advance Estimate by the Directorate of Economics and Statistics of the Department of Agriculture and Co-operation, Government of India, the production of foodgrains reached an unprecedented level of about 212.2 million tons, comprising about 111 million tons of *kharif* and 101.2 million tons of *rabi* foodgrains. Compared to 2002-2003, which was marked by severe drought in various parts of the country, the production of total foodgrains in 2003-2004 was higher by about 38.2 million tons.

The improvement in agricultural production performance in 2003-2004 could largely be attributed to favourable weather conditions. However, a favourable price regime, and both market and minimum support prices (MSP) would have also played a positive role. The minimum support prices are prices, which are announced by the union government prior to the harvest season. The average actual rainfall during June 2003 to February 2004 (covering monsoon, post monsoon and winter seasons) in the country was estimated at 109.4 cm, which was higher by about 2.7 cm than the normal rainfall of 106.7 cm for the same period. However, the regional distribution was quite uneven.

The government announced the price policy for *Kharif* crops for the 2003-2004 season on 30 July 2003. The minimum support prices as recommended by the commission were fixed. The minimum support prices of coarse cereals were marginally hiked; especially to encourage farmers to grow maize as a substitute for paddy crop wherever feasible, because maize is not only a less water-consuming crop, but also it has large yield potential and diverse uses. The market prices of paddy, maize, jowar and bajra were also reported to be lower than MSPs in several places. This happened because the government did not give emphasis to the procurement of these coarse cereals and instead concentrated on fine cereals like wheat and rice. In the case of maize, bajra, jowar and barley, the FCI (the government agency responsible for procurement) has always failed to procure adequate quantities on some pretext or other, thereby defeating the very purpose of fixing minimum support prices for these commodities. About 6.5 lakh tons of coarse cereals were procured. The total stock of grains as of 1 April 2004 has been estimated to be higher by about 3.08 million tons than the stipulated buffer stock norm of 15.8 million tons, the likely stock as on 1 April 2005 will be less by about 1.92 million tons. The stock of rice alone is likely to be less by about 1.74 million tons than the buffer norm of 11.8 million tons.

Table 7.1 Minimum support price and procurement of maize in India

Year	*Minimum support price (INR /ton)*
1974-1975	740
1980-1981	1 050
1990-1991	1 800
1995-1996	3 100
1998-1999	3 900
1999-2000	4 150
2000-2001	4 450
2001-2002	4 850
2002-2003	4850
2003-2004	5 050

Source: Agricultural Statistics at a Glance, Various Issues, Ministry of Agriculture.

The Wholesale Price Index (WPI) of all agricultural commodities (base 1993-1994 = 100) was higher by about 4 per cent in 2003-2004, compared to that of 2002-2003. However, the WPI of several commodities, namely jowar, bajra, maize and barley fell sharply.

The international prices of agricultural commodities remained quite buoyant during 2003. The price of maize rose from $ 99.3 in 2002 to $ 105.4 in 2003. Since international prices of agricultural commodities fluctuate widely from year to year and do not often give accurate price signals to Indian producers and traders, one does not really know whether the current upward trend in international prices will be sustained in the future to stimulate domestic price buoyancy and help improve India's exports of agricultural commodities. Doubts arise because world production of several agricultural commodities have also shown an upward trend. According to FAO's Food Outlook (April, 2004), global cereal output increased from 1,835.2 million tons in 2002-2003 to 1,884.3 million tons in 2003-2004. This is expected to increase further by 2 per cent in 2004-2005.

7.1.2 Credit support programme for farming, processing and marketing activities

The objective of the government is to double the credit flow to the agricultural sector in three years. The government has taken several policy initiatives to strengthen the rural credit delivery system to support the growing credit needs of the agricultural sector. The emphasis of these policies has been on progressive institutionalization providing timely and adequate credit support to farmers with particular focus on small and marginal farmers and weaker sections of society to enable them to adopt modern technology and improved agricultural practices for increasing agricultural production and productivity. The policy essentially lays emphasis on augmenting credit flow at the ground level through credit planning, adoption of region specific strategies and rationalization of lending policies and procedures. Some of the important initiatives taken in recent years for improving agricultural credit flow are as follows:

Non-availability of adequate credit at affordable rates of interest is another area of concern. In view of declining public investment in agriculture, increases in private investment through institutional borrowing appears to be the only hope for the modernization of agriculture. Unfortunately, the prevalent rates of interest on crop loans continue to be high from the perspective of a small farmer. Also, farmers have to face many inconveniences to access institutional credit. It is indeed unthinkable as to how accelerated and diversified agricultural growth would take place in the absence of adequate and easily loanable funds for facilitating the increased use of modern technical inputs by small and marginal farmers. During 2003-2004, the government reduced the interest rate on crop loans up to INR 50,000. However, due to a lack of information, farmers in most places could not make use of this interest cut. Also, the value of loans required for high value crops is much higher. Therefore, the ceiling of INR 50,000 should go. In order to avoid the hassle and harassment, farmers in many parts of the country continue to obtain loans from private money lenders at exorbitant rates of interest. Therefore, the entire credit delivery system should be made easier and more farmer friendly. In fact, the credit support programme in the country is meant for the special crops/cash crops and farmers *per se.*

Credit for the marketing of crops (pledge financing) should be substantially stepped up to reach a level of at least INR 70,000 million by the end of 10th Five Year Plan Period in 2007. RBI needs to formulate appropriate marketing credit policies and to introduce a separate MIS for loans given for pledge financing in order to monitor progress. NABARD need to augment the resources of State Marketing Cooperatives to provide pledge financing facilities to farmers and to provide 100 per cent refinance to RRBs, on similar lines as that of cooperative banks. RBI should also consider evolving an appropriate arrangement to ensure that warehousing receipts/godown receipts issued by licensed operators of rural godowns are acceptable to bankers for providing credit to farmers. To facilitate easy access to pledge loans, RBI should evolve a simplified procedure in consultation with commercial banks.

7.1.3 Food diversification policies

In a country like India, government initiatives on food diversification policies have never been at the forefront. Consumption has largely depended on the varied agro-climatic features and the availability/suitability of crops in the region. However, recently several state governments as well as the central government have made efforts to promote agricultural diversification. Some state governments have even worked out plans for agricultural diversification, involving a shift in area from paddy-wheat cropping systems to pulses, oilseeds, fruits and vegetable. It is however, necessary to ensure that any such diversification plan is economically viable and sustainable. Farmers only change their cropping patterns when they expect economic gain from such a change. A close examination of relative net returns from various possible alternative crop rotations, especially in the Indo-Gangetic plain region indicates that at the current levels of yield, price and costs, no cropping system really provides an economically rewarding alternative to paddy-wheat rotation. In the case of pulses, there has been virtually no technological breakthroughs to improve the yield levels and therefore, despite favourable market prices, both the area and production of pulses have stagnated over time. Oilseed crops however, merit special attention for strategic diversification, as the country is importing huge quantities of edible oils at present and also the supply response to price change in oilseed crops is quite significant. Nevertheless, unless there is a well coordinated policy package involving wide availability of high yielding seeds, adoption of farming practices, effective price support cum marketing arrangements and a reasonable level of tariffs on imports on edible oils, the much desired oilseed based agricultural diversification may not be forthcoming.

There is enough evidence to suggest that per capita consumption of cereals as food has declined while that of fruits, vegetables, meat, fish, eggs and dairy products has increased in past decades. Research supports that household income and food prices strongly influence food consumption patterns. Shifts in consumption patterns also take place as a result of urbanization. Coarse cereals were excluded from the purview of PDS and only fine cereals and a few commodities were in the ambit of same. A larger proportion of subsidies were extended to rice and wheat. This eventually had an adverse impact on the consumption pattern of coarse grains and pulses. In the past, even consumption policies were centered on fine cereals.

Considering the importance of crop diversification in the overall development strategy for Indian agriculture, the government has taken several initiatives towards agricultural development in general and crop diversification in particular. These initiatives are as follows:

(i) *Launching a technology mission for the integrated development of horticulture in the north eastern region*: The programme will establish effective linkages between research, production, extension, post-harvest management, processing, marketing and exports and bring about rapid development in agriculture in the region.

(ii) *Implementing a National Agricultural Insurance Scheme*: The scheme will cover food crops and oilseeds and annual commercial and horticultural crops. Small and marginal farmers are eligible for a 50 per cent subsidy under this scheme.

(iii) *Operationalizing technology*; *Mission on Cotton*: The technology mission will have separate mini-missions on technology generation, product support and extension, market infrastructure and modernization of ginning and pressing units.

(iv) *Provision of capital subsidy of 25 per cent for the construction/modernization/ expansion* of *cold storage facilities and storage for horticultural produce.*

(v) *Creation of Watershed Development Fund*: At the national level for the development of rainfed lands.

(vi) *Infrastructure support for horticultural development with emphasis on post-harvest management.*

(vii) *Strengthening agricultural marketing*: Greater attention to be paid to the development of a comprehensive, efficient and responsive marketing system for domestic marketing as well as exports by ensuring proper quality control and standardization.

(viii) *Seed crop insurance*: A pilot scheme on crop seed insurance has been launched which will cover the risk factor involved in the production of seeds.

(ix) *Seed bank scheme*: About 7-8 per cent of certified seeds produced in the country are kept as a buffer stock to meet any eventualities arising from drought, floods or any other form of natural calamity.

(x) *Co-operative sector reforms*: Amendment to the National Cooperative Development Corporation (NCDC) Act. 1952 and Replacement of the Multi-State Cooperative Societies (MSCS) Act, 1984.

All these measures will lead to crop diversification and increase production and productivity of crops, especially commercial and horticultural crops. However, no concrete policy is directed to coarse grains except maize and pulses for which a mission-oriented approach, by way of the Technology Mission, is being undertaken.

In the past, most agricultural developmental policies were geared towards the larger farmers and resource rich regions. CGPRT crops are cultivated mostly by small and marginal peasants and in predominantly marginal and fragile environments, therefore, the ideal mix of a technological, economic and institutional package needs be devised and promoted.

The government's incentives for investing in infrastructure such as improved farm storage and processing units will encourage the increased use of CGPRT crops. Finally, the policies that augment food availability in seasons of scarcity will contribute to improved productivity and household income gains by increasing the income levels of farmers. Hence, the pragmatic interplay of institutional, economic and technological policies is a must for multi-pronged strategies effecting the overall improvement of the CGPRT economy. Recognizing crop diversification as an element of poverty alleviation, equity and natural resource conservation, a well designed mechanism has to be developed through the participation of various stakeholders to strengthen a sustainable agricultural economy.

7.1.4 International trade policies

Up until the end of the eighties, imports and exports of major agricultural commodities were restricted. The trade flows were generally residual in nature and controlled through quantitative restrictions and canalization. Since 1991, the trade policy regime has undergone considerable change. Canalization has been almost abandoned. The negative lists of both imports and exports have been pruned. In the EXIM (exports and imports) policy announced for the period 2000-2001, most of the agricultural commodities have been deleted from the negative lists of imports and exports. The agricultural commodities which do not appear on a negative list are exportable without restriction and importable under an open general license. The quantitative restrictions on agricultural products have been withdrawn and duties on imports reduced. By the end of March 2003, the quantitative restrictions on almost all agricultural commodities were removed. Trade policies in the past have only contributed to the extent of the introduction of some crops, like soybean in the mid eighties. The import of 50,000 tons of maize in the late nineties had an impact on the prices of domestic maize which had fallen to below the MSP level adding misery to the poor maize farmers.

7.1.5 Investment policies

The investment policies of the country in the past were only aimed at creating infrastructure for marketing and processing. With a view to attract requisite investment for the development of marketing infrastructure in the country, a new central scheme should be formulated to provide credit linked assistance for the development of general and commodity specific agricultural produce markets and for strengthening existing agricultural markets; wholesale, rural periodic and in tribal areas. For the construction of storage, cold storage and a cold chain infrastructure, the ongoing central schemes should be further expanded to create

additional capacity for the existing rural storage of 8.5 million tons, cold storage of 5.6 million tons and requisite cold chain infrastructure during the Tenth Plan Period. Central assistance should be conditional and linked to reforms in the APMC acts and deregulation. Considering the magnitude of outlay, required external funding should be sought, if required, to augment the resources of central and state governments to support the infrastructure development programme.

7.2 Infrastructure provisions

7.2.1 Irrigation

Irrigation has been the cornerstone of agricultural diversification in the country. The availability of irrigation in the hitherto rainfed regions prompted farmers to switch over to the more remunerative crops setting aside area under coarse grains. Irrigation planning in India is in a phased manner. Irrigation projects in India are classified into three categories, namely major, medium and minor. Projects having a Cultivable Command Area (CCA) of more than 10,000 hectares are termed as major projects, those having a CCA of less than 10,000 hectares but more than 2,000 hectares are termed as medium projects and those which have a CCA of 2,000 hectares or less are known as minor projects. A broad assessment of the area that can be ultimately brought under irrigation both by surface and ground water made by the various states in the sixties indicated that the ultimate irrigation potential of the country would be in the order of 113 million hectares. The ultimate potential is 139 million hectares, the increase being primarily due to upward revision of the assessed potential of minor groundwater schemes and minor surface water schemes to 64 million hectares and 17 million hectares respectively. Minor irrigation projects have both surface and groundwater as their source, while major and medium projects mostly exploit surface water resources.

In the initial phase of water resources development during the planning period after independence, rapid harnessing of water resources was the prime objective. Accordingly, the local authorities were encouraged to expeditiously formulate and develop water resource projects for specific purposes like irrigation, flood control, hydro-power generation, drinking water supply, industrial and various miscellaneous uses. As a result, a large number of projects comprising dams, barrages, hydro-power structures and a canal network. have come up all over the country in successive Five Year Plans. A milestone in water resources development in India is the creation of a huge storage capacity. Because of these storage works it has now become possible to provide assured irrigation, ensure the supply of power, flood moderation and supply drinking water in different parts of the country.

In order to attain self-sufficiency in food, various major, medium and minor irrigation and multi-purpose projects were formulated and implemented through successive Five Year Plans to create additional irrigation potential throughout the country (Appendix 3). This drive, compounded with the green revolution in the agricultural sector, has enabled India to become a marginally surplus country from a deficit one in food grains. The scenario of development of irrigation in the states during the planned development is discussed in the following section.

While the development of irrigation is most essential for increasing food and other agricultural production to meet the needs of the growing population, the development of minor irrigation should receive greater attention because of several advantages it possesses like small investment, simpler components, also being labour intensive, quick maturing and farmer friendly. The Ministry of Rural Areas and Employment launched a Million Wells Scheme (MWS) in 1988-1989. As of 1997-1998, a total of 1,263,090 wells have been constructed under MWS costing INR 47.28 billion in total. The Ministry of Rural Areas and Employment is also implementing a Drought Prone Area Programme (DPAP) on a watershed basis.

Groundwater development is primarily through the individual and cooperative efforts of farmers with the help of institutional finance and their own savings. Surface water minor

irrigation schemes i.e. surface lift schemes and surface flow schemes are generally funded from public sector outlay. NABARD provides finance to banks for the installation of minor irrigation works in the states. In addition, the Land Development Bank provides bank credit to farmers under their normal programmes also. During 1997-1998, the total credit disbursement for minor irrigation works was INR 4.89 billion. Further, many old schemes became obsolete due to one reason or another. Minor irrigation schemes are not being recorded systematically in most cases as these schemes are implemented and monitored by individual farmers. All the Groundwater Schemes and Surface Water Schemes having Cultivable Command Area (CCA) up to 2,000 hectares are included in the minor irrigation sector.

The state wise Net Irrigated Area (NIA) and Net Sown Area (NSA) of the selected states is shown in Table 7.2. The percentage of NIA to NSA was highest in Punjab to the tune of 93 per cent, while it was lowest in Madhya Pradesh at nearly 32 per cent. However, in the country as a whole, the percentage of NIA to NSA was nearly 39 per cent. This calls for more concerted efforts in the direction of creating irrigation infrastructure in the country. With this premise, the Government of India announced the National Water Policy in 2002.

Table 7.2 State-wise details of net irrigated area (NIA), net sown area (NSA) and percentage of NIA to NSA

(Thousand hectares)

State	Net Sown Area (NSA)	Net Irrigated Area (NIA)	Percentage of NIA to NSA
Bihar	7,337	3,624	49.39
Madhya Pradesh	19,794	6,399	32.33
Punjab	4,139	3,847	92.95
Rajasthan	16,790	5,588	33.28
Uttar Pradesh	17,475	11,999	68.66
Grand Total	142,819	55,143	38.61

Source: Agricultural Statistics at a Glance, Ministry of Agriculture, Government of India.

The National Water Policy envisages irrigation planning taking into account the irrigability of land, cost-effective irrigation options and appropriate irrigation techniques for optimizing water use efficiency. It also calls for close integration of water use and land use policies. It regards equity and social justice on top of its planning and aims to remove the disparities in the availability of water between head-reach and tail-end farms, and between large and small farms it should be obviated by the adoption of a rotational water distribution system and supply water on a volumetric basis subject to certain ceilings and rational pricing. The policy also streamlines efforts to ensure that the irrigation potential is fully utilized by adopting a command area development plan in all irrigation projects. The reclamation of water logged/saline affected land by scientific and cost-effective methods should form part of the command area development programme.

7.2.2 Transportation

An efficient transport system is a prerequisite for sustained economic development. It is not only the key infrastructural input for the growth process, but the transport system plays an important role in promoting the development of backward regions and integrating them with the mainstream economy by opening them to trade and investment. In a liberalized economy, an efficient transport network becomes all the more important to increase productivity and enhance the competitive efficiency of the economy in the world market. The road transport sector in India has expanded manifold in the first fifty years of planned development, both in terms of spread and capacity. The development of a road network coupled with market infrastructure adds considerably to the returns of the farmers by way of smooth marketability of the produce due to efficient market linkages and remunerative prices. However, the road network, though extensive, remains inadequate in terms of spread, suffers from a number of deficiencies and is unable to handle high traffic density in many places and is of poor quality in some areas. The main reason for these shortcomings is the inadequacy of funds. Efforts are now underway to

address these issues and improving the road network has been accorded very high priority. This expansion of capacity will have to be accompanied by technological upgrades in many critical areas. The need for new technology acquires greater urgency because the sector has been suffering from slow technological development for a long time.

The Ninth Plan (1997-2002) envisaged a comprehensive package to address various transport sector issues. It emphasized the need for improving the capacity and quality of the transportation system through technological adoption. It also stressed improving the self-financing capacity of this sector and on the need for ensuring an improved transport system to provide speedy, efficient, safe and economical carriage of goods and people. The Planning Commission feels that the achievement of objectives and targets for the road sub-sector have been encouraging during the plan period.

The Tenth Plan Document (2002-2007) reiterates the need for expeditious development of the primary system [national highways (NH) and expressways], secondary system [state highways (SH) and major district roads (MDR)] and rural roads. The expeditious completion of the Golden Quadrilateral and also the North-South and East-West corridors is therefore essential. Encouragement for private sector participation in the highway sector, levy of tolls on the NH network, phased removal of deficiencies in the existing NH network, provision of wayside amenities along highways, popularization of use of containers and multi-axle vehicles in the carriage of goods for reducing transportation cost and road safety are some of the other major thrust areas. With 2004 being declared as the year of road safety, there is a concomitant requirement to tackle road safety related issues.

The total length of the roads in India has increased significantly from 0.4 million km in 1951 to 3.83 million km in 2002. The length of surfaced roads has also increased from 0.16 million km to around 1.6 million km during the same period. The 'surfaced' length constitutes 47.3 per cent of total road length as of 2002, up from 39.3 per cent of the total road length in 1951. Among the different categories of roads, national highways constitute around 2 per cent, state highways 4 per cent, PWD roads 21 per cent and urban roads 7 per cent. The rest of the road length in the country is accounted for by the rural roads. While the development and maintenance of national highways is under the purview of the central government, all other categories of roads come under the purview of the respective state/UT governments.

The existing road network is showing signs of serious distress due to neglect of maintenance, which is highly uneconomic from a national point of view. Of the total length of 65,569 km of NH, about 25,000 km is under severe strain due to the high volume of traffic. One of the main factors responsible for this is the upgrading of large segments of state highways to national highways during the Ninth Plan. The total estimated cost of removing deficiencies on national highways is about INR 1,650 billion. The present allocation for the maintenance of national highways is only 40 per cent of the requirement based on the norms for maintenance. The situation in respect to state roads is worse still. Due to resource constraints, the private sector also needs to be involved in the maintenance of national highways. A massive programme for 4/6 laning about 14,279 km of existing national highways falling under NHDP phase-I and phase-II have been taken up at a cost of INR 646.4 billion. This aims at 4/6 laning the existing two lane national highways comprising the Golden Quadrilateral (GQ) linking Delhi-Mumbai-Chennai-Kolkata and the North-South, East-West corridors connecting Srinagar to Kanyakumari and Silchar to Porbundar. The total length of GQ (after alignment finalization) is 5,846 km. The GQ is expected to be substantially completed by December 2004 and the entire NHDP phase-I and phase-II by December 2007.

7.2.3 Marketing

Agricultural marketing is a process that starts with a decision to produce a tradable farm product and involves all aspects of the market structure or system, both functional and institutional, based on technical and economic considerations. In the past, the increased market network in most parts of the country has benefited farmers by way of remunerative prices for

their produce. Currently, agricultural diversification programmes in the country are centered around market provisions; remunerative prices. Though agricultural marketing is a state subject, the Government of India has an important role to play in laying down a general policy framework, establishing and maintaining quality standards, conducting surveys and research studies and in providing guidance, technical and financial support to the local authorities. The central government is aided and advised by two organizations under its control, namely, the Directorate of Marketing and Inspection (DMI) and the National Institute of Agricultural Marketing (NIAM), Jaipur. The DMI, as a central advisory organization, provides technical assistance and advice to the states in framing suitable market legislation. Due to the constant endeavour of DMI, all states and UTs except Manipur, Kerala, Andaman and Nicobar Island, Lakshadweep and Dadra, and Nagar Haveli have enacted legislation. The Jammu and Kashmir Assembly has passed a bill on Market Regulation. The DMI is pursuing with remaining states/UTs for the enactment of necessary legislation. Out of 7,245 wholesale assembling markets in the country, 7,062 markets have been brought under the ambit of regulation as of 31st March 2001.

The DMI is conducting 20 market surveys for various commodities and the reports are likely to be published soon. The Marketing Planning and Design Centre (MPDC) of DMI prepares a State Master Plan for the development of Agricultural Produce Markets and imparts training to the personnel of state authorities/marketing boards for the preparation of the State Master Plan. A draft of the Master Plan for Market Development in Mizoram state is almost complete. So far, DMI has published 325 reports on market surveys for various agricultural and allied commodities. The NIAM has also taken up the formulation of state master plans for the development of agricultural produce markets for Goa, Himachal Pradesh, Andhra Pradesh, Jammu and Kashmir, and Sikkim. Further, the institute has taken up case studies on the post-harvest management of various commodities and formulation of integrated action plans for the promotion of handlooms.

With regard to grading and standardization, the Agricultural Produce (Grading & Marking) Act, 1937 empowers the central government to fix quality standards, known as 'AGMARK' standards and to prescribe terms and conditions for using the seal of AGMARK. So far, grade standards have been set for 159 agricultural and allied commodities. During 1997-1998, new grade standards were formulated for five commodities, namely caraway seeds, vermicelli, macaroni and spaghetti, cloves, mace and large cardamom. As a result of special efforts initiated to increase grading under AGMARK, 271 new packers enrolled during the 1998-1999 financial year; up to September 1998.

In order to review the present state market acts and workings of various agricultural marketing bodies, and to recommend appropriate measures for streamlining and strengthening the set up for marketing agricultural produce, a High Power Committee on agricultural marketing was constituted in January 1992 under the chairmanship of Shri Shankarlal Guru, former chairman of Council of State Agricultural Marketing Boards (COSAMB), New Delhi. The High Power Committee in their report submitted 81 recommendations to the government, of which 58 recommendations have been accepted and 21 recommendations rejected. The accepted recommendations have been communicated to the state authorities/UT administrations for implementation. Further, the recommendations were discussed in the first meeting of ministers in charge of agricultural marketing of all states/UTs held on 30 January 1997 in New Delhi. The state/UTs have been directed to implement the recommendations of the High Power Committee as early as possible.

7.2.4 Potential and constraints in infrastructure provisions

Potential

Ensuring road infrastructure development for sustained economic development in all regions of the country, with special attention to integrating backward regions and the Northeast into the economic mainstream.

1. Maintenance of roads to be given priority with increased emphasis on maintenance standards, so as to reduce the need for frequent reconstruction.
2. Association of the private sector in the development of road infrastructure and in the provision of public transport services.
3. Encourage higher capacity and better technology vehicles for the movement of both passengers and goods, so that development of road transport operations keeps pace with development of high quality roads.
4. Encourage the adoption of low tare weight, multi-axle commercial goods vehicles to minimize damage to roads.
5. Rationalize the motor vehicle tax regime across all states.
6. Implement the recommendations of the Auto-Fuel Policy Committee (Mashelkar Committee) as accepted by the government, which pertains to road transport.
7. Reduction of barriers including check posts, octroi and sales tax posts. to allow freer movement of road transport.
8. Discourage overloaded trucks, which not only endanger road users but also damage road infrastructure.
9. Adopt a multi-disciplinary approach covering engineering, education and enforcement of regulatory provisions to reduce the increasing number of road accidents.
10. Promote a sustainable transport system with increased emphasis on safety, energy efficiency, environment conservation and positive social impacts.

Constraints to road infrastructure development

1. Land acquisition
2. Shifting of utilities
3. Cutting of trees
4. Law and order
5. Encroachments and ribbon development along national highways

Encroachment of government lands is a common phenomenon. Almost all NHs suffer from this menace. The central government which has the control of national highways has been notified (Land and Traffic Act 2002) for the removal of encroachments, control of traffic and control of access, which is applicable only within the right of way of national highways. The state authorities must also enact similar statutes to control roadside construction activities. Some states like Assam, Rajasthan, Uttar Pradesh, Haryana and Karnataka have already enacted legislation in this regard.

7.3 Research and development

7.3.1 Development of farm, processing and marketing technology

Marketing extension, training and research

Agricultural marketing is witnessing major changes owing to liberalization and globalization of markets. In this context agriculture has to be market driven, more cost effective, competitive, innovative and responsive to high-tech and I.T. applications. Training and extension systems in agricultural marketing will have to sensitize and orient the beneficiaries to respond to these challenges. It is necessary to build the capacity of each of the beneficiary

groups, namely the farmers, market functionaries and other officials involved in agricultural marketing activities. Knowledge has to be imparted at the grassroots level in areas such as a market driven production programme, post-harvest management of agricultural and horticultural crops, availability of marketing finance, information on facilities for quality assurance and standards, grading, packaging, storage, transportation, contract farming, alternative markets including forward and futures markets, commodity exchanges, and online market information systems. Training and education modules will have to be prepared in these areas to reach region specific farmers in vernacular languages. The objective of imparting training to marketing functionaries and stake holders should be to create an ambience of good marketing practices to protect the interests of farmers as well as consumers.

The major areas of extension and training in marketing are as follows:

a) Legal reforms
b) Direct marketing
c) Group marketing
d) Contract farming
e) Grading and standardization
f) SPS measures
g) Packaging
h) Storage and cool chain
k) Pledge financing
l) Warehousing
m) Transportation
n) Market infrastructure
o) Forward and futures market
p) Quality certification
q) Commodity exchanges
r) I.T. in agricultural marketing
s) Agri-business
t) WTO and its implications

Considering the limited reach of the public extension services, privatization of extension services with appropriate financial support from the public sector is considered more appropriate and practical. Privatization of extension activities would facilitate tailor made extension services beneficial to both farmers as well as entrepreneurs. The NGOs, cooperatives, trade associations, private limited companies, and corporate bodies need to be encouraged to undertake marketing extension activities.

The Ministry of Agriculture, in association with NABARD, recently launched a unique programme to take improved methods of farming to each and every farmer across the country. This programme aims to tap the expertise available in the large pool of agricultural graduates to set up agri-clinics or agribusiness centres and offer professional extension services to innumerable farmers. Committed to this programme, the government is now also providing start-up training to graduates in agriculture, or any subject allied to agriculture like horticulture, sericulture, veterinary sciences, forestry, dairy, poultry farming and fisheries. Those completing the training can apply for special start-up loans for the venture from commercial banks with refinance and support from NABARD.

Agri-clinics and agribusiness centres will provide paid-for services for the enhancement of agricultural production and income of farmers. These centres will advise farmers on crop selection, best farm practices, post-harvest value-added options, key agricultural information (including internet-based weather forecast), price trends, market news, risk mitigation and crop insurance, credit and input access, as well as critical sanitary and phyto-sanitary considerations, which the farmers have to keep in mind.

The National Institute of Agricultural Marketing (NIAM), Jaipur should be the nodal agency for implementing training, extension and research programmes in agricultural marketing. The institute should coordinate research activities in collaboration with state agricultural universities, state agricultural marketing boards, the Directorate of Marketing, Ministry of Agriculture and Cooperation and international agencies involved in promoting agricultural marketing. Important areas of research are as follows:

a) Structural conduct and performance analysis of agricultural markets.
b) Role and effectiveness of marketing institutions.
c) Study of cost and margins of important agricultural/horticultural crops.
d) Export effectiveness of agricultural and horticultural crops.

e) Information needs of stakeholders in agricultural marketing.
f) Marketing of organically produced commodities.
g) Price discovery mechanism of different agricultural commodities.
h) Supply chain management
i) Implication of WTO on agricultural marketing.
j) Risk management in agriculture.

7.3.2 Development of extension service networks

The extension service network in India is comprised of a network of state agricultural universities, Krishi Vigyan Kendras. Trainers, training centres and information kiosks are run by private corporate players.

1. Indian agriculture is on the threshold of a second revolution. It is becoming increasingly clear that the next leap will come from information and knowledge intensity transfer to the agricultural sector, together with the other traditional inputs and interventions. The real challenge facing policy makers is to overcome the information asymmetry between farmer and farmer, village and village, region and region and the country as a whole versus other countries. Fortunately, developments in the field of communication and information technology in India make it possible to attempt this task.
2. The country today has an impressive telecom network both in the private and public domains. Over 5 lakh villages have a public telephone in the country. It has been felt for a long time that this impressive telecom network could be put to effective use for delivering knowledge and information to the farming community. With the decrease in the number of extension workers, there is a need to use the latest technologies for delivering extension services. Towards this goal, the Department of Agriculture and Cooperation has been working on schemes to use both mass media and the telecom network to deliver extension services.
3. One of the drawbacks in the current human resource based extension service is that the monitoring authorities are unable to receive clear feedback on the quality of the extension service being delivered in the villages. Further, the extension service delivered is knowledge and information based on the anticipated needs and what has been passed down by higher authorities. On the other hand, a call centre based extension service would deliver knowledge and information exactly as per the requirements of the farming community. This system would also help keep a record of what is being delivered to the farmers in terms of knowledge and information.
4. The objective of the scheme is to make agricultural knowledge available free of charge to the farmers as and when desired.
5. This scheme has an in-built system of monitoring and continuous evaluation for modifications and improvements. The services are also of a foundational nature. Many more exciting tiers will be built on this infrastructure.
6. The Kisan Call Centre scheme is available throughout the country. At present the call centre's services are available at a common toll-free telephone number which can be dialed from anywhere in the country. The location is immaterial as the calls can originate from any village to contact a specific call centre and a specific seat, which is answered by an agricultural graduate fluent in the local language and having an understanding of local agricultural issues.
7. The call centres operational as of today have been selected on the basis of a tender document which was floated by TCIL, a government company which was appointed by the Department of Agriculture and Cooperation as the consultant.
8. The Kisan Call Centre scheme has been functioning from 21 January 2004. The call centres can be accessed by farmers all over the country on a common toll-free number; 1551.

9. The calls are received at 13 call centres wherein 116 agricultural graduates attend to the query of the farmer in the local language. Experts (123) are located in different parts of the country at state agricultural universities, ICAR institutes, the Department of Agriculture, Horticulture and Other Development answer the calls at Level II.

Recently, a knowledge management system in the form of a software tool has been developed by the Telecommunications Consultants India Ltd. (TCIL), a Government of India enterprise. The knowledge management system shall be supported by a database built using the farmers' queries and their solutions. The Kisan Call Centre report generation software provides user interface forms which the call centre's agents have to fill in according to which report is to be generated. The report/data generated concerns crops, locations, districts, states, problems, levels, call types, and nationwide is available at the end users. The data generated through this knowledge management system will be available on Internet after hosting.

7.3.3 Potential and constraints in the development of technology and an extension service network

Development of technology

Since independence, the major thrust of agricultural technology and development has centered on improving agricultural productivity, discovering and using new seeds, and controlling pests. The Indian Council of Agricultural Research (ICAR) and the network of agricultural universities have been behind new knowledge and the research programmes. Currently, efforts are focused around problems of arid and semi-arid areas as well as highly humid, hilly and other problems areas so that a larger proportion of the country's rural population and cultivated areas may benefit.

In spite of all round developments in the several spheres of agriculture, technological development seems to have failed in the case of producing pulses and oilseeds. The production of pulses has been stagnant for the last 30 years while the demand has been continuously increasing. Hence the greatest potential lies in the area of coarse cereals; pulses in marginal environments of arid and semi-arid regions in the country.

However, technological development is plagued with weaknesses. We are still unable to utilize the available scientific and technical manpower. In the past, technology imported from advanced countries was used to promote centralized development and the benefits did not reach to poorer regions and people. Technological dissemination was only limited to advanced regions with better resource endowment. The new emphasis is on decentralized development, which will be based in marginal environments using coarse cereals and other similar crops. Hence the new plan accords importance to the development of rural areas, reduction of unemployment and raising the standard of living of rural people.

Extension service network

Public research and extension service networks played a major role in bringing about the green revolution. In the post green revolution era, however, extension services face important challenges in the areas of relevance, accountability and sustainability. The changing economic scenario in India and the need for appropriate agricultural technologies and agro-management practices to respond to food and nutritional security, poverty alleviation, diversifying market demands, export opportunities, and environmental concerns is posing new challenges to the technology dissemination systems. It is expected that future agricultural growth will largely accrue from improvements in the productivity of diversified farming systems with regional specialization and sustainable management of natural resources, especially land and water. Effective linkages of production systems with marketing, agro-processing and other value added activities will play an increasingly important role in agricultural diversification.

It is becoming increasingly evident that public extension by itself can no longer respond to the multifarious demands of farming systems. There is a need for a re-appraisal of the capacity of existing agricultural extension systems to effectively address the contemporary and future needs of the farming community. Public funding for sustaining the vast extension infrastructure is also under considerable strain. In response to market demand, the existing public extension network is inexorably being complemented, supplemented and in some instances replaced by private extension. As the nature and scope of agricultural extension undergoes fundamental changes, the outlook is a whole new policy mix nurturing a plurality of institutions.

Technology generation and its application will have to focus more strongly than before on the themes of optimization by producers of their available resources, sustainability, coping with diversity by adapting technology more specifically to agro-ecological or social circumstances and creating a policy environment that promotes profitable, productive and sustainable farming. Reforms in agricultural extension have already been initiated and proposed to be undertaken on a wider scale as follows:

1. Replacement of the old T&V system approach of single commodity, single discipline to a farming system approach.
2. Multi-agency extension service involving the public sector, the private sector, mass media and information technology.
3. Public extension service focus towards knowledge based technologies.
4. Promotion of farmer participatory approach.
5. Promotion of demand driven and farmer accountable extension.
6. Thrust on marketing extension.
7. Encouraging private sector involvement in technology transfer.
8. Public funds for private extension services.
9. Use of information technology.
10. Mainstreaming women in agriculture.
11. Empowerment of farmers.
12. Improving research-extension linkages.

As agricultural extension transforms itself into a diversified farming system approach from its present simplistic accent on yield enhancement by increasing some limited inputs, farmers will be required to adopt a wider range of inputs and practices and develop skills for their more efficient use. The task of the extension service network will become more challenging in the wake of the post-WTO era, which demands a system of market led extension with specific focus on crop diversification keeping sustainability issues at the fore in the diverse agricultural milieu, post-harvest management and export orientation. This will present a more complex role, but simultaneously requiring a flexible approach allowing specific information to be customized for different farmer groups. A strategy of institutional innovations in extension will be evolved which optimizes the strengths of the public and private sectors to service the needs of the farming community.

7.4 Concluding summary

This section throws light on the existing infrastructure and the government's policy. Various economic policies showed that in the past, government policies regarding agricultural issues have been biased towards fine cereals to the detriment of coarse grains. Though the minimum support price for maize has increased substantially there is still no provision for its procurement. Credit support is more important for these farmers but much still needs to be done in terms of increasing access and the timely availability of credit to smaller farmers.

Food diversification policies are also pursued actively to increase the importance of coarse grains in human consumption. A consumer budget analysis showed that increases in

income lead to a shift away from the consumption of coarse cereals, also a negative price affects the consumption of coarse grains. However, the derived demand of these commodities increases with increases in income.

Existing infrastructure in the maize growing states is poor. The government is playing an important role in increasing irrigation and transportation. The maintenance of existing roads and other infrastructural facilities needs to be addressed. Presently, the two most important government institutions DMI and NIAM are working to improve agricultural marketing through interconnecting the markets and improving the accessibility. The bill passed on market regulation is another step towards improving the legislative framework related to agricultural marketing.

The main highlights of research and development are the development of farm processing and marketing technologies and the development of an extension service network. Ministry of Agriculture, NABARD, NIAM and agri-clinics provide important services to this end. NGOs, cooperatives, trade associations, private companies and corporate bodies need to be encouraged to provide marketing extension services which are more demand driven.

8. Prospect for Enhancing the Sustainable Development of Diverse Agriculture

The successes achieved so far in sustainable agriculture are still only on a relatively small scale. This is largely because an enabling policy environment is missing in almost every state of the country. Although, there are rare exceptions, most policy frameworks still actively encourage dependency on external inputs, technologies and knowledge.

Governments have long provided public support to their domestic agricultural sector. Through a wide range of direct and indirect monetary transfers from consumers and taxpayers to farmers and other producers, they have sought to ensure that agriculture provides the food and other products needed by the non-farming population. Support measures have included price support, direct payments, input cost reductions and the provision of general services. The level of support varies hugely between countries. Most types of support however, have encouraged a greater use of external inputs, such as pesticides, fertilizers, credit and water.

Most, if not all, of the policy measures used to support agriculture currently act as powerful disincentives against sustainability. In the short term, this means that farmers switching from high input to resource conserving technologies can rarely do so without incurring some transition costs. The principal problem is that policies simply do not reflect the long-term social and environmental costs of resource use. The external ecosystems are not incorporated into individual decision-making by farmers. For the full benefits of sustainable agriculture to accrue, policies must be more integrated and more directed towards alternative policies.

Hence the policies for sustainable agriculture should be economically, environmentally and socially viable. Above all, the co-ordinated action of the government is to encourage and nurture the transition from modernized systems towards more sustainable alternatives. Without appropriate policy support, it will remain at best localized in extent and at worst wither away.

8.1 Overall assessment of potential

There is enough potential to achieve the sustainable development of diverse agriculture in India mainly through the following:

- *Use of improved varieties*
  Research institutions have developed/released high yielding varieties of CGPRT crops (mainly maize) which can achieve yields as high as 7 tons/ha.
- *Integrated nutrient management*
  Nitrogen is the nutrient that most frequently limits yield levels. There should be approaches to regulate the timing of N application based on the needs of the plant to increase the efficiency of the plant's use of applied nitrogen. Many farmers use very little applied nitrogen, primarily due to non-availability, lack of cash to buy it, or due to poor yield response or high risk. In addition to chemical fertilizers there are good avenues in the country to apply organic manure for enhancing sustainable agriculture.
- *Water and irrigation*
  Because of water scarcity in most of the CGPRT growing regions, the major challenges of growing rice are to develop farm water reservoirs for water harvesting, as well as selecting drought tolerant varieties, good land leveling and sub soiling. All of which are requisites for proper irrigation scheduling to increase water use efficiency.

- *Policy support to increase production*
  This could be done through appropriate policies and socio-economic adjustments, which include pricing and institutional support, to address the needs of the farmers.
- *Credit*
  Credit facilities and loans to small and resource-poor farmers ought to be provided.
- *Input availability*
  The government should ensure the availability of seeds, fertilizers, pesticides and machinery for different farm operations and make maintenance services accessible to farmers.
- *Good quality seeds*
  The use of good quality seeds is the most important factor for achieving high yields. The government and the private sector should play an important role in establishing programmes for good quality seeds from the released varieties and hybrids. The government is encouraged to come up with proper legislation for seed multiplication and certification.
- *Reduction of post harvest losses*
  Introduction of more efficient technologies for handling, drying, storage and milling rice is essential to reduce post-production losses.
- *Technology transfer*
  Knowledge on improved varieties and agronomic practices should be disseminated through extension and technology transfer programmes.

8.2 Overall assessment of constraints

In spite of the above mentioned potential, there are various factors/constraints currently affecting the sustainable development of diverse agriculture in India which include:

1. Poor quality seeds and short supply of improved and quality seeds.
2. Inadequate water management resulting into low efficiency of water use.
3. Inefficient drainage systems resulting in soil salinity/alkalinity problems.
4. Declining soil fertility and improper land management.
5. Prevalence of insect pests and diseases.
6. Lack of training and technology transfer at the farm level.
7. Weed infestation and inappropriate weed control management.
8. Lack of suitable machinery and field equipment.
9. Inadequate input supplies (seeds, fertilizers, pesticides).
10. High post-harvest losses.
11. Insufficient specific and encouraging policies supportive of CGPRT farmers.
12. Inadequate research support.
13. Inadequate and ineffective extension support services to farmers; and low adoption of recommended technologies.

8.3 Search for strategies and policies to enhance the sustainable development of diverse agriculture

For sustainable agriculture to succeed, policy formulation must arise in a new way. Policies must be enabling; creating the conditions for sustainable development based more on locally available resources and local skills and knowledge. In practice, policy is the net result of the actions of different interest groups pulling in complementary and opposing directions. Effective policy will have to recognize this and seek to bring together a range of actors and

institutions for creative interaction. Some of the required policies for enhancing the sustainable development of diverse agriculture are as follows:

1. Formulation of national policy for sustainable agriculture.
2. Prioritize research directed towards sustainable agriculture.
3. Support for farmer training and farmer field schools.
4. Establishment of a national strategy for IPM.
5. Grant farmers appropriate property rights.
6. Direct subsidies and grants towards sustainable technologies.
7. Link support payments to resource conserving practices.
8. Set appropriate prices with taxes and levies.
9. Provide better information for consumers and the public.
10. Encourage the adoption of natural resource accounting.
11. Establish appropriate standards and regulations for pesticides.
12. Encourage the formulation of local groups.
13. Foster rural partnerships.
14. Incentives for on-farm employment.
15. Permit groups to have access to credit.
16. Encourage the formal adoption of participatory methods and processes.
17. Support for information systems to link research, extension and farmers.
18. Strengthen the capacities of NGOs to upscale.
19. Foster stronger NGO-government partnerships.
20. Reform teaching and training establishments.
21. Develop capacity in planning for conflict resolution mediation.

Sustainable agriculture has to be economically, environmentally and socially viable. There are resource conserving technologies, local institutional structures and external institutions that are all known to work. However, until recently, there have been very few policies that were effective. The above policies can be used to support the transition to greater sustainability and self-reliance. The greatest challenge therefore will be the reform of the policy processes themselves. These will have to focus more on participation and social mediation if the complexities and uncertainties of sustainability are to be continually addressed.

9. Conclusions and Policy Recommendations

Agricultural growth in the past has been sufficient to change India from a severe food crisis to a state of aggregate food surplus today. Most of the development in agriculture has taken place in irrigated regions bypassing the rainfed marginal environments. The rainfed regions are mostly dominated by CGPRT crops, i.e. coarse grains, pulses, roots and tubers. In the post green revolution period, agricultural diversification has gained substantial importance mainly due to its role in increasing agricultural income and addressing poverty related issues. CGPRT crops like sorghum, maize and pulses. have high potential for diversified uses. CGPRT crops are less input demanding resulting in positive long-term effects on the environment and addressing the sustainability issue. Barring maize and potato, CGPRT crops are loosing ground against the finer cereals, and cash and commercial crops. Moreover, some of the coarse grains and pulses are nutritionally superior and the increased productivity of these crops will add to nutritional security.

It is in this context that five traditionally important maize growing states in India, namely, Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh were selected for study. These states account for almost 40 per cent of the total area under maize cultivation. Maize is one of the most important crops grown in the region next to fine cereals.

The socio-economic profile of the region presented startling revelations. Unemployment issues in rural as well as urban areas remains one of the major concerns in many of the states. It was observed that there has not been much change in the employment scenario. The national average rate of unemployment among urban male youths was 14.7 per cent in 1999-2000. It was much higher in Bihar (24.0) and marginally so in Madhya Pradesh (14.9) while Punjab and Rajasthan had only 8 to 9 per cent unemployment. Unemployment rates were lower in rural areas although poverty is more rural in nature mainly due to disguised unemployment in the region. There were wide variations in incidence of poverty across the states.

Over exploitation of water, increasing use of fertilizers and injudicious cropping patterns in the post-green revolution period have cast a shadow and threatened sustainable production in some regions. The increased depletion rate of ground water in a few states resulted in an unsustainable balance of groundwater potential in states like Punjab and Rajasthan. Apart from environmental degradation, the increasing use of fertilizers to enhance the yield and production has adverse repercussions on sustainable production. On the other hand, CGPRT crops were found to be much more efficient users of water than other crops. Infrastructural bottlenecks remain a major challenge before the planners in fighting rural poverty and creating gainful employment for the growing workforce.

The majority of maize growing farmers are small-scale farmers who cultivate maize mainly for the purpose of augmenting farm income and self-consumption. Maize cultivation as such is less labour intensive compared to other crops like paddy and wheat. However, labour utilization depends on its opportunity cost. Variations in labour use depend on the worker to family size ratio. Farm yield does increase with the cultivation of hybrid and composite varieties, but still in many states such as Uttar Pradesh and Rajasthan, farmers prefer to grow local or traditional varieties. This is true especially in cases where maize is used for home consumption.

The cost structure is mainly human labour, fertilizers, irrigation, plant protection measures and seeds. Of them, the major expenditure incurred was for human labour. The costs incurred on hybrid varieties were higher compared to that of local varieties but the revenue associated with the yield were also very high. Diversification in favour of maize production is mainly to reduce the risk associated with yield and price fluctuations of other crops. This also has implications on employment generation and income augmentation.

It was observed that the majority of farmers across all categories fell under the 'low adoption' for HYV adoption category that approximated to 54 per cent. In Bihar, Madhya Pradesh, and Rajasthan more than 70-80 per cent were cultivating either the local variety or were not applying recommended levels. Average technical efficiency among selected farmers was 61 per cent. About 39 per cent of farms operated below the frontier output levels. In addition to the technology adoption bottlenecks, the institutional constraints identified were a lack of transportation facilities, insufficient supply of power, non-availability of quality seeds, shortage of fertilizer and untimely credit availability.

Assessment of the marketing system showed that the marketing and distribution channel depended on the type of market where the maize is produced and marketed. With the rural market infrastructure being not so well developed, farmers have to depend mainly on traders and middlemen to market their products. The majority of the produce is sold at the local market in the absence of any agro-processing industries in the locality. A collective effort by the central and state governments would help create market infrastructure and would go a long way in providing accessible markets for the produce. This would also result in better price realization by the farmers.

The critical review of various economic policies showed that in the past, agricultural price policies in India have been biased towards fine cereals and away from coarse cereals. Although the minimum support price for maize has been increased substantially from Rs 750/ton in 1974-1975 to Rs 5,050/ton in 2003-2004 there is still no provision for procurement. Credit support is more important for these farmers but much still needs to be done to increase the access and timely availability of credit to smaller farmers. A consumer budget analysis showed that increases in income lead to a shift away from the consumption of coarse cereals. Also negative prices effect the consumption of coarse grains. The government is developing farm, processing and marketing technologies and developing the extension service network in a big way.

Policy recommendations

Although the adoption of high-yielding maize varieties has been the key element to bring technological breakthroughs to the maize sector in the country, maize growers from marginal production environment areas have not yet realized the benefits of technological advancement in maize production. Keeping this in mind, the following policy recommendations have been suggested for equitable and sustainable growth in maize production:

i. Crop diversification policies that put maize on the exclusive agenda will not only provide the crop enough leverage on the productivity front but, due to its inherent qualities, will also overcome some of the sustainability woes. Further, the increased productivity and reduced net costs will also give an income boost to the farmers in poverty stricken, fragile environments.

ii. Although maize production in the country has witnessed impressive growth during past decades, there exists a wide spatial variation in productivity across regions. This has resulted in wide regional imbalances and instability in maize production in the country. The genetically modified high yielding cultivars suiting marginal production environments are an effective option. Effort should be made to interlink the technological, economic and institutional support to the farmers of these areas.

iii. Providing needed impetus for effectively canalizing maize produce to the various post-harvest uses by establishing small-scale post-harvest manufacturing units in the hinterlands. This will not only provide incentives to the producers by way of commensurate prices, but will also smoothen the marketing and disposal hassles.

iv. A larger proportion of maize is being utilized as feed and industrial raw materials in the country. In order to meet the growing demand for maize for its varying end uses,

especially starch and the feed industry, the maize R&D and extension strategy should address the specific needs of these sectors.

v. Under the changing global scenario, economic policies need to be directed towards improving trade competitiveness of maize vis-à-vis other crops. Reductions in per unit cost of maize through increased productivity, improvement in market functionaries and infrastructure development to reduce transaction costs are prerequisites to make Indian maize globally competitive and a lucrative proposition.

The above policy options directed towards CGPRT crop especially maize, grown predominantly in the resource poor and heavily populated regions will aide in alleviating poverty and generate gainful employment in maize-based agro-industry. This will also bridge the widespread inequities in the region as well as arresting the degradation of resources arising from singular cropping long practiced in the region.

10. References

Central Pollution Control Board (CPCB), (various years). Annual report. Ministry of Environment & Forest, Government of India, New Delhi, India.

Centre for Monitoring Indian Economy, (various years). CMIE-Industry, Economic Intelligence Service, Mumbai, India.

Chand, Ramesh, 1999. Effects of Trade Liberalization on Agriculture in India: Commodity Aspects. CGPRT Centre Working Paper No. 45, Bogor, Indonesia: CGPRT Centre.

Compound Livestock Feed Manufacturers Association of India (CLFMA), (various issues). Livestock & Feed Trends. Mumbai, India.

Hutabarat, B., 2003. Feed and the Feed Crop Economy in South Asia. Palawija News 20(2):1-9, The CGPRT Centre Newsletter, Bogor, Indonesia.

Ministry of Agriculture, Government of India, 2001. Market Development through Regulation, Planning and Designing of Physical Markets. Directorate of Marketing and Inspection, Department of Agriculture and Cooperation, New Delhi, India.

Ministry of Agriculture, Government of India, 2003. Agricultural Statistics at a Glance 2003. Agricultural Statistics Division, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, New Delhi, India.

Ministry of Agriculture, Government of India, 2003. Report of Expert Committee on Strengthening and Developing of Agricultural Marketing. New Delhi, India.

Ministry of Agriculture, Government of India, 2004. Agricultural Statistics at a Glance 2004. Agricultural Statistics Division, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, New Delhi, India.

Ministry of Finance, Government of India, 2005. Economic Survey 2004-05. New Delhi.

Pathak, P.S., 2003. Prospects of Feed Crops in India: The Role of CGPRT Crops. CGPRT Centre Working Paper No. 64, Bogor, Indonesia: CGPRT Centre.

Russel, N.P. and Young, T., 1983. Frontier Production Function and the Measurement of Technical Efficiency. Journal of Agricultural Economics 34(2):139-150.

Singh, N.P., Singh, R.P. and Kumar, Ranjit, 2003. Feed Processing Industry in India: Silent but Robust Propositions. Indian Journal of Agricultural Economics 58(3):554-565.

Subramani, M.R. 2004. Demand Flows for Corn: Exports May Top 10 lakh t, The Hindu Business Line, Financial Daily from THE HINDU group of publications (April 9, 2004).

The Fertilizer Association of India, (various years). Fertilizer Statistics. New Delhi, India.

U.S. Grains Council, 2003. Corn-based Plastics Deliver Economic, Environmental Benefits. Grain News 1(1):1-4.

Vyas, V.S., 1996. Diversification in Agriculture: Concept, Rationale and Approaches. Indian Journal of Agricultural Economics 51(4):636-651.

Appendices

Appendix 1. Project cost

The project cost for setting up of a 100 mt wet maize mill has been assessed at INR 14.32 crore and summarized as follows:

S. No.	Particulars	Amount (INR lakh)
1	Land and land development	320.00
2	Building and civil work	250.00
3	Plant and machinery	769.65
4	Misc. fixed assets	34.25
5	Preoperative expenses	27.48
6	Margin money for working costs	30.63
	Total	1 432.01

Source: Indian Maize Development Association, New Delhi (*mimeograph).*
Lakh stands for 0.1 million, one crore stands for 100 lakh.

Working capital requirement

The working capital requirement of the unit will be very high**.** As the raw material is seasonal in nature, there will be high inventories. The farmers will be required to be paid immediately, hence, credit of one week is assumed. Starch is marketed through traders and it takes one month to realize the sale proceeds.

Appendix 2. Financial viability

The financial indicators of a wet milling unit

Financial indicator	Estimated	Requirement
NPW	INR. 912.64	Should be + ve
IRR	34.21 %	15%
BCR	1.1	Should be > 1.0
DSCR	1.63	Should be > 1.5

Source: Indian Maize Development Association, New Delhi (*mimeograph).*

All the financial indicators meet the requirement, hence a wet milling unit of 100 TPD of maize crushing capacity will be a viable unit as well as bankable.

Appendix 3. Plan-wise position of irrigation potential created and utilized (million hectares)

Plan	Potential created					Potential utilized				
	Major and medium	Minor			Total	Major and medium	Minor			Total
		Surface water	Groundwater	Total			Surface water	Groundwater	Total	
Pre-Plan up to 1951	9.70	6.40	6.50	12.90	22.60	9.70	6.40	6.50	12.90	22.60
I Plan (1951-1956)	12.20	6.43	7.63	14.06	26.26	10.98	6.43	7.63	14.06	25.04
III Plan (1961-1966)	16.57	6.48	10.52	17.00	33.57	15.17	6.48	10.52	17.00	32.17
IV Plan (1969-1974)	20.70	7.00	16.50	23.50	44.20	18.39	7.00	16.50	23.50	41.89
VI Plan (1980-1985)	27.70	9.70	27.82	37.52	65.22	23.57	9.01	26.24	35.25	58.82
During VIII Plan (1992-1997)	2.22	n.a.	n.a.	6.25	8.47	2.13	n.a.	n.a.	5.78	7.91
End of VIII Plan (Provisional)	32.96	n.a.	n.a.	56.60	89.56	28.44	n.a.	n.a.	52.32	80.76
Targets for IX Plan (1997-2002)	9.81	n.a.	n.a.	7.24	17.05	8.71	n.a.	n.a.	4.92	13.63
During 1997-2000 (Provisional)	2.39	n.a.	n.a.	2.78	5.17	2.03	n.a.	n.a.	1.91	3.94
End of 1999-2000 (Provisional)	35.35	n.a.	n.a.	59.38	94.73	30.47	n.a.	n.a.	54.23	84.70

Source: Economic Survey (Various Issues), Government of India.

Working Paper No. 80 *Enhancing Sustainable Development of Diverse Agriculture in Bangladesh*
by Jahangir Alam

Working Paper No. 79 *Prospects of Feed Crops in Malaysia*
by Tunku Mahmud bin Tunku Yahya and Sarmin bin Sukir

Working Paper No. 78 *Status and Prospects of Feed Crops in the Philippines*
by Danilo C. Cardenas, Lara Marie M. De Villa and Fezoil Luz C. Decena

Working Paper No. 77 *Integrated Report of the Project "Stabilization of Upland Agriculture and Rural Development in El Nino Vulnerable Countries"*
by Shigeki Yokoyama and Rogelio N. Concepcion

Working Paper No. 76 *A Preliminary Assessment of the Potential Role of Information and Communication Technology in Support of Poverty Alleviation Policies for Rural Populations – AGRI-ICT Project Report*
by Robin Bourgeois

Working Paper No. 75 *Multilevel Impact Assessment and Coping Strategies against El Nino: Case of Food Crops in Indonesia*
by Bambang Irawan

Working Paper No. 74 *Indigenous Drought Coping Strategies and Risk Management against El Nino in Papua New Guinea*
by Sergie K. Bang and Kud Sitango

This series is published by the UNESCAP-CAPSA. The series contains research papers, statistical profiles and bibliographies. For further information, please contact:

Publication Section
UNESCAP-CAPSA
Jl. Merdeka 145
Bogor 16111
Indonesia

Telephone: (62-251)-356813, 343277
Fax: (62-251)-336290
E-mail: capsa@uncapsa.org
Web site: http://www.uncapsa.org.

UNESCAP-CAPSA
Publication Section

Editor: Matthew L. Burrows

Production: Agustina Mardyanti
S. Tayanih (Yayan)

Distribution: Fetty Prihastini

Printer: SMK. Grafika Desa Putera