PUBLIC POLICIES AND SUSTAINABLE AGRICULTURAL DEVELOPMENT - A CASE STUDY OF THE COMMERCIALIZED AGRICULTURE

Brajesh Jha

(March 2008)

Institute of Economic Growth,
Delhi University Enclave (North),
New Delhi – 110 007

Contents

List of Tables

List of Figures / Boxes

List of Appendices

(Tables supportive of concerned chapter)

List of Annexure Tables

(Table supportive for discussion irrespective of Chapter)

Preface

An urgency to reform Agriculture has been realized by a cross section of people. Though there have been some debilitating steps towards reducing the role of state in the last decade; experiences with these changes have however been mixed. Some of the age-old apprehensions in relation to decreasing role of State have come true in the medium term; the long-run implications can be even more profound. In this context the case of one of the most acclaimed agricultural policies in the post-independent era is noteworthy: with supportive Government policy the biochemical technology of the late sixties has undoubtedly metamorphosed selected regions, the ill effects of such growth is however jeopardizing the present as well as future rate of growth in agriculture. Government policy towards agriculture is often blamed for this; and it is argued that with the rationalization of agricultural prices disconcerting trend in agricultural development will subside. Reforms in agriculture, domestic or trade also tends to rationalize prices.

Government policy towards agriculture can broadly be grouped into domestic- and external- sector related policies. In the post-WTO era liberalization of trade (external market) is imminent; it is however in the interest of the country that domestic market is integrated with the world market. Such integration will affect relative prices of commodities; subsequently this may influence the existing pattern of resource utilization and also several parameters that affect the long-term growth of agriculture in a region. The net result of interaction between policy variables and developmental parameters are not obvious. An increase in the prices of farm inputs, for instance may encourage farmers to adopt the agronomic practices that uses less of external inputs; this will improve soil health, but may have adverse effect on agricultural production and farmer's immediate return from agriculture; these trade-offs need to be elicited in a farming system framework.

The present study is an attempt to assess effect of Government policies for agricultural development of a region. The factors constraining long-term growth of agriculture vary across regions depending on the state of natural resource in that region. The likely effect of changes in agricultural prices on resource utilization will be profound for a region, where agriculture to large extent is commercialized. As far as adoption of commercial practices in agriculture is concerned farmers in the Northwest India have been in the forefront; present study therefore evaluates likely effect of changes in agricultural prices on the long-term growth of agriculture in the Northwest India. The study may illustrate certain ameliorative measures to counter the ill effects in agriculture.

The above study will help in operationalising the concept of sustainability and may encourage similar studies for other regions of the country. The findings of the study will help in understanding the region-level impact of reforms in agriculture. The present work will be useful to any student of agriculture and economics interested in reforms and understanding implications of reform for long-term growth of agriculture in a region. The above study in its existing form would not have come without help of some benevolent officers, researchers distributed across country; it is difficult to name all of them, author expresses sincere gratitude to all of them. Present investigator is particularly grateful to Mr. Biswajit Mohanty, Rajesh Kumar for their periodic assistance in accomplishing this research work. Author is also thankful to computer section of the Institute of Economic Growth for their continuous and ungrudging support. Author alone is however responsible for any errors or omissions in the present study.

Brajesh Jha

March 2008

Institute of Economic Growth

New Delhi-110007

I
Introduction

There are innumerable reasons to reform Indian agriculture. Trade liberalization in the aftermath of World Trade Organisation (WTO) is imminent, and dovetailing of domestic policies with the liberalized trade policies is just one of such reasons. In the emerging trade order, cost and quality is supposed to determine trade flows and increasing efficiency in the production and processing of agricultural commodities is often presumed as one of the most important reasons for undertaking reforms in agriculture. Such reforms are more desired in the marketing of agricultural commodities as several studies highlight inefficiency in the post harvest operations of many agricultural commodities (World Bank1997) [1]. There have been numerous controls in domestic market on account of food security related concerns. Though this concern has not subsided, continuance of a set of policies for long years has often created inefficient structures. Burgeoning food subsidy and decreasing cereal consumption in lower income groups is just an example.

The situation is not comfortable on account of production of many crops. Though India by virtue of its diverse natural resource endowments and surplus labour has potential to produce a large number of agricultural commodities. There is dearth of adequate exportable surpluses on sustained basis; India's imports of agricultural commodities have in fact increased considerably. Growing population, increasing per capita income, perverse aggregate supply response is often quoted as reasons for such performances. The breaking of this perverseness requires high investment, improved technology, adequate infrastructure and similar other measures in agriculture. A significant proportion of planned expenditure in agriculture is consumed in subsidizing agricultural inputs. The subsidized farm input though instrumental in increasing agricultural production has also discouraged efficient use of these resources. This has caused degradation and depletion of natural resources in certain regions of the country.

All these highlight the need to reorient the existing role of Government in agriculture. This essentially requires removal of some of the distortions in domestic market, evaluating existing institution and creating newer institutions. There has been significant progress towards reforming agriculture in the recent decade; though this has not been irreversible like other sectors of economy. Agriculture is a state subject; and as far as reforms in agriculture is concerned economic rationale has unfortunately taken a back seat in the years of 'competitive politics'. Yet one would presume that economic sense would prevail and agricultural prices will be rationalized. The desired direction of reform in agricultural prices is not ambiguous; prices of tradable input and out put will be aligned to international prices, while that of non-tradable inputs would reflect scarcity of resources for the society.

The changes in relative prices would definitely affect resource utilization pattern of farmers. The farmers who actually implement an agricultural policy attempt to maximize their farm return; the externalities associated with the stated objectives are often ignored. At times we find that particular farm policy is detrimental to the long-term growth of agriculture in a region on account of negative externalities associated with it. The much acclaimed biochemical technology of late sixties is an example. The farm policies are however politically so important that alteration becomes difficult, prioritizing the long-term concerns over the short run objectives therefore become even more difficult.

The long-run effects of any policy changes therefore need to be evaluated *apriori*. This evaluation has to be region-specific since the externalities, which constrain long-term growth of agriculture in a region vary across regions depending on the status of natural resources in the region. The Northwest India is selected purposively for the present analysis since the region, which emerged as the grain basket of India is in news in recent years, because of certain disconcerting trends in agricultural development. The region is also in the forefront of adoption of commercial agricultural practices; implications of liberalisation is therefore supposed to be the maximum for such a region.

These changes in agricultural prices would influence resource utilization pattern of farmers, finally affecting the elements of sustainability of a region. The factors that constrain sustainable agricultural development of a region vary across regions depending on the status of natural resource in that region[2]. Present investigation is therefore a case study of the Northwest India as farmers of the North-west India have been in the forefront of adoption of commercial agricultural practices (Jha B 1995). The study has following broad objectives.

1. To assess changes in public policies towards agriculture in the nineties and its likely effect on prices of agricultural commodities.

2. To study the extent of sustainability of agricultural development in the Northwest India.

3. To evaluate responses of alternate price policies and technological options on the elements of sustainability in a farming system framework.

The above objectives are discussed separately in three chapters. The following section deliberates alteration in agricultural price policies and reasons for selection of Northwest India, Haryana and Kurukshetra.

Commercialization and Farmers in the Northwest India

Trans-gangetic agro-climatic region comprising of the state of Haryana, Punjab and the selected districts of Uttar Pradesh in the Northwest India has been in the forefront of commercialized agriculture. The present study therefore focuses on the Northwest region. The region falls under semi-arid and arid climate and problems related to water is probably the biggest threat for sustained growth of agriculture in the region; in this sense region is homogeneous. The nature and quality of data however varies across states, therefore, Haryana has been selected purposively as a representative of the North-west India.

Table 1.1 Some of the Indicators of Intensive Agriculture in Haryana

S.N.	Indicators	1972-73	1980-81	1992-93	2003-04
1	Area under rice and wheat crop (in percent)	--	49.53	61.6	94.22
2	Net irrigated to net sown area (in percent)	48.7	59.2	72.7	84.10
3	Ratio of tube well to canal-irrigated area	0.60	0.81	1.2	1.12
4	Tractor (hectare/tractor)	168.7	--	26.8	15.3
5	Fertilizer consumption per hectare of cropped area (Kg)	22.2	--	107.7	--
6	Cropping Intensity (in percent)	145.9	151.7	165.6	174.2
7	Bovine Density per sq. km				170
8	Per Capita Availability of milk (gms/day)				660

It is now almost a foregone conclusion that agricultural prosperity of the region is largely associated with the area under rice and wheat crops. It is apparent from the table that proportionate area under rice and wheat crops have increased from less than 50 per cent to almost 80 per cent during the last 27 years. These crops require assured irrigation and proportion of area irrigated witnessed a consistent increase during the period. Some other factors associated with the intensive agriculture such as consumption of fertilizers, cropping intensity, density of tractor also increased during the reference period indicating that the state of Haryana is a true representative of the North-west India more so the green belt of the country. One notable point is, however, increasing dependence on tube-well vis-à-vis canals for irrigation, this dependence on tube-well in the semi-arid and arid regions have depleted groundwater resources in the region.

Though the state of Haryana is known for its progressive agriculture, preliminary investigations indicate that statistics related to few important parameters of intensive agriculture are not uniform across the state. The proportionate area under rice and wheat is probably the single most important indicator to assess agricultural prosperity, across districts; the districts in Haryana have therefore, been segregated on the basis of proportionate area under these crops (Table 1.2). It is apparent from table that proportionate area under these crops has been as high as 96 per cent in the selected northern districts such as Kurukshetra and Karnal. The corresponding figure has been less than 50 per cent in the selected southern districts like, Bhiwani and Mohindergarh. Generally districts in the northern part of the state are more progressive than the districts in the southern part of the state.

Table 1.2 Distribution of Districts with proportionate area under Rice and Wheat Crops

Per cent Area Intervals	Districts
Less than 50 per cent	Bhiwani, Jhajjar, Mohindergarh, Rewari
50 – 75 per cent	Faridabad, Fatehabad, Gurgaon, Hissar, Rohtak, Sirsa
75 – 100 per cent	Ambala, Jind, Karnal, Kurukshetra, Panipat, Sonepat, Yamunanagar

Apart from indicating different level of progressiveness, this variation in the proportionate area under rice and wheat crops also reveals different set of crop-enterprise mixes in these extreme groups of districts primarily because of differences in the natural resource base. The southern districts are largely in the arid climate, where ground water is more scarce than the northern districts generally categorized in the semi-arid climate. Inspite of it area under wheat has increased in Mohindergarh and similar other district. This trend is evident with respect to other indicators as well clearly suggesting mono-cropping following commercialization without much regard for the carrying capacity of the region. Since the present study assumes that effect of liberalization on various indicators for sustainable agricultural development would primarily be through changes in crop-enterprise mix; the present study selects Kurukshetra that lead other district as far as adoption of commercialized agriculture practices is concerned, for farm level analysis.

Alternate Price and Technological Options

The alternate price scenarios in the third objective will be continuance of existing price regime and the price situations following reforms in agriculture. Most of the changes in Government policies would influence farm input and output prices. Economic logic suggests that prices of tradable input and out put will be aligned with the international prices, while price of non-tradable inputs would reflect the cost to the society. There are sufficient studies to suggest ways to rationalize prices of agricultural input and outputs and likely price situations in alternate development paradigm have been discussed.

As discussed earlier, farmers will respond to changes in the relative prices of farm inputs by adopting suitable technology. Alternate technology to be assessed in the present study are; first, the existing enterprise-mix with present level of resource use; second, existing enterprise-mix with various environment friendly agricultural practices like adoption of integrated pest and nutrient management practices; and finally, alteration in existing land utilization pattern by incorporating pulses, horticulture and agro-forestry based crop rotations with the existing level of resource use.

Impact of alternate price policy and technological options on small, medium and large farms, will be assessed by the Econ-Environmental Impact Matrix (EEIM). The EEIM refers to different farm level indicators for assessing economic and environmental performances of farms. Some of these indicators are aggregate return over variable cost, stability in return, aggregate employment inclusive of distribution of employment, amount of irrigation water, amount of synthetic farm inputs (chemical fertilizers, plant protection chemicals), amount of crop and livestock residues for fuel and fodder purposes. These specific indicators have been assigned weight by a panel of farmers, experts in the region. The change in these indicators over existing situation will be assigned a score in scales from 1 to 10. Alternate situations / plans have been discussed in three Economically-Environmentally-Efficient Plans.

The present work has been divided into three broad sections, and each section into chapters. The next section elaborates the extent of domestic and trade liberalization of agriculture, successively likely effect of liberalisation on farm input and output prices have been discussed. The second section assesses the extent of sustainability of agriculture in the North-west India followed by discussion about possible reasons for unsustainable trend in the agricultural development of the region. This section also presents alternate technological options for the farmers of the Northwest India. The last section, after a brief background of the study area, evaluates alternate technological and policy options in a farming system framework. In the report many of the tables / information are supportive for concerned chapter, the same has been presented as Appendices Table; whereas some information and tables that describes the study area and would be helpful in providing a background of the study are presented as Annexure in the report.

—

II
Public Policies in Agriculture

Agriculture is one of the most contentious issues in the ongoing millennium round negotiation. The post Uruguay round discussions on trade related to agriculture recognizes multi-functionality of agriculture. All these slowed down the pace of trade liberalisation in agriculture. Opening up of trade often referred to as trade liberalisation is desired for more than one reasons; first the WTO Agreement on Agriculture warrants country to liberalize trade in all commodities including agriculture; second, there are enough evidence to suggest that a country gains if it reorient its production base as per its comparative advantage. In the post Uruguay round there was a general belief that trade liberlization is imminent, and cost and quality would determine flow of trade in goods. The WTO member countries therefore must attempt to increase cost efficiency in maximum number of commodities; cost efficiency in trade means efficiency at border rather at farm only.

In India there are studies to suggest market inefficiency in the post harvest operations primarily because of high transaction costs owing to restrictions on domestic markets (World Bank 1997, Jha B. 1999). Some of the Government restrictions on farm input market are constraining future growth of agriculture in the country; on account of high subsidies to various farm inputs, investment in agriculture has suffered; nevertheless farm input subsidies, which were initiated to encourage adoption of bio-chemical technology has several adverse effects on natural resources of the selected regions. There is thus an urgent need to reorient the existing controls on the domestic agricultural market; of late the Government has undertaken some steps towards removal of these controls; a plethora of Government control still exists.

The present chapter discusses process of opening up of domestic and external market relevant to agriculture. The liberalization process as mentioned above has two distinct elements; one, the opening up of external sector or trade liberalisation, which is mandatory for WTO member countries and second, reorientation of existing controls on the domestic market or domestic liberalization which is primarily to increase efficiency and equity in the domestic market. The forces for these liberalizations as is apparent from the above discussions are different; the subject of liberalization in Indian agriculture has therefore been discussed separately into two groups; domestic liberalization and trade liberalization.

2.1. Trade Liberalization in Agriculture

In the post Uruguay round India was restricting trade liberalization in agriculture by taking refuge in the Balance of Payment (BOP) provisions of the WTO agreements for not liberalizing its imports, following pressures from various WTO member countries and decision of the Dispute Settlement Body (DSB) of the WTO, most of the Non-Tariff-Barriers (NTBs) in imports was removed in April 2001. The country has, however, devised a list of sensitive commodities, imports of which are effectively canalized. It is interesting to note that more than 250 items were recognized as sensitive for the country. Some WTO member countries object to such a long list of sensitive commodities. The on-going millennium round negotiations on agriculture recognizes need to protect selected agricultural commodities. There is possibility that a developing country can self-designate a maximum of 20 percent of agriculture tariff line as special product. The self-designation can be on the basis of three criteria: food security, livelihood security and rural development needs of the country.

2.1.1. Review of Trade related Policies in Agriculture

Government has been regulating the country's external sector or trade by imposing quantitative restrictions on trade. The WTO Agreement on Agriculture discourages countries from imposing quantitative restrictions and wants member countries to regulate import by imposing import tariffs. The country can have export promotion schemes, but these schemes must not distort world trade. Often countries also enforce various quality norms / specifications to check imports, this is referred here as qualitative restrictions. Though certain WTO Agreements as that of Sanitary and Phyto-sanitary Standard (SPS) also attempt to reduce subjectivity in relation to qualitative standards. These issues and India's performance in this relation have been discussed below.

Quantitative Restrictions

In India trade for a large number of agricultural commodities were restricted till late nineties. These restrictions popularly known as the Non-Tariff Barriers (NTBs), or Quantitative Restrictions (QRs) are of various types: requirement of license for exports and imports, monopoly of a public agency in trade, linking imports of certain commodities with exports of a commodity as in the Special Import License (SIL). Trade in selected items, like animals, animal fat, etc. is also prohibited on the religious and environmental grounds. The objectives behind trade restrictions / regulations in relation to agricultural commodities has been numerous; in the earlier decades of planned development objective was to facilitate urban consumers, off-late self-sufficiency became important and import was restricted primarily to encourage domestic production. As regards restrictions on exports of agricultural commodities in the historical years, there were two broad groups of the commodities.

One group consists of commodities, in which India has definite export advantages. The examples in this category include traditional export items like tea, coffee, spices, tobacco, jute and a few newly emerged export items like fruits, vegetables and oil meals. Exports of these items were already liberalised, though exports of some of the above commodities were regulated through respective commodity boards.

The second group of commodities includes items like food grains, sugar and cotton. These are sensitive items from the point of view of domestic consumers. Exports of these items were by and large canalized. The principal motive behind canalization had been to match domestic supply and demand through limited imports or exports. There has hardly been any change in this perception even though private exports were allowed for many of these commodities in the nineties. Exports of a few of the sensitive commodities are regulated atleast periodically through one or the other measures.

The situation has been even worse in imports of agricultural commodities. The prime motive behind import control has been insulation of domestic market so as to encourage domestic production and achieve self-sufficiency in maximum possible commodities. There were not many changes in import restrictions of agricultural commodities during earlier years of liberalization. In light of the removal of Quantitative Restrictions following India's debacle in DSB of the WTO, our policy makers have devised a list of sensitive commodities, imports of which are effectively canalized. The WTO agreements, as such have no reservations on the issue of canalization

Qualitative Restrictions

Various quality specifications often restrict trade between countries. These quality specifications often vary amongst the member countries. The WTO Agreement on Sanitary and Phytosanitary Standards is about objective standards for raw semi-processed and processed commodities. Whereas, the Agreement on Technical Barriers to Trade is about quality specifications for processed, mostly packaged items, this agreement is still a plurilateral agreement. In India exports as well as imports of many commodities are suffering because of the SPS standards (Jha 2000).

Export Promotion Schemes

India does not provide any direct subsidy to agricultural exporters, though various export incentive schemes have been there to facilitate exporters. Government has been providing Special Import Licenses (SIL) to exporters, these were used either to import restricted item directly or can be hawked in the market to earn premium out of sales of such licenses. It amounts to indirect export subsidies. The country was also providing income tax exemptions for profit from agricultural exports under section HHC of the Income Tax Act. This income tax exemption was almost a direct subsidy, therefore discontinued towards the end of nineties. With the pruning of list of restricted commodities, the SIL has lost its relevance and was subsequently scrapped. Some of the export incentive schemes such as Export Promotion Capital Goods (EPCG) Scheme, Duty Entitlement Pass Book (DEPB) Scheme, and Duty Drawback Schemes are still there in one or other variants. The DEPB schemes validity has been extended up to March 31 2008; the scheme has been modified to allow reimbursement of the cost of duty on food and special additional duty by way of notifying brand ratio of DEPB for such products. The EPCG scheme is rationalized and cottage and tiny sectors have been provided extended exports obligation. Duty-free imports of capital goods related to infrastructure meant for agro-processing to promote agricultural exports were allowed.

In the emerging trade order there does not appear to be anything specific about the Duty Drawback Scheme; though EPCG and DEPB discriminate imported products based on their purpose. India also subsidizes cost of freight on export shipment of selected horticultural crops. India is not required to reduce these subsidies as these payments are exempted from reduction commitments for the developing countries. In recent decade Government has also come forward with innovative export promotion schemes in relation to agricultural commodities. Vishesh Krishi and Gram Udyog Yojana (VKGUY) is one; this scheme grants duty-free scripts of 5 percent against exports of identified agro-based products. The Focus

Product and Focus Market schemes were launched in 2006. This scheme offers duty-free scripts to exporters of identified products and also to exporters for exporting to identified markets equivalent to a specified percentage of exported goods. On trade facilitation front certain measures were taken to further reduce transaction cost. Some of these measures include dispensing with the requirement of double verification at customs for EPCG and advanced authorization schemes, downsizing of application forms required for availing of various schemes and removing uncertainty regarding taxation for Export Orientated Units (EOU).

Though the extent of trade liberalisation in agriculture may be studied on the basis of aforesaid four points, in the present section trend towards trade liberalization has been discussed on the basis of trend in the first and second indicators of trade restrictions only. The effect of third and fourth indicators of trade liberalisation on resource allocations will be meager and also difficult to establish, therefore ignored from the present study.

Trade Liberalisation after Nineties

The WTO agreement also calls for tariffication, that is, the NTBs must be replaced with a suitable tariff. The tariff must be bound, that is, upper limit of the tariff must be decided and submitted to the WTO. The applied rate of tariff has however been very low and fluctuated, with the domestic regimes and also situations, across the commodities. Though the peak rate of tariff reduced from 12.5 to 10 percent. In agriculture, a few steps towards liberalising trade were initiated about a year and half after the July 1991 reforms. The changes in quantitative restrictions and tariffs for the imports of selected agricultural commodities have often been in association with the exports of these commodities. Trade liberalisation in the nineties for various commodity groups has been reviewed below.

Rice from the view of trade is of two types, basmati and non-basmati. Trade in basmati rice was freed towards the late eighties, but was subjected to Minimum Exports Price (MEP) restriction. The MEP restriction though abolished in January 1994 resurfaces time and again. Exports of non-basmati common rice and wheat were canalized through the FCI. Since 1994 exports of these commodities on private account have been allowed, though it is subjected to quantitative ceiling indicating trade in non-basmati rice and wheat as residual.

Exports of coarse grains suffered from quantitative ceiling. Imports of coarse cereals were also canalized through FCI. There were not many changes in import policy during the nineties, though flourmills were allowed to import without duty and were also subjected to fulfillment of exports of wheat products directly. Similarly, imports of 35 per cent broken rice were allowed to check rise in domestic prices of rice following the exports.

In pulses, India is in chronic deficit; imports of pulses have therefore been allowed. The import duty declined in successive years and since October 1998, import duty in pulses has been zero. On the same account, exports of pulse have been restricted, though exports of processed pulses, which use imported raw pulses are allowed. India is also deficient in oil and oilseeds; exports of oilseeds and edible oil have therefore been restricted. In 1995, export controls (quantitative ceiling) from certain oilseeds like hand-picked-select (HPS) groundnut, rapeseed, mustard and sunflower seeds were removed. In oil meals, a joint product of edible oil, since the domestic production exceeds the domestic demand, exports have been free from export licensing. These were, however, subjected to registration of export contracts in the earlier years. In May 1995, the registration rule was also abolished. Import of edible oil was canalized through State Trading Enterprises (STEs). In February 1995, imports of most of the edible oils were de-canalized. Free imports for most of the edible oil were allowed at a duty of 30 per cent. The duties were reduced in successive years; import duty was as low as 15 per cent. Recently this has been hiked to 40 per cent for and 60 per cent for soybean. Coconut is an exception; this is still canalized.

Import restrictions on the oilseeds, however, continued on phyto-sanitary ground for quite a long period of time. In October 1998, imports of selected oilseeds such as sunflower, and soybean in cracked and split form were placed under Open General License (OGL). This was primarily to make use of the excess capacity of the oil seed crushing industry. Exports of edible oil is virtually banned, whereas, exports of oil cake remained open.

Table 2.1: Import-Tariff in Percent and Import Policy Status of Major Agricultural Commodities.

Commodity or Commodity group	Import Tariff as on 1-8-07	Import Tariff as on Oct. 2000	WTO bound rate of tariff	Policy Status as on Oct. 2000
Rice -nonbasmati	70-80	80	0*	Canalized
Wheat – durum	0	0	100	Canalized
Wheat - non durum	100	100	100	Canalized
Maize,Millet,Sorghum	70-80	60	0*	Canalized
Barley,Rye,Oats & others		0	100	Canalized
Cereals preparations	30	354	150	Restricted
Pulses	0	5	100	Free
Oilseeds – Soybean	30	35	100	Free
Oilseeds – others	5	5	100	Free
Oils-soybean, rape,mustard	40, 75	25	45	Free
Oils- groundnut, palm	85, 45	25	300	Free
Oils- coconut	85	35	300	Canalized
Cotton- raw		5	100	Free
Jute raw		5	40	Free
Tobacco- unmanufactured		35	100	Free
Sugar	60	100	150	Free
Tea	100	15	150	Restricted
Coffee – unprocessed	100	15	100	Restricted
Coffee -roasted, decaffeinated		15	150	Restricted
Natural rubber		25	25	Restricted
Spices	30-70	35	100-150	Restricted
Coconut	70		100	
Vegetables	30	35	100	Restricted
Vegetables- preparations	30	35	55	Restricted
Potato	30	35	100	Restricted
Onion	5	35	150	Restricted
Fruits	30	35	100	Free
Fruits – preparations	-	50	100	Restricted
Fruit juice	-	35	85	Free
Milk and cream		35	100	Restricted
Skim milk powder		15, 60*	0*	Canalized
Whole milk powder		30	40	Restricted
Yogurt		35	150	Restricted
Whey		30	40-150	Restricted
Butter		40	40	Restricted
Cheese		30-40	40	Restricted
Chicken sausage and leg processed		100	150	Restricted
Poultry & other meat		30	100	Restricted
Processed ham		30	55	Restricted
Fish		30	unbound	Restricted

Note: Asterisk suggests renegotiation of bound rates; in fact applied rate and bound rate for the above re-negotiated commodity is same. Existing tariff includes basic and special duties, additional duty is not included in the existing tariff. In a commodity group there are commodities with different trade policy status. Trade policy status presented here holds good for bulk of the commodities in the group.

Exports of sugar and its by-product molasses were canalized through STC before 1991. Successively, sugar export was re-canalized, from STC to ISGIEIC (Indian Sugar and General Industry Export Import Corporation) a company owned by sugar mills. In January 1997, monopoly of ISGIEIC was abolished; export of sugar is almost free, though it is subjected to quota determined by the Government or agencies like the APEDA. Import of sugar was restricted till March 1994, when import was delicensed and was allowed at zero duty. In the successive years, import duty was hiked. In 1991, export of molasses was freed altogether, though in successive years, it was regulated through an association of distilleries. Import of molasses was not restricted, though import tariffs were prohibitive (50 per cent). It was reduced successively to 10 per cent in March 1995.

Exports of cotton are restricted by export quotas, announced by the Commissioner of Textiles and is generally allocated to parastatals and state government dominated co-operatives. These agencies, in turn, contract out most of the export allocations to private traders for a commission, thereby causing inefficiency in the export market. There is also uncertainty in exports market following variation in the export quotas. Import of cotton is, however, de-canalized and is free from duty. Exports of jute, tea, coffee, and spices are free from any restriction. Imports of these commodities are practically banned, though allowed from the SAARC countries on some preferences. Export of tobacco is allowed with Minimum Export Prices (MEP) as there is wide variation in prices of tobacco depending on its use and qualities. Import has been allowed recently. Similarly, one can export natural rubber without any restriction, but imports require license. These are the commodities in which India has comparative advantage. Therefore, allowing import with a moderate duty (30 per cent) would protect the domestic farmers and simultaneously improve country's impression in the WTO on account of import restriction. Exports of fruits and vegetables have been largely free. Onion is, however, an exception; export of onion is canalized through NAFED (National Agricultural Co-operative Marketing Federation). Import of fruits and vegetables are, however, tightly regulated.

The recent trend (2000-07) in import tariff suggests a general decline in import tariff for most of the commodities. This decline was particularly high for processed commodities like cereal preparation, sugar. Incidentally import tariff was raised for certain commodities like tea, coffee, spices. There was a general belief that India has comparative advantage in these commodities and lower duty would protect these commodities from imports. Unfortunately in many of these commodities country has lost its competitive edge; nevertheless regional agreement and lower duty for partner countries has also affected imports of these commodities. In order to protect growers of these commodities import tariffs have been raised.

The major traded farm input is fertilizer. India is deficit in major fertilizers supplying macronutrients such as nitrogen, phosphate and potash. Urea, an important nitrogenous fertilizer is an exception. Imports of important phosphate and potash fertilizers have been de-canalized, while imports of nitrogenous fertilizers like urea is canalized. The canalization of urea is primarily intended to protect the domestic urea manufacturer. The domestic urea industry is cost-heterogeneous because of inward looking approach of the Government in the historical years

Imports of other tradable inputs like seeds, pesticides, farm machinery, etc. were either restricted through import licensing or attracted high import tariff. During the nineties, import duties on specified bulk pesticides and pesticide intermediaries were reduced. In addition, seeds of pulses, vegetables, fruits, flowers, and ornamental plants, tubers and bulbs of flowers, cutting and saplings of flower plants, oilseeds for the purpose of sowing and planting were exempted from import duties. Similarly, import duties on various machineries used for agriculture, horticulture, forestry, poultry, were reduced. Import duties on tractors and specific trailers were also reduced. The reduction of import duties will definitely increase competition in the domestic market.

The above discussion delineates India's attempts towards opening Indian agriculture in last few years of the nineties. Import restrictions continued for many agricultural commodities. This is against the WTO requirement for tariffication, that is, all the NTBs must be replaced with a suitable tariff. There are few exceptions, Article XVIIIB is one of them and India along with few selected countries[3], had been taking refuge in this article. Following adverse decision of the WTO's dispute resolution body, India has removed NTBs in March 2001 for most of the commodities, barring a very small negative or prohibited list, banned on environmental or religious grounds. Imports of sensitive commodities were effectively canalized. The peak rate of tariff has also declined from 12.5 to 10 percent; though import tariff for selected commodities are raised frequently primarily to protect domestic growers.

2.1.2 Changing Protection in Indian Agriculture

With the above set of import liberalization, domestic market to some extent would be integrated with the world market. This may be reflected in decreasing protection to agricultural commodities. The changes in the levels of protection in agricultural commodities have been evaluated by protection coefficients: Nominal and Effective. The methodological detail about protection coefficients is mentioned in Appendices.

The estimates for Effective Protection Coefficient (EPC) and Nominal Protection Coefficient (NPC) are presented in Table 2.2. The NPCs are incentive indicators at product price level, while EPCs include protection at the level of product as well as inputs used in the production process. The NPCs are often used as indicators of competitiveness due to easy availability of domestic and international prices. Whereas, EPCs require intensive data on cost of production, domestic and international prices of farm inputs used in the process of production. Such information is not available for many agricultural commodities; these estimates have therefore, been calculated for certain period only. These estimates are also for limited number of commodities since adequate information for many agricultural commodities is not available from published sources.

As is discernible from Table 2.2, (EPC>1) India had protected coarse cereals like, sorghum; the country was at the either side of border in maize and wheat; whereas, the country had dis-protected cotton and rice during the earlier years of trade liberalization. The estimates for NPCs are similar to that of EPCs; though this is presented for a larger period so as to get a temporal trend in the levels of protection. For commodities like maize and sorghum, differences between these coefficients are even less. These crops are cultivated with less fertilizers, since fertilizer is one of the most important traded farm inputs, protection in farm inputs have not been reflected in the EPCs. Stated differently, value additions for these crops have not made any significant difference. The NPCs are slightly higher than EPCs for crops like rice, wheat, cotton, jute and tobacco. These are the crops to consume higher doses of fertilizers.

The NPC results also demonstrate that the country has distinct advantage in producing commercial items like, cotton. The NPCs for these commodities have been less than one in the reference years. The NPCs for fine cereals fluctuated on the either side of one, while for coarse cereals it was more than one for both the reference years in the nineties. The NPCs for cereals indicate that the country is protecting coarse cereals; while, it is at the margin in wheat and rice.

An attempt has also been made to present NPCs over the years (1992-93 and 1996-97, and between 2000-04). Temporal trends in NPCs indicate impact of trade liberalization on the levels of protection. For cereals, there has been marginal increase in NPCs over the years; though cereals like, wheat and maize are exceptions. The increase in NPCs has been significant for commercial crops like cotton, jute, and tobacco. The increase in NPCs over the years suggests decrease of protection in the nineties. A lower NPCs during 1992-93 owes it to devaluation of rupee during the year 1992; levels of protection declined in subsequent years. The NPCs for most of the commodities was more than one from 2000 onwards. This is continuation of previous trend; a higher NPCs during latter years highlights role of fluctuating world price on protection coefficients. This is also evident from the NPC results presented in the Table 2.2.

Table 2.2: Some Estimates for Measuring Protection in Indian Agriculture: Effective Protection Coefficient (EPC), Nominal Protection Coefficient (NPC).

Commodities	**Effective Protection Coefficients**		**Nominal Protection Coefficients**					
	1995-97	**2001-03**	**1992**	**1996**	**2000**	**2001**	**2002**	**2003-04**
Paddy	0.89		0.90	0.82	1.10	1.14	1.28	1.20
Wheat	0.94		1.02	0.94	1.14	1.04	1.10	1.12
Maize	1.00		1.14	0.86	1.18	1.3	1.24	1.05
Sorghum	1.10		1.10	0.86	1.10	1.16	1.25	1.22
Cotton	0.81		0.81	0.83	1.06	1.15	1.12	0.91

Note: These estimates are for leading producing state of the commodity. For example, Punjab for rice and wheat; Uttar Pradesh, Rajasthan, Gujarat, West Bengal and Andhra Pradesh for maize, sorghum, cotton, jute and tobacco respectively.

A comparison of present study with similar other study (Gulati and Sharma 1997) presents wide disparity; results vary on the basis of reference years in the study. Author regrets that the present study could not work out protection coefficients for oilseeds, sugarcane and similar other crops. Adequate information for many agricultural commodities is not available. International prices for sugarcane and many edible oils for instance, are not available; though prices for its end products such as, sugar and selected edible oils are available. From the prices of end products, one way of arriving at the commodity price is to do backward calculations. This will however, lead to wrong conclusion as significant amount of protection exists in India in the post harvest operations (World Bank 1997, Jha B. 1999).

The above discussion suggests that commodities were at different levels of protection, high for coarse cereals, low for fine cereals, commercial commodities were actually dis-protected. With opening of economy NPC tend towards one and such differences in levels of protection was actually mitigated.

Future Direction of Trade in Agriculture

Liberalisation of import is thus going on hesitantly (Jha B. 1999). This hesitation is on account of various factors; trade distortions in world market, volatile world prices and its effect on producer and consumers are some of the important reasons. Considering the political economy associated with agriculture, liberalisation in agriculture is not irreversible. This is apparent with frequent increase of import tariff in agricultural commodities. The adverse effect on domestic producers assumes greater importance considering the magnitude of inefficiency in the post harvest operations. The selected agricultural commodities therefore, require protection as long as bulk of government control on domestic agricultural market continues and world trade in selected commodities remains distorted.

In this perspective, Government was continuing with its policy of import restrictions; import restrictions for most of the agricultural commodities had, however, gone in April 2001, following the decision of the DSB of the WTO. The policy makers have cleverly devised a list of sensitive commodities, imports of which are practically canalized. At this juncture, it is necessary to point out that the WTO Understanding on State Trading Enterprises (UoSTE) is not against functioning of the government parastatals provided it works in transparent way, though there are pressures especially from Cairns group of countries to limit the role of Government parastatals. In the emerging trade order, import tariff is another way of protecting domestic market.

India’s trade policy is often criticized on the ground of high tariff bindings, following WTO commitments: 100 per cent for wheat, barley, rye, oats, pulses, tobacco, most of the fruits, vegetables and their preparations; 150 per cent for raw cotton and tobacco; 45 per cent for edible oils like soya, rape seed, mustard, olive and colza; while remaining oils including coconut and palm are bound at 300 per cent. There are exceptions, commodities like rice, maize, sorghum and millet, milk powder, etc; can be imported at zero duty; though imports of these commodities are canalized. In the successive negotiations under the umbrella of WTO these bound rates were renegotiated; zero bound rates for non-basmati rice, coarse cereals, skimmed milk powder was replaced with a moderate rate under the TRQ-system.

As compared to bound rates, applied rates of import duty, that is basic plus additional plus special duties, has been low; though this has been fluctuating over the years and trend often defy economic logic. There have been studies to indicate that an effective import duty of 50 per cent is sufficient to protect bulk of agricultural commodities (Jha B 2000c). In the long run, especially when domestic regulations on agricultural market will reduce significantly and distortion in world trade would minimize, import tariffs, as suggested by the Tax Reform Committee (GOI, 1993), may be pursued.

The Tax Reform Committee recommended three rates of import duties for agricultural commodities. First, zero per cent duty for essential agricultural commodities like wheat and rice; second, 10 per cent duty for commodities like oilseeds and pulses; and, third, 50 per cent duty for non-essential commodities like almond and cashew nut. It appears that the recommendations are based on the necessity of the commodities in the consumer basket. Import tariff is also gradually decreasing; reduction of import tariff in a commodity should also consider the intensity of government control on the domestic market. Many of the agricultural commodities become price inefficient because of high transaction cost associated with the Government control; sugar is an example (Jha 1999). Removal of these controls would provide level playing field to domestic producers.

2.2. Liberalization of Domestic Market

Government intervention in agricultural market has been aimed at correcting the perceived market failures in the aftermath of Bengal famines. The objective, thrust and instruments of intervention has undergone significant changes during last 60 years. Till mid-sixties the emphasis was more on controls/ restrictions, imports and distribution of food grain below the market price; in subsequent years self-sufficiency by providing incentive through price was designed. Mandatory liberalisation of trade under WTO Agreements has thrown new set of challenges for market intervention policies. Trade liberalisation has dis-protected agricultural commodities making price-based support less effective. The market intervention policies have also created inefficiencies in the post harvest operation. The regulation of price based support and reduction of market intervention is the subject matter of discussion in the present section.

2.2.1 Review on Market related Policies in Agriculture

Market restrictions take various forms and the forms have changed over time depending on the objectives and the prevailing environment in the country. Most of these restrictions are rooted in certain legislations that were enacted primarily to facilitate interest of producers and consumers. Of-late these restrictions have led to inefficiencies in the domestic market; whereas, efficiency is paramount in a globalised world. Some instances of restrictions on the domestic market are the zonal restrictions on movement of commodities, compulsory procurement levies on processors, license and stock requirements and credit control on traders. These restrictions are often selective in nature and its removal would change relative prices of these commodities, which in turn would influences sustainable agricultural development of the region. Trend towards removal of these restrictions has therefore been discussed.

In the post-independent years Agricultural Produce Markets Regulation Act was adopted by most of the states to protect interest of farmers. Several evaluation studies eulogize regulated market on following account: visibly open process of price discovery, more accurate and reliable weighing, standardized market charges, dispute settlement mechanism, availability of several amenities and so on (Acharya 1988). Despite Governments effort to expand number of regulated markets, the area served per market yard is quite high, more than 450 sq km per yard. Of-late the APMCs emerged as Government monopolies with all drawbacks and inefficiency associated with a monopoly[4]. The Ministry of Agriculture, Government of India (GOI), in consultation with state government, trade and industry has formulated a Model Act and circulated to state governments. Some states have infact adopted this act. Salient features of this act is present below:

- Permission to establish new markets extended to cooperatives, growers or local authorities;
- Establishment of direct purchase centers and consumers/farmers markets for direct sale;
- No compulsion on growers to sell their produce through existing regulated market yards;

- Prohibition of commission agency in any transaction of agricultural commodities with the producers;
- Separate constitution for special markets for commodities like onions, fruits, vegetables and flowers;
- Promotion of public private partnership in the management and development of agricultural markets;
- Market committee to promote alternative marketing system, contract farming, direct marketing and farmers / consumers markets;
- Separate chapter to regulate and promote contract-farming arrangements;
- State Agricultural Marketing Boards to promote standardization, grading, quality specifications, market-led extension and training of farmers, and market functionaries in marketing related areas;
- Constitution of State Marketing Standards Bureau for promotion of grading, standardization and quality certification of agricultural produce.

The Essential Commodities Act (ECA), 1955 and a large number of control orders issued there under primarily attempt to protect the interest of consumers. The ECA empowered Central and State Governments to impose restrictions on storage and movement of commodities such as food grains and edible oil, thus restricting the scope of private investment in these markets. The post harvest operation in agriculture especially agro-processing is constrained with multiplicity of legislations; recently Government has come out with Integrated Food Law. There have been similar attempts in marketing and processing of agricultural commodities; some of the recent attempts towards deregulation are as under:

- The commodities included under ECA have been reduced.
- Government removed restrictions on investment in bulk handling and storage by private investors in 2001, this also includes foreign investments upto 100% ownership.
- The licensing requirements for wholesale trade and also stocking limits for both wholesale and retail trade was lifted in 2003. Though the process of simplification was started in September 1994, when states were advised to abolish licensing requirements for wholesale trade, and also stock-holding limits on rice and wheat.
- The production levies on rice and sugar primarily to meet the demand for PDS was reduced. Levy on sugar was as high as 40 per cent; this has come down to 10 per cent in the year 2002. Levy for rice varies across states, whereas in sugar it is uniform throughout the country.
- Some of the rigors of Selective Credit Controls (SCCs) were eased in 1996; though re-imposed for a few commodities like wheat, in subsequent years. Again in 2002 Government removed restriction on access to credit under SCC.
- In 2003 the GOI eliminated the ban on futures trading on 54 commodities including wheat, rice, oilseeds and pulses, which were prohibited under the Forward Contract (Regulation) Act, 1952. The ban on future trading for wheat and rice was reimposed in the year 2006.

- The GOI has removed the restrictions on plant scale and capacity expansion as also the licensing requirement for most of the food processing industries. A single unified food law was designed by constituting a Group of Ministers at the Centre. This has drafted / submitted Integrated Food Law.
- There are other controls on domestic market. This includes the prescribed use of jute bags for retail packaging and fortnightly release control system in sugar.
- The problem of non-unitary sales taxation of food grains in states has been solved[5].

The major objective of these interventionist policies in agricultural output market has been to provide food to bulk of consumer at affordable prices. These interventions, to some extent, have fulfilled the stated objective, but at an enormous cost in the sense of increased inefficiency in the post harvest operation. Government controls therefore need to be dismantled in the phased manner. Yet over all trend is towards removal of restrictions from domestic market so as to increase competition in the market and simultaneously meet the objective of food security. Though soaring food prices has often forced Government to reimpose many of the restrictions on agriculture market in the recent decade.

Agricultural Price Policy

Government price policy for agricultural commodities attempts to balance the twin objectives of assuring remunerative prices to farmers and providing food and raw material to domestic consumers and industry. Government announces Minimum Support Price (MSP) for 24 commodities and Statutory Minimum Prices (SMP) for sugarcane. In sugarcane the SMP is dormant for most of the state except Maharashtra, the price at which sugar processor procure cane from the farmers are the state advised prices (SAP) and this is significantly higher than the SMP for sugarcane. The higher SAP is instrumental in making domestic sugar price-inefficient in the world market. For some other commodities not covered under MSP policy (fruits, vegetables and spices), Government or quasi-Government organization undertakes selective market intervention scheme. These interventions are often criticized on the ground of its effective operationalization in the selected regions of the country. There have been suggestions for decentralized procurement.

In the farm input market prices of major farm inputs such as fertilizers, canal water and power for its use in agriculture, is being determined by the central and state Government respectively. It is generally felt that these prices do not reflect its opportunity costs and result in various problems; on one hand this affects viability of resource supplying agency and the quality of resources supplied to farmers; on other hand this encourages inefficient use of scarce resources and constrains future growth of agriculture in a region. In the early nineties prices of most of the fertilizers, except urea, were decontrolled. For urea, price is still administered by the Central Government; whereas, prices of non-tradable inputs like canal water and electricity is regulated by the state Governments. Variation in these prices across the states and similar related issues has been discussed in detail in the successive chapter.

2.2.2. Liberalisation and Agricultural Prices

Various forms of Government interventions and extent of its removal have been discussed in the preceding chapter. Domestic liberalization has been in the nature of removal of movement restrictions, facilitation of private trade and market functionaries; naturally one would expect that with the domestic liberalization market would integrate, prices in the domestic market would converge and become robust. With the opening up of the economy, world price is supposed to influence market prices of the commodities; whereas in a closed economy administered prices were playing dominant role in influencing the market prices at least in the selected region. Administered prices for farm output attempts to balance the interest of producers as well as consumers, while the behavior of international prices is erratic and depends on innumerable, often unpredictable, factors. It is often argued that bulk of domestic producers and consumers in India are too poor to be left for the forces of world market. In recent years administered prices have also been on attack on several accounts; more than considerate hike in administered prices has out-priced many Indian commodities in the international market (Jha B 2002). A consistent support to the selected crops through administered price has also caused specialization in certain regions of the country without any regard for the resource endowments in that region. In this perspective, it is necessary to analyze the behavior of farm output prices and how this is being influenced with the domestic and trade liberalization of agriculture.

In agricultural input market, administered price plays even larger role; it is generally criticized that the administered price for farm inputs do not reflect scarcity of these inputs. A regime of relatively lower prices for farm inputs was initiated in the seventies to increase adoption of biochemical technology. The stated objective to some extent has been achieved; its continuance has, however, created wide range of problems. On one hand it leaves less Government resources for investments in agriculture; on the other hand this has induced farmers to use it indiscriminately causing degradation and depletion of natural resources in a large part of the country. Present discussion about liberalization and agricultural prices has been divided into two subsections; first section discusses behavior of farm output prices while the next section analyses trends and problems related to pricing of the selected farm inputs and also future direction of farm input and output prices.

2.2.2.1 Behavior of Farm Output Prices

In Indian agriculture Minimum Support Price[6] (MSP) is probably the most important price announced / administered by the Government. Market price in the present analysis is the Farm Harvest Prices[7] (FHP) of commodities at the state level (Haryana) and wholesale prices[8] are at the country level. The growth in these market prices has been estimated separately for the decade of eighties (1980-81 to 1989-90), nineties (1990-91 to 1999-2000) and 2000s (2000-01 to 2005-06); and the same is presented in Table 2.3.

The MSP growth has generally been higher for pulses, followed by cotton, fine cereals, oilseeds, and coarse cereals. The country is deficient in pulses and oilseeds and a high MSP in these commodities is to motivate farmers to grow these crops. In the nineties as the economy was opening there was a feeling that import of the selected edible oils such as palm, sunflower, soyabean can meet the domestic demand for edible oil and a consistent price support to oil seeds tapered off; but again it revived as is apparent with the high growth in the prices of rape and mustard during the recent period (2001-05). In cotton, slightly higher growth in the prices of hybrid cotton reflects its importance over *desi* cotton as perceived by the policy makers. A higher growth in the MSP of cotton, fine cereals during the nineties is also on account of fact that there has been demand from certain quarters for equalization of domestic prices with the international prices; and the MSP were used as a tool for this process of equalization. The MSP is unfortunately downward rigid unlike world prices. The MSP for coarse cereals did not experience large growth during the reference period as its importance is not realized by the policy makers; maize is however an exception.

The Farm Harvest Price (FHP) in the table is for Haryana; the commodity-wise trend growth in the FHP has been similar to that of the MSP; only recently (2001-05), FHP has started decreasing for many commodities though MSP continued to increase steadily for the same. A relatively higher growth in the FHP of paddy during the eighties and nineties is more because of statistical anomaly; market price of rice in Haryana consists of prices of basmati and non-basmati rice[9], proportion of basmati in total rice often fluctuates and so the pooled price of rice in the state.

A period-wise comparison of trend growth in FHP and MSP shows that market price of coarse cereals were growing at a pace higher than the administered prices during the period I, for rest of the commodities growth in market prices was lower than the administered prices. The lower growth of the market prices suggests that market in the region is not in a position to support the higher growth in the administered prices of the commodities. This phenomenon is more conspicuous during latter periods: period II and period III. The growth in the FHP is in fact negative for paddy, arhar, cotton (hybrid), bajra and jowar during Period III.

Table 2.3: Annual Compound Growth Rates (in percent) in Minimum Support Prices (MSP), Wholesale Price Indices (WSP) and Farm Harvest Prices (FHP in Haryana) of Principal Crops

Crops	Period I (1980-81 to 1989-90)		Period II (1990-91 to 1999-00)			Period III (2000-01 to 2006-07)		
	MSP	FHP	MSP	WSP	FHP	MSP	WSP	FHP
Paddy	6.5	8.6	7.9	8.1	11.4	2.1	1.2	-9.8
Wheat	5.4	4.7	8.7	9.2	9.4	2.7	3.6	2.4
Maize	5.3	6.7	7.7	7.6	7.4	3.2	4.2	1.3
Jowar	5.1	7.6	6.2	12.9	6.4	2.9	5.3	-0.8
Bajra	5.1	4.9	6.2	8.2	6.7	2.9	4.3	-3.1
Barley	5.2	6.9	7.5	-	7.2	2.3	-	4.7
Gram	12.4	9.4	7.9	3.1	6.9	4.9	5.0	1.4
Arhar	9.9		8.2	10.3		2.4	3.4	-4.4
Rapeseed and Mustard	10.9	9.4	5.5	6.2	4.5	6.9	6.1	5.3
Cotton (Desi/F414)	10.7	6.9	9.4	5.1	10.2	1.5	-0.1	3.5
Cotton (Ameri/H4)	9.8	4.7	8.6	5.1	9.9	1.5	-0.1	-2.7

Note: The Farm harvest Prices (FHP) are available till the year 2003-04, therefore ACGR in FHP during period III is for the period (2000-04).

The pattern of growth in the MSP and FHP is not equally clear after 1990 (period II and III); for the commodities like paddy, wheat and cotton growth in the FHP has been higher than the MSP in the 1990s (period II); but in the next period (2000-05) growth in FHP of paddy and cotton were lower than the MSP, *desi* cotton was an exception. One may note that world prices of rice and cotton are decreasing during this period (2001-05) while world prices has been increasing during the large part of the earlier period. Though world prices of wheat declined during the recent period (2001-05), market prices of wheat did not decline; in fact both the market prices –farm harvest and wholesale prices increased at a rate higher than the MSP. Like rice and cotton, India often exports wheat; but downswing in world piece has not affected wheat because of increasing demand for wheat.

A lower growth in the WSP of gram during the nineties could also be because of significant amount of its imports. The MSP for pulse is increasing primarily to motivate farmers to increase land allocation under these crops; farmers sowing decisions however, depend on many other factors. As is evident from Table 2.3, in the recent period (2001-05) farm harvest prices in Haryana have decreased for jowar, bajra, arhar, and stagnated (less than 1.5 percent) for maize and gram; though, growth in the MSP and wholesale prices has been moderate for the country. This to some extent reflects importance of commodities in a market; it appears that for the above commodities wholesale markets in Haryana are not very sought after; as a consequence little produce that are available in these markets did not fetch sufficient price for farmers. The growth in the wholesale prices (WSP) of certain exportable commodities has been significantly higher than the other prices- MSP, FHP during the nineties; this rate of growth subdued afterwards (2000s) and was in fact negative for a few commodities (cotton).

The above analysis shows that Farm Harvest Prices were by and large following Minimum Support Prices during the eighties; since mid-nineties difference in these prices has increased for most of the commodities. The FHP has in fact declined for many commodities in recent years though prices of the same commodities are increasing in the wholesale market. International prices have started influencing domestic prices while farmers still rely on MSP for sowing decisions. With this brief background about the behavior of domestic prices, the study attempts to analyze influence of domestic and trade liberalization on the market prices.

Liberalisation and Farm output Prices

In India domestic liberalisation has been in the nature of reduction in Government restrictions on market and this should integrate the domestic markets; in other words, prices should converge with the domestic liberalisation. There are different ways of measuring integration. The present study works out coefficient of variation (CV) in market prices of a commodity across states to measure convergence of prices in the domestic market. The concept of market and so market prices often varies; the farm harvest price (FHP) reflects price received by farmers and for analysis of FHP individual state has been considered as a market since the set of market restrictions are state specific. For some specific state-level analysis Haryana has been selected purposively as this is in the forefront of commercialized[10] agriculture; and the effect of liberalization on market prices will be more emphatic in this situation. This will also have bearing for other states in the forthcoming years. An increase in CVs would suggest decline of spatial integration of market. The CVs have been worked out for three time periods, Period I involves years between 1987-88 and 1989-90, period II encompasses the years between 1997-98 to 1999-00, while Period III includes recent years (2002-05) and the same is presented in Table 2.4

Table shows that crops are in different levels of price divergences; the crops with decreasing order of divergence in the recent period (2002-05) are cotton, arhar, rape-mustard, potatoes, wheat, maize, gram and paddy. There can be several reasons for such crop-wise differences in price disparity. The marketing institutions for these commodities are of extreme types; a significant proportion of wheat and rice marketing is in the hands of public institution (Food Corporation of India) and one of the objectives of this institution is to reduce interregional differences in prices[11]. This is however, not the case with other agricultural commodities. The differences in quality also account for some of the disparity in prices across states.

A significantly high disparity in market prices of rice and cotton is on several accounts; variation in quality of these commodities and varying proportion of these varieties in the pooled price (FHP) of a commodity is one of the important reasons[12]. A part of dispersion in the FHP is also because of prevalence of state-level movement restrictions in relation to the above commodities in certain states. In rice, price disparity during the eighties and nineties were high; price disparity however declined in the recent period (2002-05). One may note that movement restriction in Andhra Pradesh was abolished only in the recent period. In potato price dispersion has been high since the period I. A high disparity in the prices of potato is on account of its perishability and inadequate infrastructures.

The disparity in price increased for all crops during the reference period. Interestingly, for crops other than paddy the increase in price-disparity has been phenomenal during the recent period. The external trade appears to have played an important role in increasing such disparity in the prices of agricultural commodities. Though effect of removal of some state-specific controls on spatial integration is also evident. A correlation-based analysis[13] of market integration shows mixed trends; for wheat and oilseeds market integration in the nineties has increased over the eighties; whereas, for maize and pulses market integration has declined during the same period (Jha 2003).

Table 2.4 Inter-State Disparity in Farm Harvest Prices of the Selected Commodities

Crops	Period I (1987-88 to 1989-90)			Period II (1997-98 to 1999-00)			Period III (2002-3 to 2004-05)		
	Mean	St Dv	CV	Mean	St Dv	CV	Mean	St Dv	CV
Paddy	224.1	35.3	15.7	570.9	124.4	21.8	605.4	224.0	37.0
Wheat	243.4	31.7	13.1	619.9	90.1	14.5	554.0	271.0	48.9
Maize	195.9	24.9	12.7	480.6	72.8	15.1	423.8	183.2	43.2
Gram	584.5	67.0	11.5	1327.9	196.5	14.8	1490.0	486.8	32.7
Arhar	607.9	54.7	9.0	1593.5	205.6	12.9	1227.8	850.5	69.3
Rapeseed & Mustard	679.9	91.8	13.5	1340.5	215.6	16.1	391.4	202.7	66.5
Cotton	717.0	139.7	19.1	1831.3	567.8	31.0	1463.1	1196.5	81.8
Potatoes	178.3	54.6	30.7	425.6	141.3	33.2	391.5	202.7	51.8

The above discussions indicate the extent of market integration in some agricultural commodities. A temporal trend in FHP, WSP, MSP and IP of important agricultural commodities[14]: paddy, wheat, maize and cotton have been presented in Figures. They represent different situations in relation to trade[15]. Such comparative account would show influence of IP and MSP on FHP and WSP of a commodity. This may reflect price movement in vertical direction. The extent of association between these prices is presented in the appendix Table 2.1A. Though reference period for above presentation is 1990-2006, the price series are often incomplete. The farm harvest prices are available till 2003-4. Whereas, the comparable international prices and wholesale price indices are available between 1991-2005 and 1993-2006 respectively. The wholesale prices used in the present analysis are the price derived from wholesale price indices as obtained from the Ministry of Industry (GOI)[16]; and the FHP is for the state of Haryana.

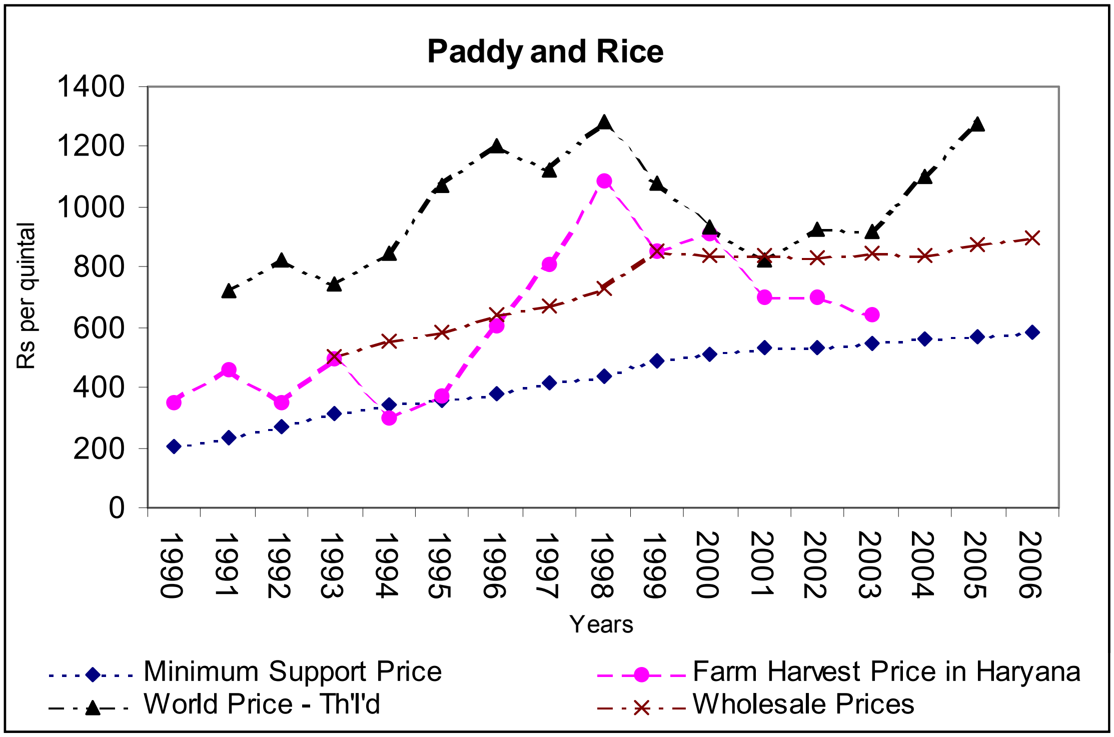
The international prices are the freight on board *(fob)* prices at a port of a leading exporting country; for rice it is Thailand port, whereas for wheat, maize and cotton it is the *fob* price at a port in Australia, USA and UK respectively. As is evident from the figures that international prices are fluctuating for all commodities. International prices for rice and cotton are significantly higher than the domestic prices of these commodities; some of the differences in prices of these commodities can also be attributed to the comparable quality. International price of wheat is higher than the domestic prices for most of the years; whereas in maize domestic prices are higher than the international prices. This has implications for India's trade in these commodities. The Farm Harvest Prices in paddy are more volatile than other domestic prices. Since 1994 trend in the FHP has been similar to the international prices. The FHP has come closer to the IP in the year-1998 and thereafter started decreasing. The WSP of rice reflects a non-linear trend during the reference period; it increased rapidly till 1999, in subsequent years it declined and stagnated further. The MSP is downward rigid at least in nominal terms therefore MSP of paddy started stagnating since 1999.

In wheat interestingly it is the WSP that fluctuates the most amongst all the domestic prices. Fluctuation in the WSP of wheat, unlike rice, is less significantly related to trends in international prices suggesting increased role of domestic compulsions on such fluctuations. For wheat the MSP and FHP is almost same; often it is difficult to distinguish them. In maize domestic prices are greater than the international prices; at times the MSP is also greater than the IP. Interestingly, farm harvest prices in Haryana and price in the wholesale markets of the country were not in harmony till 1999; subsequently, with imports, prices have started moving together. In cotton international price is not only fluctuating but is also decreasing over the years; such decreasing trend is evident in maize as well. In cotton domestic prices- the FHP and WSP are also fluctuating like international prices; very recently (2003-4), the FHP in Haryana has been lower than the MSP. This highlights inadequacy of the MSP and to some extent also reflects the reasons for farmers distress.

The above analysis shows that price divergence in domestic market has increased in the recent period while this divergence is supposed to decrease with the liberalization of domestic market. It appears that removal of certain restrictions from domestic market has not affected private trade significantly; various local level restrictions and infrastructure bottlenecks actually persist. In this situation external trade in a commodity, generally in small amount, appears to have affected market price of commodity only in regions adjacent to the port. This further widens disparity in market prices across states. The above pictorial presentations clearly shows increasing role of international price on market prices of many agricultural commodities; while, market prices were following administered price in the eighties. The MSP considering its politico-economic situation cannot decline in nominal terms therefore fails to reflect the likely situations in an open economy, and relying on MSP as a price signal for farmer's resource allocation decisions leads to hardships for farmers. Domestic price trends are different across commodities, in wheat and cotton the FHP and the WSP are moving together; but not so in paddy and maize.

The present study found that disparity between FHP and MSP increased in the nineties; for exportable commodities FHP has been fluctuating with the world prices. In this situation farmers' sowing decisions based on the MSP actually results in severe hardships to farmers. A robust future market that discovers prices of a commodity in future, taking into account all the complexities of an open economy, becomes important. The spatial integration as an inverse of coefficient of variation in farm harvest prices across states weakened consistently over the years; this weakening tendency has further strengthened in the recent period (2002-05). This is against a general belief that with domestic liberalisation markets across space would integrate. The FHP for certain commodities has decreased with the world prices during a specific period; but prices in the wholesale market increased for the same period. Increased transparency in domestic market is therefore desired and future market can play an important role. The study finally concludes that expanding reach of future market, disseminating information about agricultural prices may go a long way in integration of markets.

Fig. 2.1: A Comparative Account of Prices of Important Agricultural Commodities



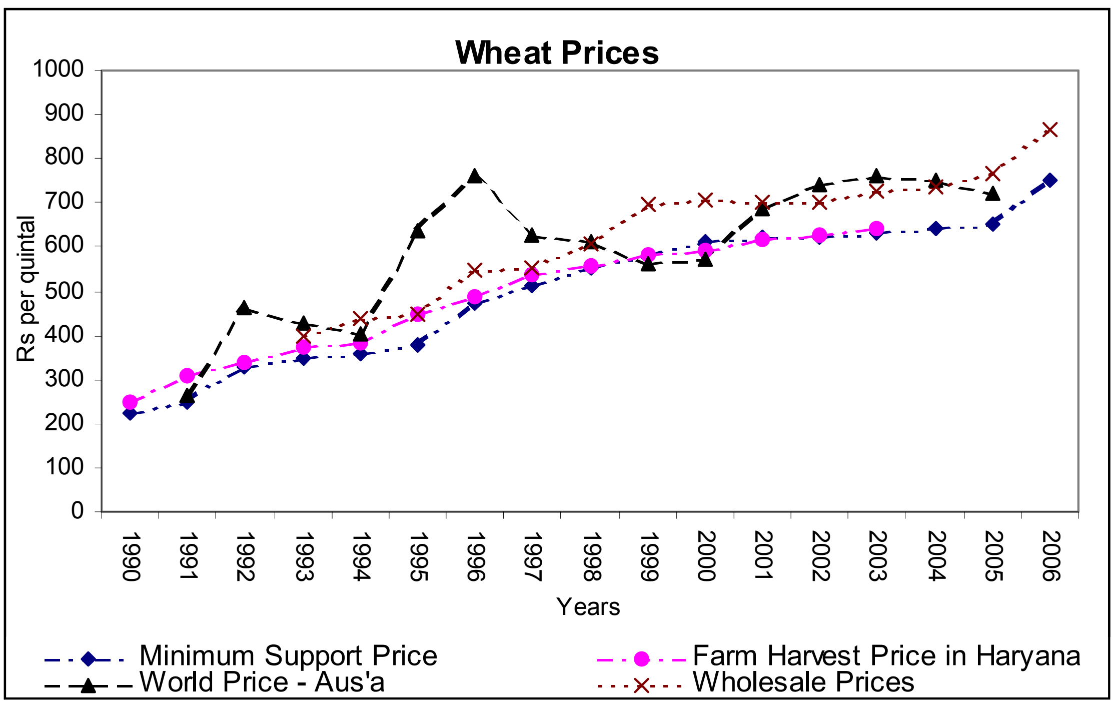
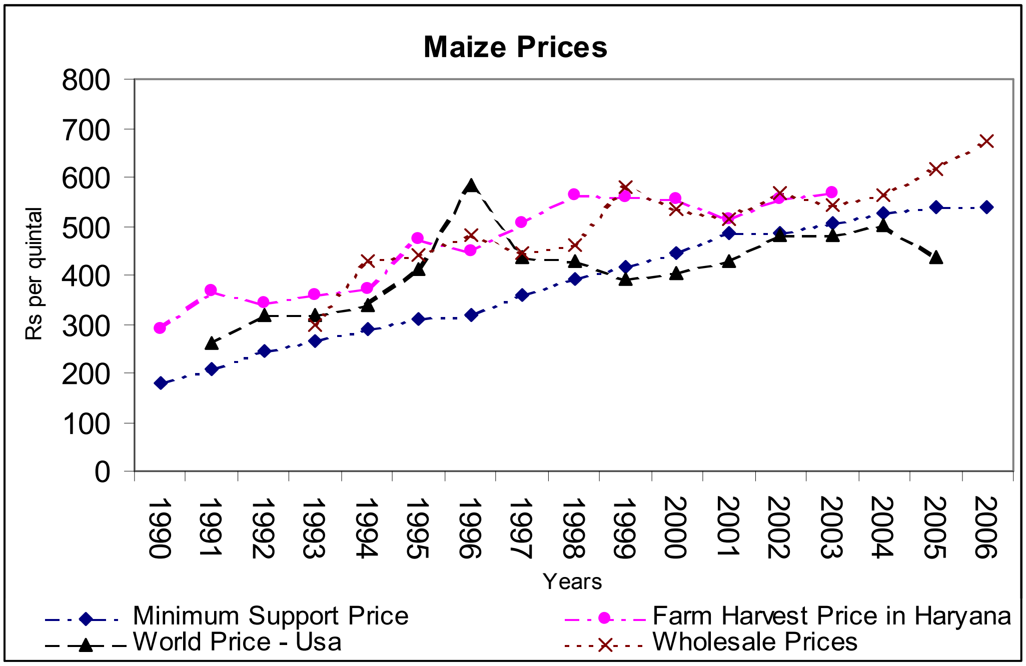


Fig. 2.1: A Comparative Account of Prices of Important Agricultural Commodities



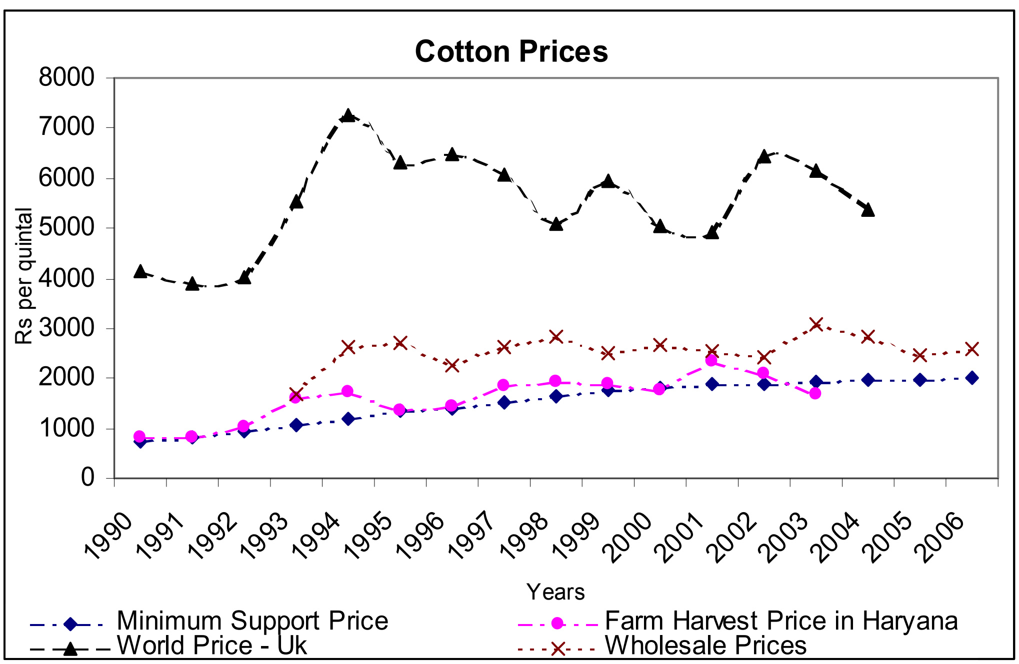


Table 2.5 Correlation Coefficients of Farm Harvest Prices between Haryana and Important States of India for the Selected Crops in Eighties and Nineties

S.No.	States	Paddy		Wheat		Maize		Gram		Rapeseed & Mustard	
		1980	1990	1980	1990	1980	1990	1980	1990	1980	1990
1	Andhra Pradesh	.88**	.73*	--	--	.84**	.95**	.90**	.71*	--	--
2	Assam	.96**	.71*	.91**	.93**	.88**	.87**	--	--	0.55	.87**
3	Bihar	.81**	.76*	.87**	.97**	.83**	.92**	.91**	.87**	-0.56	.77**
4	Gujarat	.92**	.75*	.79**	.93**	.87**	.90**	.80**	.88**	0.66	.93**
5	Himachal Pradesh	.70*	0.59	.95**	.97**	.78**	.94**	.96**	.85**	0.39	.82**
6	Jammu & Kashmir	.65*	0.63	.98**	.96**	.85**	.92**	0.67	0.59	0.61	-0.36
7	Karanataka	.97**	.68*	0.56	.91**	.69**	.92**	.87**	.83**	--	--
8	Madhya Pradesh	.95**	.76*	.89**	.94**	.77**	.83**	.93**	.95**	0.44	0.76
9	Maharashtra	.97**	.76*	.85**	.95**	0.62	.93**	0.64	0.58	--	--
10	Punjab	.83**	.64*	.92**	.98**	.78**	.87**	.90**	.75*	0.39	.79**
11	Rajasthan	.85**	.77**	.91**	.96**	.84**	.87**	.97**	.95**	0.79	.90**
12	Tamilnadu	.94**	.76*	--	--	.86**	.92**	.88**	.83**	--	--
13	Uttar Pradesh	.93**	.73*	.94**	.96**	.81**	.92**	.95**	.93**	0.62	.79**
14	West Bengal	.82**	.94**	.87**	.95**	--	--	.96**	.76*	0.32	.85**

Note: Asterisk shows level of significance of correlation coefficient, (**) indicate significance at 1 per cent while (*) indicate significance at 5 per cent

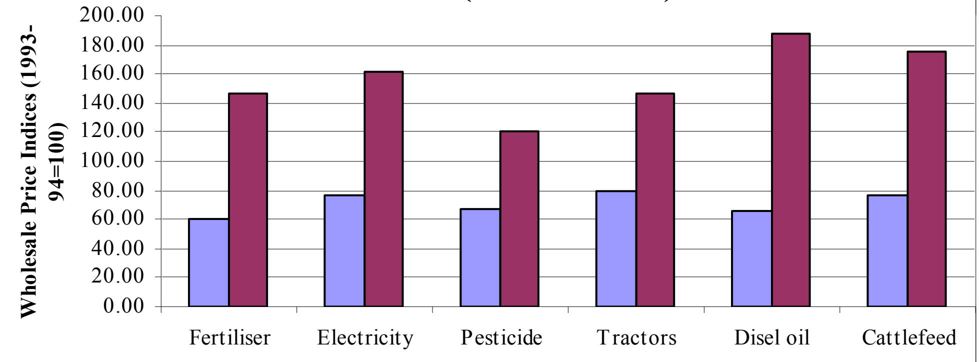
2.2.2.2. Behavior of Farm Input Prices

Prices of important farm inputs such as, fertilizers, canal water, and power prices are administered. In fertilizer, a tradable farm input, price is regulated by the Central Government, whereas, prices of non-tradable inputs like canal water and electricity is regulated by the state Governments; variation in these prices across states is therefore large. In the context of liberalization, behavior of farm input prices are analyzed by categorizing these inputs as tradable and non-tradable farm inputs. The examples of farm inputs in the tradable category are seeds, fertilizers, pesticides, while in non-tradable category these are water for irrigation and electricity for agricultural use. The behavior of administered prices for these important commodities and services has been analyzed in detail.

The discussion in this sub-section however begins with a general behavior of a large number of farm input prices during the nineties, the same has been presented in Figure 2.2, this figure is a comparison of wholesale price indices of the selected farm inputs during the reference period. There has been large variation in the growth of wholesale prices of farm inputs; growth has been maximum for diesel oil, and minimum for pesticides. The variation in wholesale prices across farm inputs is primarily because of different level of integration of domestic and world market for specific commodity, and also differential impact of these integrations on market prices of these commodities. For instance, with the integration of domestic and external market, prices of diesel oil increased at a rapid pace, while prices of pesticides increased at a lower rate. It may be recalled that imports of a large number of pesticides were liberalized during the referred period (1990-91 and 1999-2000) as a result protection to domestic pesticide manufacturer has reduced.

Implications of these price changes for sustainable agricultural development of the region appears to be mixed. A more than average increase in price of diesel and tractor would discourage unnecessary mechanization in the region. Similarly, more than average increase in price of electricity, if percolated effectively at the farm level, may discourage over-mining of groundwater. On the reverse side, less than average increase in price indices of pesticides would encourage application of chemical pesticide; and more than average increase in the prices of cattle feed can discourage cattle rearing having negative bearing on the sustainable agricultural development of the region.

Fig 2.2: Wholesale Price Indices of Farm Inputs during the reference Years (1990-91 / 2000)



A comparison of the changes in farm input price indices with the changes in farm out put price indices (earlier section) indicates that wholesale price of most of the farm inputs have almost doubled during a span of 10 years; this one-fold increase in farm-input prices as compared with the more than one-fold increase in farm output prices indicates towards the bias in favor of agriculture sector. Even though this in-commensurate increase in farm input prices appears to be less logical, this slow growth is because of the political economy of the agriculture.

In this backdrop, it is not easy to chalk out the future direction of farm input prices; yet one can generalize that in an opening economy, farm input prices for tradable inputs will be more integrated with the international prices, whereas for non-tradable inputs, prices would reflect opportunity cost of these resources. Likely direction of prices for the selected farm inputs has been studied in detail.

Fertilizer Pricing

Fertilizer is undoubtedly the most important of all the tradable farm inputs. Government had been controlling production and marketing of fertilizers, though it crumbled for most of the fertilizers except urea in the nineties. The nature of control in the historical years, extent of removal of these controls and effect of removal of these controls on prices of fertilizers and its implications has been discussed herewith in detail.

It is interesting to note that fertilizer emerged as one of the most important farm inputs, only with the advent of bio-chemical technology. In the year 1965 consumption of fertilizers in the country was as low as seven kilogram per hectare, this has now increased to almost 100 kg. Even though fertilizers were produced in the meager amount, domestic need was largely fulfilled by the import of fertilizers. Government used to intervene in the market to manage imports and distribute it at a uniform price throughout the country.

The infamous 'oil-shock' of the year 1974, and its consequences on domestic fertilizer consumption and agricultural production has forced the country to adopt an in-ward looking approach for fertilizers. In the late seveties Government has adopted Retention Price cum Subsidy (RPS) scheme to promote domestic production and consumption of fertilizers on a sustained basis. The domestic and external market related to fertilizers was regulated to the maximum extent; prices of chemical fertilizers were pan-Indian, that is, same throughout the country (Table 2.6)

This RPS-regime has increased domestic production as well as consumption of fertilizers and country to a large extent has emerged self-sufficient in food as well as selected fertilizers. Of late, it was realized that self-sufficiency has been achieved at an enormous cost. The costs here are explicit and implicit as well; explicit cost is huge fertilizer subsidy while implicit costs are unnecessary protection to domestic urea industry and the second- generation problems related to the consumption of fertilizers (Jha B 1999). The need for reorientation of Government interventions, therefore, arises. In the early nineties prices of fertilizers other than urea were decontrolled. Successively, imports of DAP and MOP, an important phosphatic and potassic fertilizers respectively were also decanalised to increase efficiency in imports; yet, there was no respite on the farm gate prices of the imported fertilizers. The imbalances in fertilizer consumption a major constrain on the future growth of agriculture continued[17].

This follows a series of ad-hoc steps to rectify the nutrient imbalances; concessions to the DAP and MOP fertilizers were increased in the successive years, differential concession to the domestic vis-à-vis foreign suppliers of the DAP was also initiated, during the selected years farm gate prices of urea were also increased successfully. These steps have led to improvement in nutrient imbalances towards the end of nineties. The subsidy to fertilizers has, however, surpassed Rs.120 billion in the year 2000. The share of fertilizer subsidy in total government revenue expenditure, which dropped to 3 per cent in the year 1992-93, from 6 per cent in the year 1991, has again reached to almost same level during the year 1998-99 (National Accounts Statistics).

Table 2.6: A Historical Perspective of Fertilizer Prices / Price range (in Rs. per Kg of nutrients)

Year / effective date	AS	Urea	CAN	DAP	SSP	MOP
2004-05	26.5-28.8	10.5	24.8-40.0	16.2	16.3-23.4	7.4
2001-02	24.1-26.3	10.5	32.0	16.2	15.6-21.8	7.4
1998-99	20.4-21.4	8.7	24.0	14.6	15.6-18.7	6.2
1996-97	19.42	7.22	NA	14.9-16.9	16.2-19.2	6.6-7.5
10-6-94	Decontrol	7.22	Decontrol	Decontrol	Decontrol	Decontrol
25-8-92	9.32	6.00	8.00	Decontrol	Decontrol	Decontrol
14-8-91	Decontrol	6.65	Decontrol	7.57	7.75	2.83
25-7-91	Decontrol	7.17	Decontrol	8.15	8.38	3.03
31-1-1986	8.01	5.11	6.80	5.83	5.94	2.17
2-7-1980	7.28	4.35	6.40	4.93	5.27	1.83
8-6-1980	Decontrol	4.35	Decontrol	4.93	5.27	1.83
1979-80	4.37	3.15	4.00	3.55	3.65	1.34
1976-77	4.54	3.80	4.38	4.17	4.51	1.52
30-3-72	2.72	2.08	2.26	1.89	3.17	0.92

Note: Abbreviations for fertilizers, are AS (Ammonium Sulphate), CAN (Calcium Ammonium Nitrate), DAP (Diammonium Phosphate), SSP (Single Superphosphate), MOP (Muriate of Potash). These prices are the Maximum sale prices inclusive of excise duty for a packing of 50 kg. By and large the above prices do not include Sales taxes and local taxes. These prices are for particular date or for a large part of during the year. At number of time prices for some fertilizers have changed within weeks, or in some cases have changed after weeks. For these finesse one can refer to the Fertilizer Statistics, published by the Fertilizer Association of India, New Delhi.

In the aforesaid process of liberalization, fertilizers other than urea were almost integrated with the international prices. This could not be done for urea primarily because of cost heterogeneity of the domestic urea industry[18]. Government has appointed several committees and commissions in the recent past to look into problems related to urea industry essentially to make it cost-homogeneous industry. The High Power Committee (HPC) on fertilizer under the chairmanship of Prof. Hanumantharao was one; the Expenditure Reforms Committee (ERC) further delineates steps to integrate it with the world market. The goal of reforming the existing pricing policy in urea, as per the ERC, will be to bring fertilizer prices charged from farmers to the level of import parity price. In this process, small farmers real income, food production of the country, and balanced use of N, P, and K must not be affected.

These recommendations of HPC and ERC will essentially bring about a shift from the existing policy of fixed price and variable subsidy to producers, to a framework of fixed subsidy and flexible farm gate price subject to ceiling. The ERC as commissioned after the

HPC is, in fact, a step ahead as it delineates discreet steps towards an out-ward-looking paradigm. A different kind of control regime for favorable distribution of fertilizer to small and marginal farmers will, however, emerge in this process. Though the Finance Minister in his budget speech (2001-2002) has vouched to implement the recommendations of the ERC, there has hardly been any progress; for instance, the ERC calls for 7 per cent increase in the real prices of urea every year, this has not come about in the successive budget. Yet one can believe that this would guide our future policy related to fertilizers more specifically urea.

Pricing of Canal Water

Canal irrigation is undoubtedly one of the most important agriculture infrastructures under public domain; and all state governments except the North-East States charge directly or indirectly for the use of irrigation water from public sources. In some states notably Andhra Pradesh and Tamil Nadu there are no separate water rates for some area under old system; however, the wetlands being more productive are charged land revenue at a much higher rate than dry land. In all other states separate water rates are levied on area actually irrigated. The water rates vary within the states, this is invariably differentiated by season and crops, in many states this is further differentiated by categories of irrigation projects to allow for differences in the quality of irrigation as reflected in the quantum, duration and assurances of water supplies. A few states levy general or special purpose cess on irrigated areas crops. The range of water rates for the important states of the country has been presented in Table 2.3A. In some states like Gujarat, Karnataka, Madhya Pradesh, Orissa and Uttar Pradesh variation in water rates have been more than 20 fold. In spite of it, resources generated from irrigation charges have been less than 10 per cent of the working expenses of canal irrigation network (Gulati and Ruth 199-). The low level of resource generation because of low water charges have affected irrigated agriculture in many ways. Poor maintenance of canal irrigation network has affected the quality of irrigation water supplied to the farmers. Again the low price of canal water often not linked with the volume of water consumed has induced farmers to use water indiscriminately resulting in the problem of salinity and water logging in many part of the country.

This situation definitely calls for rationalization of water rates. Some of the possible determinants of water rates would be quantum of water consumed, assurances of water supply, paying capacity of farmers, and need to cover annual costs in providing irrigation. These criteria are seldom utilized and water rates have not been increased in the states for years. There have been recommendations by different commissions and committees to rationalize water rates. In this regard National Water Policy adopted in 1987 argues that water rate should cover annual maintenance and operation charges and also a part of the fixed cost. The norm appears strict as a large part of the cost for irrigation services is because of defective design, inordinate delay in completing projects, over-extended distributaries, waste and other factors which inflate capital costs; and relatively high administrative cost, avoidably high cost of repair work, over-manning and other factors which raise operating costs and / or effect the efficacy of assessment and collection of revenue. The basis for determining the cost of irrigation services and the desirable extent of recovery may be debatable, but no one would disagree that users of public irrigation must meet the cost of services. In this regard, Irrigation Commission had suggested that water rate should be fixed at around 5 per cent of gross income for food crop and 12 per cent for cash crops[19]. The Irrigation Commission further recommends for reviewing and adjusting rates every five years.

Vaidyanathan's Three Phases of Water Pricing

Phase I: Rationalization of crop-based rates
Phase II: Switch to Group-based Volumetric assessment
Phase III: Systems Improvement

Considering intricacies in rationalization of water pricing Vaidyanathan in his report argues for phase-wise adoption of water pricing. In the first phase the existing system of assessment (based on crop-wise irrigated area on an individual basis) be rationalized and simplified to a system of season-specific area rates which would reflect differences in irrigation requirements of crops between different season. In each season the Commission distinguish at best three categories of crops; viz; paddy, sugarcane and perennials and other crops.

The second phase aims to shift to a fully volumetric assessment system. This would require additional investments to modify the distribution system for effectively regulating water supply volumes at the outlets. In this phase, system should take responsibility only for bulk deliveries to relatively large group of farmers, thereby creating conditions for formation of farmers groups for water management, which would be the beginning of the Phase III. In this phase the system of farmer-group management be extended and consolidated for upgrading the system to a higher level of efficiency in water use and therefore productivity.

Power Tariff for Agriculture use

Power tariff for agriculture comes in the farm decision-making indirectly as electricity is often used to draft ground water for irrigation purposes. With increased mechanization and realization of ground water as a reliable source of irrigation, importance of electricity in agriculture increases. The electricity tariff varies as per its use in different purposes, generally tariff for agricultural purposes has been low as compared to the other uses of power. In the historical years it was started essentially to support the low input and output price agriculture. During these years proportion of power consumed in agriculture has been low, in the successive years with the rural electrification proportion of power consumed in agriculture is reported to have gone as high as 30 per cent. This figure is over-stated since all unaccounted power is often attributed to agriculture. Power Tariff for use in agriculture has varied widely; in order to avoid the high cost of metering and collection of power tariff farmers are charged flat tariff; this flat tariff has no relation with the actual consumption of electricity though this is linked with the capacity (horse-power) of the tube well.

Off late the low and irrational power tariff has created several kinds of problems. The power supplying agencies have gone bankrupt, and assured supply of power especially in rural area has been affected. The irrational power tariff has also induced farmers to exploit ground water from lower aquifer without considering the cost of drafting the ground water; this has endangered aquifer in the selected region of the country.

There is thus need to rationalize power tariff for its use in agriculture. In this regard there have been steps in the decade of the nineties. In January 1993, the Ministry of Power directed the states to charge a minimum of 50 paise per kwh for agricultural consumption, but majority of the states did not pay heed to it. Again in the year 1996 Chief Ministers of various states agreed to improve the power sector through adoption of Common Minimum National Action Plan for Power (CMNAPP). The gist of the action plan having implications for present discussion is the formation of state level Electricity Regulatory Commission, which will fix tariffs for different types of consumers. Power tariff for any sector cannot be less than 50 per cent of average cost of supply, and subsidy will be borne by the state governments and not the SEBs. Implementation of these recommendations, however, requires great deal of "political will". The BJP-led coalition Government in May 1998 brought out a draft policy on power in line of the CMNAPP; this was however, objected by some state Government as interference in states' jurisdiction.

In spite of this imbroglio on rationalization of power tariff some states have undertaken reforms in power tariff. The reforms primarily unbundled the SEBs into three separate corporate entities for generation, transmission, and distribution of power. It will inculcate accountability in transmission and distribution of power and will finally improve viability of power generation units. This will attract investments for generation of power and would ensure adequate supply of electricity.

2.3. Conclusions and Lessons for Future Analysis

In the emerging trade order free-from NTBs, trade policy needs to be drawn cautiously, as this has profound impact on the present as well as future growth of agriculture in the country. This caution assumes more importance, as many of the domestic regulations on account of concern for food-security still continue in the country, while import is being liberalized under external pressure. This is clearly evident with decreasing protection of agricultural commodities. In a globalising world, cost and quality is supposed to determines trade flows in the world market; while, some Government restrictions are causing inefficiency in the post harvest operation. A reorientation of Government policy towards agriculture is therefore desired.

This reorientation would further influence prices of farm inputs and farm outputs in the domestic market. The pattern of growth of the market and administered prices clearly shows influence of later on the market prices; this influence has however weakened with the opening up of the economy. Following removal of restrictions domestic market is supposed to integrate, which can be manifested in the convergence of domestic prices in the country; analysis in the present chapter, however, does not establish it, price divergence across states have in fact increased in the late –nineties when meaningful trade liberalization in agriculture was initiated. This finding is not unfounded as the study further suggests that exports of the selected variety / commodity from the certain region of the country have widened the price disparity; similarly imports of selected commodities in small amount because of various domestic market restrictions and infrastructure bottlenecks might not have reduced prices in the distant domestic market; as a consequence price disparity has not reduced rather increased with the trade liberalization.

The lower prices of farm inputs have definitely played an important role in adoption of a technology; further extension of a technology depends on the existence of basic infrastructure like irrigation. The creation of infrastructure has suffered because of limited resources available for public investment in agriculture. Nevertheless low prices of farm inputs have encouraged farmers to use it injudiciously, which has long- term implications for growth in agriculture. The farm input prices therefore need to be rationalized and there have been suggestions and recommendations of experts about how to rationalize the farm input prices. Reforms in canal irrigation pricing and power tariff for agriculture is a state subject. The political compulsions of the Central Government especially coalition politics, is constraining implementation of reforms in agriculture. Likely direction of changes in the prices of farm inputs is summarized below.

In non-tradable farm inputs like, power and canal irrigation, a significant reduction in subsidy and manifestation of opportunity cost for these resources is expected while rationalizing prices of these farm inputs. As per the CMNAPP power tariff for agriculture should not be less than 50 per cent of the cost of supply of power. Similarly Vaidyanathan Committee recommends that price of canal irrigation should be 5 per cent of gross outputs for most of the crops and 12 per cent of gross output for cash crops. In tradable farm inputs like fertilizers, import parity price would influence domestic prices; present analysis assumes that with the help of subsidy farm-gate-prices of fertilizer would settle at a level 25 per cent less than the import parity price. In farm outputs, domestic prices are getting aligned with the world prices. The analysis in the final chapter with the alternate prices of farm input and outputs will be based on these assumptions.

—

Appendices

Apndx. 2.1: Methodology for Nominal and Effective Protection Coefficients

The extent of protection in agricultural commodities is assessed by computing Nominal and Effective Protection Coefficients (NPC & EPC). The NPC is the ratio of domestic to world prices. NPC helps in measuring divergence between domestic and international referred prices. The Nominal Protection Coefficient of ith commodity (NPC_i) is the ratio of domestic producer prices of the ith commodity (P_i^d) to its border price (P_i^b), expressed as under

$$NPC_i = \frac{P_i^d}{P_i^b}$$

The domestic price and the border prices must be comparable. For instance, if border price referred here is the fob (freight on board) price at a foreign port, domestic prices of the commodity should also be adjusted to arrive at the fob price at the domestic port. NPC less than one, indicates that the country has dis-protected the commodity in question. The NPC greater than one indicates that the country is protecting the commodity in question.

The NPC considers distortion in output prices only. The Effective Protection Coefficient (EPC) takes care of distortion in inputs as well as output prices by considering value additions in specific commodity. The EPC is the ratio of value addition in domestic price to value addition at border prices. Scandizzo and Bruce (1980) expressed Effective Protection Coefficient of ith commodity (EPC_i) as:

$$EPC_i = \frac{P_i^d - \sum_{j=1}^{k} (A_{ji} . P_j^d)}{P_i^b - \sum_{j=1}^{k} (A_{ji} . P_j^b)}$$

Where, A_{ji} = Quantity of the jth input used to produce one unit of the ith output

P_j^d = Domestic prices of the jth input

P_j^b = Border prices of the jth input

P_i^d & P_i^b = Domestic and border prices of the ith commodity as in NPC.

j = all traded inputs.

The EPC greater than one indicates that protection in input and output market provides incentive to produce the commodity; the country as such has no comparative advantage in producing the commodity. However, an EPC less than one, reveals that the protective measures discriminate against the commodity in question. As the economy opens up that is, protection reduces; the effective protection coefficient (EPC < 1) in the domestic market reduces.

Domestic price referred here is the wholesale prices obtained from various issues of Agricultural Situation in India. These prices were adjusted for freight charges, marketing and trading margins, and other processing costs to make it comparable to the world (border) prices. These figures were obtained from traders in and around Delhi. International prices of agricultural commodities were collected from FAO Production Year Book, 1995, and also from various issues of the Center for Monitoring Indian Economy (CMIE). While making comparison between domestic and international prices of commodities, utmost care is undertaken about the varieties and qualities of commodities being compared.

For calculating EPCs cost of production, input-output structures have been obtained from the report of the Commission for Agricultural Costs and Prices (CACP) on price policy of Kharif and Rabi crops. Considering the variation in data on input-output structure and international prices, and EPCs have been worked out for an average situation (1994-96). The desired information is not available for a large number of states. Therefore, the NPCs, EPCs have been calculated for the leading producing states of the commodity. Stated differently, these coefficients have been calculated for the state, which accounts for maximum in the domestic and international trade of that commodity. Thus it is Punjab in case of rice and wheat. For commodities like, sorghum, maize and cotton; the states selected were Rajasthan, Uttar Pradesh and Maharashtra respectively. The selected state was West Bengal for jute and Andhra Pradesh for tobacco of flue-cured-virginia variety.

The present study has also made some difficult assumptions while calculating these coefficients. For instance, fertilizers and seed have been assumed as the only tradable inputs. These inputs account for around 90 per cent of the costs of traded farm inputs. International prices for nitrogenous, phosphatic and potassic fertilizers are obtained from the Fertilizer Statistics, an annual publication of the Fertilizer Association of India. The international prices for seeds are not available. In order to arrive at the international prices for seeds, differences in domestic and international prices of seeds have been assumed to be similar to their respective principal crops. International price of rice seed has therefore, been arrived at by multiplying the domestic rice seed prices with a factor of 1.07 (reverse of NPC).

Appendix Table 2.2A: Correlation Coefficients between Farm Harvest Prices (FHP), administered Prices (MSP), Wholesale Prices (WSP) and International Prices (IP) of the Selected Commodities during 1990-2006

Commodity	IP&WSP	IP&FHP	IP&MSP	MSP&FHP	FHP&WSP	MSP&WSP
Paddy	0.24	0.58	0.45	0.65	0.64	0.97
Wheat	0.66	0.81	0.99	0.99	0.97	0.74
Maize	0.48	0.61	0.62	0.92	0.83	0.88
Cotton	0.70	0.23	0.45	0.86	0.09	0.53

Note: Asterisks shows level of significance of correlation coefficients; (**) indicates significance at 1 per cent while (*) indicate significance at 5 per cent.

Appendix Table 2.3A: Period wise Comparative Differences between international, Domestic and Administered Prices.

Commodities	Average International Prices (Rs./Qtl.)			Average Domestic Prices (Rs./Qtl.)			Average Administered Prices (Rs./Qtl.)		
	1980's	1990's	2000s	1980's	1990's	2000s	1980's	1990's	2000s
Maize	131	361		170.02	428.01		130	298.5	
Wheat	175	484		176.62	426.93		163.1	389.5	
Soybean	360	880		-	-		-	-	
Cotton	-	5461		550.33	1580.47		626	1355	
Rice	-	698		239.77	837.81		209.1	516	

Table 2.4A: Range of Water rates, Receipts as proportion of Working Expenses of Potential Utilized of Irrigation and Multipurpose River Valley Projects during 1995-96.

States	Range of Water Rates (Rs. / Ha)	Receipts as percent of Working Expenses
Andhra Pradesh	Rs 148 to Rs1236	13.3
Bihar	Rs74 to Rs297	36.8
Gujarat	Rs 25 to Rs830	5.1
Haryana	Rs 24 to Rs120	9.2
Karnataka	Rs 20 to Rs 556	4.9
Kerala	Rs. 17 to Rs. 99	7.7
Madhya Pradesh	Rs 15 to Rs. 297	21.3
Maharashtra	Rs. 50 to Rs. 800	7.2
Orissa	Rs. 14 to Rs463	24.7
Punjab	Rs.15 to Rs99	22.3
Rajasthan	Rs20 to Rs. 143	6.4
Tamil Nadu	Rs19 to Rs. 62	2.5
Uttar Pradesh	Rs 20 to Rs 474	17.1
West Bengal	Rs. 37 to Rs. 123	3.2
All India		10.4

Table 2.5A: Actual Cost of Power Supply of SEBs during the Selected Years

SEBS	1980-81	1985-86	1990-91	1995-96
	Unit cost in paise per kwh			
Andhra Pradesh	37.8	53.27	78.72	156.1
Assam	76.46	164.39	249.59	356.1
Bihar	67.68	127.83	168.97	252.4
Gujarat	46.01	92.31	110.11	181.5
Haryana	40.31	71.57	103.66	208.7
Himachal Pradesh	59.71	62.19	94.77	111.5
Jammu & Kashmir			125.59	242.5
Karnataka	26.26	63.98	82.55	152.3
Kerala	22.38	35.64	68.17	134.5
Madhya Pradesh	52.44	73.3	116.44	181.6
Maharashtra	36.52	69.25	107.44	185.3
Orissa	37.57	55.63	71.43	227.5
Punjab	36.46	60.45	106.79	179.7
Rajasthan	39.12	76.38	114.59	213.2
Tamil Nadu	43.82	76.42	114.32	170.9
Uttar Pradesh	56.33	85.64	110.04	192
West Bengal	49	100.21	157.19	189.4
All India	41.9	74.59	108.59	179.6

III
Sustaining Growth in Indian Greenbelt

In the recent decades sustainability is probably one of the most frequently used concept transgressing the narrow boundaries of discipline. Though this concept has been interpreted in different contexts, for example maintaining biodiversity by ecologist, carrying capacity by biologist, and growth by economist, one essential element in all these interpretations is the maintenance of inter-generational equity. That's why it is often defined as maintenance of well being of humans. Considering the importance of the concept, need to incorporate it in the decision making process often arises. In relation to economic development the Brudtland Commission has provided one of the most widely accepted definitions of sustainability. The commission defines sustainable development as development that meets the need of the present generation without compromising the ability of the future generations to meet their needs (World Commission on Environment and Development 1987). The ability of future generation to meet their needs can be constrained, because of innumerable reasons; economic and others as well. The economic inputs used in the development process, which often consists of natural resources, are often depleted and degraded because of developmental needs of the present generation. These natural resources, in spite of all technological advances are often not substitutable by the manufactured economic inputs, and future development is affected. Apart from resource depletion there are other factors, which constrain future growth of agriculture in a region.

The higher present rate of growth often jeopardizes the potential of future growth by depleting natural resources, creating inter- and intra- generational inequity and similar other concerns. Nevertheless, high economic growth in few years often leads to dip in economic growth; this has large ramifications. At macro-level, sudden dip in the economic growth leads to severe unemployment and unrest in the society. A prolonged unrest in the society also leads to fragmentation of the states. In a developing country like India, where unemployment is already high, further slowdown of the economy would lead to severe penuries. The ramifications will be even larger if the dip is in the agrarian economy of the country, which is the mainstay of around 60 per cent of population. Considering these facts, it is important that sustained growth for a long period is more important than the high present rate of growth, and it is necessary to know whether the present rate of growth would sustain for long or not? Alternately, the existing economic system or agricultural system is sustainable or not.

There have been few studies about assessing the extent of sustainability of a system. Most of these studies indicate that it is not easy to measure sustainability in an objective way; therefore, researchers have attempted to develop operational or observable indicators of sustainable development. A comparison of these indicators across time and space would help in assessing the development performances from the point of sustainability. The study by Gordon Conway (1985) is one of the earliest studies on these indicators and is particularly relevant for the agriculture system. He identifies few indicators for assessing sustainability of an agricultural system, these are: i) productivity (measured in terms of yield or net income), ii) stability of yield or net income, iii) low vulnerability of yield or net income, iv) equitability in terms of income distribution. The first and second of these indicators, productivity and stability of yield or net income are self-explanatory.

As per Conway low vulnerability of a system is the propensity of a system to withstand collapse under stress, it is related to the robustness or continuing viability of a system. Some of the agricultural systems even though productive are subjected to substantial risk, especially in the advanced agriculture, which depends on narrow genetic base and uses high doses of chemicals. The narrow genetic base makes food supply dependent on the success of a small number of species, and failure of one of them may cause loss of production and failure of system.

Similar to the Conway's low vulnerability, Pearce et al (1996) stresses importance of resilience of a system in assessing sustainability of that system. He suggests two possible measures for resilience of a system, diversity and output variability. The variability in output reduces resilience of the system and is definitely an indicator of vulnerability. Often diversity of a system strengthens power of resilience of the system as this also leads to low output variability. This negative relationship between diversification and output variability does not hold true especially in advanced or commercialized agriculture, since crop outputs are positively correlated amongst themselves (Jha B 1996/97) whereas the necessary condition for diversification to reduce output variability is that the farm portfolios is not correlated or are negatively correlated amongst themselves. Therefore diversity though an important indicator for resilience or vulnerability, in general, is not of much importance for the commercialized agriculture as in the Northwest India. Again output variability as such would not indicate about the vulnerability of the farmers, as low output variability is often accompanied with high price and income uncertainty. This uncertainty in production and prices may make the farmers vulnerable if production or return dips beyond a tolerable limit. Though economists' concern for equity in development has a long history, this is particularly important for sustainable development. A particular resource may be scarce from the point of view of the society as a whole and has to be used carefully to last long. The purchasing power is in general concentrated in the hands of a few and the resources which is scarce for the society, may not be perceived so by these people; for example, groundwater in the semi-arid region may be scarce for the society but not for the large farmers who can invest in the submersible pump and harness groundwater, further depleting the groundwater table.

In this backdrop present section assesses sustainability of agriculture in the North-west India. This assessment is based on the indicators as suggested by Conway; these indicators have however, been modified considering ground reality and also availability of information. For instance, in the Conway's indicators, growth in production and income is not explicit, though this to some extent is implicit in the productivity; present study considers growth in production and income as an essential element of sustainable agricultural development. The growth in production is important as the Northwest India is often termed as the grain basket of the country; whereas, growth in income is important from the farmers' perspective. The growth in production and income needs to be less unstable as instability increases vulnerability of farmers. In the Northwest India, this assumes greater importance as studies indicate that instability in agriculture has increased with the commercialization of agriculture (Jha B 1995, Jha B. 1996).

The sources of growth in production and income are important for its sustenance in the long run. For example increase in agricultural production based on the extensive agricultural practices cannot be sustained for long considering the kind of pressures on land. Similarly increase in farmer's income if it is because of increase in the prices of the commodities[20], cannot be expected to continue for long since price distortions are supposed to be rectified in the process of liberalisation. Productivity is thus the most important element for sustenance of growth in agricultural production and farmer's income. The issue of low vulnerability to some extent will be addressed by stability in production and income; nevertheless tolerable limit of uncertainty has also been evaluated by calculating downside risk in farm income and productivity exclusively in the headings of vulnerability. The inequity in the agricultural system is mostly associated with the distribution of land, and the Northwest India as compared to other regions of the country is known for an egalitarian distribution of land amongst the farmers (Johl and Ray 2002), the issue of equity has therefore been ignored from the present analysis. Present discussion therefore concentrates on growth including stability, downside risk or vulnerability and productivity of agriculture in the Northwest India.

3.1. Growth and Stability

Growth in agricultural production is undoubtedly an essential element of agricultural development and so about sustainable agricultural development as well. Growth in agricultural production at the aggregated level is often contributed by the increase in area under the crop or productivity per unit of land under the crop; therefore, to understand nature of agricultural growth and relative importance of its constituents, growth in area, production and productivity of principal crops has been studied for more than two decades (1980-2004). Though productivity can be measured in different ways[21] land productivity is often used because of easy accessibility of related data. The growth in agricultural production and its sources: yield, area has been carried forward for the state of Haryana; ideally this should have been analyzed at micro-level for selected districts: Kurukshetra and Mohindergarh. The district-level growth estimates have been avoided because net sown area in the districts has often changed because of reorganization of the districts in state. A high growth in agriculture is often associated with the instability in agricultural production. Instability in agricultural production has various macro- meso- and micro- level repercussions for the economy and livelihood security. The study therefore, works out growth and instability in agricultural production; the same is presented in Table 3.2. The growth rate has been arrived from the trend equation and figures in the table are annual compound growth rate in percent. The stability discussed herewith is the inverse of the instability indices. The methodology for calculating growth and instability index is presented in the appendix.

It is apparent from table 3.2 that agricultural growth in Haryana is more about growth of rice and wheat crops. Production of these crops grew at an annual compound growth rate of more than 4 per cent. In rice this growth in production has been contributed more by the growth of area (3.99 per cent) during the reference period; the increase in productivity has been low for the state. This is disconcerting as it suggests that the effect of technology is tapering-off in rice. The low growth in rice productivity is also because of the quality of data, the existing data for rice pools both basmati and non-basmati rice[22]. Interestingly situation has changed considerably in the recent period (1999-2004), production has decelerated, and inspite of increase in productivity acreage under paddy has declined.

The wheat production in the state has been growing at an average compound rate of 5 per cent. It is heartening to note that major contribution to the growth in wheat production has been because of the growth in productivity, though area under wheat also increased at a significant rate (1.6). The growth in productivity has been even larger (3.5) in the Mohindergarh, a less progressive or late adopting district (Jha 2002). This suggests that sufficient potential for growth in wheat still persists in the state, though this requires assured irrigation in the resource-starved region. In wheat, situation has changed completely in the recent decade; growth in wheat production has been negative, this is true for acreage and productivity of wheat during the 1999-2004.

Production of coarse cereals has registered a negative growth in the state; though bajra till nineties and jowar and bajra in the recent decade has been exception. The decline in production has primarily been because of decline in area under the crop as productivity of most of the coarse cereals has been positive; sorghum and bajra are exceptions. The negative growth in productivity of maize and barley appears to be primarily because of its cultivation on the marginal land. Area under coarse cereals is very small; in fact continuous decline in ground water and fragmentation of land has made some small pieces of land almost uncultivable with the tube well in absence of effective water market. Yet, increase in productivity of the coarse cereals has not stopped its' downward slide in acreage under these crops till nineties; resurgence of selected coarse cereals in the recent decade has to do a lot with the industrial-use of coarse cereals.

Area under pulses was decreasing, only recently area under pulses has started increasing. Interestingly area under pulses in recent years has increased because of pulses other than the gram. Field visit suggests that summer pulse has great potential in the paddy-wheat dominated crop rotation. Though production of pulses has been increasing inspite of decline in production of gram during the period (1981-99). Production of pulses has increased significantly primarily because of increase in the productivity of pulses (1.6 per cent). Trend at the district level has been similar to that at the state level (Jha 2002).

There has been encouraging result for pulses and oilseeds; production of oilseeds grew at a rate of more than 9 per cent during the reference period. This growth has been because of increase in production of pulses and oilseeds in rabi season. Examples of rabi oilseeds are rape seed, mustard, sunflower. Available data indicates that with increase in productivity of rabi oilseeds, area under these crops has increased significantly. Area under kharif oilseeds has however decreased; as a consequence total area under oilseeds has increased only marginally. In pulses also area under kharif pulses like, urad, moong increased; while, area under rabi pulse (gram) decline in the nineties. The situation in pulses improved in the recent period. As a matter of fact, a favorable price policy since mid eighties in commensurate with the technical breakthrough in the selected oilseeds has brought about this favorable changes in pulse and oilseed production. The world market for these commodities has further contributed to recent trend in pulse and oilseeds production. Most interestingly, oilseeds has experienced maximum increase (around 10 percent) in area in the recent decade. In a state like Haryana this change has been more emphatic in a resource poor district like Mohindergarh, since most of the oilseeds and pulses are less water intensive and are cultivated more in rain-fed conditions.

In commercial crops, sugarcane production has registered a modest growth (2.33 per cent). This growth has been contributed by growth in acreage as well as productivity of the sugarcane. The cotton production in the nineties has increased at an annual compound rate of 4 per cent; in the recent decade situation has however reversed. The growth in american cotton has been higher than the *desi* cotton. It is astonishing to note that production growth in American cotton is primarily because of increase in area rather than productivity of the crop; whereas, in *desi* cotton though productivity increased marginally increase in area has been lower than the American cotton. The higher growth in American cotton has also been because of lower production value during the base year as compared to the *desi* cotton since American cotton is a recent phenomenon. An abysmal increase in the productivity of American cotton during the reference period may be viewed in conjunction with the negative growth in productivity of sunflower. Both of these crops/variety are hybrids; seeds of these hybrid varieties need to be replaced more frequently. Availability of quality seeds has to do a lot with the imperfections in farm input market.

The high growth in agriculture is often associated with the high instability in growth; though test of significance of growth estimates to some extent indicate about its robustness specifically about the degree of robustness. This does not explain the amount of instability associated with these growth estimates; therefore present study discusses stability in growth with the help of instability index. The stability is in fact inversely related to the instability indices. The instability indices are also presented in Table 3.2. A glance to the instability indices indicates that wheat is the most stable crop of the region followed by rice and sugarcane. Though instability indices of area under the later crops have been in double digit, relatively stable productivity of these crops have led to lower instability in production of these crops. A lesser instability in productivity of wheat, rice and sugarcane crops has been because of assured irrigation for these crops. Again wheat being a rabi crop is less infested with the pests and has the lowest instability in its productivity.

Production of coarse cereals, pulses and oilseeds has been highly unstable. Further comparison of instability in area and productivity of these crops indicate about sources of instability in these crops; it appears from the above analysis that in coarse cereals instability in production has been more because of instability in productivity, whereas, in oilseeds this instability has been because of instability in area under the crops. The fluctuation in area under the crop has been largely influenced by the price policy of the Government. A higher instability in productivity of coarse cereals is primarily because of its cultivation in the marginal land[23]. In pulses kharif pulse involves more instability in production. The high instability associated with the kharif pulses is because of higher fluctuation in area and productivity of kharif pulses. The marginal land hypothesis to some extent explains this instability. Moreover, farmers in the Kurukshetra district complained about the susceptibility of the existing kharif pulses to the high temperatures in the month of April and May.

The above discussions indicate that rice and wheat thoroughly dominate the cropping pattern of the region. These crops have however seen some reversal in the recent period (1999-2004); production of wheat declined while paddy production stagnated during the period. Area under both the crop has decreased marginally showing constrain in the carrying capacity. Productivity growth has been positive for paddy but negative for wheat. Oilseeds has recorded maximum increase in area in the recent period. Though present analysis indicates significant level of instability in agricultural production of the region; a comparison of instability indices with other regions of the country suggests that this is not as high as in many other parts of the country.

Farmers Costs and Returns

A glance at the secondary data related to area production and productivity does not reveal much of the problems directly faced by the farmers in the study area. A visit to the study area, however, indicates towards an altogether different picture. Farmers in general complained that their cost of cultivation has been increasing and increase in return has not been in commensurate with the increase in cost of cultivation as a consequence, profit is decreasing. This situation prevails even though there are allegations that prices of wheat and paddy largely cultivated in this region has been increasing at a rate higher than that of the other crops. This has implications for private investments and future growth of agriculture in the region.

Present study therefore attempts to investigate trend in returns and costs of the farmers. In a developing country like India where farmers do not maintain any record any time series analysis of farm returns has to be based on secondary information. Present study considers trend in gross returns for the selected crops; gross return here is the yield per hectare multiplied by the farm harvest prices of the crops. Trend in gross returns has been worked out for the period (1981-99), a recent period (1999-2004) was also included; the analysis is done separately for the decade of the eighties and nineties. The component of gross return: gross yield and prices have been studied in previous section / chapters; however a separate study of growth in gross return is important from farmers perspective as the effect of low yield in crops is often offset by an increase in the prices of these commodities. This phenomenon of high price as a consequence of low production is supposed to be strong in a region, which is considered food grain basket of the country.

It is evident from Table 3.3 that gross return for important crops like paddy and wheat has decelerated in the recent decade; in paddy and maize the growth was in fact negative. In nineties most of the crops grew at an average compound rate of 10 per cent and above; jowar and American cotton were exceptions. This rate of growth was slightly lower during the individual period. A higher growth in pulses and oilseeds returns during the eighties is well acknowledged. This high growth, however, could not be maintained during the nineties at least for the oilseeds. The growth in these commodities peaked up again in the recent decade. Interestingly coarse cereals recorded considerable growth rate in the recent decade.

It is essential to assess the robustness of growth in returns of individual crops, stability of growth indicates about it; instability in return also indicates about the vulnerability of the individual crop growers. The instability in gross return is calculated for all principal crops during the reference periods and also for the selected districts. Instability was high for coarse cereals, cotton and paddy[24], and relatively low for pulses, oilseeds, and cotton. The instability in return was the lowest for wheat. The high stability in wheat was primarily because of the effective Government procurement operation for the crop. This operation is also effective for rice; variation in return for rice is primarily because of quality of data (explained earlier). Lack of this type of support for crops other than rice and wheat has encouraged farmers of this region to practice mono-cropping.

The fluctuation in gross return to large extent is because of the temporal variation in prices of these commodities. The market prices in the Northwest India are influenced by the administered prices and we know about the periodic biases of the Government in announcing support prices for the selected commodities.

The cost of production for most of these commodities increased consistently in the Northwest India. In order to check some of the related concerns associated with the costs, cost of production of important commodities has been analysed for its components. The Commission for Agricultural Costs and Prices (CACP) publishes cost of production data at state level for selected crops. For Haryana cost of cultivation data for a considerable period is available for paddy, wheat and cotton. Wheat is important for the state as a whole since most of the districts in the state cultivate wheat during rabi season. In kharif season, paddy is important for the districts in the northern and eastern part of Haryana; while, cotton is important for the southern and western part of Haryana.

A study of cost components indicates that fertilizer accounts for more than 10 per cent of total cost of paddy and wheat in most of the reference years. In cotton also the trend was similar. Temporal trend in the share of fertilizer in total cost was similar for all the crops; trend to a large extent is reflection of fertilizer price policy of the Government. Fertilizer prices were decreasing till early nineties when prices were deregulated. Subsequently, with increase in the prices of flat concession to phosphatic and potassic fertilizers, fertilizer prices have started decreasing. Trend in proportion of fertilizer in total cost was similar for both the crops. The proportion of pesticides in total cost of production is higher in kharif crops like paddy and cotton; in paddy it is around 5 per cent while for cotton it is slightly higher. Its proportion fluctuated for all the crops considered in the present analysis. In the early nineties, there has been general decline in its proportion. As a matter of fact, imports of many pesticides and its intermediates were liberalized with the onset of economic liberalization. Again since mid-nineties its share has started increasing for paddy and wheat.
The proportion of fertilizers and pesticides is fluctuating so much so that it is difficult to arrive at certain conclusion about its increase over the years. The component of operational costs has therefore been compared over the decades (Figures). The decadal comparison indicates significant increase in the share of labour rather than fertilizers in total cost. The proportion of pesticides in operational costs has also increased for the crops considered in the present exercise. A field visit to one of the selected districts (Kurukshetra) indicates that since mid-nineties problem of pests in wheat and paddy crops has increased in the area. The district level cost data as available with the Krishi Gyan Kendras (KGKs) of Haryana Agricultural University shows that proportion of pesticides in the operational cost is significantly higher (around twice) in the Kurukshetra district as compared to the Mohindergarh. The proportion of fertilizer is marginally higher in the Kurukshetra district. This may be seen in the backdrop that cost of cultivation is significantly higher in the Kurukshetra district as compared to the Mohindergarh. A glance at the secondary data also indicates that like Kurukshetra district, Mohindergarh district is also adopting intensive agricultural practices at a fast pace. Yet, in Mohindergarh district area under wheat is low on account of dearth of assured irrigation. On the same account paddy is not cultivated at all; in kharif season farmers cultivate one amongst coarse cereals, cotton and kharif pulse. Adequate alteration in crop rotation saves the district from consequences of mono-cropping.

The above analysis reveals that growth in returns for most of the crops has been satisfactory (more than 10 per cent), and there has been no significant difference in growth of the return across the crop. Inter-crop variation in return has increased during the recent period (1999-2004). A comparison of cost components indicates general increase in the cost of labour and significant increase in the proportion of pesticide in the progressive districts. The growth in returns for crops other than rice and wheat was not very stable.

Table 3.3 Period wise Growth (ACGR in per cent) and Instability in Gross Return Per Hectare for Principal Crops in Haryana

	Annual Compound Growth Rate				Instability Indices (in percent)			
Crops	**1980s**	**1990s**	**1980-00**	**2000s**	**1980s**	**1990s**	**1980-00**	**2000s**
Rice	8.39	9.39*	11.94	-7.75	9.92	30.09	36.50	11.1
Wheat	8.64	11.17	11.69	1.02	6.92	4.07	18.46	1.29
Maize	7.40	--	13.24	-0.27	19.00	17.49	31.42	11.54
Jowar	4.23*	-2.28*	7.65	4.98	31.68	22.62	35.66	7.32
Bajra	5.68*	10.92	11.94	4.25	44.45	30.68	39.61	38.17
Barley	11.17	10.92	13.50	4.27	12.20	12.12	21.55	9.53
Gram	14.55	6.91*	12.46	7.44	35.49	23.27	27.26	12.22
Rapeseed & Mustard	1.39	4.23*	11.17	6.63	12.47	20.15	21.51	10.84
Cotton (American)	6.41	6.17*	9.90	3.84	16.06	20.72	24.98	21.24
Cotton (Desi)	5.93	9.40	11.43	16.23	16.51	15.60	24.16	33.13
Sugarcane				6.95				

Note: Notations (--) indicates that data for these crops and districts are not available; further notation (*) indicates that the exponential function used to calculate ACGRs are not robust (Adj $R^2 < 0.50$). For the decade 2000s most of the estimated growth rates were not robust as no. of observation was less.

Table 3.2 Growth and Instability in Area, Production and Productivity of Principal Crops in Haryana

	Annual Compound Growth Rate						Instability Indices (CVt)			
Crops	**Area**		**Production**		**Productivity**		**Area**	**Produ-ction**	**Productivity**	
	1981-99	**1999-04**	**1981-99**	**1999-04**	**1981-99**	**1999-04**	**1981-99**	**1981-99**	**1981-99**	**1999-04**
Paddy	3.99	-2.77	4.23	0.66	0.01	3.53	10.54	10.61	8.53	2.79
Wheat	1.62	-0.39	4.71	-1.64	2.80	-1.25	3.67	27.37	4.98	1.39
Jowar	-0.46	-1.70	-0.92	2.93	-0.23	4.89	13.94	35.52	33.35	12.29
Bajra	-2.05	-0.44	1.86	7.63	3.99	8.06	12.07	36.41	30.34	24.74
Barley	-6.24	-10.11	-1.37	-9.92	4.47	-1.42	19.92	18.72	8.73	12.95
Maize	-6.24	-3.45	-2.50	-4.63	3.75	-2.01	11.08	19.09	16.02	3.32
Pulses	-0.46	5.88	1.16	10.76	1.62		17.91	24.95	12.22	
Gram	-5.81	-4.11	-2.73	4.30	3.28	8.74	29.55	41.54	25.76	10.58
Oilseeds	0.69	10.87	9.90	12.59	3.51		21.40	33.94	19.52	10.37
Cotton	3.75	-1.34	3.99	-1.34	0.23	-0.03	9.71	20.01	17.72	
Cotton-Am	4.23	-0.32	4.23	-0.92	0.00	-0.59	13.40	24.40	17.86	31.03
Cotton-desi	1.86	-3.79	3.28	-2.42	1.39	1.47	33.10	40.36	16.42	29.35
Sugarcane		6.15		6.75		0.64	12.02	13.75	8.96	0.88

Table 3.7 Estimates for Downside Risk (DSR) in Return and Yield for Haryana and the Selected Districts

	DSR in Yield (in kg)			DSR in Return (in Rs)		
Crops	**1980s**	**1990s**	**2000s**	**1980s**	**1990s**	**2000s**
Paddy	121 (.6)	215 (.4)	66 (0)	651 (.2)	1863 (.2)	1376 (.1)
Wheat	299 (.1)	154 (.1)	56 (0)	534 (.1)	1046 (0)	167 (.1)
Maize	142 (.2)	240 (.2)	56 (.3)	214 (.2)	613 (.2)	556 (.3)
Jowar	52 (.7)	67 (.4)	11 (0.3)	58 (.4)	46 (.4)	36 (0.3)
Bajra	156 (.3)	204 (.3)	264 (.5)	160 (.3)	319 (.3)	991 (0.5)
Barley	203 (.3)	245 (.1)	69 (0)	357 (.2)	634 (.2)	420 (0.2)
Gram	158 (.3)	137 (.5)	71 (0.3)	532 (.3)	500 (.2)	532 (0.2)
Rboils'd	178 (.2)	154 (.2)	133 (.2)	962 (.3)	644 (.3)	1007 (.5)
Cotton-Am	51 (.3)	38 (.4)	93 (0.3)	175 (.3)	305 (.3)	616 (0.3)
Cotton-De	28 (.3)	34 (.3)	68 (0.4)	114 (.3)	241 (.3)	604 (0.3)
Sugarcane			53			144

Note: Figures indicate Average Negative Deviation in the Expected Return while figures in parentheses indicate Probability of Failure (PF) in the expected return and expected yield.

3.2. Total Factor Productivity

Productivity analysis provides an answer to the question that to what extent change in input is responsible for the change in output. Partial productivity index measures the change in output with a single resource. The broader the coverage of resources, generally the better is the productivity measure. The best measure is one that compares output with the combined use of all resources. In this context total factor productivity is important. It is a composite measure of productivity, which relates output to all inputs simultaneously. The changes in total factor productivity index, thus, can be used as a measure of the effects of technological change. The sustainability aspects of present output growth can also be inferred from the movement of total factor productivity over a substantially long period of time.

Considering the importance of total factor productivity in evaluating sustainable development, present study has calculated factor productivity for the state of Haryana during the period 1989-90 to 2000-01. Total factor productivity have been calculated by several researchers, using different methodologies discussed elsewhere. Present study is based on translog index of total factor productivity growth explained in the Appendices. As per the formula total factor productivity is essentially a ratio of total output and input indices. In Haryana productivity growth for most of the crops was positive with few exceptions as that of certain coarse cereals; interestingly paddy also registered zero rate of growth. All these warrant proper analysis of factor productivity growth instead of the existing partial productivity growth.

Total factor productivity has been calculated for paddy and wheat. For calculation of output index, value of main product has been considered as total revenue[25]. In calculation of input indices human labour and fertilizer have been considered separately since desired information for construction of input indices are available for these commodities only. The costs other than labour and fertilizers have been pooled together. The sources of data for the present analysis are the Commission for Agricultural Costs and Prices (CACP) reports, Agricultural Situation in India, and Agricultural Statistics of Haryana.

Table 3.4 presents total output and input indices and also total factor productivity of paddy and wheat during the period 1989-90 to 2000-01. The comparison of output indices during the period indicates three-fold increase for paddy. Though output indices maintained an increasing trend during the reference period, there has been abnormal increase in these indices during the year 1992-93 and also during the period 1997-2000. The output indices are in fact the value indices consisting of productivity and price of the commodity. The pattern of increase in the output indices suggests that an abnormal increase in output indices during specific years was more because of price rather than the real factor like productivity. In the nineties prices of many agricultural commodities fluctuated because of certain domestic and external reasons[26]. In paddy, fluctuation in output indices is also because of aggregation of basmati and non-basmati rice data[27]. The output indices for wheat were increasing steadily; fluctuations in these indices were incorporated only towards the end of the nineties (1997-2000).

Table 3.4: Trend in Total Output, Input, and Factor Productivity Indices of Paddy and Wheat in Haryana

Years	Paddy			Wheat		
	TOI	TII	TFP	TOI	TII	TFP
1989-90	100.00	100.00	100.00	100.00	100.00	100.00
1990-91	108.20	121.93	95.50	121.32	123.27	100.50
1991-92	201.20	144.60	149.60	154.77	125.72	111.40
1992-93	278.10	180.90	113.20	164.13	142.10	92.82
1993-94	180.80	171.50	72.10	188.18	156.70	106.40
1994-95	263.20	179.35	128.21	214.10	159.60	111.20
1995-96	240.30	187.90	79.40	236.30	175.50	98.80
1996-97	217.00	214.10	84.50	270.50	213.30	96.70
1997-98	370.50	252.70	159.60	251.80	210.50	86.20
1998-99	444.40	257.30	115.30	305.70	207.20	121.90
1999-00	553.40	288.40	112.20	353.30	277.80	94.30
2000-01	398.20	308.30	64.70	340.10	326.60	83.90

The input indices as compared to the output indices have increased at a lower pace during the reference period; fluctuation in these indices was also low, this was so even during the late nineties, when effect of trade liberalization was apparent in output indices. Price of one of the most important farm inputs urea is still administered in the country and thus is secluded from the outside world. The fluctuation in input indices was visible during the year 1997-99; these were the years when subsidy in fertilizer was increased. A comparison of trend in input indices suggests that increase in input indices for wheat has been significantly higher than that of rice. An analysis of components of cost indices reveals that this increase is more because of increase in the cost of labour and miscellaneous items for wheat. The miscellaneous cost item includes cost of all farm inputs other than labour and fertilizers. The field survey of the region manifests increased weed infestation and consequent increase in the pesticide cost for wheat in recent years.

In paddy though increase in input indices during the reference period has been lower (208 per cent) than the output indices, total factor productivity is less than 100 for some of the years suggesting that the increase in the output index has been less than the increase in the input indices. Total factor productivity of paddy was also higher than 100 in certain years, when output indices increased primarily because of relatively higher increase in paddy prices. Like paddy, in wheat also total factor productivity index has been less than 100 for most of the years. Trend in factor productivity of wheat also suggests that increase in factor productivity of wheat is more because of abrupt increase in its price instead of the real factors.

The historical trend in factor productivity suggests that for both the fine cereals, wheat and paddy, resource use efficiency has decreased. It appears that with the maturity of biochemical technology, diminishing return has started. This hypothesis is further examined with the district level information since there is lot of heterogeneity with respect to adoption of biochemical technology in the state. Wheat has been chosen for the present analysis since this crop unlike rice has relatively uniform agronomic practices. In Kurukshetra wheat is being cultivated in the considerable area since the advent of the bio-chemical technology; whereas, in Mohindergarh wheat has found its place in recent decades with increase in assured irrigation in certain pockets of the district. In Kurukshetra more than 90 per cent of the net sown area is under wheat; the corresponding proportionate area is less than 50 in Mohindergarh. Considering the differences in cropping pattern in both the districts, some of the negative externalities of the rice-wheat crop rotations are supposed to be less in the later district. It is encouraging to note that in a late-adopting-district like Mohindergarh, wheat productivity is as high as that of the early-adopting district like Kurukshetra (Table 3.5).

Total factor productivity of wheat has therefore been worked out separately for Kurukshetra and Mohindergarh districts, in order to segregate the effect if any, of early and late adopters of technology in wheat. The cost of production data for the district-wise analysis has been obtained from the Krishi Gyan Kendra of Haryana Agriculture University; this cost data is based on the imputed value of farm inputs unlike the CACP data, which is based on the actual costs of input. The state level estimates are therefore not comparable with the district level estimates. The reference years (1985-86 to 1999-00) for the district wise estimates of factor productivity presented in Table 4.7 is based on the availability of data. The approach for district level calculation of input, output and factor productivity indices is similar to that of the state-level analysis.

Table 3.5: Profile of Districts in Haryana on the basis of average productivity of wheat

Yield Intervals	Districts
34 – 37 qntls.	Bhiwani, Gurgaon, Jhajjar, Rohtak
37 – 40 qntls.	Ambala, Faridabad, Jind, Panipat, Rewari, Sonepat, Yamunanagar
40 – 43 qntls.	Fatehabad, Hissar, Kaithal, Karnal, Kurukshetra, Mohindergarh

A comparison of total output indices of wheat in Table 3.6 indicates that the trend is similar in both the districts, though increase in output indices during the reference period has been higher in Kurukshetra. The increase in input indices is also higher in the Kurukshetra district. Of late differences in input indices between the districts have increased. The cost indices in Kurukshetra, which was almost similar to Mohindergarh till early nineties, has become significantly higher towards the second half of the nineties. An analysis of cost indices suggests that this difference is more because of increase in the cost of labour and also miscellaneous items. The miscellaneous item essentially constitutes cost of pesticides. The field survey of the region reveals that outbreak of particular weed in wheat field has caused increase in the cost of pesticides[28].

A temporal comparison of operational cost, as obtained from CACP, between late eighties (1986-89) and recent period (1998-2001) at the state level suggests that in paddy share of fertilizers and manure in operational cost has decreased from 18 to 14 percent, while that of pesticides has increased from 3 to 6 percent. The above trend was observed for wheat as well (details see Jha 2002). Interestingly, district level cost data as available from KGK further support the above trend. In Kurukshetra operational cost of paddy and wheat shows sharper decline in the share of fertilizer and manure; increase in the share of pesticides was also sharp. Mohindergarh also noticed increase in the share of pesticides but decrease on fertilizer and manure was noticed in the district. With maturity of technology incidence of pest infestation increases, consequent increase in the proportion of pesticides in operational cost is obvious. The decrease in the share of fertilizers and manure suggest that overdose of nitrogen reported during eighties from progressive districts to some extent has reduced.

Table 3.6: Total Factor Productivity (TFP) and its components, Total Out Put Indices (TOI) and Total Input Indices (TII) in the selected districts for wheat

	KURUKSHETRA				MOHINDERGARH			
YEAR	TOI	TII	TFP	Yield/ hectare	TOI	TII	TFP	Yield/ hectare
1985-86	100.00	100.00	100.00	3371	100.00	100.00	100.00	2953
1986-87	78.40	111.60	61.20	3078	96.16	110.70	91.10	2868
1987-88	100.50	98.20	136.50	3261	123.80	124.80	116.70	2958
1988-89	111.60	125.80	83.60	3712	132.10	100.50	106.26	3659
1989-90	135.30	152.30	100.90	3397	161.20	125.50	88.10	3549
1990-91	157.70	180.36	100.60	3808	215.40	175.80	106.90	3707
1991-92	183.90	215.64	100.20	3818	253.10	212.00	95.80	3976
1992-93	--	--	--	3795	--	--	--	3825
1993-94	--	--	--	3687	--	--	--	3915
1994-95	--	--	--	3723	--	--	--	3945
1995-96	--	--	--	3762	--	--	--	4069
1996-97	332.30	430.40	85.72	4053	353.26	287.12	113.20	4029
1997-98	353.60	363.33	110.42	3820	362.15	305.30	99.20	4175
1998-99	379.22	438.80	89.85	4276	378.70	311.20	99.10	4128
1999-00	473.60	525.80	105.40	4572	428.50	382.40	93.10	4146

Total factor productivity indices of wheat in both the districts are fluctuating to the extent that it is difficult to find trend or trend growth. The fluctuation has been higher in the progressive district especially during the post liberalization years. Prices of wheat in the progressive districts are affected more with the trade liberalization and fluctuating world prices since the district is often used as the prime source of wheat for domestic and external trade in the country.

In sum, total factor productivity indices for paddy and wheat have fluctuated so much so that it is difficult to discern particular trend. The fluctuation was particularly high in the late nineties The factor productivity index is less than 100 for most of the years suggesting that increase in the value of output is less than the increase in the cost of farm inputs during the year. One can infer that the carrying capacity of nature is shrinking in the region. Towards the end of the nineties, abnormal increase in output indices during certain years is more because of output prices rather than the real factors like factor productivity. Trend in input indices suggest general increase in the production cost of fine cereal, especially in the progressive district because of increase in the cost of labour and chemical.

3.3. Vulnerability

Conway considers vulnerability as an important corner stone for measuring sustainability of the system. Vulnerability of an agricultural system can be defined as the susceptibility of farmer being hurt. A farmer will be hurt when production will be too low to be sufficient for family consumption in a subsistence system; whereas in a commercialized agricultural system farmers will be hurt if farm return falls and the fall is low enough to meet the farm and non-farm needs of the farm family.

He suggests variability and resilience as indicator for vulnerability of an agricultural system. Resilience is the ability of a system to recover from the adverse situation. Ability of an agricultural system to recover depends on the status of natural resource, extent of enterprise diversification, and genetic diversity of a region. The status of natural resource in the Northwest India will be taken up in details in the successive chapter. The previous studies indicate that as the process of commercialization sets off, farms in a region become more specialized. With commercialization, the genetic diversity also reduces; farmers being risk averse generally adopt a variety, which according to their perception has proved good. Therefore reduction of diversity and thinning of genetic base is in fact, an inescapable evil of commercialization in agriculture.

Variability is another important indicator for vulnerability. Variability has two important components; this can be across space and time. Variability across space to some extent is reflected in diversification discussed earlier. Variability across time is the instability; the issue of instability in agricultural production and farm income has been discussed in the previous section. It is important to note that variability is about upward or downward fluctuation from mean or similar parameter; however, from vulnerability point of view it is the downside fluctuation from mean or trend, which is important. Therefore vulnerability of farmers has been studied in the present section by studying the downside risk.

The downside risk has been studied by calculating Probability of Failure (PF) in yield and return, and also Average Negative Deviation from the Expected Return and Yield (AND).

The PF indicates about the frequency of shortfall in the expected return and Yield, whereas AND works out magnitude of downfall in return and yields. Expected return or yield here is the trend return and yield; since previous years performances as observable through the trend is probably the most important determinant for farmers' expectation. Most of the time farmers undertake investment decisions based on its expectations. Often these decisions are supplemented by the aid of financial institutions having repayment period, and shortfall in farmers' expectations make them vulnerable.

The downside risk has been studied in yield and return. Downside risk in yield is indicative of production risk whereas difference between yield and return risk would indicate nature and magnitude of market induced price risk. With the commercialization of agriculture, market induced risk has assumed more importance. In the nineties with the onset of the process of globalisation, market induced price risk has assumed further importance. The estimates for downside risks have, therefore, been calculated separately for the decades of eighties and nineties. Estimates for 2000s are based on only few observations between 2000-01 and 2003-04.

These estimates as in the earlier cases have been calculated for the state of Haryana and the same is presented in Table 3.7. A glance at these estimates indicates a general decline in the downside production risk for crops important for the region. The decline in downside risk was there in terms of frequency (PF) as well as its magnitude (AND). Irrigation is undoubtedly the most important ameliorating factor for the production-induced risk and overall increase in assured irrigation in the study area. Decline in downside production risk was, however, not observable for crops like paddy, rabi oilseeds and cotton. Estimates for paddy and rabi oilseeds may be inferred with caution, as these are not exactly commodities but commodity groups, for instance, rice consists of basmati and non-basmati rice; similarly rabi oilseeds consist of many oilseeds of which mustard and sunflower are important for the region. Production and price estimates for these commodities vary and depending on their proportion in the commodity aggregate, weighted price and yield of these commodity aggregates vary over the years. The increase in the downside production risk for cotton is, however, a matter of concern as this indicates growing vulnerability of cotton growers in the study area.

The estimates for downside risk in gross return presents a different picture. In case of wheat, selected coarse cereals - sorghum, barley, pulses and rabi oilseeds market induced risk has decreased over the years; whereas for commodities like rice, cotton and few coarse cereals like maize and bajra market induced risk in the nineties has increased over the eighties. A comparison of decadal change in production- and market- induced risk does not present any difference in overall trend for the crops other than the selected coarse cereals like maize and bajra. For these coarse cereals difference in production risk has declined over the years, while market-induced risk has increased over the years.

A careful analysis of these estimates indicate that production induced risk in the nineties was marginally lower than the eighties. Moreover, the market for coarse cereals in the study area are not very dip. This is apparent from the fact that market induced risk for coarse cereals like sorghum was lower than the production risk. The data for return has been generated from yield and price; therefore, in a multiplicative model higher production risk as compared to market risk is possible if production and price are negatively correlated. This negative correlation between production and price can be explained with the hypothesis of dominant player that the region is one of the most important surplus producer of the commodity, and there is limited scope of trade in the country. This is, however, not correct for the commodity like sorghum. Market imperfection for coarse cereals and pulses, therefore, appears to be the most important reason behind this. Similar inferences can be drawn for pulses like gram, it is important to note that this trend for gram is visible even in the nineties.

In the 2000s both the measure of down side risk has decreased considerably for most of the crops barring cotton and bajra. A decline in production risk is attributed to relatively uniform stable yield during the recent period of reference (2000-2004). In this regard it may be noted that the year 2002-03 was a drought year yet with assured irrigation yield of important crops for the region are not affected. Implications of drought etc., is more on the natural resources of the region, rather than on the return of farmers. In other words, drought or such natural calamity affects capability of resource-rich region in the long-run; in the short run affect on farmers return is not that profound. The decline in downside risk in return in the recent period may be attributed to subdued prices of agricultural commodities during large period (2000-03) of reference years.

The above discussion shows that downside risk to some extent reflects vulnerability of farmers. The estimates for downside risk indicate that farmers cultivating crops other than wheat are vulnerable to production as well as market forces. Amongst crops the vulnerability has been the maximum for cotton and this has unfortunately increased in the recent decade; for most of the other commodities production and market induced vulnerability has decreased over the years.

3.4. Degradation of Natural Resource

Analysis of agricultural system in the Northwest India clearly demonstrates that past growth in agriculture has already affected the present rate of growth in agriculture; the effect on future growth would be even more profound. It is generally believed that the existing rate of growth in agriculture is not in harmony with the nature. For any economic activity nature provides two sets of functions: sources of natural capital, and sink of waste products. And conditions for nature to be in harmony with the levels of economic activities require that the harvest of renewable resources should not be greater than natural growth of the resources; and waste product or pollution should not exceed the assimilative capacity of the environment / nature. Some economists refer these functions collectively as carrying capacity of the nature; Pearce (1996) defines carrying capacity in terms of exceeding limit set by ecological and environmental criteria. Arrow *etal* (1995) argues that carrying capacity of nature is not fixed or static in nature; technology plays an important role in artificially enhancing the carrying capacity of the nature, by increasing substitution of natural resources by manufactured resources. The manufacture of resources also requires natural resources; the importance of carrying capacity therefore does not diminish while studying the issue of sustainability. There is need to arrive at some objective indicators for assessing carrying capacity of nature. In this context thermodynamic indicators of sustainable development as suggested by Daly (1989) provides some clue; in relation to the use of natural resources, this principal states that harvesting rate should be maintained below regeneration rate to an extent necessary to compensate for the depletion of non-renewable resources. All these emphasize importance of natural resource in explaining the unsustainable trends in agricultural growth. Though biomass is not a natural resource in its strict sense, its availability at farm has bearing on the use of non-renewable resources like, mineral oil and gas. The present section, therefore, discusses status of soil, ground water and biomass in

Haryana and specific districts; possible determinants for the changes in resource status have also been discussed subsequently.

Deteriorating Macro- and Micro-nutrient Status of Soil

In order to assess nutrient aspect of soil, soil samples are tested for its macro and micro-nutrient status by Deputy Director Soils. The soil sample results of districts as available from Director Soils, Karnal are compared for different time periods[29]. The salient points in relation to soil health are presented below (for details see Jha 2002).

The soil samples tested for macro-nutrients: nitrogen, phosphate and potash, are categorized into low, medium and high. The soil sample results suggest that the macro-nutrient status of soil has deteriorated in all districts of Haryana. It is disconcerting to note that more than 85 percent of soil samples tested for nitrogen in various districts of Haryana have low nitrogen content. The deterioration has been more for nitrogen followed by phosphate and potash. Interestingly, soil sample results having low status of macro-nutrient is reported more from less progressive districts. Therefore blaming intensive agriculture or paddy - wheat crop rotation for most of the deterioration is not fair. The degradation of macronutrient status depends on a variety of factors, other than the cultivation of paddy and wheat crops. Some of these are perception about the role of nutrients for crops, soil temperature, and also price policy of the Government.

The important micronutrients, for which soil samples have been tested are zinc, iron, copper and manganese. The soil samples found to contain micronutrients less than the critical limit has been referred as deficient. The results suggests that a considerable proportion of soil samples are deficient in zinc and iron, while proportion of soil samples deficient in manganese and copper are less. The state of micro-nutrient status in Haryana has been found to be associated with the intensive agricultural practices in districts. Contrary to general belief, proportion of soil samples found to be deficient in iron is more than that of zinc in districts. (details see Jha 2003).

Depleting Ground Water Resources

The Directorate of Groundwater monitors groundwater table and also quality of ground water in a district with several village-level observatory tube wells, the information about which are available from mid-seventies (for details see Jha 2003). The pattern of decline of groundwater table during the reference period presents a mixed picture; in the selected districts: Hisar, Bhiwani, Rohtak, Fatehabad, Jhajjar, Sirsa and Jind ground water table over the reference period has increased while in other regions like Kurukshetra, Karnal, Mohindergarh, Panipat and Panchkula ground water table has decreased. In the selected region groundwater table has declined at a rate of more than half-a meter per year during the reference period.

Groundwater exploitation is primarily the ratio of net draft and utilizable resources of groundwater; the ground water is over-exploited (black) in all blocks of certain districts; though, it is under-exploited in certain other blocks / districts. A comparison of these trends with the quality of ground water suggests that groundwater is over-exploited in regions wherein salinity of groundwater is in tolerable limit.

Quantity and Quality of Biomass

Crop residue and dung are important biomass produced on farm. Though biomass is not a natural resource; its efficient utilization has important implications for use of exhaustible natural resource like fuel oil and gas. The biomass enriches soil by adding important nutrients like nitrogen, phosphate, potash, sulfur, calcium and magnesium; this also improves physical health of soil. The crop and livestock residues are the basis of complementary relation between agriculture and livestock on the farm. In this perspective the following paragraphs present, in brief, a comparative account of changes in the quantity and quality of biomass, for details see Jha 2003.

In between 1982 and 2003 cow dung out-turn has declined on an average farm of Haryana because of decline in livestock population[30]. This trend is even stronger in progressive districts like Kurukshetra. A low cow dung out-turn suggests lower dung-based farm-yard-manure (FYM) for agriculture land/field; this problem further aggravates as certain household cooking activities require dung cake only[31], in spite of the fact that all gas-based modern cooking facilities are available in the region. Interestingly, crop-residue has increased during the same period on account of increased cropping intensity. It is however difficult to say how far this has reduced dependence on fossil fuel and contributed to fodder availability. Field visits suggest that residues of selected crops like cotton, maize, pigeon-pea are preferred for cooking purposes but area under these crops have been replaced by wheat and paddy. Wheat and paddy straws are preferred as dry fodder, but increased use of pesticides in these crops restricts farmers to use it as fodder for their own animal. Though at times they sell this to traders for its consumption as fodder in distant places. Many of these crop-residues could have been used for preparation of FYM and obtaining energy; this however requires proper training so as to extract FYM from crop-residue. In intensive agricultural practices farmers do not have enough time between crop cycles and they prefer to burn crop-residues on field. This has limited benefits; nevertheless burning causes enough environmental pollution in otherwise serene rural environment.

The above discussion clearly suggests reduction of livestock-based residue; though crop-residue increases, its quality has decreased and pressure on fossil-fuel also increases. This trend is clearly unsustainable. In order to understand reasons behind such trend in greater detail, Jha (2003) discusses some of the factors contributing to deterioration in soil health, decline in groundwater table and biomass. The wider ramification / implications of deteriorating status of resources are discussed in Jha 2000.

Conclusions

Present study taking a cue from the Conway's indicator of sustainable agricultural development has analyzed growth, stability, vulnerability and productivity of agricultural system in the North-west India. Present analysis establishes disconcerting trend in agricultural production, productivity and farm return for important crops like rice and wheat; situation for other crops in the region is even worse. On account of stability and vulnerability, though farmers of the study area are better off than many other regions of the country; the vulnerability of cotton and coarse cereal growers is significant. The rice and wheat growers have also become vulnerable with the commercialization of agriculture and further trade liberalization towards the end of nineties. These estimates clearly demonstrate growing concern on account of sustainability of agricultural system in the region. These concerns to some extent have been compounded with the trade liberalization. Present analysis however fails to suggest the reasons behind this unsustainable trend.

Evidences in the present section establish decreasing status of natural resources: soil and ground water; which clearly indicates that the rate of use of natural resources is greater than the combined affect of resource regeneration through the natural process and application of additional resources to it in the Northwest India. This degradation has caused various inter- and intra-generational problems, which have already affected the present rate of growth in agriculture and may affect future growth more intensely. This deterioration of natural resources to large extent has been caused by intensive agriculture in general and rice-wheat crop rotation in particular. This is being practiced in the region since late ‘60s and a mix of Government policies related to technology, market and institutions have been responsible for this. Following chapter discusses ways of reversing this trend through alternate technological, price and institutional policies.

Appendices
3.1a Methodology

Measuring Growth

Growth rate is worked out to assess magnitude of rate of change per unit of time. The simple rate of growth showing absolute rate of change per unit of time can be expressed mathematically as dyt /dt or Y(t+1) – Yt according to ‘t’ varying continuously or taking only discreet value

The rate of change in Y per unit of time ‘t’ expressed as a fraction of the magnitude of Y itself, usually termed as a compound growth rate and denoted by Cr equals to 1/Yt * dyt / dt or (Y(t+1) – Yt) / Yt . This expression multiplied by 100 gives the compound growth rate of Yt in percentage term.

There is a general agreement amongst the researchers that in view of fluctuation in data within the study period, point to point method of measuring growth rates may lead to seriously biased estimate unless due care is taken in selecting the points for comparison. Hence a more appropriate method according to most of the scholars would be to take into account the entire series of observations over the period (Dandekar 1980). There are several simple functional forms to calculate trend growth rate. Trend equations are also used to see tendency of data over time, and also estimate the magnitude of rate of change per unit of time. The more often used equations their algebraic forms and corresponding growth rate formula has been presented below.

i. Linear: Yt = Yo + r*t when r is the linear coefficient

This functional form presents a constant absolute rate of change equal to ‘b’ per unit of time. In order to estimate average annual rate of growth b is divided by the average of the variable (Y) during the reference period. Though most scholars have used arithmetic mean of the variable, Minhas BS (1966) and Dandekar (1980) feel that average used for this purpose should be harmonic mean of the series.

ii. Exponential: Y = ab**t alternatively, Log Y = Log a + t log b

The loglinear or compound rate of growth Yt = Yo (1+ r)t
Alternatively it can be written as Log Yt = Log Yo + t*Log (1+r) or Log Yt = a + bt
where b = Log(1+r).

This form implies a constant growth rate over time; this characteristic has made it popular amongst researchers for measuring compound rate of growth. Finally the formula for the compound rate of growth is (antilog b – 1).

It is sometime argued that growth rate must take into account both linear and exponential equations as R*2 from both the equations have some meaningful inferences. Dandekar (1980) suggests that if linear function yields a higher value of R*2 than the log-linear (exponential) function, it could be taken as evidence that compound rate of growth over the period is not constant but is declining and vice-a-versa. If the value of R*2 is equal in both the cases or tends to be equal, the results are inconclusive and it is not possible to decide whether the growth rate is constant or declining. In such circumstances one needs to use second-degree polynomial form (logy = a + bt + ct*2) to judge whether the rate of growth is uniform.

Measuring Instability

The coefficient of variation is usually used to measure variability in data. Since time series data often contains trend component, it is suggested to use coefficient of variation around trend (CVt) instead of coefficient of variation. The appropriateness of CVt over CV was suggested by Nadkarni (1971). Cuddy and Della (1978) developed an index of instability to take care of trend component in the time series data. In order to calculate CVt, a linear equation is fitted to the time series data, and whenever trend is found significant the CV is multiplied by the square root of the unexplained portion of total variation in the trend equation. Thus CVt equals to CV*(1-R*2).

Measuring Downside risk or Vulnerability

The frequency of downside risk has been measured with the Probability of Failure (PF). This is the probability of crop return/yield falling 10 per cent or more below their respective trend value.

Expected Annual Negative Deviation from Trend = Average Absolute Deviation in Return /yield for individual crop * Probability of shortfall in return /yield from trend

Ave. absolute deviation = sum (Xt – Xt) / n

Where, Xt is the actual value in t-th year, Xt is the trend value in t-th year and n is the number of years in the period.

Measuring Total Factor Productivity

The present study works out productivity growth with total factor productivity (TFP), this may be defined as the ratio of output to a weighted combination of inputs. The TFP has definite advantage over the partial productivity. The changes in total factor productivity over a long period of time reflects extent of sustainability of the system as this indicates role of technology in increasing resource use efficiency and widening carrying capacity of the system (Arrow 1995).

Various TFP indices, like Solow index or Divisia index differ from one another with regard to the weighting schemes involved. Several researchers have discussed superiority of the Divisia index over the other indices. For application to data at discreet point of time an approximation to the continuous Divisia index is required. The translog index (developed by Tornquist) is a discreet version of the continuous Divisia index. This is based on a translog production function, characterized by constant return to scale. It allows for variable elasticity of substitution and does not require the assumption of Hicks neutrality. The translog index of TFP growth in a three-input framework is given by the following equation:

$$\Delta \text{Ln TFP}(t) = \Delta \ln Q(t) - ASL^* \Delta \ln L(t) - ASF^* \Delta \ln F(t) - ASC^* \Delta \ln C(t)$$

In this equation, Q denotes gross output, L labour, F fertilizer and C other input costs. The Δ indicates change over previous year, for instance, $\Delta \ln Q(t) = \ln Q(t) - \ln Q(t-1)$. The $\Delta \ln L(t)$, $\Delta \ln F(t)$ and $\Delta \ln C(t)$ are defined in similar way. ASL is the average cost share of labour; this average is based on present (t) and previous (t-1) years. Similarly ASF and ASC are average cost shares of fertilizer and other inputs in the cost of production of wheat and paddy. Δ ln TFP is the rate of growth of total factor productivity. The growth rate in TFP has been computed for each year using the above equation. These have been used to obtain an index of TFP. Index has been worked out by considering the base year figures as 100.

Appendix Tables

Appendix Table 3.2A: Value Indices for Important Farm Inputs Used in Wheat and Paddy Production in Haryana During the Reference Period (1989-90 to 2000-01)

Years	Human Labour		Chemical Fertilizers		Miscellaneous farm inputs	
	Wheat	Paddy	Wheat	Paddy	Wheat	Paddy
1989-90	100.0	100.0	100.0	100.0	100.0	100.0
1990-91	160.5	101.6	100.5	102.8	124.4	122.3
1991-92	195.9	130.1	141.8	140.4	128.5	145.5
1992-93	246.5	161.8	157.5	153.7	146.2	181.0
1993-94	225.2	176.1	173.4	185.7	159.5	171.5
1994-95	206.7	214.9	189.6	242.6	161.1	175.3
1995-96	259.0	260.8	207.9	298.2	178.4	174.1
1996-97	311.9	226.4	226.3	295.1	217.5	213.1
1997-98	442.4	195.2	225.9	284.9	219.0	255.8
1998-99	478.8	234.5	218.6	262.1	216.8	258.9
1999-00	472.9	262.1	231.3	278.7	284.9	289.9
2000-01	468.5	298.7	244.8	311.5	330.4	309.1

Appendix Table 3.3A: Value Indices for Important Farm Inputs Used in Wheat Production in Selected Districts of Haryana During Selected Period (1986-92 and 1997-2000)

Year	Human Labour		Chemical Fertilizers		Miscellaneous inputs	
	Mohinder garh	Kurukshet ra	Mohinder garh	Kuruksh etra	Mohinder garh	Kurukshetra
1986	100.0	100.0	100.0	100.0	100.0	100.0
1987	96.6	95.2	100.4	112.3	112.4	115.8
1988	110.3	113.3	98.2	112.8	125.8	78.5
1989	183.8	168.6	86.3	112.3	49.9	109.3
1990	224.1	193.9	97.4	121.6	104.1	147.1
1991	265.5	221.9	107.4	132.5	141.3	181.9
1992	220.7	249.5	153.9	170.5	209.3	189.6
1997	466.7	318.1	224.9	212.6	215.2	502.3
1998	531.1	374.6	224.2	226.2	195.1	403.2
1999	510.8	540.0	240.2	212.8	230.5	449.8
2000	551.7	866.7	247.6	256.3	325.1	222.9

Table 3.4A: Period-wise Annual Average Growth Rate (per cent) in Gross Return per hectare for Principal Crops in Haryana and the selected districts: Kurukshetra (Dist. I) and Mohindergarh (Dist. II).

Crops	Period I (80's)			Period II (90's)			Whole Period (80's and 90's)		
	State	Dist. I	Dist. II	State	Dist. I	Dist. II	State	Dist. I	Dist. II
Rice	8.65	9.40	--	11.29	12.29	--	17.19	18.99	--
Wheat	9.03	9.42	11.14	11.26	11.05	10.65	15.49	14.13	16.80
Maize	7.70	6.06	--	13.86	9.36	--	19.74	16.45	--
Jowar	5.51	--	--	-2.45	--	--	9.03	--	--
Bajra	9.50	--	25.26	12.29	--	20.63	18.48	--	35.93
Barley	12.08	--	30.19	10.67	--	8.59	19.10	--	30.19
Gram	18.26	--	16.52	6.22	--	7.31	16.65	--	17.67
Rapeseed & Mustard	17.99	10.36	16.09	4.21	4.93	4.20	13.23	11.42	12.16
Cotton (American)	6.87	--	--	6.03	--	--	12.36	--	--
Cotton (Desi)	6.03	--	--	8.93	--	--	15.11	--	--

Note: Notations (--) indicates that data for these crops and districts are not available

IV
Evaluating Alternate Options

Government often intervenes to achieve one set of policy objective. Though the short run objectives of such policy interventions are achieved, its long run implications are often not less deleterious. This situation arises primarily because of inadequate assessment of externalities associated with the policy objectives. These externalities are difficult to identify, sometimes these externalities interact amongst themselves to give a different net effect for the system. The net effect of these externalities will not necessary be negative. Previous chapter discusses alternate technological options; many of these would help in arresting unsustainable trend in the agricultural growth of the region; a suitable Government policy may help in adoption of these technological options. The interactions between Government policies and technology and its farm-level implications need to be assessed; otherwise we will be cursing the set of Government policy after decades of its implementation, as in the biochemical technology. The benign or malign effect of a policy objective also depends on natural resource endowment of the region.

Incorporation of these externalities in the decisional analysis is beset with several problems. In general there is a trade-off between economic objectives and externalities associated with it, this can be captured in the Economic-ecological modeling. In these modeling complexities of interactions are captured in the form of system of equations that can be used to assess effect of economic processes on various indicators related to economy and environment. The Economic-ecological models depending on the importance of environmental parameters into the economic models can be categorized into various groups (for details see Chopra and Kadekodi 1999). These models are also differentiated on the basis of techniques involved; it ranges from econometric modeling to input-output analysis and General Equilibrium models. The technique involved in the model determines amount and kind of data required for the model and inferences from the model. The macro-econometric models, for instance, does not directly incorporate welfare and often concentrate on one measure of activity usually Gross National Product. The input-output based analysis provides detailed sectoral impacts. Similar degree of dis-aggregation would in principle also be available from general equilibrium (GE) models, but the data requirements for GE analysis are generally very high. Input-output analysis avoids this problem by imposing a set of strong restrictions on production technologies; it is however, difficult to optimize input-output models.

The linear programming techniques have many essential features that of an input-output analysis but at the same time the LP technique is more amenable than the later. The objective of the present analysis is to assess impact of alternate price policy and technology related policies on various economic and ecological factors. The changes in prices of agricultural commodities as a result of liberalisation would be significant (may be 10 per cent 20 per cent), therefore can be captured in a linear programming framework in a better way as compared to the GE modeling, wherein effects are evaluated on the basis of elasticity (one or three per cent, Taylor and Naude1997). Considering these merits and demerits of alternate techniques, present study has used the linear programming technique. The linear programming based model is presented in the annexure. The model incorporates various types of constraints, primary factors of agricultural production such as land, labour, capital, and other ecology related parameters. The model integrates crop and dairy enterprises by considering fertilizer, fodder, and fuel balance equations. The model also incorporates trade-off between return and risk associated with it.

The issue of sustainability is a long-term concept, therefore proper address of this issue in an economic-ecological modeling requires model to be dynamic in nature. The model specified is not a dynamic one, but the long-term concerns have been addressed by involving the multi-criteria evaluation method, which gives weight to a host of economic-ecologic and social indicators.

The relative importance of these indicators varies across persons. An ecologist would pay higher weight to the parameters related to the ecological environment; whereas, social scientist may put higher weight to the indicators that influence harmony in the society. Whereas, farmers the actual decision maker would prioritize his immediate return; they would have limited regard for the long run interest of the society. There are chances that even though particular technological option is rated high on the basis of various economic-ecologic-social indicators, this may not find its place in the farm portfolio. Adoption of a technological option depends on several farm level benefits and costs, which is resultant of various farm level interactions. These interactions can be assessed in a farming system framework in a better way; farm level evaluation has therefore been undertaken in the present study. The first section of the chapter illustrates various economic and ecological benefits and costs associated with specific technological options; the second section of the chapter attempts to evaluate alternate price policies and technological options in a linear programming framework. The last section draws conclusions from previous discussions.

Indicators for Economic, Ecological and Social Environment

Environment is the aggregate of surroundings, farmers surroundings is multi-layered; economic conditions of farmers influences its family environment. The economic condition is aggregation of returns from farm portfolio. An enterprise is associated with primary benefits and costs, the secondary benefits and costs are not less important. The secondary benefits often influence farm family needs of fuel and fodder. Several secondary benefits and costs even though not affects farmers immediate return definitely influences long-term growth of the farm by affecting natural resource status in that region. This often transcends farm-boundaries and is considered as positive / negative externalities of an enterprise. Society is the next envelop of farm-family and social unrest / conflicts often contributed by the severe unemployment is an example of social environment influencing viability of a farm; a conducive social environment is therefore key to growth of a family-farm. Considering these envelopes indicators have been categorized as economic, social, and ecological.

The return and cost associated with the specific technological option is probably the most important economic indicator. Return has different dimensions; for a farmer, return to farm family[32] is the most important. The uncertainty associated with the return is another important determinant for adoption of a technological option. Historically, the costs associated with a technological option have been an important determinant for its adoption. With increased penetration of institutional credit size of cost does not remain important, this is reflected in a lesser weight in the Box.

Farmers' decision to adopt a particular technology also depends on availability of fodders, fuels, and fertilizer nutrients that one gets from the specific technological options. The importance of these benefits have been less-realized in a commercialized agriculture, such realization has resulted in increased paid-out costs for farm-family, which had adverse effect on farm family return. Nevertheless, the market purchased fuels and fertilizers are not substitute to the fuels and fertilizer nutrients as derived from biomass. A mis-match or overuse of chemicals has led to various long-term concerns related to agricultural development of the region.

In India, mixed farming that is, cultivation of crops along with the livestock activity has been a way of life. There is also preponderance of buffaloes in livestock activity, which essentially feed on biomass or crop residue. With the growing scarcity of fodder on various accounts[33], crop residue assumes importance for sustenance of existing agriculture and farm livelihood. Therefore the secondary benefits even though not very important from the farmer's point of view are extremely important from the society's point of view.

There are some farm inputs, whose price does not reflect scarcity of resources. The groundwater for instance, is highly scarce in the semi-arid regions of the country; its scarcity is being realized in the depleting groundwater table in the region. A part of the cost is reflected in the increasing private cost of ground water irrigation with the higher cost of draft of groundwater; this is also underestimated with the existing power tariff. There is sufficient evidence to suggest that availability of ground water has started constraining present rate of growth in agriculture, effect on future growth of agriculture in the semi-arid region would be even large. Amount of use of water is therefore important for evaluation of technological options at least from society's point of view. In a country like India precipitation is highly skewed, water requirement during the monsoon and non-monsoon period is therefore not alike. It may be noted that water required for a crop during the non-monsoon period necessarily impinges on the groundwater table; present study therefore, considers water requirement during the monsoon and non-monsoon period as separate constraints for present evaluation.

The social environment is as important as economic and ecological environment. Though social environment of the village can be disturbed on account of various reasons, unemployment is an important reason. Employment situation in rural India is grim[34]. Employment therefore remains an important indicator for present evaluation. Employment pattern is highly skewed in crops; this is more concentrated towards sowing and harvesting of crops. This strong seasonality in employment often makes the crop activities dependent on migratory labour force. The dependence of agriculture on external labour force during specific periods and unemployment in remaining large part of year vitiates village environment. Total employment in specific crop is therefore not very helpful in solving the problem of unemployment in a North-west village; distribution of labour therefore assumes greater importance in assessing technological options. A properly distributed demand for labour however utilizes family labour efficiently; this also reduces farmers' dependence on migratory labour force.

Box 4.1: Economic Ecological and Social Indicators with their weights in percent

Indicators	Weights
Economic	**70**
Gross Return	45
Stability of Return	20
Variable Costs	05
Ecological	**22**
Water requirements	12
Nutrient uptake	03
Fuel Supplement	02
Fodder Supplement	05
Social	**08**
Concentration of Employment	04
Amount of Employment	03

The relative importance of these indicators has been assessed by assigning weight to these indicators. These weights are based on value judgment of farm leaders, scientists and extension workers working in this area. In a sample of 30 persons interviewed for their value judgment in the present study, farmers, extension workers and scientists were in the proportion of 5:3:2. The average value of these weights is presented in the Box 4.1. It is apparent from the results that economic criteria dominate over other criteria. In economic criteria, gross return and stability of return are important indicators, amount of cost associated with the crop is less important as compared to other economic criteria. Amongst the ecological criteria, water requirements of crop has been the most important followed by fodder and fuel supplements, impact of crops on the nutrient status of soil comes latter. Indicators related to the social environment do not assume much importance amongst the target group; it is interesting to note that amount of employment is as important as distribution of employment.

Eco-Environment Indicators Across Crops

The above discussion highlights importance of primary and secondary benefits and costs associated with technological options. This is based on a combination of primary and secondary information, the same is presented in Appendix Table 4.1. The figures in Table 4.1 is based on a wide set of information. Information related to return and cost is based on primary information collected from sample households; whereas, stability of return is based on secondary information. Information on various secondary benefits and costs are based on a combination of sources; fertilizer Statistics provides information on a large number of parameters. Such information was supplemented with technical information collected from Scientists, Extension-workers and progressive-farmers of the region. The information presented are not complete, in the sense that it pertains to activities that is being practiced in the region; though evaluation of alternate options requires information about all possible activities that can be practiced in the region at farm level. The study therefore has to make some difficult assumptions; these assumptions are described in the annexure.

As is evident from the appendix table (Table 4.1) that sugarcane crop is associated with the highest return, other crops with decreasing order of return are potato, wheat, basmati, and non-basmati rice, cotton, rape-mustard, jowar, berseem, maize, sunflower, gram, bajra, and summer pulses. Most of the time high gross return for crops is associated with the high costs for these crops. On account of stability in return, performance of crops varies; some high return crops like potato and basmati rice are associated with high instability in return; whereas, some high return crops like wheat and non-basmati rice are also associated with the low instability in return. The reasons for low instability in return for latter crops have already been explained in the previous chapter. A high allocation of land under wheat and non-basmati crops in fact highlights importance of risk in farm portfolio.

These crops are also associated with high variable costs; the high cost was however, not a deterrent in adoption of these crops. Area under some other crops was restricted on account of local constraints; in sugarcane, for example acreage depends on the capacity of sugar mill in that area. Similarly, area under potato is constrained because of inadequate storage facilities for the crop. In the extreme ends there are crops like coarse cereals and pulses where return is low but instability in return is high. The sources of these instabilities are both in production and marketing of these crops. The summer pulse presents an extreme example wherein uncertainty associated with the production of this crop has been so high that area under this crop is not increasing; though this crop has great potential as it is a short duration crop and can easily be inserted between wheat and rice crops during April-May months.

With insertion of pulse farmers get extra income out of the existing rice wheat crop rotation, and health of soil also improves.

The ecological factor is more important from the society's point of view; in the long run it may get reflected in the private cost of production of farmers if resources are priced properly. It is generally believed that in the semi-arid region as that of NW India, private cost of production of rice and sugarcane is under-valued, as these crops are highly water intensive and private cost of irrigation through groundwater does not reflect the actual cost of draft at existing power tariff. The nutrient uptake of crops from soil is definitely a drag on future agricultural growth of the region as chemical fertilizers added into the soil are not a substitute to the organic fertilizer, traditionally applied in the mixed farming system; as these fertilizers do not improve physical health of soil. Nevertheless, only a part of chemical fertilizer is absorbed by crop and a significant proportion of chemical fertilizers, percolates down to pollute groundwater. In general hybrid and improved seed varieties are nutrient intensive whereas pulses are nutrient replenishing crops, therefore these crops are often considered to improve physical health of soil.

Though, with increased commercialization of agriculture importance of fuel and fodder obtained from crop residue is generally undervalued; some of the crops are still preferred on account of these supplements. The recent hike in the price of mineral oils / fossil fuel further suggests scope of technological advancements in harnessing energy from crop residues. As crop residues have been traditionally used as important energy supplements. Fodder supplements from these residues are also important considering the kind of pressure on land to meet the multiple demand of food, fiber and fodder requirement of burgeoning population. Popularization of buffalo based allied activity is a testimony to importance of crop-residue in the existing farming system of the region. One may note that amongst allied activities, more specifically livestock, buffalo is the most efficient converter of roughage into milk.

Rural employment definitely affects the social environment of the villages. Agriculture accounts for around three-fourth of rural employment in the country; while, employment in agriculture is highly skewed as demand for labor in crops is concentrated in the selected agronomic operation. This concentration of labour requirement varies across crops; as compared to potato concentration is more for crops like paddy. With specialization of area under wheat and paddy crops concentration of employment has increased in the study area and agriculture becomes highly dependent on migratory labour force. This does not help in improving rural unemployment situation either. None of these are good for social environment of rural sector; the present study therefore evaluates technological options on the basis of labour absorption in crops and concentration of labour during crop seasons.

The above discussion suggests that primary and secondary benefits and costs obtained from crops vary. One can rank alternate technological options (crops) on the basis of a set of Economic-Ecological-Social indicators. Adoption of these options depends on various farm level constraints and opportunities; alternate technological options may therefore be evaluated in a farming system framework.

Farm-level Evaluation

The present section evaluates alternate price and technological options, as this evaluation presumes that rationalization of agricultural prices would trigger positive changes on economic-environment indicators mentioned in the Box 4.1. Such evaluation must be assessed at the level of farm only as it is the farmers who respond to the changes in farm input and output prices. Again farm level evaluation about implications of domestic and trade liberalization requires farming system approach as this captures interaction between different farm activities and resources under farmers' control. The farming system approach in a linear programming framework can also takes care of domestic and market needs of the farmers. The farm situations in present analysis would represent average farms, synthesized from primary data collected from sample farmers during the year 2001-02. The selection of farmers involves multistage-stratified-random sampling technique illustrated in the Appendix 4.2.

The average situation in the small, medium, and large farms are presented in Table 4.2 and 4.3. Table 4.2 presents available resources on different size group of farmers, whereas Table 4.3 depicts land allocation for different size group of farmers. Availability of resources varies across the farm sizes; for instance, small farms are generally surplus with labour, while large farms are labour scarce. Evaluation of alternate options should therefore be carried for different size group of farmers like, small, medium and large.

It is not easy to simulate alternate price and technological options for all the three farm situations. Moreover the local constraints that restricts area under the selected crops remains true for all the farm categories; therefore provides limited scope for change in enterprise mix in a LP framework and hence on the selected economic, ecological and social indicators of the system. Bulk of the present simulation exercise has therefore been carried for the medium farm only; this also represent average farm situation. Though alternate technological options have been discussed for small and large farms as well. In Table 4.4 the existing situation depicts crop-combination in the average farm of 2.7 hectare during the survey year.

Table 4.2: Resource Available on Average / Synthetic Farm of different Sizes

Particulars	**Small**	**Medium**	**Large**
Land Holdings (hectares)	1.14	2.70	7.31
Family labour (man days)			
January	59.9	77.1	102.3
February	51.2	64.8	84.6
March	59.9	77.1	102.3
April	77.0	113.0	176.4
May	59.0	77.1	102.3
June	57.0	73.0	96.4
July	64.0	107.0	162.0
August	59.9	110.0	146.0
September	57.0	93.0	124.0
October	74.0	117.0	182.0
November	57.0	80.5	126.4
December	59.9	77.0	102.3
Capital ('000Rs.)			
Milch animals	26.2	42.6	86.5
Tubewell	6.3	28.5	61.4
Other implements	12.2	62.4	122.4

Table 4.3: Existing Land Allocations on Farms in the Kurukshetra District

Crops	Small (1.14 ha)	Medium (2.70 ha)	Large (7.31 ha)
Paddy – dwarf	0.70	1.50	4.00
Paddy – basmati	0.16	0.41	1.22
Jowar – chari	0.16	0.41	0.61
Potato	0.04	0.08	0.41
Wheat – timely sown	0.81	1.40	4.00
Wheat – late sown	0.08	0.50	0.81
Mustard	0.04	0.04	0.20
Sunflower	--	0.10	0.41
Pulse – summer	--	0.04	0.20
Berseem	0.16	0.41	0.61
Sugarcane	--	0.08	0.61
Vegetable –nonpotato	0.04	0.08	0.20
Total cropped area (hac)	2.19	5.02	13.28

The Economically-Efficient or E-Efficient presents crop combinations as farmers try to use their resources optimally on the basis of two economic criteria, that is, maximization of gross margin (return) and parameterization of negative deviation from mean (risk). The E-Efficient plans have been derived for four situations, termed as E-Efficient-I to III.

In E-Efficient-I plan, resources are used optimally with the existing enterprise-mixes, input and output prices are the average prices as prevailed during the survey year (2003-04). Availability of resources and resource utilization pattern varies across different sizes of farm. Certain land-based technological options are evaluated for its usefulness on different synthetic farms. Possibility of alternate land-based technological options and technical information about it is collated during the field visit. This suggests incorporation of pulses between wheat and paddy crop rotation; a complete annual cycle of vegetables, fruits (*kinnow,* a citrus fruit), agro-forestry (eucalyptus, papular, *subabul* / acacia).

In E-Efficient-II plan, resources are used optimally with the existing enterprise-mixes, while input and output prices are rationalized. In India output prices are closely getting linked with the international prices, the domestic prices during the period 2001-04 was very close to international prices. Domestic price therefore is assumed to have been representing undistorted price. In tradable farm inputs prices of fertilizers other than urea is linked with the world prices. In non-tradable farm inputs price of canal irrigation water and power tariff used for agriculture are important and there have been several expert committee to guide about rationalized prices for these commodities. Rationalization of input and output prices is deliberated in details in Appendix (App 4.4).

In E-Efficient-III plan, in addition to the E-E-Efficient plan-II, the existing non-land based resource utilization pattern is altered. The said resources utilization pattern incorporates conjunctive use of synthetic and organic chemicals as in integrated pest and nutrient management (IPM and INM) practices to increase production and simultaneously conserve natural resources. Evidences of crops wherein integrated pest and nutrient management has been practiced in the Northwest India are paddy, wheat, rape-mustard and cotton.

In the study area existing crop enterprise-mix is dominated by paddy and wheat crops there are not much differences across farms. The next most important crop rotation in the study area is fodder consisting of jowar (chari) and berseem crops. A trend across farm sizes is visible; proportionate area under fodder is less on large farm as compared to small farm. This indicates that intensity of livestock is more on small farm. Similar trend across farm size is apparent in vegetables and agro-forestry, though their percent is very small in the synthetic farm. These crops unlike paddy, wheat and fodders are not cultivated on all farms; therefore, proportion of these crops in synthetic farm is small.

A complete rotation of vegetables has been extremely profitable on small and marginal farms wherein intensity of labour has been very high. Some of the important vegetables being cultivated in the study area with its duration in parentheses are pea and cauliflower (September – January), ladyfinger, bottlegourd, *tinda* (February-June), tomato (January-April), *Arbi* (March-September). Cultivation of vegetables has been highly profitable in urban vicinity as better price is assured. *Sundhi* is an important pest for many vegetables. Eucalyptus and papular are important plants planted in private land of farmers, the same is referred here as agro-forestry. Some large farmers have considerable area under the above plants, while many large and middle size farmers have eucalyptus and papular on the edge of their agricultural land. Agro-forestry is less labour intensive, provides regular supply of fuel, and is a long-term investment (around 8 years or more) for better return.

Cultivation of pulse improves soil health. Prices of pulse are increasing consistently; yet, this has not been found very profitable on an average farm of the region. In rabi season, gram to a lesser extent has found a place. There is however sufficient scope of cultivating area under summer pulse between April-June months, when land remains fallow in wheat-paddy based crop rotation. Some farmers, who have sown their field with summer pulses like moong / urad, reported considerable instability in yield of these crops. Summer pulse has been found to be very sensitive to the rise in temperature during crop season. This is not less water-intensive as it is cultivated in summer season (May-June).

Oilseeds are other agricultural commodities wherein prices are increasing consistently. Yet it is not as profitable as paddy-wheat based crop rotation. In rabbi season rape-mustard to some extent has found a place in average farm. In the mid-nineties sunflower to lesser extent had replaced late-sown wheat. This had favorable effect on groundwater resources as well (Jha 2000). Area under sunflower has however decreased in the recent years. Field visits to the region shows that the yield of sunflower has decreased; farmers doubt quality of seeds that is being supplied through the private seed agencies. In hybrid variety quality of seed becomes important, as this has to be replaced every year. These are some examples of production related constraints in diversifying area away from paddy-wheat crops.

Commercial crops like potato, sugarcane is highly profitable, also involves less production risk; yet, these crops are not cultivated to its full potential in the study area. Field visit to study area suggests some local institutional and infrastructure constraints; area under sugarcane depends on the crushing capacity of the only sugarcane processing facility in the district. Sugarcane is highly water intensive therefore area restriction under sugarcane is good for conservation of natural resources like water. Similarly area under potato is constrained by dearth of sufficient storage facilities in the district, though the district has highest storage capacity in the state. The cost of storing potato is already high (more than one rupee in the year 2001-02) in the district. Most of the crops other than fine cereals face similar constraints. The long-term growth of agriculture in the Northwest India that is often believed to rests on reducing area under rice and wheat, would definitely require removal of these constraints in the region.

In E-efficient –I plan, optimization as usual leads to specialization; area under dwarf rice increased at the cost of basmati rice and that under wheat increased at the cost of other rabi crops. This specialization has favorable effect on the economic indicators but had adverse impact on the ecological indicators especially water. In the E-Efficient –I plan; the increase in return over the existing plan has been only marginal indicating that the existing resources on an average farm of the region is utilized efficiently considering the region-specific local constraints, in the existing linear programming framework this has come as maximum constraints on activity. The present evaluation is about assessing impact of these alterations in the prices of farm inputs on the optimal resource allocation for farmers. A comparison of the prevalent (existing) and the optimal combination (E-Efficient-I) indicates that there is no significant difference between resource allocations in both the situations, indicating that the existing linear programming model is close to the real situation. In the present analysis role of institutions has already been ascertained in the E-Efficient Plan-I. Linear programming in fact, leads to specialization; but local constraints restrict area under the most profitable crop-rotation. The difference in return between specialized crop rotation without any local constraints and returns as obtained in Plan-I after incorporation of local constraints would indicate return foregone due to local constraints. The local constraints here include ground water scarcity as well. The complete specialized crop rotation is therefore not very practical for the study area, hence ignored from the present analysis.

Alternate prices suggested in the present analysis are the rationalized prices of farm inputs and outputs. The rationalized prices to large extent depict the shadow prices; in the present analysis rationalized price is significantly lower than the shadow price because of several reasons. The farm input prices in the present analysis is lower than the shadow prices on account of the fact that farm input subsidy would not be abolished altogether. Similarly on the farm output front some check and restrictions are, in fact, necessary for the domestic farmers considering the volatility of the world agricultural market. Protection coefficient trend suggests integration of domestic market with the world market. In farm inputs, present analysis targets urea and power tariff for alternate prices. Prices of urea in the world market are highly unstable, yet various forecast available indicates that the urea price (*fob*) in the world market will average at around US$ 140 per ton. This would translate urea prices *(farm-gate-prices)* at around Rs7 per kg at the farm gate, while the price of urea in the year 2000 was Rs. 4.80 per kg of urea. There is dearth of evidence about proper relationship between power tariff and the cost of irrigation of groundwater. In this situation farmers with tube-wells were directly asked about the likely increase in the price of irrigation with the rationalization of power tariff. Rationalization here means power tariff would be 50 percent of pooled cost of power as reported by the state electricity boards. The farmers were of the opinion that with the aforesaid increase in the power tariff cost of irrigation will almost double; present analysis therefore considers Rs. 140 as the cost of irrigation of 4 hectare-cm depth of water.

Table 4.4:Emerging Crop-combinations in Alternate Situations at an Average Farm (2.7 hectare)

Crops	Existing	E-E-Plan-I	E-E-Plan-II	E-E-Plan-III
Paddy - HYV	1.5	1.9	0.5	1.2
Paddy – Basmati	0.4	0.0	0.0	0.0
Wheat	1.9	1.9	1.0	1.2
Maize	0.01	0.2	0.5	0.3
Bajra	0.00	0.00	0.0	0.0
Pulse - rabi	0.02	0.00	0.00	0.0
Pulse - kharif	0.00	0.00	0.00	0.0
Pulse – summer	0.02	0.1	0.5	0.2
Rape-mustard	0.03	0	0.4	0.5
Sunflower	0.1	0.1	0.5	0.3
Sugarcane	0.1	0.1	0.1	0.1
Potato	0.08	0.1	0.5	0.3
Cotton	0	0	0.4	0.5
Jowar chari	0.41	0.41	0.41	0.41
Berseem	0.41	0.41	0.41	0.41
Vegetables	0.07	0.07	0.07	0.07
Fruits	0.01	0.01	0.01	0.01
Agro-forestry	0.03	0.03	0.03	0.03
Total Cropped Area	5.11	5.33	5.33	5.53

The crop combination arrived with the altered prices has been presented in the Table 4.4 in the column E-Efficient-II. It is apparent from table that area under rice and wheat has decreased; the cropping intensity has, however, increased with the adoption of small duration crops. The most important crop rotation that emerged in the present policy scenario was the summer pulse-maize-potato-sunflower. This alteration in crop rotation had limited effect on groundwater resources, positive effect is observed more on irrigation requirement during monsoon season. In season other than the monsoon demand for water has not decreased significantly as there has been many-fold increase in cropping intensity. This increase in cropping intensity will increase mechanization and may have adverse effect on physical health of soil. The changes in cropping pattern have however significant positive effect on fuel and fodder availability and also on absorption of labour on an average farm. The farm return has decreased because of increase in costs and non-commensurate increase in farm return. Interestingly farm return has not increased even though cropping intensity has increased significantly. This indicates that rationalization of agricultural prices would be highly taxing for farmers. The rationalization will not reduce the extent of degradation of natural resources; the kind of degradation would actually change.

Table 4.5: Evaluation of Alternate Situations on the basis of different Economic, Ecological and Social Parameters

Parameters	Existing	E-E-Plan -I	E-E-Plan -II	E-E-Plan -III
Economic parameters				
Farm return (‘00Rs)	552.87	567.74	483.76	586.86
Negative Deviation (‘00Rs)	139.16	110.67	211.42	182.16
Ecological parameters				
Total water requirement (hacm)	506.7	518.6	332.2	438.8
Irrigation-monsoon (July-Oct)	239.4	244.2	107.8	184.1
Irrigation-otherseas. (Nov-June)	90.2	86.4	82.3	80.8
Nutrient mining (kg)				
Nitrogen	514.2	536.7	421.5	523.1
Phosphate	106.1	110.4	106.9	131.0
Potash	596.5	629.9	467.6	613.3
Fuel derived (‘000 kcals)	6138.8	6198.8	3596.6	4454.5
Fodder obtained				
Dry crude protein	143.5	153.5	176.1	146.6
Total digestible nutrients	2582.4	2839.4	2544.1	2493.0
Social parameters				
Employment - total (mandays)	432.7	439.2	390.5	439.6
Emp- Sowing and harvesting	291.5	298.9	242.3	284.6
Emp- other operations	141.2	140.3	148.2	155.1

The role of technology in improving productivity alternately reducing the unit cost of production and conserving natural resources cannot be overemphasized. Present analysis in E-Efficient Plan-III tries to assess the role of technology in solving problems related to agriculture in the region. Some of the biggest technological challenge in the study area has been increased use of resources both natural (water) and artificial (chemicals). In important crops like rice and wheat, cost of chemical has increased during the recent years. Though many resource conserving technological options are suggested, in actual only few of them have been adopted at field level and Integrated Pest Management (IPM) is one. Field-based evaluations of Integrated Pest Management (IPM) practices are not there for all crops cultivated in the study area; though it is for important crops like rice, wheat, rape-mustard and cotton. Resource conserving technology is desired more for paddy and wheat.

The E-Efficient Plan-III therefore evaluates plans with alteration in technical coefficients for paddy, wheat, rape-mustard and cotton. Interestingly, optimization leads to restoring area under paddy and wheat and increase in area under summer pulse. In other words, paddy-wheat-summer pulse emerged as the next best crop rotation. But considering implication of this crop rotation on ground water, maximum limit was imposed and the next best possible was maize-potato-rapeseed. Interestingly cotton and rape-mustard emerged important in the plan III. In the above plans fodders, vegetables and fruits have entered as predetermined variables as ecological parameters for these crops are not available. In actual fodder is highly profitable on mixed farms of all sizes, whereas vegetable has been found to be highly profitable on small farm and agro-forestry on large farm has remained profitable; in other words its area has not decreased.

The above changes in crop rotation following price, technology and institution related interventions have significant effect on farm return; these interventions also have significant effect on economic, ecological and social parameters related to the long-term growth in agriculture. The economic parameters: return, risk and costs in E-Efficient plan-III improved over the E-Efficient Plan-II at times it was better than the E-Efficient Plan-I also. This necessarily implies that rationalization of prices alone will not lead to sustained growth in agriculture; this has to be effectively supported with the technology in agriculture. Infrastructure remains the most important intervention that improves economic, ecological and social environment of average farm in the region.

Implications for Policy Options

The rationalization of price is often believed as panacea for many ills in the economy. Farmers in response to the changes in agricultural prices would adopt alternate technological options in a given institutional setup. The present study attempts to evaluate implications of these interactions in a farming system framework. The study is for an average farm (2.7 hectare) of North-west India. The study using linear programming techniques incorporates several economic, ecological and social factors that constrain long-term growth of agriculture in the Northwest India. The above analysis shows that the average farm in the study area allocates resources efficiently in the existing resource and non-resource constraints. Rationalization of agricultural prices have significant effect on the existing crop-combination; this has reduced farm return on account of increase in the input costs; though new crop-enterprise-mix to some extent has checked resource degradation and also improved social environment. In the emerged situation farmers may like to adopt certain technologies, alteration in land-based options and adoption of IPM practices have been important for the region. Optimization with the changed input-output (technical) coefficient therefore suggests significant changes in crop enterprise-mix. Adoption of alternate technologies shows significant improvement in economic, ecological and social indicators considered in the present evaluation. The above analysis also shows sub-optimal use of resources on account of region-specific infrastructure / institutional constraints. The above exercise suggests that rationalization of price alone is not answer to the balanced growth of agriculture in a region. A sustained agricultural growth warrants suitable resource conserving technology and also favorable institutions that unbound the region-specific local constraints.

Appendices

Appendix 4.1. Assumptions related to the Economic and Environmental Parameters

The Gross returns and Costs associated with the individual crops are based on the primary data collected during the survey of the present study. Gross returns and costs of production available from secondary sources such as Directorate of Economics and Statistics, Ministry of Agriculture (Government of Haryana) and CACP are not available for many crops. The coefficient of variation around trend has been chosen as an indicator for stability of return, it is needless to assert that lower CVt would indicate stable return. In most of the cases CVt has been worked our for a large period of time (around 10 years), in many cases secondary information on prices and yield are not available, for these chosen commodities instability in gross returns is based on data as obtained from the Krishi Gyan Kendra (KGK).

Total water requirement is the total water required for a particular crop including the monsoon rain in hectare-cm. The water requirements have been worked out after consultation with the individual Scientists, extension workers based on the KGKs of the selected district. The total water requirement follows sub-headings like irrigation water required during the monsoon period (June 15 to October 15) and non-monsoon period (rest of the period). This differentiation is necessary since it is easy to get irrigation water from either of the sources, canal or tube well, during the monsoon season. Nutrient uptake from soil is based on the various study cited in the Fertilizer Statistics. Most of the estimates for nutrient uptake are also presented in the aforementioned book under different Tables. Since these estimates are pooled from different sources, inferences on account of draft of nutrients may be drawn with caution.

The secondary benefits received from crops can be many, present study tries to parameterize these benefits from crop-residues into three broad headings, fuel, and fodder and fertilizer nutrients. These estimates are based on the studies of ICAR (1980), Healley and Soffe (1988) as cited in Parikh J., R. Ramanathan, J. P. Painuly (1993) "Energy, Agriculture and Environmental Interactions: The Case of Rural India" in Parikh (edited) Energy Models for 2000 and Beyond, Tata MacGrawhill Publisher, New Delhi, India.

Employment in man days provides total employment in respective crop in a normal mechanized condition, that is, land preparation by tractor, and other crop-based operations by human labours. This is the practice for bulk of the farmers, though some large farmers use combine for harvesting of wheat. The requirements of labour for specific agricultural operations are concentrated, generally in the sowing and harvesting seasons of the crops. This high labour requirements are not made-up with the village based labour force, but with the migratory workforce. This has various implications, which constrains social environment of village.

Appendix 4.2: The Sampling Procedure

The selected district, Kurukshetra, has been studied for heterogeneity with respect to cropping pattern and the natural resource status. The difference in the selected parameters was not significant for the tehsils of the district. Yet, two clusters of villages each of three villages have been selected randomly. The selected villages are Ramgarh, Pratapgarh, and Sanwla (Cluster I), Alampur, Dayalpur and Salarpur (Cluster II). A complete enumeration of all the selected villages was done. A list of all households with operational holdings in the villages was prepared. The households have been categorized into three groups -small, medium, and large, by adopting cumulative square root method of stratification. The combination of crops and dairy has been identified as the most important enterprise-mix.

Again, a list of farmers with the above enterprise mix in each of the farm category has been prepared, arranged in an ascending order and finally 60 households based on the probability proportion to the size of holdings in each of the three categories of households were selected. Primary data regarding technical requirements of inputs and outputs of farm activities, and details of resource constraints on farm has been collected through a well-structured and pre-tested questionnaire. Farmers were interviewed with a detailed and pre-tested questionnaire to assess their resource utilization pattern and also their opinion about various factors plaguing the agricultural development of the region. Average farm situations have been created out of this information.

Appendix 4.3 : Alternate Prices

Alternate prices suggested in the present analysis are the rationalized prices of farm inputs and outputs. The rationalized prices to a large extent will depict the shadow prices, though in the present analysis it is supposed to be significantly lower than the shadow price because of several reasons. In farm input prices, difference may be on account of the fact that farm input subsidy would not be abolished altogether. Similarly on the farm output front some check and restrictions are, in fact, necessary for the domestic farmers considering the volatility of the world agricultural market. Protection coefficient trend suggests integration of domestic market with the world market. In farm inputs, present analysis targets urea and power tariff for alternate prices, the analysis thus assumes that price of phosphatic and potassic fertilizers will be as it was in the year 2003-04. This is not irrelevant considering integration of these fertilizer prices with the world market, and there is no controversy on the present mode of subsidies and concessions in these fertilizers.

Fertilizer subsidy for urea is in the form of price difference between the farm gate price and the accumulated cost of urea, a large part of the domestic consumption of urea is the domestically manufactured urea. For non-urea fertilizers, subsidy is in the form of direct flat concession to imported and domestically produced urea. Present analysis assumes that flat concession would be the mode of subsidizing fertilizers in the forthcoming years. Even in the worst situation total fertilizer subsidy inclusive of urea and non-urea fertilizers would not be less than the concessions exclusively provided to the phosphatic and potassic fertilizers in the year 2003-04. This implies that farm gate price of urea will reflect the world urea price with minimum distortion (if flat concession prevails). In the year 2000-01 total concession to the phosphatic and potassic fertilizers was around 50 per cent of the total fertilizer subsidy, this assumption will ease us from making more difficult assumptions in our present analysis. In this backdrop the natural question will be that what would be the world urea price for the present analysis? Prices of urea in the world market are highly unstable, yet various forecast available indicates that the urea price (fob) in the world market will average at around US$ 140 per ton. This would translate urea prices *(farm-gate-prices)* at around Rs7 per kg at the farm gate, while the price of urea in the year 2001 was Rs. 4.80 per kg of urea. In the present analysis, price of fertilizers other than urea has been assumed as it was in the year 2001.

Power tariff for agricultural use has been extremely low, this has implications for the cost of irrigation through groundwater. During the year of survey for the present analysis cost of irrigating one hectare of land through groundwater was Rs. 70. This irrigation varied from three to five cm of depth; present study therefore assumes that volume of water per irrigation is around 4 hectare-cm. It was clear during the survey that the cost of irrigating water is a function of power tariff and the cost of establishment of tube-well. The rationalisation of power tariff, which is essentially about hiking the power tariff for agriculture, would lead to increase in the cost of irrigation. The basic question is about the rate of power tariff for agriculture. In non-tradable commodities like power, cost of generating power needs to be reflected in the power tariff. Though chances of full tariff to be charged from farmers are remote at least in the medium run (next five to seven years). About the rate of power tariff for agriculture, during Chief Ministers meeting in the year 1996 there was almost consensus that power tariff for any sector cannot be less than 50 per cent of the average cost of supply of power. There is dearth of evidence about proper relationship between power tariff and the cost of irrigation of groundwater; moreover, ground water market in the study area is far from perfect. In this situation farmers with tube-wells were directly asked about the likely increase in the cost of irrigation with the proposed power tariff. The farmers were of the opinion that with the aforesaid increase in the power tariff cost of irrigation will almost double; present analysis therefore considers Rs. 140 as the cost of irrigation of 4 hectare-cm depth of water. In a crop like paddy, desired number of irrigation during crop season is 10 and in such situation cost of irrigating paddy field in the study area would be Rs. 14000. The cost of irrigating paddy field is almost 5 percent of gross value of paddy (around 25000 per hectare). The High Power Committee on Irrigation pricing suggests that cost of irrigation should be at least 5 per cent of the value of output of crops. Though the recommendation about the price of irrigation is in the context of canal irrigation.

Appendix 4.4 : Alternate Technological Options

4.4A Land-based Technological Options:
Alternate technological options referred to here are the principal crops cultivated in the selected districts of the state. The duration of the crops is as in the selected districts, there may be minor variations at the ground level about the crop seasons, the crop-seasons presented here is in fact the most comprehensive one for the most important variety for the region. Some of the crops have alternate importance; for example Jowar in the study area is more frequently used as fodder rather than grains. This is the case for berseem also.
About pulses, its seasonality and examples; rabi pulses is dominated by gram, summer pulse is primarily moong, kharif pulses moong and mash are rarely cultivated. Lentil is common in both, kharif and rabi seasons.

4.4B Non-Land based Technological Options
There are numerous suggestions about altering the existing pattern of (non-land) resource utilization; efficacy of these practices is well documented. Instances of adoption of these practices in actual at ground-level are not many; integrated pest management (IPM) has been an exception. The IPM encourages conjunctive use of synthetic and organic chemicals. Advantages of adoption of integrated pest and nutrient management practices are well documented. The findings are often region specific; in the Northwest India evidences of crops wherein integrated pest and nutrient management has been practiced are paddy, wheat, rape-mustard, pigeonpea and cotton. Evaluation of IPM by and large suggest that adoption of IPM increases cost on account of FYM / organic fertilizers, and labour. Adoption of IPM requires labour more specifically family labour as preparation of organic farms / pesticides require labour in small amount but intermittently during crop season. With the adoption of IPM cost of cultivation decreases on account of lesser use of chemical fertilisers and insecticides. The farm return increases on account of increase in yield and also decrease in cost. Impact of IPM has been maximum for those crops wherein chemical fertilizers / insecticides are used more intensively.

Table 4.1A Farm level Impact (percent change in IPM over non-IPM Farmers) of Adoption of IPM in

Parameter	Paddy#	Paddy	Wheat	Cotton	Pigeonpea#	Cotton#
Farm Yard Manure	+2.6	+25.0	+15.0	+45.0	+45.9	+45.0
Chemical nutrients	-5.6	-20.0	-25.0	-5.6	-9.8	-5.6
Plant protection chemicals	-4.6	-25.0	-40.0	-34.0	-53.7	-67.6
Human labour	+4.7	+6.0	+8.0	+8.0	+8.0	+8.0
Cost of cultivation	-5.8	-17.0	-22.0	-22.0	-25.6	-30.0
Yield	+8.9	+5.0	+8.0	+10.0	+18.2	+18.3
Cost of production					-37.0	-41.5
Net return	+30.4	+32.0	+38.0	+42.0	+161.2	+376.1

Note: Sign # shows that estimates for these crops are reported from various studies (Ramarao etal 2007). Estimates for other columns are arrived after consultation from Scientists of selected research institutes and field level workers in the Northwest India.

Appendix 4.5: Analytical Framework and Data

The Multi-objective Linear Programming technique has been used to arrive at Eco-Environment efficient farm plans. These plans have been obtained from average farm situation by varying price and technological factors. These farm situations will be evaluated considering changes in a host of economic and environmental parameters over the existing farm situations. The ecological parameters relevant to the field condition, and also incorporated in the present study are mentioned below.

a) Soil degradation- Extraction of Soil macro- nutrients
b) Decline in groundwater table- Use of water during Monsoon (July-October), and other period (November-June).
c) Bio-mass produced- Crop residues in the system
d) Stress on Common Property Resources (CPRs)- Availability of fodder & fuel from the system
e) Social conflicts- regularity of employment, stability of farm income.

The Multi-objective Linear Programming Model will be specified as under.

Objective function:

$$\text{Maximize } Z = \sum c_i X_i - \sum p_m L_m - \sum p_r P_w - \sum p_w C_w - \sum p_f F_n + \sum p_s R_s - \sum p_p R_p - \sum p_l F_p \quad \text{--- (1)}$$

Subject to following resource and non-resource constraints

Land restriction: $\sum a_{ij} X_i < LH$ --- (2)

Water constraint: $\sum w_i X_i — P_w < CIW$ --- (3)

Labour Constraint: $\sum l_{im} X_i + - L_m < FLM$ --- (4)

Working Capital Constraints: $\sum k_i X_i + \sum p_r P_w + \sum p_m L_m + \sum p_w C_w + p_t C_t + 0.2 C_t + \sum p_f F_n + \sum p_p R_p + p_l F_p - \sum p_s R_s - C_w < WC$ --- -(5)

Fertilizer nutrient (N,P,K) balance:

$$\sum f_{in}X_i - F_n = 0 \qquad \text{--- (6)}$$

Fodder (dry and green) balances: $- \sum s_iX_i - Rp = 0$ --- (7)

Fuel balance: $- \sum f_i X_i - F_p > FA$ --- (8)

Deviation as constraint in MOTAD: $\sum (c_{hi} - g_i) X_i + Y_{th} > 0$ --- (9)

Average deviation from mean return: $\sum Y_{th} = \backslash$

(where $\backslash = Y_{th} > 0$) ---(10)

Maximum restrictions: $X_i < X_i^*$ --(11)

Non negativity constraints: $X_i, L_m, C_w, C_t, F_n, R_p, > 0$ --- (12)

Where, the **parameters** are:

a_{ij} = area of land (acres) used by one unit of the harvested crop 'i' in jth bi-monthly season.

c_i = gross margin from one unit of crop activity (Rs/acre)

c_{hi} = gross margin of ith crop activity in hth year (Rs/acre).

CIW = Average Canal irrigation water available at farms of various sizes (acre-inch).

f_i = fuel obtained from biomass of ith crop (Kcals).

f_{in} = fertilizer nutrient - nitrogen/ phosphorus (kg) required per acre by ith crop activity.

FA = Amount of fuel required for domestic purpose.

FLM = Amount of family labor available (man-days) in the mth month.

g_i = Mean value of the gross margin of the ith crop activity.

k_i = working capital required by one unit of ith crop activity.

l_{im} = labor used in mth month by one acre of ith crop activity(man days).

LH = average land holding (acre).

p_f = average market price (Rs/kg) of nitrogen/phosphate/potash fertilizers on nutrients basis.

p_l = average price of fuel purchased for domestic consumption.

p_m = average market wage rate of hired labor (Rs/man days) in the mth month.

p_p = average purchase price (Rs/qtl.) of green fodder.

pr = average cost to pump one acre –inch of water.

p_s = average sale price (Rs/qtl.) of green fodder.

p_t = rate of interest on medium term capital (percent/annum).

p_w = rate of interest on working capital (per cent/annum, for six month).

s_i = amount of fodder produced (qtls.) by unit crop activity.

w_i = amount of water required by unit crop activity (acre-inch).

WC = amount of working capital (Rs.) available during the year.

Y_{th} = maximum value that average deviation from Mean return can take on.

X_i^* = maximum possible acreage under ith crop activity.

\ = average negative deviation from mean return (Rs.).

and, the **decision variables** are:

C_w = amount of working capital to be borrowed (Rs.).

F_p = level of fuel purchased.

F_n = amount of fertilizer nutrients - nitrogen, phosphate purchased (kg.).

L_m = amount of hired labor (man days) in mth month.

P_w = amount of ground water lifted (hectare-cms).

R_p = amount of green fodder purchased (qtls.) in the year.

R_s = amount of green fodder sold (qtls.) in the year.

X_i = level of ith crop activity (hectares).

Y_h = absolute value of negative total gross margin deviation from mean return in the hth year.

Z = value of the objective function.

V
Conclusions

Government policy towards agriculture has played an important role in the planned development of the country. A considerable level of self-sufficiency in agriculture with the bio-chemical technology was achieved with a set of protectionist policy in external sector coupled with a suitable domestic policy most notably price and credit policies related to agriculture. The World Trade Organisation (WTO) and various agreements associated with it attempt to limit the role of Government. The process has already started; a regime of selective protection wherein country was protecting certain commodities like oilseeds and dis-protecting commodities like fine cereals, has crumbled. Though on going Millennium Round Negotiation recognizes importance of special products in agriculture for developing countries. With trade liberalisation the Nominal Protection Coefficient (NPC) for most of the agricultural commodities is approaching towards one and difference in protection coefficients between commodities has also reduced.

The decreasing protection clearly suggests integration of domestic and international market; while, certain restrictions on domestic markets continue. These restrictions are often blamed for post harvest inefficiency in agricultural commodities. In the recent decade there have been attempts to reorient Government policy towards agriculture. Restrictions on movement of many agricultural commodities were abolished. The special provision of the Essential Commodities Act, which has come in force in 1981, was been repealed towards the end of nineties primarily to encourage private trading activities. The decade old Agriculture Produce Market Regulation (APMR) Act has been redesigned in the Model APMR Act to address emerging concerns related to marketing of agricultural commodities. The state governments are being encouraged to adopt the model act. The growth of processing sector has been affected by multiplicity of legislation; an integrated Food Legislation is therefore attempted. Further to encourage large-scale investments in processing sector, many agriculture-based industries have been de-reserved, for some other commodities scale of investment was also increased. The intensity of compulsory procurement levies for rice and sugarcane has reduced gradually.

All these attempt are to improve efficiency in the post harvest operations. Incidentally some of the reforms in domestic market were also reversed on account of food security related concerns. This is typical of agriculture. Though Minimum Support Price (MSP) has been instrumental in agricultural development of the country; its relevance decreases in an opening economy. The downward rigidity of the MSP has also resulted in problems as that of the burgeoning food stocks. The opening up of trade has started showing its impact on the market prices of many farm outputs. The above analysis shows that Farm Harvest Prices (FHP) were by and large following MSP during the eighties; divergence in these prices has started since mid-nineties. Interestingly, world prices have started influencing domestic prices while farmers still rely on MSP for sowing decisions. The FHP has declined for many commodities in recent years though prices of the same commodities are increasing in the wholesale market. An effective implementation of administered prices for the selected crops has also influenced cropping pattern in certain regions of the country without any regard for the carrying capacity of the region.

With the removal of restrictions from domestic markets, it is hypothesized that market across space would integrate; whereas, price integration, as measured with the correlation coefficient between FHP in states, has increased in the recent period (nineties and 2002-05). The spatial integration as an inverse of coefficient of variation in farm harvest prices across states has also weakened consistently over the years; the weakening tendency has further strengthened in the recent period (2002-05). The three periods considered for above comparison are late-eighties, -nineties and a recent period (2001-04). Removal of certain restrictions from domestic market in the nineties and thereafter, does not appear to have affected private trade as significantly as was expected on at least two accounts; informal restrictions on domestic market actually persist, uncertainty associated with the fumbling of some of the domestic market restrictions have also discouraged private trading activities. In this situation external trade in a commodity, generally in small amount, appears to have affected market price of commodity only in regions adjacent to the port. This further widens disparity in market prices across states.

A tendency towards integration of domestic and world prices of tradable farm outputs and inputs has already started. The changes in relative prices would definitely affect resource utilization pattern of farmers. The farmers who actually implement an agricultural policy attempt to maximize their farm return; the externalities associated with the stated objectives are often ignored. At times we find that particular farm policy has been detrimental to the long-term growth of agriculture in a region on account of negative externalities associated with it. The much acclaimed biochemical technology of late sixties is an example. The farm policies are however politically so important that alteration becomes difficult and prioritizing the long-term concerns over the short run objectives become even more difficult. The long-run effects of any policy changes therefore need to be evaluated *apriori*. This evaluation has to be region-specific since the externalities, which constrain long-term growth of agriculture in a region vary across regions depending on the status of natural resources in the region. The Northwest India is selected purposively for the present analysis since the region, which emerged as the grain basket of India is in news in recent years, because of certain disconcerting trends in agricultural development. The region is also in the forefront of adoption of commercial agricultural practices; implications of liberalisation is therefore supposed to be the maximum for such a region.

The present study therefore begins by evaluating sustainability of agricultural system in the Northwest India with the help of Conway's indicators. He considers productivity, stability, low-vulnerability and equity as the yardsticks for measuring sustainability. The importance of these indicators however varies across regions; farmers in a resource rich region for instance, are not as vulnerable to natural calamities as they are in the resource-starved region. Present analysis assumes that risk especially downside risk in return would reflect vulnerability of farmers in the Northwest India. The study assumes that growth is an essential element of sustainable agricultural development of a region wherein population is growing. The study finally evaluates sustainability on the basis of three indicators, growth, stability, and productivity.

In the Northwest India, paddy and wheat occupying around 80 per cent of the cropped area, have been the main source of agricultural growth. The growth in productivity of these crops has, however, tapered off in the recent decade. In rice, decreasing trend in productivity is also because of poor quality of data. In wheat, total factor productivity is decreasing for the state as a whole. Further to observe regional pattern in agricultural productivity, total factor productivity of wheat has been calculated for the selected districts. Though downward trend in productivity was established at the district level as well; the decreasing trend in factor-productivity in a progressive district like Kurukshetra, started earlier than in a late-adopting district like Mohindergarh. The result to some extent substantiates the theory of technological maturity in agriculture as propounded by several researchers.

Further enquiry into decreasing trend line in total factor productivity suggests increasing cost of production and stagnation in yield of these crops as important reasons. The hike in administered wages for agricultural labour; which cannot be justified on the basis of decreasing total factor productivity of the important crop of the region is accounting for the higher share of labour in total cost. Interestingly, real wages for agriculture workers has also decreased in the subsequent years (2000-03). A higher proportion of chemicals in total cost is because of higher application of pesticides in an early adopting district like Kurukshetra. Again, decline in macro- and micro-nutrient status of soil has led to increase in cost of production, as farmers have to apply higher doses of fertilizers. The ramifications of such resource degradation go beyond the agricultural system. The degradation of physical health and plant nutrient status of soil has reduced potable quality of ground water. Similarly depletion of ground water resources and introduction of submersible technology has not only threatened the ground water aquifer but have also introduced a new source of inequity in the rural areas of the semi-arid region.

The disturbing trend in agricultural productivity owes it to various biotic and abiotic stresses; often said to be aggravated by policy variables. Present study assesses various technological and policy options for reversing the unsustainable trend in the Northwest India. Technological options can be segregated in alternate land utilization and farm practices. Alternate land options are suggested to minimize negative externalities of the existing rice-wheat crop enterprises; there is limited possibility of diversification towards fruits and agro-forestry on large farms and vegetables on small farms. This, however, requires adequate infrastructure in the form of sufficient storage and processing capacities. There is need to develop suitable technologies / varieties. Field visits to area suggest that short durational pulse varieties which can be adjusted in between wheat and rice crops is an example. Farmers across all size groups are willing to adopt it.

Alternate farm practices considered in the present analysis are the practices that have potential to reduce the negative externalities of intensive agriculture. In this context several agricultural practices like organic farming, based on the wisdom of the conventional agricultural practices are often suggested but yield at least in short-run are relatively lower and farmers generally prioritize their short-term interest over the long-term goal. A compromise between intensive use of chemicals and traditional agricultural practices is available in the form of integrated pest management, integrated nutrient managements etc. These practices are reported to have increased agricultural production and simultaneously reduce negative externalities otherwise associated with the biochemical technology.

In the era of liberalization price rationalization is often argued as panacea for many ills that Indian agriculture is plagued with. This presumes that existing market prices are distorted and the farm input and output prices need to be aligned with the shadow prices of the commodities. The shadow prices for tradable farm outputs and inputs are close to world prices; and effective trade liberalization tends to equalize domestic market prices with the world prices. This is already reflected with the decreasing protection to agricultural commodities. This process is on for most of the tradable farm inputs except urea. Prices of most of the fertilizers except urea in actual have been integrated with the international prices.

In non-tradable farm inputs, rationalization of prices should reflect cost of production of these inputs. The power tariff for agriculture in most of the states is not related to the actual cost of power; whereas, a consensus amongst the state Chief Ministers that power tariff in no case can be less than 50 per cent of the cost of power produced in the state was arrived in the year 1996. This appears quite sensible as it reflects scarcity of resources and also discount for inefficiency in the production, transmission and distribution of state monopolies and similar public good delivery system. About canal irrigation pricing Vaidyanathan Committee suggests that price of canal irrigation should vary across crops, ranging from a minimum of 5 percent of gross output for cereals to a maximum of 12 percent for commercial crops.

The present study attempts to evaluate impact of alternate price policies and farm practices by adopting the farming system approach. The farm-level impacts has been studied in a linear programming framework by ascertaining changes in the level of various activities with the changes in output and input prices (alternate price policy), and input-output coefficients (alternate farm practices). Impact of alternate price policies and technological options on sustainable agricultural development of the region has been assessed in a farming system framework with different farm level indicators that explain economic, ecological and social environment.

These indicators are farm return, variability in return, variable cost, amount of irrigation water, amount of synthetic farm inputs (chemical fertilizers, plant protection chemicals), amount of crop and livestock residues for fuel and fodder, aggregate employment and distribution of employment. Analysis of these indicators suggest that some crops, like, basmati rice, even though highly profitable are not being cultivated by farmers as returns were highly unstable. The unstable return was on account of various institutional and technological factors. Similarly crops like sugarcane, very sound on the basis of economic parameters, can be cultivated on a limited scale depending on the availability of sugar mills and its crushing capacity. Such institutional and infrastructure bottlenecks restrict cultivation of many commercial crops to its optimal level. The ecological consideration is also important for evaluating a crop; for example, sugarcane a highly water intensive crop could only be recommended hesitatingly in the semi-arid region of the country. Information on the above indicators and questions related to resource allocation pattern pertains to the survey year (2000-01).

In a multi-objective programming framework the changes in these indicators over the existing situation has been assigned a score in scales from 1 to 10. Alternate situation was intended to be discussed on the basis of the weighted scores for individual situation, but could not be pursued beyond a limit. The Economically-Ecologically-Efficient or E-E-Efficient plans presents crop combinations when farmers are trying to use their resources optimally on the basis of two economic criteria, that is, maximization of gross margin (return) and parameterization of negative deviation from mean (risk). The E-E-Efficient plans have been derived for three situations, termed as E-E-Efficient plan-I to III with an average synthetic farm of 2.7 hectare.

In E-Efficient-I plan, resources are used optimally with the existing enterprise-mixes, input and output prices are the average prices as prevailed during the last three years of survey. Availability of resources and resource utilization pattern varies across different sizes of farm. Certain land-based technological options are evaluated for its usefulness on different synthetic farms, large (7.30 hectare), medium (2.60 hectare) and small (1.14 hectare).

Possibility of alternate land-based technological options and technical information about it is collated during the field visit. This suggests incorporation of pulses between wheat and paddy crop rotation; a complete annual cycle of vegetables, fruits (*kinnow,* a citrus fruit), agro-forestry (eucalyptus, papular, *subabul* / acacia).

In E-Efficient-II plan, resources are used optimally with the existing enterprise-mixes, while input and output prices are rationalized. World price would reflect shadow prices of tradable farm input and outputs while prices of non-tradable input would be reflected in the scarcity of said resources. Several Expert group / commissions and committees have opined about prices of non-tradable farm inputs like canal irrigation water, power tariff for its use in agriculture.

In E-Efficient-III plan, resources are used optimally with the existing enterprise-mixes and average prices. The existing non-land based resource utilization alternately farm practices is being altered. Such alteration incorporates conjunctive use of synthetic and organic chemicals as in integrated pest and nutrient management (IPM and INM) practices.

In the study area existing crop enterprise-mix is dominated by paddy and wheat crops, in this regard there is not much difference across farms. The next most important crop rotation in the study area is fodder consisting of jowar (*chari*) and berseem crops. A trend across farm sizes is visible; share of fodder in total cropped area decreases with increase in farm size. This indicates that intensity of livestock is more on small farm. Similar trend across farm size is apparent in vegetables and agro-forestry; vegetable on commercial scale is cultivated on selected small farms; whereas, agro-forestry is being practiced on large farm. These crops unlike paddy, wheat and fodders are cultivated on selected farms; therefore, proportion of these crops in synthetic farms is extremely low.

The linear programming based optimization leads to specialization in favour of certain crops like sugarcane, wheat-paddy and potato-based crop rotations (maize-potato-sunflower/ rapeseed). Vegetable- and fodder-based crop rotation has been very profitable on small farms due to regular supply of labour. The optimal levels of the above profitable crops are restricted on account of market-related constraints. This constraint varies from lack of sufficient storage facility in potato to dearth of sufficient processing facility in sugarcane and inadequate road/ transport to connect it to distant urban places in vegetables. Apart from infrastructure, resource-based constraints are already there; the present study presumes that any optimal plan must not consume water more than the existing plan. Sugarcane like paddy and wheat is also a water intensive crop and this involves maximum constraint on this account as well. If we impose maximum constraints on above technological options, there is not much scope for improving existing land utilization pattern on an average farm.

The difference between highly specialized enterprise mix and the one obtained after imposing maximum constraints suggests losses on an average farm due to institutional and infrastructure constraints in the region. On an average farm of 2.7 hectare, there has been considerable amount of return foregone (more than 14 percent) on account of infrastructure, institution, and resource constraints. Rationalization of farm input and output prices has resulted in decrease in area under paddy and wheat crops and increase in area under maize- and potato-based crop rotation. All these have resulted in loss of farm return (more than 10 per cent), a high cost agriculture; though, there is significant respite on account of use of natural resource especially water. Since rationalization has squeezed farmers' return; there are less chances of it getting adopted by farmers. Too much of emphasis on price or market-based instruments has not worked in the present evaluation. The above scheme needs to be supplemented with alteration of technology. In the study area IPM and INMS appears to be an important option to counter the existing stress on natural resources. In the E-Efficient plan III paddy and wheat regained its status; maize-potato-mustard emerged as another important crop rotation. As a result of adoption of improved farm practices farm return in E-E-plan III has increased considerably over the E-E-plan II.

In the era of globalization, it is trendy to highlight role of price-corrections in increasing growth; the present analysis however suggests that merely rationalization of price would not lead to a sustained growth in agriculture. The sustained growth in fact requires suitable technology, adequate infrastructure facilities, and a set of institutions. Institution not only in the sense of aggregator or facilitator primarily to stem out problems associated with the small and scattered production but also in the form of interventionist policies like limiting the use of groundwater aquifer. Since factors influencing future agricultural growth vary across regions the present study may promote similar studies for other parts of the country and would help in long-term evaluation of an agricultural policy. Such evaluation study would generate evidences on role of alternate policy instruments: price, technology and institution in sustainable agricultural development of a region.

Annexure

Description of Study Area

The Northwest India: Haryana, Kurukshetra

The Northwest India referred here is the trans-gangetic agro-climatic region comprising the states of Haryana, Punjab and the selected districts of Uttar Pradesh. The region has been in the forefront of commercialized agriculture. The nature and quality of data often varies across states, therefore, one state Haryana has been selected purposively. Though the state is known for its progressive agriculture, statistics related to agricultural development of the state is not uniform across the districts. Generally districts in the eastern part of the state are more progressive than the districts in the western part of the state. Again the progressiveness of districts increases as one moves from South to North Haryana. A background information on the status of agriculture and natural resources in the state is presented below. The discussion in the present chapter frequently refers to Haryana and two districts Kurukshetra, Mahendragarh located in the Northern and Southern part of Haryana respectively to understand agriculture and rural development in the state.

Area and Population

In Haryana economic development is associated with high population density and increased urbanization, a higher estimate for these parameters in the Kurukshetra as compared to the Mohindergarh district is obvious; while Haryana presents average situation in the state. Though Kurukshetra is more urbanized than Mohindergarh; proportion of people dependent on agriculture was more in the Kurukshetra. In the year 1990-91, cultivators and agricultural labour together, account for around 60 per cent of total workers in the Kurukshetra district; the corresponding figure decreased to 46 percent in the year 2000-01, suggesting larger employment diversification in the district. Whereas in Mohindergarh proportion of worker dependent on agriculture has increased substantially from less than 50 percent to almost 66 percent. The proportion of literates were similar in both the districts, temporal trends in literacy was also similar during the reference period. This to some extent reflects lower importance of literacy in the rural development of Haryana.

Soil, Climate, Rainfall and Ground Water

The climate of the state is very pronounced, hot in summer, temperature ranges from 43* to 21.5*c in June) and markedly cold in winter, temperature ranging from 22* to 4*C in January. Though average rainfall of the state is 77 cm, this varies from 148 cm in Punchkula district to 36 cm in the Sirsa district. The average rainfall in Kurukshetra and Mahendragarh districts were 79 and 64 cm respectively. Though more than 80 per cent of the rainfall is received from the South-west monsoon between June and September; the winter rains are important as they affect prospects of rabi harvest.

Haryana is almost enclosed with the rivers like Yamuna and Sutlej. The state is benefited with the canals emanating from these rivers namely Western Yamuna canals and Sutlej canal. A small part of the state, in Hisar and Sirsa district has also been benefited with the Indira Gandhi Canal. Off late ground water has been considered as a reliable source of irrigating the crops. Private investment in tube-well irrigation also increased especially in the areas where irrigation quality of ground water was not bad. The quantity and quality of ground water in recent years has therefore emerged as the most important constraints on agricultural development of the region. The quality of water in the southern and western part of the state is saline whereas, in the Northern Haryana bulk of water is not saline and in such regions decline in ground water table have been the major concern. An attempt has been made herewith to study changes in behavior of groundwater balance at the level of the block (Anx Table 2). This has been studied for the decade of the nineties; ground water balance at the block level is not available for many years.

Land Use, Crops and Intensity of Agriculture

In Haryana and the selected districts more than 80 per cent of geographical area are under plough indicating importance of agriculture for the state. The general concern about decline in the forest area was found true in the state as well. The permanent pastures and other grazing land has also declined significantly in the State and the Kurukshetra district, this decline was however not significant in the Mohindergarh district. The permanent pastures and grazing lands are often 'common lands' and its ownership is with the panchayats. Such common lands in Kurukshetra have been converted to agricultural land and are available to villagers for cultivation at an annual rent. As a result percent area under pastures and grazing land is less in Kurukshetra. This is an instance how high opportunity cost of land is leading to shrinkage of village commons.

A greater emphasis has been provided to strengthen canal irrigation system in Haryana; as a result, percent of area irrigated increased steadily. Off late tubewell was perceived as a more reliable source of irrigation and this was emphasized; though at an individual farmers level. On an average one tube well is there for around 6.2 hectare of land in the state, the average figure is as low as 4 in Kurukshetra while 7.5 in Mohindergarh district. One may note that average rainfall in Mohindergarh was less than 70 cms as compared to 93 cms, in the Kurukshetra district and even the existing intensity of tubewell is beyond its existing carrying capacity as a consequence groundwater table is decreasing consistently. Assured irrigation has led to adoption of HYVs; these are fertilizer responsive as is apparent with the increase in per hectare consumption of fertilizers. The HYVs are short durational crops; this has contributed to increase of cropping intensity. All these have encouraged mechanization of farm. There has been a steady decline in the net area cultivated per tractor in the state and the selected districts. Most of the above figures suggest that Kurukshetra is in the forefront of adoption of bio-chemical technology in Haryana. While Mohindergarh, a water scarce district presents a below-average case in relation to adoption of intensive agriculture.

The cropping pattern in Haryana and selected districts has already been discussed. In order to recapitulate area under fine cereals and oilseeds has increased; while, area under coarse cereals and pulses has declined in the recent decade. There has been marginal change in area under commercial crops. The overall trends at the state level percolates down to that district level depending on the natural resource endowment of the region. In Kurukshetra there was increase in area is under fine cereals and marginal increase in area under oilseeds where sunflower was replacing late sown wheat to some extent; this process was however constrained. In Mohindergarh there was limited scope of increasing area under wheat, area under oilseeds has increased significantly. There is not much scope for increasing area under commercial crops such as sugar cane and potato. Area under sugar cane is dependent on sugar processing facilities in the region. The soils of the Kurukshetra district are suitable for potato, this district accounts for more than one-third of the potato area; further increase in acreage is constrained by dearth of storage facility. The changes in cropping pattern by and large reflect price policy; the local resources and constraints have also greatly influenced these pattern.

An inequitable distribution of land and consequent concentration of economic power is also reported to have effect on the adoption of agricultural technology and particular cropping pattern. Such effects are less reported from the state. The land distribution in the state is less inequitable as compared to the other states of the country. The marginal and small farmers together account for more than 82 per cent of total land holdings in the state, while their share in total operated area of the country / state / district has been less than 40 percent. The situation is alike in both the selected districts of the state.

Livestock Resources

The state occupies a very prominent place in the country for its bovine wealth. Two famous breeds namely, Haryana cows and Murrah buffaloes have their home tract in the state. The information regarding bovine population and infrastructure associated with the dairying for the state and the selected districts have been presented in the Anx Table 6. A perusal of table reveals that buffalo population predominates total bovine population in the state. According to the Livestock Census 1997, population density of cattle *vis-a-vis* buffalo is higher in the progressive districts like

Kurukshetra as compared to the less progressive district like Mohindergarh. The structural change in the stock of milch cows in favor of increased cross-bred stocks as well as changes in the dairy farming practices accounted for the increased production and supply of milk over the years.The establishment of veterinary institutions is important considering its role in providing breeding and health cover facilities for increased milk production. Both the districts appear to be well endowed with the veterinary institution, though in Mohindergarh stockmen centers appears to be less as compared to the state average. The status of dairy cooperatives in the chosen districts is at the extremes the Kurukshetra district has a good number of cooperative societies and members in these societies while these parameters have been less in the Mohindergarh district.

Infrastructure, Institutions and other Development

Some key facilities, which encourage agricultural production and prosperity of the region are transportation, storage, marketing and financial facilities. The extent of electrification, though not an indicator of the quantity and quality of electricity available to the farmers, is important for efficient production of agriculture and other development of rural sector. The state has a good network of road, almost all villages in the state are connected with all-season road. With the advent of new technology, agriculture and animal husbandry practices have become capital intensive. To cater to the increased demand for credit the study area has different financial institutions. The concentration of these institutions is better than many other regions of the country. Yet, farmers are highly dependent on *Arhat* (middle men) for credit.

Though cooperatives and regulated markets co-exist, farmers have to depend more on the regulated market. In the state as a whole an average of 64 villages depend on regulated markets, the corresponding figure is 56 for the Kurukshetra and as high as 91 for the Mohindergarh district. It is important to note that around 30 per cent of the aggregate storage capacity is in the Kurukshetra district; yet, area under potato could not be increased because of paucity of cold storage facilities in the district. This highlights inadequacy of existing storage facilities in the state. This has emerged as a major bottleneck in our efforts to diversify agriculture in the region. The growth in crop production also triggers development of related activities like dairy and other economic activities. In relation to dairy development indictors Kurukshetra is ahead of Mohindergarh; though Government support in the form of infrastructure and institutional facilities for dairy is similar in both the districts.

It appears from the above discussion that as per natural resource endowments are concerned there have been extreme situations in a small state like Haryana. Farmers in the resource dis-advantaged region are also moving towards a production possibility curve that is similar to a resource advantaged region as that of Kurukshetra. Farmers of the region are also responsive to the Governments price policy, which is evident with the periodic shift in area under certain crops. The present study to evaluate options for sustainable agricultural development has therefore been specific to Kurukshetra. The resource endowments to large extent influence profitability of crop production in the region. The intensity of crop production depending on the status of natural resource in a region often leads to several second-generation problems.

Anx Table 3: Distribution of Districts on the basis of Cropping Intensity (%)

Cropping Intensity	Districts
More than 180 per cent	Bhiwani (183.9), Fatehabad (191.4), Hissar (181.6), Kaithal (187.3), Karnal (182.1), Kurukshetra (190.5), Panipat (188.8)
Less than 180 per cent	Ambala (167.5), Faridabad (167.7), Gurgaon (167.9), Jhajjar (154.9), Jind (176.2), Mohindergarh (179.9), Panchkula (145.4), Rewari (159.2), Rohtak (153.2), Sirsa (169.0), Sonepat (174.7), Yamunanagar (158.9)

Anx Table 6: Selected indicators of Dairy Development in Haryana and the selected districts (2003-04)

Sl. No.	Particulars	Kurukshetra district	Mohindergarh district	Haryana
1.	Buffaloes per cattle population	3.19	7.13	3.92
2.	Density of bovine per sq km	234	135	172
3.	Annual milk production (000' M.T.)			5220 1
4	Percapita Availability of Milk (gms/day)			660
	a) Number of producers' Co-operative Society	229	7	3782
	b) Number of members for Dairy Co-operative Society (000')	13	1	229
6.	Veterinary Institutions (No.)			
	a) Civil Veterinary Hospitals	30	26	621
	b) Stockmen centres	42	16	748

Source: Statistical Abstract of Haryana (2004-2005)

Anx Table 7. Some Indicators of Infrastructure Facilities in the Selected Districts of Haryana (2004-05)

Sl. No.	Particulars	Kurukshetra district	Mohindergarh district	Haryana state
	Average number of villages served per regulated market	58	92	64
	Cooperative Marketing Societies (no)	5	4	77
	Cold storage capacity (000' tons)	80	--	267
	Financial Institutions			
	(a) Primary agricultural credit societies (No.)	111	94	2,435
	(b) Primary land development banks (No.)	4	5	86
	(c) Number of scheduled commercial banks	59	49	1,668
	(d) Credit deposit ratio (01-03-2005)	64.3	41.9	51.9

Source: Road (100%) Electricity (--%) Statistical Abstract of Haryana (2004-2005)

Anx Table 1 A Temporal and Spatial Comparison of Demographic Features in Selected Districts and Haryana

S.N.	Particulars	Kurukshetra district		Mohindergarh district		Haryana State	
		1990-91	2000-01	1990-91	2000-01	1990-91	2000-01
1.	Average Rainfall (mm)	792		638		768	
2.	Density of population (per sq km)	527	540	405	428	372	478
3.	Percentage of rural population to total	75.99	73.89	87.59	86.51	75.37	71.10
4.	Literates to total population (%)	58.78	69.88	57.87	69.89	55.85	67.91
5.	Total main workers (in 000')	179.7		172.6		4717.7	
a)	Cultivators (%)	31.82	23.70	40.08	54.70	35.85	36.03
b)	Agricultural labourers (%)	26.97	22.70	8.45	11.01	17.57	15.30
c)	Other workers (%)	41.21	53.57	51.47	34.20	46.58	48.71
6.	Main workers to total population (%)	28.00	37.36	25.31	43.31	28.66	39.62

Source: Statistical Abstract of Haryana (2004-2005)

Anx. Table 4: A Temporal Comparison of Major Indicators of Agricultural Development in Haryana and the Selected Districts

S. N.	Particulars	Kurukshetra district			Mohindergarh district			Haryana state		
		1972-73	1985-86	2000-01	1972-73	1985-86	2000-01	1972-73	1985-86	2000-01
1.	Percentage of net sown area irrigated	77.2	94.3	100	10.8	26.5	68.2	43.9	62.2	78.3
2.	Net sown area irrigated per tubewell (in ha.)	9.4	4.0	4.1	22.2	6.8	7.5	23.9	8.7	6.2
3	Fertilizer consumption per cropped area (in kg)	87.11		232.4	4.24		105.52	18.10		142.69
4	Area under fine cereals (in %)	62.81		78.02	12.36		16.25	30.11		51.80
5	Area under oilseeds (in %)	1.66		4.61	7.12		27.44	4.28		8.32
6	Cropping Intensity (%)	153	168	191	159	163	180	142	155	174
7	Net sown area per tractor (ha)	104.0	30.4	12.6	614.9	111.2	41.8	183.7	43.5	18.9

Source: Statistical Abstract of Haryana (1973-74, 1986-87, 1999-2000)

Anx Table 2: Comparison of Groundwater balance in the Selected Districts

District/Block	Utilisable Resource (MCM)			Net Draft (MCM)			Stage of Development (%)		
	1990	1993	1997	1990	1993	1997	1990	1993	1997
KURUKSHETRA									
Ladwa	44	55	43	140	94	97	318	172	246
Pehowa	46	182	224	172	185	199	373	102	96
Shahabad	73	57	64	146	142	86	200	250	146
Thanesar	102	78	89	181	150	163	178	193	198
Kurukshetra (agg.)	265	372	419	639	571	545	241	154	141
REWARI									
Bawal	n.a	51	41	n.a	43	47	n.a	83	126
Jatusana	n.a	43	46	n.a	54	55	n.a	127	131
Khol	n.a	45	45	n.a	51	53	n.a	114	127
Nahar	n.a	28	50	n.a	44	43	n.a	156	92
Rewari	n.a	41	57	n.a	50	53	n.a	122	101
Rewari (agg.)	n.a	208	238	n.a	241	251	n.a	116	114

Note: (n.a) implies that the data were not available for the respective years

Anx Table 5: Distribution of Operational Holdings According to Size in Haryana and the Selected Districts (1995-96 / 2000-1)

Holding Categories with size (in hectares)	Kurukshetra district		Mohindergarh district		Haryana state		All India 2000-01	
	Holdings (%)	Operated Area (%)	Holdings (%)	Operated Area (%)	Holdings (%)	Operated Area (%)	Holdings (%)	Operated Area (%)
Marginal (<1.0)	42.09	7.86	46.43	9.77	47.14	11.00	63.01	18.82
Small (1.0–2.0)	19.42	12.55	19.74	13.05	19.59	12.87	18.9	20.18
Semi-medium (2.0–4.0)	21.54	26.68	18.66	23.75	19.01	24.91	11.7	23.96
Medium (4.0–10.0)	14.73	36.27	12.58	34.59	11.94	33.26	5.4	23.84
Large (>10)	2.23	16.65	2.59	18.84	2.32	17.97	1.02	13.21
No. of holdings and area in '000	66.67	141.39	72.58	156.98	1,727.99	3,675.73	120822.00	159903.00
Average size of holding		2.12		2.16		2.13		1.32

Note: Figures in parentheses indicate percentage to total numbers/area as in the row six of the table
Source: Statistical Abstract of Haryana (1999-2000)

References

Acharya S.S. (1997) “Agricultural Price Policy and Development: Some facts and Emerging issues” Indian Jl. of Agricultural Economics, Vol.52, No.1

Acharya S. S. (2000) “Domestic Agricultural Marketing Policies, Incentives and Integration” in Acharya S.S. and Chaudhary D.P. (edited) *Indian Agricultural Policy at the Crossroads,* published by the Rawat Publications, Jaipur and New Delhi.

Acharya S. S. (2005) “Agricultural Marketing and Rural Credit: A Policy Paper for Strengthening Indian Agriculture” presented in an ADB-sponsored Seminar on Agriculture, Food Security and Rural Development in New Delhi during November 2005.

Arrow, K., B. Bolin, R. Costanza, P. Dasgupta, C. Folke, C. S. Holling, B.-O. Jansson, S. Levin, K.-G. Maler, C. Perrings and D. Pimentel (1995) “Economic Growth, Carrying capacity and the Environment” *Science* 268: 520-521

Caves D. W., L. R. Christeensen, and W. E. Diewert (1982), “The Economic Theory of Index numbers and the Measurement of Input, Output and Productivity”, *Econometrica*, Vol. 50, No. 6, pp. 1393-1414.

Chopra K. and G.K. Kadekodi (1998) "Price and Non-Price Response in Agriculture: An Ecological Model of a Region in India." *Indian Jl. Of Agric. Econ*. 53(4): 577-599.

Christeensen. L. R. (1975), “Concept and Measurement of Agricultural Productivity”, *American Journal of Agricultural Economics*, Vol. 57, No. 5, December, pp. 910-915.

Conway G. R. (1985) “Agro-ecosystems Analysis” *Agricultural Administration*, Vol. 20, pp 31-55

Cuddy and Della V. (1978) Measuring the instability of time series data. *Oxford Bulletin of Economics and Statistics*, February 1978.

Daly, Herman (1980) “The steady State Economy: Towards a Political Economy of Biophysiscal Equilibrium and Moral Growth.” in Herman Daly (Ed.) Economics, Ecology, Etics: Essays Towards a Steady-State Economy, Freeman and Co., New York.

Daly H. (1991) “Sustainable Development: from concepts and theory towards operational principles” In: Steady –state Economics (2nd Edition0 Island Press, Washington D.C.

Dandekar V.M. (1980) Introduction to the seminar on Measuring Agricultural Growth, *Indian Jl. of Agricultural Economics* Vol. 35 No. 2 pp 1-12.

Fertilizer Statistics, a year Book published from Fertilizer Association of India, New Delhi.

Forward Markets Commission (2006) http://www.fmc.gov.in accessed on September 10, 2007

Freund, J.R. (1956) "The Introduction of Risk into a Programming Model." *Econometrica*, Vol. 21, pp 253-263.

Government of India, "*Report of the Commission on Agricultural Cost and Prices*, Ministry of Agriculture, New Delhi. (Various issues).

Hassan R., D. Greenaway and G.V. Reed (1992) "Nominal and Effective Protection in the Egyptian Agriculture Sector: A Multi-commodity Analysis." Applied Economics, Vol. 24, pp 473-482.

Hazell P.B.R. (1971) "A Linear Alternative to Quadratic and Semi-variance Programming for Farm Planning under Uncertainty." *American Jl. of Agricultural Economics*, Vol. 53, pp 53-62.

Jha B. (1995) "Growth and Instability in Agriculture Associated with New Technology: District Level Evidences" Agricultural Situation in India, Vol. 49, No.7

Jha B. (1996) "Market Induced Risk in the Greenbelt Farms of India." Journal of Rural Development, Vol. 14, No. 3

Jha Brajesh (1995) "The Trade-off between Return and Risk in Farm Planning, MOTAD and Target MOTAD Approach." *Indian Jl. of Agricultural Economics*, Vol 50, No 2, pp 193-199.

Jha B. (1999) "Towards Globalising Indian Dairy Sector" Business Standard, Nov.15, 1999.

Jha Brajesh (2000) "Implications of Intensive Agriculture on Soil and Groundwater Resources." *Indian Jl. of Agricultural Economics*, Vol 55, No 2, 182-193.

Jha Brajesh (2000) *Indian Agriculture and the Multilateral Trading System*, a book published from Bookwell, New Delhi.

Jha Brajesh (2002) Implications of Liberalisation on Sustainable Agricultural Development: A Case Study of the Northwest India, interim report submitted to Indira Gandhi Institute of Development Research, Mumbai.

Jha B. and B. B. Mohapatra (2003) "*Liberalisation and Agricultural Prices: Some Disconcerting Trends"* Indian Jl. of Agricultural Economics, Vol. 58, N0, 3, pp. 375-386.

Malik R.P.S. (1994) "Public Policy and Sustainable Agricultural Development: A natural resource accounting approach." *Indian Jl. of Agricultural Economics*, Vol 49, No. 4.

Minhas B.S. (1966) "Rapporteur's report on Measurement of Agricultural Growth" *Indian Jl. of Agricultural Economics* Vol. 21 No. 4 pp ---

Morrison J. and Pearce R. (2000) "Interrelationships between Economic Policy and Agri-environment Indicators: an investigative framework with examples from South Africa" Ecological Economics Vol 34 pp 363-377

Munasinghe, M., and Cruz W. (1994) Economy-wide Policies and the Environment, World Bank, Washington DC

Nadkarni M.V. (1993) "Sustainable Development: Concept and Issues with Special Reference to Agriculture", Indian Jl. of Agricultural Economics, Vol. 48, No.3, pp 516-526

National Centre for Integrated Pest Management (ICAR): Some bulletins on intergrated pest management practices for specific crops, published from NCIPM, also Annual Report of NCIPM Pusa, New Delhi

OECD (1999) Environmental Indicators for Agriculture: Concepts and Framework, Vol. 1, OECD, Paris

Pant K.P. and V.K. Pandey (1999) "Minimizing Environmental Problems in Hill Agriculture of Nepal through Multi-objective Farm Planning." *Indian Jl. of Agricultural Economics*, Vol 54, No. 1, pp 79-92.

Parikh J., R. Ramanathan, J. P. Painuly (199-) "Energy, Agriculture and Environmental Interactions: The Case of Rural India" in Parikh (edited) Energy Models for 2000 and Beyond, Tata MacGrawhill Publisher, New Delhi, India.

Parikh, K.S., N.S.S. Narayna, Manoj Panda and A. Ganesh Kumar (1995) "Strategies for Agricultural Liberalisation: Consequences for Growth, Welfare and Distribution." *Economic and Political Weekly*, Vol. 30, No. 39.

Paroda, R.S. (1996) "Sustaining the Green Revolution: New Paradigm." in B.P. Pal commemoration lecture in *2nd International Crop Science Congress*, November 22, 1996, New Delhi.

Pearce D.,Hamilton K., and G. Atkinson (1996) "Measuring Sustainable Development: Progress on Indicators" *Environment and Development Economics* Vol. 1, pp 85-101

Praduman K. and Mark W Rosegrant (1994), "Productivity and Sources of Growth for Rice in India", *Economic and Political Weekly*, Vol.29 No.53 pp. A-183-A-188.

Praduman K. and Mruthyunjaya (1992), "Measurement and Analysis of Total Factor Productivity Growth in Wheat", *Indian Journal of Agricultural Economics*, Vol.47 No.3 pp.451-458.

Ramarao C.A., M. Srinivasa Rao, and Y. V. R. Reddy (2007) *An Economic Analysis of Adoption of Integrated Pest Management in Cotton, Groundnut, Pigeonpea,* an unpublished report submitted to Indian Council of Agricultural Research (ICAR), New Delhi.

Romero C., and Rehman T. (1985) "Goal Programming and Multiple Criteria Decision Making in Farm Planning: Some Extension." *Jl. of Agricultural Economics*, Vol. 36, pp 171-178.

Romero C., and Rehman T. (1989) "Multiple Criteria Analysis for Agricultural Decision" *Elsevier Publishing Co*. Amsterdam.

Samuelson P. and Swamy, S. (1974) "Invariant Economic Index Numbers and Canonical Duality: Survey and Synthesis" *American Economic Review,* Vol. 64, pp 566-93.

Scandizzo PL and Coline Bruce (1980) "Methodologies for Measuring Agricultural Price Intervention Effects." *World Bank Staff Working Paper no. 394.*

Singh R.P., J.P. Painuly, J. Parikh and Chandra Sen (1992) "Rural Energy and Agricultural Interactions in 2000 AD: A Study of Uttar Pradesh." *Indian Jl. of Agricultural Economics*, Vol 47, No. 4, pp 601-617.

Taylor E. J. and Antonio Yunez-Naude (1999) “Agricultural Policy and the Village Economy: A Computable General Equilibrium Analysis” in Roger Rose, Carolyn Janner and MargretA. Bellary edited Issues in Agricultural Competitivemess: Markets and Policies; International Association of Agricultural Economists, Occasional Paper No. 7.

Tisdel, C. (1988) “Sustainable Development: Different Perspectives of Ecologists and Economists and Relevance to the LDCs”, *World Development*, Vol. 16, No.3, March, pp 373-384.

Vaidyanathan A. (1992) Report of the Committee on Pricing of Irrigation Water, Planning Commission, Government of India, New Delhi

Victor P. A. (1991) “Indicators of Sustainable Development: Some Lessons from Capital Theory” *Ecological Economics*, Vol. 4, 191-213.

World Bank (1997) “India, the Indian Oilseed Complex: Capturing Market opportunities” Report No. 15677-IN, Rural Development Sector Unit, South Asia Region, World Bank, New Delhi.

World Commission on Environment and Development (WCED) (1987), Our Common Future, Oxford University Press, London.

—

End Notes

[1] The World Bank (1997) suggests that country can efficiently produce a large number of agricultural commodities; the efficiency, however, reduces in the post harvest operations (World Bank 1997).

[2] Any encouragement to water-intensive crop may be a constraint on the depleting groundwater resource base of the semi-arid region of the country; this may not be true for the humid regions of the country.

[3] The selected WTO member countries using Article XVIIIB to protect domestic market were India, Pakistan, Srilanka, Bangladesh, Turkey, Nigeria, Philippines

[4] Some of the generally reported maladies in the functioning of regulated market are: lack of regular election to market committee so that bureaucrats can dominate the committee, unannounced restriction on farmers to sell their produce outside market yard.

[5] A uniform floor rate of sales tax has been implemented in majority of the states from January 2000. The four general floor rates are 0, 4, 8 and 12 per cent; whereas, two special floor rates are 1 and 20 per cent for specified category of items.

[6] The MSP is announced for around 24 commodities, these commodities are rice, wheat, coarse cereals, pulses, oilseeds, and some commercial crops. Government also announces statutory minimum prices (SMP) for sugarcane, though its influence on the cane market is not significant as most of the states announce their own state advised prices (SAP) for sugarcane.

[7] The FHP available for the state is the weighted average of the district level farm harvest prices.

[8] The wholesale price indices (WSP) at the country level has been selected purposively instead of the district-level *mandi* prices, as there are problems in dealing with the district level mandi prices. In the district level wholesale markets (*mandies*), prices for a commodity and specific variety were not available for a longer period of time. Often there were changes in the variety of a commodity for which price is available during a year. The country level WSP is arrived by evening out these discrepancies; this has therefore been chosen for the present analysis.

[9] Price of basmati rice is many- fold higher than the non-basmati rice. There is similar disparity between other varieties of rice; and weighted average at the state level is arrived from these prices.

[10] Commercialization of agriculture here means farmers are more dependent on market for purchase of agri-inputs and disposal of farm-outputs. Present study considers commercialization as an important indicator for selection of study area as markets in this situation will be robust and effect of liberalisation on the market prices can be studied in a better way.

[11] The "open market sale" policy of Food Corporation of India is especially targeted to reduce price disparity in producing and consuming states.

[12] In cotton prices of *desi* and hybrid cottons are different. Similarly the actual price received by farmers for different varieties of paddy is significantly different. The FHP as reported in the Ministry of Agriculture publication is the weighted average of prices, for different varieties of paddy, as received by farmers in that state.

[13] Jha *etal* (2003) worked out correlation coefficients in farm harvest prices for paddy, wheat, maize, gram, rapeseed and mustard. The correlation coefficients in FHP were between Haryana / Punjab and remaining states of the country for the 1980s, and 1990s. The strength of association was very high for wheat, followed by maize, rice, gram, rapeseed and mustard.

[14] The comparable world and domestic prices are not available for many commodities; there are in fact, four commodities, which are important for the region and comparable world prices are also available.

[15] It may be noted that in rice and cotton India is net exportable, in maize the country is net importable, whereas in wheat we occasionally exports and imports as well.

[16] The Wholesale Price Indices published by Ministry of Industry is the weighted average of prices in the wholesale markets of the country.

[17] As a consequence of these measures, relative price of nutrients was disturbed so much so as to cause a serious imbalance in nutrient consumption (N:P:K) ratio. The nutrient imbalances affect soil health adversely; this has even larger ramifications for natural resources, plant and animal health.

[18] The urea industry is highly cost- heterogeneous depending on the feed stocks used for its manufacture. The cost-heterogeneity can be understood from the fact that cost of production of gas-based urea plant is less than half of the cost of production of naptha and fuel-based plants.

[19] The gross receipts per hectare of area irrigated by major and medium project are barely 2 per cent of the estimated gross output per hectare of irrigated area.

[20] The market prices of a large number of commodities are influenced by the administered prices; the changes in administered prices are often affected by some macro policy goals, which change frequently. The increase in prices of oilseeds to achieve self-sufficiency in edible-oils in the mid-80s is an example, similar increase was not pursued in the '90s.

[21] Partial productivity measures productivity with respect to a single variable; whereas, total factor productivity measures productivity with respect to a set of variables.

[22] It is important to note that productivity of basmati is less than half of the non-basmati or high-yielding dwarf varieties of paddy

[23] In fact lower productivity of coarse cereals accompanied with an unattractive prices for these coarse cereals had made it less remunerative, though these crops are more resistant to weather fluctuation and requires less water as compared to other crops; these crops therefore find a place in farmers portfolio.

[24] The high instability in return for rice was primarily because of the anomalies related to the quality of the rice and variation in price and yield data in reference to basmati and non-basmati rice.

[25] The value of by-product has not been taken into account, as this constitutes only an insignificant proportion of total revenue. Again absolute quantities of byproduct of paddy and wheat and their prices are not available at the aggregate level.

[26] In early '90s administered price of paddy and wheat was increased following an attempt to equate domestic prices with the international price. In late '90s domestic price has fluctuated more because of external reasons (for details see Jha B 2002).

[27] The average yield of basmati paddy is less than half of the non-basmati paddy; with increase in area under basmati average yield of paddy in the state has decreased. This has been used to calculate revenue from paddy and the output indices.

[28] The particular weed in wheat –paddy crop rotation *gullidanda* has developed resistance to most of the widely available (less costly) pesticides. The weedicides such as *topic, leader* (trade names) which are effective against particular weed, are very costly. The operational cost components of wheat also indicates that in Kurukshetra proportion of pesticides in total cost was more than double of the Mohindergarh district; increase in absolute terms will be even higher since cost of cultivation in the latter district is significantly lower than the earlier district (details see Jha B 2002)

[29] The number of soil samples tested for macro- and micro-nutrients were not same.

[30] Bovine population decreased between 1992 and 2003; pattern of decline is interesting, population of cattle especially indigenous cattle has decreased while that of buffalo has increased during the same period (for details see Jha 2004).

[31] Field-level visits suggest that cooking gas are available in many villages; yet farm-family prefer to boil their milk with dung cake only. The cow dung cake is used wherever release of slow energy for a long-time is desired for example heating room during winter days.

[32] Return to farm family is the gross return minus the explicit cost; the explicit costs here are the costs incurred in obtaining farm inputs including hired labour. This does not include the imputed value of family labour.

[33] Scarcity of fodder is on account of increasing competition between man and animal for limited land, availability of fodder have also been affected because of decreasing CPRs, quality of dry fodder is reported to have deteriorated because of increased use of pesticides.

[34] The recent NSSO survey results on employment (2004-05) indicate that unemployment on the basis of CDS of employment is almost 8 percent.