INPUT DEMAND AND OUTPUT SUPPLY OF SELECTED CROPS OF VIDARBHA-PROFIT FUNCTION APPROACH

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of

DOCTOR OF PHILOSOPHY
IN
AGRICULTURE
(AGRICULTURAL ECONOMICS)

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2011

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled **"Input demand and output supply of selected crops of Vidarbha – Profit function approach"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organization. The source of material used and all assistance received during the course of investigation have been duly acknowledged.

Thakare

Place: Akola (Sandip Shridhar Thakare)

Date: 13/06/2011 Enrolment No. AA/348

CERTIFICATE

This is to certify that thesis entitled **"INPUT DEMAND AND OUTPUT SUPPLY OF SELECTED CROPS OF VIDARBHA – PROFIT FUNCTION APPROACH"** submitted in partial fulfillment of the requirement for the degree of **"Doctor of Philosophy in Agriculture (Agricultural Economics)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Sandip Shridhar Thakare** under my guidance and supervision.

The subject of the thesis has been approved by the Student's Advisory Committee.

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Date: 13/06/2011

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ACKNOWLEDGEMENT

Words are sufficient to express the emotions and there of my acknowledgement are many times more than what I am expressing.

I am very happy to have an opportunity to express sincere gratitude and indebtedness to the chairman of advisory committee Dr. N. V. Shende, M.Sc. (Agri.), Ph.D., Associate Professor, Department of Agricultural Economics and Statistics, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for suggesting a research problem. I am thankful to him for his constant inspiration, valuable guidance, keen interest, parental affection and for painstaking efforts taken for scrutinizing the manuscript and everlasting encouragement during the course of the present investigation. I consider it to be my greatest fortune and an honour to have been given an opportunity to work under him.

Words fall short to express my emotional feelings and affection towards my advisory member Dr. S. J. Kakde, M.Sc. (Agri.), Ph.D., Associate Professor, Department of Agricultural Economics and Statistics, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and Dr. A. S. Tingre, Assistant Professor Department of Agricultural Economics and Statistics, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for their timely suggestion and kind co-operation, constant source of encouragement and help throughout the research work.

I am highly indebted to the member of advisory committee, Shri. R. K. Kolhe, Assistant Professor of Statistics, Department of Agricultural Economics and Statistics, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for their valuable guidance and timely suggestions during the course of present investigation.

I am grateful to express my co-ordinal thanks to the member of my advisory committee, Shri. K. J. Shinde, Assistant Professor of Mathematics, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola for his guidance and kind co-operation during the course of my research work the research work. I am also thankful to Shri. P. D. Thakare and Shri. S. S. Bhoyar J.R.A. Department of Agricultural Economics and Statistics, for Co-operation and encouragement during research work.

I am also thankful to my friends Bavita Nair, Pritesh Tayade, Ujwal Dhakal, Dinesh, Gajendra, Rajendra, Nilima and Bankar Madam for their co-operation, help and support from time to time during course of present study.

I have no words to express my gratitude to my parents for their pathetic efforts, scarifies, encouragement in educating me at the cost of their comfort and consolation. I humbly express deepest sense of my beloved father Shri. Shridhar Thakare and mother Sau. Sunanda Thakare for their love, affection, moral support and blessings without which work would not have been achieved. Whose words are encouragement kept me ahead in my studies and research work.

I am also grateful to my Brother Praful whose well wishes helped me to attain my goal.

Above all I bow my head before God all mightly whose blessings gave me strength to make this a successful venture.

Last, but not least I am greatly thankful to (Parvati Computers) and all whose names are not mentioned but were indirectly associated with my research work.

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A) List of Tables

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D) Abbreviations

(%)	:	Percentage
/	:	per
@	:	At the rate
Agril.	:	Agricultural
APC	:	Agricultural Prices and Costs Scheme
C	:	Total Consumption
CGR (r)	:	Compound Growth Rate
Dr. PDKV, Akola	:	Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
e.g.	:	For example
et al.	:	et alia (and others)
etc.	:	Etcetera
Fig.	:	Figure
FYM	:	Farm Yard Manure
GCA	:	Gross Cropped Area
GR	:	Gross Returns
ha	:	Hectare
i.e.	:	That is
K_2O	:	Potassium
kg	:	kilogram
kg/ha	:	kilogram per hectare
kg/qt.	:	kilogram per quintals
M	:	Marketed Surplus
M.S.	:	Maharashtra State
MSP	:	Minimum Support Price
N	:	Nitrogen
No.	:	Number
NR	:	Net Returns

P_2O_5	:	Phosphorus
qt.	:	Quintal(s)
₹	:	Rupees
₹/kg	:	Rupees per kilogram
Sr. No.	:	Serial Number
Vis-à-vis	:	in relation to
viz;	:	Videlicet (Namely)
w.r.t.	:	with respect to
Y	:	Total Production

E) Glossary

Parity Prices: Parity prices for farm products are those prices which would give the same purchasing power to the producer as prevailed in the base year. In order to examine the parity between the prices received for output and prices paid for agricultural inputs, parity indices were computed by deflating output price indices by the input price indices.

$$\text{Parity index} = \frac{\text{Output price index}}{\text{Input price index}} \times 100$$

Marketed Surplus: Marketed surplus is the quantity of the produce which the producer-farmer actually sells in the market, irrespective of his requirement for family consumption, farm need and other payments.

(F) THESIS ABSTRACT

a. Title of the thesis	:	INPUT DEMAND AND OUTPUT SUPPLY OF SELECTED CROPS OF VIDARBHA – PROFIT FUNCTION APPROACH
b. Full Name of student	:	Thakare Sandip Shridhar
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d. Degree to be Awarded	:	Ph. D. (Agri.)
e. Year of awarded of degree	:	2011
f. Major Subject	:	Agricultural Economics
g. Total number of pages in Thesis	:	152
h. Number of Words in abstract	:	411
i. Signature of Student	:	Thakare
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ABSTRACT

The output supply and factor demand are closely interlinked to each other. Therefore, any change in input and output prices affects the factor demand and output supply simultaneously. The present study used cross sectional cum time series data of Vidarbha region for cotton, paddy, soybean and sorghum crops for the ten years from 1999-00 to 2008-09 were collected from the Agricultural Prices and Costs Scheme, Department of Agricultural Economics and Statistics, Dr. PDKV Akola by keeping in view to study the temporal variation in input and output prices and cost of cultivation, to estimate the input demand and output supply by using normalized Cobb-Douglas profit function and to estimate the marketed surplus of selected crops. Every year's 100 farmers were selected purposively for the present study.

The study revealed that, the gross income from cotton, paddy, soybean and sorghum increased at an annual rate of 10.25, 5.84, 10.76 and 5.49 per cent per annum respectively.

The cost of cultivation for cotton, paddy, soybean and sorghum has depicting an increase by 1.82 times, 1.42 times, 1.86 times and 1.17 times during the period under study.

The analysis of factor demand equations showed that the demand elasticities with respect to own prices had the expected negative signs indicating that the results were in accordance with theory of demand.

The effect of wage rate was more on bullock demand (-0.114), while the effect of bullock labour price on human labour demand was low (-0.071). This indicates the one way complementarity between bullock labour and human labour in paddy cultivation.

The output supply equation revealed that among the fixed factor, capital was found to be effective in increasing the supply of selected crops.

Assuming no change in fixed factors or level of technology, the input-output price structure has not resulted in a appreciable increase in human labour employment, bullock labour employment and fertilizer demand in the production of paddy crop. While the impact of input-output price on demand for farm yard manure and demand for fertilizer significantly increased in the production of paddy and sorghum respectively.

The price observed during last decade was better to maintain the growth in cotton supply by 5.04 per cent per annum.

The elasticities of marketed surplus with respect to soybean (-0.577) and sorghum (-0.081) prices were negative while it was positive for cotton (0.744) and paddy (0.104), while the elasticities of marketed surplus with respect to bullock labour prices were negative for sorghum (-0.138), soybean (-0.127) and paddy (-0.126).

CHAPTER I

INTRODUCTION

1.1 Background Information

Economic regeneration attempted in the successive five year plans has made agriculture a pride of national economy. This sector, at present, provides livelihood to about 70 per cent of labour force contributes nearly 35 per cent of the net national product and accounts for a sizeable share of total value of country's exports. It supplies the bulk of wage goods required by the non-agricultural sector and raw material for a large section of industry. The rapid increase in population and standard of living as a result of economic development exert strong pressure on demand, which can be met only by an adequate supply of agricultural output. This calls for enormous concentration in matching the demand for and supply of food grains.

Agricultural production is seasonal with much dependence on vagarious of nature. The supply of agricultural product is not uniformly distributed while the consumption of the agricultural commodities is evenly spread over the period. In such circumstances, the price of agricultural commodities would naturally be depressed during the post-harvest period and would tend to rise during lean period when the farmers have disposed most of their produce. The implication of wide fluctuations in prices results in fluctuation of income of producers more than that of the output. The aspect of supply where a substantial part is retained by the farmers for home consumption is importance because their responsiveness to price stabilises the supply to market. On the other hand, unrestricted rise in agricultural prices would affect the welfare of consumers. So, the planners and policy makers are confronted with the challenge to formulate a suitable agricultural price policy by which the desired growth of agricultural output can be achieved. In this direction, a positive agricultural price policy plays an important role in stimulating production. In the process, the need for a sound empirical knowledge about the degree of responsiveness of supply of products and demand for factors to relative price changes is quite imminent. The degree of responsiveness, however, will be different in different period and regions.

Cotton is a very important fibre crop of global importance with a significant role in Indian Agriculture, Industrial development, employment generation and improving national economy. Cotton known as white gold or king of fibre and plays a prominent role in Indian economy. In India it is grown annually on 9.41 million hectares with 23.16 million bales of an average production. Even though India ranks first in area in the world, it occupies third position in production and low position in productivity. The average productivity of cotton in India was 419 kg lint ha^{-1}, (Anonymous [a] 2009), while in Maharashtra it is grown in an area of 3.14 million hectares with production of 4.94 million bales and productivity is only 267 kg lint ha^{-1}.

Cotton is one of the important cash crops of Vidarbha. In Vidarbha it is grown in an area of 11.24 lakh hectares with production of 18.58 lakh bales of an average production and productivity is 262 kg lint ha^{-1} which is comparatively lower than India's cotton productivity. (Anonymous [b] 2009)

Rice is one of the important cereal crop in India which occupied 45.4 million hectares area with production of 99.2 million tones and productivity of 2186 kg ha^{-1} (Anonymous [a] 2009). In Maharashtra the area under rice during 2008-09 was 1.49 million hectares and production and productivity of rice were 2.24 million tones and 1491 kg ha^{-1} respectively, while in Vidarbha the area under rice cultivation was 7.32 lakh hectares with production of 5.62 lakh tones and productivity was 768 kg ha^{-1} (Anonymous [b]2009).

At present, India is deficit in production of edible oils and large quantities of oilseeds are being imported which results in overflows of scarce and precious foreign exchange. Government of India and state governments are making efforts to increases in production of oilseed in a country. In view of present low level of production and availability of edible oil, soybean assumes a most important place in Indian Agriculture. Soybean cultivation is steadily increasing in India since 1968-69. In India during year 2008-09 area under soybean was 9.52 million hectares with production 9.90 million tones and productivity was 1040 kg ha^{-1}. (Anonymous [a] 2009), while in Maharashtra area sown in 2008-09 was 30.65 lakh hectares with total production of 18.49 lakh tones and productivity 603 kg ha^{-1}. In Vidarbha the soybean was grown on area of 20.43 lakh hectares with total production of 9.28 lakh tones and productivity 454 kg ha^{-1}. (Anonymous [b] 2009)

Sorghum is also important cereal crop in India. Sorghum ranks fifth, among the world cereal food crops (After Rice, Wheat, Maize, and Barley). The main states of India where the sorghum is cultivated are Maharashtra, Karnataka, Madhya Pradesh, Andhra Pradesh and Rajasthan. In India during 2008-09, the area under sorghum was 7.70 million hectares with production of 7.30 million tones and productivity was 952 kg ha^{-1}, (Anonymous [a] 2009) while in Maharashtra the area under sorghum was 4.17 million hectare with production of 3.67 million tones and productivity was 877 kg ha^{-1} and the area in Vidarbha under sorghum cultivation was 2.88 lakh hectares with production of 3.77 lakh tones and productivity was 1308 kg ha^{-1}, (Anonymous [b] 2009)

1.2 Importance of study

The importance of these crops in Vidarbha's agriculture is viewed from the fact that they together account for 65 per cent of area in gross cropped area of Vidarbha. It is interesting to note that Vidarbha has a pride of place in the production of cotton and paddy accounting for 37.59 and 25.16 per cent respectively to total production in Maharashtra.

In the production of cotton, soybean, paddy and sorghum the prices of inputs such as human labour, bullock labour and chemical fertilizers have some influence on the quantity of input use. Similarly, some degree of substitution and complementary relationship between factors is expected in the production of these crops. The price received for the production also has a bearing on producer's income. The influence of these factors have been examined keeping in view some pertinent questions like Are inputs efficiently utilized? Are there economics of scale in agricultural production? Is the agricultural sector responsive to changes in incentives? Are there identifiable inefficiencies in the institutional arrangement? How much changes can be achieved by changing prices in output and marketed surplus and how it needs to be attained by technological change?

Technological change and positive price policy can play a significant role in stimulating agricultural production through the desired allocation of resources. At these stages, the policy planners face the challenge to formulate suitable agricultural policy by which the desired growth of agricultural output can be achieved.

In order to formulate effective price policy, one needs reliable empirical knowledge about the degree of responsiveness of demand for factors and supply of products, to reliable prices and technological changes. The output supply and factor demand are closely interlinked to each other. Therefore, any change in factor and product prices affects the factor demand and output supply simultaneously.

Rising cost of inputs discourages the input use and reduces the output supply. The decline in output supply raises food prices. The rapid increase in population and the increase in money income as a result of economic development create a strong pressure on demand which also leads to increase in food grain prices. These cause hardship to the consumers. This can be corrected only by a large and adequate supply of agricultural output and a greater attention is, therefore, required to be focused for matching the demand for foodgrains and agricultural commodities with the supply thereof. The rise in foodgrains prices should be sufficiently high not-only to feed, seeds and other payment have been made. Marketed surplus on the other hand represent only that portion of the Marketable surplus which is actually marketed.

The supply and demand of agricultural commodities ought to have been in equilibrium so that, supply of and demand for agricultural commodities are said to have established desired relationship. It is however, to be taken into account that Marketed surplus which has to play a vital role in setting up equilibrium between supply and demand in the market. It is there for, necessary to make crucial appraisal of the Marketed surplus which is bought for disposal in the market.

Marketed surplus is the quantity of the produce which the producer-farmer actually sells in the market, irrespective of his requirement for family consumption, farm need and other payments. The response of marketed surplus to changes in prices and non-price factors like irrigation, acreage and productivity, is important for forecasting the supply of food grains and formulating agricultural price policy. For crops which are wholly or almost wholly marketed, the elasticities of output and marketed supply will be approximately equal. But in crops such as paddy and Jowar, where a substantial part of output is retained by the farmers for home consumption, the responsiveness of the marketed surplus must be measured separately.

This study is an attempt to examine the changes in costs and returns and also to understand the foregoing issues by developing a system of factor demand and output supply relationship for principle crops in Vidarbha. In addition, the response of marketed surplus to product and factor price changes has been assented by computing the elasticities of output supply and factor demand. These output supply, factor demand and marketed surplus functions have been further used to access the required price changes and productivity to compensate the inflationary pressure in the form of increasing factor prices. The specific objectives of the study are

1.3 Objectives of study

1) To study the temporal variation in input and output prices and cost of cultivation.
2) To estimate input demand and output supply of selected crops.
3) To estimate Marketed surplus of selected crops.

1.4 Hypothesis

In the light of the foregoing theoretical proportions and the review of literature the following hypothesis are proposed to be tested for fulfilling the requirements of the objectives of the study.

1) There is a variation in input and output prices as well as in cost of cultivation due to variation in market prices.
2) The output supply and input demand are closely interlinked to each other. Therefore, any change in input and output prices affects the input demand and output supply simultaneously.
3) The response of marketed surplus is depends upon the price and non-price factors and elasticities of output and market supply will be approximately equal.

1.5 Scope and limitation

The present study was conducted in Vidarbha region of Maharashtra State. This study will provide useful information which can be used to project the direction and the extent of the response of farmers to changes in input and output prices. Results of this study would help the policy makers to formulate policies pertaining to the various aspects of changing these prices.

The present research was conducted for Vidarbha region of Maharashtra state and restricted for only four selected crops viz cotton, paddy, soybean and sorghum of Vidarbha and the response of marketed surplus to product and factor price movements were also assessed for cotton, paddy, soybean, and sorghum. The present study is limited with cross sectional cum time series data of Vidarbha region for selected crops for ten year from 1999-00 to 2008-09. Every year's 100 farmers were selected purposively for the present study except 85 farmers for sorghum in 2008-09 of and 82 farmers for soybean in 1999-00 due to availability of data.

CHAPTER II

REVIEW OF LITERATURE

The review of literature is one of the important aspects in the research process which helps researcher to get acquainted with the subject matter under study and future channelize efforts in desirable direction. It also provides necessary guideline and helps the researcher to delineate his research problem.

The main purpose of this study is to study the temporal variation in input and output prices and cost of cultivation, to estimate the input demand and output supply of cotton, soybean, paddy and sorghum and to study the marketed surplus of paddy and sorghum. Several research workers have worked on the problem in different regions. This chapter takes brief account of research work in changes in input and output prices and cost of cultivation, input demand and output supply and marketed surplus.

This chapter has been organized into the following subsections.

2.1 Temporal variation in input and output prices and cost of cultivation

2.2 Input demand and output supply

2.3 Marketed surplus.

2.1 Temporal variation in input and output prices and cost of cultivation

The cost structure of important food grains under different farm and price situation were examined by Acharya and Agarwal (1976) and also studied the extent of increased in input prices has been offset by an increased in productivity and product prices for the year 1965-66 to May 1976. The study revealed that the total cost of cultivation for wheat was less on pump operated situations compared to other because of substitution of electricity for human and bullock labour. The study also revealed that the cost structure and the relative importance of different components for barley under different situation were similar to that of wheat. The total cost of cultivation of bajra in 1971-72 was more than double of 1965-66. The productivity per acre of wheat increased but the increase in input prices was proportionately more. An increase in input prices between 1971-72 and 1976 was not offset by an increase in product prices in all situations except for wheat on the pump operated farms.

Based on the cross section data for the period 1968-69 to 1975-76 Jha and Kumar (1976) analysed the effect of price changes on the cost structure and demand for labour and fertilizers in the Union territory of Delhi. The study clearly indicated that the share of labour and fertilizer increased substantially in the total cost over a period of time. The study revealed that the changes in real wage rate were found to significantly influencing the labour use. However, the use of fertilizer or plant nutrients remained unaffected by changes in prices.

The changes in the prices of purchased inputs like seeds, fertilizers, insecticide and pesticide and non-purchased inputs like human labour, bullock labour and irrigation were examined by Marothia (1976) observed that in case of plant protection material there was higher increase in price which rose by 50 to 62 per cent during 1967-68 to 1970-71 while the price of seed had not increased. The prices of non-purchased inputs like human wages, bullock labour and irrigation had increased by 50, 43 and 25 per cent respectively. The study also revealed that the levels of inputs use had also changed during 1967-68 to 1970-71. The cost of seeds had declined by nearly 25 per cent in paddy and nearly 14 and 6 per cent in maize and wheat. The cost of fertilizer inputs had increased by 101, 72 and 33 per cent for wheat, paddy and maize, while the cost share of human labour had also declined by 63.50, 33.40 and 26.68 per cent in case of paddy, wheat and maize respectively.

The impact of sharp rise in the prices of modern farm inputs on the level of use of inputs and profitability in farming in Sadar block of

Basti district of Uttar Pradesh were examined by Misra et al (1976) revealed that there was a sharp increase in the prices of different fertilizer in 1974-75 over 1970-71 which was highest, being 141.17 per cent in the case of dia-ammonium phosphate and lowest in the case of ammonium sulphate being 68.48 per cent. The analysis of input, output and net income on the sample farms as a whole clearly revealed that a sharp rise in the input prices increased the total input cost per hectare in 1974-75 by 19.57 per cent and reduced the margin of net profit by 14.11 per cent during same period. The per hectare expenditure on quality seeds, fertilizers, irrigation, human labour and bullock labour was higher in 1974-75 as compared to 1970-71 because of the increased in prices of these inputs.

The impact of the increase in prices of inputs on the profitability and production of sugarcane and paddy in Mandya district of Karnataka were examined by Rebello et al (1976) revealed that the cost incurred on account of all the factors were increased considerably in the cultivation of HYVs of paddy. The increase was highest in farm yard manure, being 295 per cent. The cost on plant protection chemicals, fertilizers and labour were increased by 162 per cent, 117 per cent and 110 per cent respectively. The study further revealed that the total cost of the inputs increased by 131 per cent and price of paddy was also increased from ₹ 80 per quintal in 1972-73 to ₹ 105 per quintal in 1975-76 (i.e. by 31 per cent during the period) with increased in production by 35 per cent.

The impact of input prices on level of their use and productivity in agriculture were studied by Singh et al (1976) concluded that the rise in the prices of farm production inputs adversely affected the level of its utilization on the one hand and the level of farm productivity on the other. The study also concluded that the rise in the prices of modern farm inputs like fertilizer, irrigation and plant protection measures restricted their use by farmers and thereby reduced the level of productivity in recent years. The study revealed that there was increased in the level of inputs like manure, fertilizer and irrigation in 1970-71 over 1967-68 while the level of input use went down in 1973-74 as compared to that of 1970-71. The level of utilization of manure and fertilizer and irrigation was the highest in 1970-71, but it went down in 1973-74 mainly because of the exorbitant rise in the prices of fertilizers on the one hand and that of electricity and diesel used in pumping sets on the other in 1973-74.

The cost structure of some major crops viz. food grains and cash crops grown in various farm sizes in four agro-climatic regions of Uttar Pradesh were studied by Pandey *et al.* (1977). The data relates to the period 1973-74 for a sample of 309 farmers. The study revealed that the share of purchased inputs has tended to increase during the period 1966-67 to 1973-74. In general, the share of inputs increased with the size of farm. This highlights the increasing inter-sectoral dependence in major crops, which is facilitated by technological improvements. The study also revealed that the fertilizers, water and human labour accounted for major share of total purchased inputs on all farm sizes in all regions. Lastly the study concluded that the impact of increase in input prices would significantly affect the profitability and productivity of these crops.

Agarwal and Kumawat (1979) constructed the farmers term of trade in Rajasthan for the period 1965-66 to 1976-77 taking 1970-71 as the base year. The aggregate index of agricultural inputs prices and aggregate index of prices of all agricultural crops were worked out. The study revealed that in the period prior to 1970-71, the term of trade remained more favourable to the farmers for food grains, oilseeds, and cash crops as well as for all agricultural crops. In the case of fibre crops, the period following 1970-71 was more favourable while the farmer's term of trade turned unfavourable in 1975-76 and 1976-77 for all crops except the fibre crops. This situation in agriculture had arisen because of a large fall in the prices of agricultural crops.

The indices of input-output prices for wheat and gram were analysed by Acharya (1981) revealed that the ratio of wheat price to prices paid by the farmers has remained unfavourable to farmers after year 1966-67. This index was only 53.66 and 56.63 in 1977-78 and 1978-79 respectively, but the ratio of gross income to prices paid has remained, by and large, above 100. Thus the parity between gross income from wheat and prices paid by the farmers had been maintained. The study also revealed that the inter-crop parity for wheat and gram in terms of administered price, market price, real price, gross income and ratios of prices received to prices of purchased inputs and cost C had remained in favour of gram.

The intra-sectoral parity between cost, price and income in agriculture was studied by Bhatia (1981) with the objective was to evaluate the present price policy from the angle of parity in the cost, prices and income in the agricultural sector. The study used time series data on the cost of production of wheat and paddy, those generated under the comprehensive scheme for studying cost of cultivation. In order to examine the parity between the prices received by the farmer for their produce and the price paid for agricultural inputs, parity indices were computed from the indices of prices of agricultural products and agricultural inputs. The study revealed that there was near parity in prices announced by the Government and increasing in prices of agricultural inputs in case of Paddy and groundnut. In case of cotton, price-cost parity were much higher in later years which showed higher increase in output price than that in input prices. The parity indices were near 100.00 through from 1970-71 to 1979-80 except during the years 1974-75 to 1976-77.

The growth rates in the cost of production, fertilizer price and real wages were worked out by Khatkar and Nandal (1981) revealed that the rate of growth in prices was highest in gram followed by rapeseed, cotton, maize and wheat respectively while the price elasticity of gram, rapeseed and cotton was also relatively higher.

Efficiencies, factor share and the productivity of various factors in crop cultivation in central districts of Punjab were analysed by Bal et al (1983) with the data of 50 holding for pre price hike period (1972-73) and post price hike period (1980-81) were taken from the comprehensive scheme of cost of cultivation of principle crops. The study revealed that the elasticities of production of human labour, draft power and rental value of land had declined in 1980-81 over 1972-73, but that of irrigation had increased over this period. Per hectare input use of human labour had decreased from 636.11 man hours in 1972-73 to 568.11 man hours in 1980-81. The average level of use of other factors had also increased over this period. Similarly, the factor share of human labour had decreased from about 43 per cent in 1972-73 to only about 21 per cent in 1980-81, where as the factor shares of all other factors had increased over this period. This indicated the substitution of human labour with other factors mainly with irrigation, fertilizer and weedicides.

George et al (1983) studied factor share in Indian agriculture. The study used the data from the comprehensive scheme on the cost of cultivation of principle crops to the year 1970-71 to 1980-81. The study revealed that the factor share of labour had improved in all region for the period 1970-71 to 1980-81 mainly due to increase in wage rates and to a lesser extent due to increase in the intensive use of labour. The only exception is that of Punjab where the factor share of labour had declined mainly due to substitution of labour by machinery although wages had gone up substantively. The family labour components, however is on decline in all region which affects the farm family income. But in case of jute, family labour still constitute a major part of the total labour inputs.

Overall estimate of the increased in productivity over time by working out the productivity in value terms for all the crops (rice, wheat, maize, barley, bajra, pulses, oilseeds, sugarcane, potato and cotton) taken together were worked out by Grewal and Rangi (1983) revealed that at current prices, there had been almost a threefold increase in value productivity during the period 1970-71 to 1981-82. However, at constant prices, the increase in value productivity for base year i.e.1970-71 was rather moderate. The study further revealed that the compound growth for productivity was increase by 11 per cent at current prices and 3.3 per cent per annum at constant prices.

The changes in the individual cost items over time and place by making used of published data of the studies in the Economics of Farm Management in the Punjab for 1962-63 and a similar set of data was taken from the Cost of Cultivation Scheme and impact of drought on the farming community in Haryana for 1978-79 were analysed by Pandey et al (1983) revealed that the relative share of land in total farm assets increased from 65 per cent in 1962-63 to 87 per cent in 1978-79 whereas the share of farm livestock and dwelling were declined. Although the absolute share of human labour in the total cost per hectare increased during the post green revolution period, its relative share declined due to increased expenditure on fertilizers and chemicals, farm machinery and implements, irrigation etc. The study also revealed that with the expansion of assured irrigation facilities, the relative share of modern yield increasing inputs in the total cost of cultivation of crops increased and that of the use of traditional inputs were declined.

The growth rates in fertilizer price and the share of fertilizer cost in the total cost of production of major crops of Haryana were estimated by Singh and Tomer (1983) revealed that on an average, the fertilizer prices in Haryana had increased at an annual compound growth rate of 7.30 per cent. The study had further revealed that except in barley and rapeseed and mustard, in all other major crops of Haryana namely wheat, paddy, cotton, sugarcane, potato, bajra and gram, the share of fertilizer cost had decreased. On an average, the share of fertilizer cost decreased from 12.64 per cent in 1975-76 to 8.88 per cent in 1981-82.

The changes in factor share due to use of high yielding variety seeds, irrigation and improved method of cultivation over the use of local varieties, unirrigated cultivation and traditional method of cultivation respectively for paddy, bajra, jowar, cotton, wheat and sugarcane were analysed by Waghmare and Dhongade (1983) revealed that the comparison of the factor shares in respect of local and HYV of paddy, unirrigated and irrigated wheat, indicated that the relative share of capital has increased as against a declined in the share of labour, indicating thereby a substitution between labour and capital had taken place in HYV paddy and in irrigated wheat. In case of Jowar and cotton, the share of both labour and capital had declined while that of profit increased sharply especially in nontraditional varieties over traditional varieties of cotton. The study also revealed that there was a decline in the share of profit in sugarcane cultivation while there was neither an increase nor a decrease in the share of profit on Jowar cultivation.

The trends in the share of rental value of land in cost of cultivation of major crops of India were analysed by Kahlon and Kurien (1984) revealed that with increased use of purchased technological inputs like improved varieties of seeds, chemical fertilizers, modern irrigation and mechanical labour, the share of imputed rental value of owned land in the cost of cultivation as well as in gross value of output were declined. Out of the six major crops, in four crops viz. paddy, wheat, sugarcane and jute the share of rental value of land in the total cost of cultivation would declined where as cotton provided reverse trend and ground nut did not provide any clear trend. Also across the state comparison indicated that, on the whole, yield levels and rental shares were inversely related.

Singh et al (1986) suggested quite often is to give sufficiently higher prices for agricultural products, which may cover not only the cost of production but also take into account the price rise. They also suggested that to keep in check the prices of farm inputs and subsidies these to the extent that the parity between prices received and price paid by the farmers for the inputs and other items of house hold consumption was maintained.

The relationship between the procurement price and or support price, the area under food grain crops, prices of food grains and agricultural inputs and investment of inputs in Uttar Pradesh from 1975-76 to 1984-85 were examined by Singh et al (1986) revealed that in case of food grains, except fertilizers and pesticides, the price index of other inputs like water rates, wage rates of labour and machinery charges increased at a much faster rate than the price index of wheat and paddy during 1984-85. The study also revealed that with the increase in the prices of food grains like wheat and paddy, the cost of production had also risen higher due to increase in the prices of inputs like water rates and labour plus machinery charges and resulted in a declining trends of net returns in wheat and net returns were almost constant in paddy crop.

The changing structure of factor and product prices in Punjab agriculture were studied by Sharma and Singh (1987) revealed that during the period 1967 to 1983, output price index increased by 136.27 percent where as input prices increased by 233.80 percent. Besides, the prices did not have a smooth course and fluctuated considerably in between. Consequently the term of trade as reflected by parity index had been mostly unfavorable to the farmer and this requires the adjustment in output prices along with increase in productivity level of various crops.

The movement of term of trade between agricultural and non agricultural sector during the period 1952-53 to 1983-84 was analysed by Tyagi (1987) and they also focused on how the term of trade between agricultural and non agricultural sectors had moved since early fifties and what had been the impact of adverse or favourable terms of trade on the growth of agricultural output in different periods. The study revealed that during the period 1952-53 to 1963-64, the term of trade had remained against the agricultural sector and fluctuated between 73 to 91 per cent and on an average the term of trade was 85 per cent while during the period 1964-65 to 1974-75, the term of trade had remained in favour of agricultural sector in almost all the years. During the last nine years i.e. from 1975-76 to 1983-84, also the term of trade had remained against the agricultural sector.

The trends in production costs and returns of cotton in Gunter district of Andhra Pradesh from 1969-70 to 1985-86 were analysed by Rao et al (1988) revealed that the seed cost of cotton increased in the early seventies because of shortage of seed supply compared to sudden increase in demand while fertilizer and pesticide costs were maximum both at the end of the early seventies and the early eighties. The study further revealed that the higher initial profits from cotton in the early seventies attracted the farmers to apply higher doses of fertilizer and to use pesticides indiscriminately and this resulted in losses from cotton production in later years. Though the return from cotton production was stabilised in the early eighties, they started decreasing from 1984-85 onwards due to improper use of modern inputs, increased costs of labour and declining yields.

Cost structure of Kharif jowar in Marathwada region of Maharashtra were studied by Satpute *et al* (1990) revealed that the proportion of variable cost increased with the increase in size of holding, which was noticed inverse trend in respect of fixed cost. On an average in total cost, the contribution of variable and fixed cost was 61.98 per cent and 38.02 per cent respectively. Amongst variable cost human labour, bullock labour, manures and fertilizers covered about 80 per cent share in total variable cost. Amongst fixed cost rental value of land constitute 53.65 per cent share and family labour constitutes 26.04 per cent shares to the total cost. Thus, the study suggested the adoption of labour saving technology in the cultivation of Kharif Jowar as they contribute more to the total cost.

The term of trade between input and output prices of wheat and rice in India were studied by Suhag and Nandal (1990) revealed that the inputs prices of rice had increased at a faster rate than the output prices in most of states. In Haryana, the input prices for rice were increased by 259 per cent as against output prices i.e. 173 per cent, whereas, the term of trade showed a decline trend of about 24 per cent. The study also revealed that the term of trade between the input and output prices for wheat and rice have moved against the farmers and producers and the term of trade between input and output prices of wheat deteriorated much faster as compared to the rice crop.

The trends in input and output prices of the Punjab wheat economy were analysed by Sindhu and Byerlee (1991) showed that as expected with rapid technical change, the cost of production in real terms decreased steadily at the rate of 2.9 per cent annually and the real prices of most inputs declined from 1972 to 1987. The finding of the study showed that farmers were beneficiaries of much of surplus generated during the green revolution period but in 1990's and 1980's wheat consumers have received the bulk of benefit.

The trends in rice productivity in Bangladesh were studied by Ahmed (1992) and made efforts to increase such inputs as area under cultivation, irrigation, chemical fertilizer and pesticides. The results showed that despite of increased inputs, the trends in rice productivity were found negative. This was attributed to the use of the same type of fertilizer year after year, increase salinity of the soil as a result of irrigation, especially in the lower delta region and traditional methods of farming. The study suggested that the relevant Government agencies should co-operate with academics and researchers to conduct appropriate research and implement the findings.

The trends in variable cash costs in nominal dollars for maize, soybean and wheat in USA were examined by Ali (1993) founded that the variable costs to be increased during 1975 and 1991. However, real costs (adjusted for inflation) for producing these crops were declined, except during 1978-81 when fuel and fertilizer prices rose sharply. Per bushel real costs also showed a downward trend due to increasing crop yields over time.

The district wise trend and growth of fertilizer consumption in Orissa for the period 1968-1992 were studied by Pradhan *et al.* (1993) concluded that the growth rate of total fertilizer consumption in Orissa was close to that of India. But wide variation was observed in the growth rates at district level. It was between 5.92 per cent and 17.47 per cent as against the growth rate of 8.67 per cent at all India level. At the same time, the range of growth rates at district level was from 1.51 per cent to 14.23 per cent, which was also wide. The compound growth rate of total fertilizer consumption and per hectare fertilizer consumption for almost all the districts of Orissa was statistically significant.

The inter-regional and temporal variation of costs, productivity and sources of growth of paddy in Andhra Pradesh were analysed by Reddy (1997) by making the used of data on cost of cultivation from 1981-82 to 1991-92 collected from the Comprehensive Scheme on cost of cultivation of principal Crops. The study revealed that the yield per hectare of paddy had increased by 22 per cent from 35 to 42 quintals in 1981-83 and 1989-91 in the state while per hectare fertilizer consumption in this region varied from 109 to 172 kg between 1981-83 and 1989-91. The data on cost per quintal at constant prices revealed a declining trend at the state as well as at the zonal levels during the period. The cost per quintal of paddy at constant prices declined from ₹ 121 to ₹ 96 during the period 1981-83 and 1989-91. The study also revealed that the unit cost among zones was declined mainly due to increased in productivity and also due to decline in the value spend on human labour, bullock labour and manure.

The temporal variations in production costs and prices of paddy and sugarcane were studied by Govindarajan *et al.* (2001). The time series data on cost of production and Government announced prices were collected for the period 1971-1998 for paddy and 1981-1998 for sugarcane. Statistical tools like percentage analysis, correlation coefficients and trend analysis were used in the study. The results concluded that the compound growth rate of price was higher than that of cost of production for both the crops. One year-lagged price was found to be significantly influencing the current year's price for sugarcane; the effect was only marginal for paddy. The current year's price of paddy was influenced by two year lagged cost whereas in sugarcane the influence of lagged cost was very minimal.

The trends in farm costs, income, factor shares, and price-cost relationship in rice cultivation by size and zone in Andhra Pradesh, India, during the period 1981-82 to 1991-92 were analysed by Reddy (2002) showed that decline in per hectare labour input, bullock labour and manure has pushed down the per hectare cost at the state as well as in south coastal Andhra where rice is predominant crop. Net income of rice cultivation at constant prices revealed an increasing trend at the state and zonal level. The factor share analysis indicated a declining trend with respect to labour, capital and current inputs. It was concluded that HYV technology as well as the Minimum Support Prices have played an important role in bringing parity between cost and support prices and thereby ensuring reasonable returns to the farmers.

The production and economic factors growth in Indian Agriculture were studied by Singh and Chandra (2003). The trends in cost of cultivation, Support Price and profits from paddy, Wheat, Coarse cereals, Pulses and Oilseeds, cost of inputs affecting cost of cultivation and share of cost of inputs to total cost were analysed. The analysis was carried out for period 1975-1998. The study revealed that the

Minimum Support Price in Mustard has been higher than cost of cultivation but not in Groundnut and soybean. The crops in marginal and dry land areas recorded negative profits. The study also revealed that the human labour component was found very high in cost of cultivation for most of the crops however, the costs of machine labour and insecticides were also increased in recent years.

The competitiveness and comparative advantages of various rabi crops in terms of cost of cultivation, the cost structure and changes in cost over time for wheat, barley, gram and rapeseed and mustard were studied by Gurjar and Varghese (2005) revealed that the share of operational cost to total change in cost of cultivation has been almost the same for all major rabi crops indicating that the operational cost and fixed cost increased over time in a commensurate manner for rabi crops. The major contributing factors for the change in operational cost has been increase in wage rate, increase in quantity and price of fertilizers, increase in price of seed and substitution of bullock labour by machine labour. Consequently the share of bullock in total cost has declined over time for all major rabi crops except gram. For all crops, the cost of cultivation had increased at a faster rate as compared to increase in the price of their output.

The input-output prices, their parity and income from Jowar, bajra and Wheat in Maharashtra were studied by Shendage et al (2009) based on time series data on the cost of production and input-output prices of Jowar and bajra generated under the CACP report during 1992-93 to 2002-03 and the data for the wheat crop was utilized from APC reports. It was observed that the price-cost ratios for wheat and bajra was less than unity during period under study indicated that the increased in cost of production was more than increased in the output price and the compound growth rate of gross income was maximized in wheat.

Mathematical modelling for demand and supply estimation were studied by Shende and Shinde (2010) revealed that in year 1997-98 to

2007-08, the input price index for soybean increased by 29 per cent, while the increased in output price was 87 per cent. Further , the output-input price parity index were decreased during 1999-00 to 2001-02, and increased in the subsequent years, indicated that up to the year 2001-02, the output price was lower than input price and term of trade was unfavourable for soybean grower. However, the term of trade was favourable for the soybean grower afterward. The study also revealed that the gross income from soybean increased at an annual rate of 9.826 per cent per annum. It may be attributed to both, the increased in output prices as well as increased in yield. However an estimation of change in returns from soybean showed that the profitability has increased over the years and the output ratio was increased from 0.938 in 1997-98 to 1.559 in 2007-08.

2.2 Input demand and Output supply

By making used of aggregate time series data for Japan covering a period from 1833 to 1937 Hayami (1969) observed that the policy of government was to encourage agricultural research and extension resulting in upward shift of production function. The study revealed that during the above period, the fertilizer price declined when compared to prices of farm products due to technological innovations in production of fertilizers.

The supply function derived from empirically estimated production function and the reliability by comparing them with the elasticities obtained directly by using regression analysis of time series data were examined by Wipf and Bowden (1969) indicated that the derived supply equations were not reliable. The output prediction obtained from the derived supply function did not exhibit consistent magnitude or direction of bias as they varied from slight under-estimate to extreme overestimate of actual output. The authors also indicated that the inconsistent results of production function approach could be due to inconsistent assumption.

The alternative fertilizer price policies and their impact on the use of fertilizer in corn and wheat production in Argentina was highlighted by Janvry (1972) revealed that the prevalence of low prices for food grains and high prices for fertilizers decreased the use of fertilizer ultimately resulting in lower yields. They also suggested that there is a need to modernise the outdated industry so as to reduce the cost of fertilizers was suggested.

By using data pertaining to Indian agriculture Lau and Yotopoulos (1972) estimated the output supply and factor demand equations through profit function approach. This research work demonstrated derivation of supply and demand equations from profit function within the Cobb-Douglas frame work. The profit and factor share equations were estimated jointly imposing the restriction of profit maximization which required that the common parameters occurring in different equations were same. The estimates of elasticities obtained by this method were compared with that of production function by using single equation method. These estimates were further compared with those obtained indirectly from the corresponding profit function. The authors observed that the estimates obtained directly from production function were inconsistent because of simultaneous equation bias.

The state wise demand function for chemical fertilizers viz. N, P and K in India were estimated by Singh and Ramakrishnaiah (1972) and also measured the quantitative significant of the factors affecting on fertilizer consumption showed that in the estimated demand function for nitrogen fertilizers, the nitrogen price had a significant effect on nitrogen use only in the states like Andhra Pradesh, Assam, Maharashtra, Rajasthan, Uttar Pradesh and Delhi, while the estimated demand functions for phosphate fertilizers showed that the price elasticity of demand was significant only in the states of Andhra Pradesh, Gujarat, Kerala, Jammu and Kashmir, Maharashtra, Rajasthan, West Bengal and Himachal Pradesh. For all states, as well as for the whole country, price elasticity for fertilizers was insignificant.

In case of Potassic demand function, the price elasticities of demand were insignificant for the country and for all regions, with the exception of the eastern region.

By using cross sectional data for U. S. A. agricultural sector Binswanger (1974) described the advantage of using cost function rather than production function in derivation of factor demand elasticities. The factor substitution was estimated both the translog as well as the Cobb-Douglas cost function. The factor share equations were derived simultaneously along with the cost function by applying restricted generalized least squares. The study revealed that the own price elasticities of factor demand had the correct sign and the values were close to one. The estimates were comparatively higher for translog when compared to Cobb-Douglas except in case of fertilizers.

The demand for home consumption and supply of food grains marketed in a closed village of Nigeria was estimated by Walter (1975), the consumption decisions were considered as a function of price of food grains and farmers income. The results indicated that large farmers were relatively more price elastic and income responsive than the small farmers. The estimated price elasticity of consumption ranged between - 2.0 and 2.7 which appears to be irrelevant in the Indian context. The supply elasticity of marketing in short run was positive.

The Cobb-Douglas type of profit function to agriculture in Taiwan were employed by Yotopoulos et al (1976) with the variable inputs such as human labour, animal labour, mechanical labour, fertilizer use and two fixed inputs namely, land and fixed assets. The restriction of profit maximization were imposed and tested for significance. This particular study compared the two approaches namely, Cobb-Douglas production function with that of normalized restricted profit function. The authors were founded that the own price elasticities of output supply and factor demand being greater than one and all variable inputs were complements to each other.

The elasticities of demand for fertilizer with respect to its own price were estimated by Dhillon and Sankhayan (1977) showed that the estimates of elasticities of demand for fertilizer with respect to its price were very low and close to zero, indicating thereby that the demand for fertilizer was inelastic with respect to its price. The estimated elasticities with respect to product price were observed to be positive and varying from 0.1624 to 0.4309.

An employment decomposition model based on the UOP profit function was formulated by Bisaliah (1978) by using farm level primary data from the Ferozepur district of Punjab State for the year 1967-68. The study revealed that the technology effect was negative in the employment decomposition model based on the constrained-Cost-Minimization framework and this negative technology effect followed from efficiency gain in production that was a given amount of output could be produced with less man hours of labour. But in the employment decomposition model based on the UOP Profit function, technology effect was positive. This positive technology effect followed from the condition that technical change shift profit function upwards. This upwards shift profit function, shift demand for labour and this was clearly suggested the Labour demand function.

By using cross sectional data, the farm level demand for wheat in Punjab were estimated by Sidhu and Baanante (1979) revealed that the price elasticity for fertilizer demand was -1.16 and that of wheat supply was 0.71. The elasticity of labour demand was 0.44.

The labour demand function and labour absorption in agriculture were estimated by Kumar et al (1981) with specific objective was to estimate employment elasticities for key variables such as wages, fertilizer price, irrigated land and capital inputs. The estimated result was that the profit function was decreasing in prices of labour and fertilizer and increasing in land and fixed capital inputs. The estimated elasticities for wages and fertilizer become negative in all farms while it was positive for capital and output of crop.

Farm level input demand and Wheat supply in the Indian Punjab were estimated by Sidhu and Baanante (1981) based on the normalized restricted profit function and the derived system of demand equations for variable inputs were estimated with farm level data for Mexican wheat varieties from the Indian Punjab. In addition to the variable inputs of labour, fertilizer, and animal power and the fixed inputs of land, physical capital and irrigation water were included in the model. The particular importance in this result that the flexibility afforded by the translog formulation allowed the exogenous variables produce different impacts across input demand function of labour, fertilizer and animal power are much more natural as compared to the symmetric impacts produced in the case of the Cobb-Douglas formulation.

By using translog cost function, the fertilizer demand for Republic of Ireland was estimated by Boyle (1982). The elasticities of own and cross price of demand for nitrogen (N), phosphorus (P) and potassium (K) were also estimated and the share equation for N, P and K that correspond to the translog cost function were estimated jointly by imposing the symmetry restriction and seemingly unrelated regression estimate technique. The result of the study indicated inelastic own price elasticities for P and K and elastic own price elasticity for N. The cross price elasticities between N, P and K were significant.

The application of profit function in agricultural finance was studied by Tyagi and Pandey (1982) analysed the profit function for the estimation of demand for crop loan on different categories of mechanized farms. The elasticities of demand for crop loans with respect to interest rate, price of output and price of input were estimated. The profit function developed by Lau and Yotopoulos had been used as an analytical tool. The study revealed that the estimated demand for credit was highly elastic with respect to the prices of both inputs and outputs but it was inelastic with respect to the rate of interest. The profit function was increasing in all the fixed inputs in both seasons on all categories of farms but the fixed input elasticities of profit function were not significant. This study also revealed that with the increased in fixed inputs, the variable profit per unit of output would not be significantly changed.

Technological change and factor shares in cotton production were studied by Alshi et al (1983) with the profit function formulation suggested by Lau and Yotopoulos was used to derive the partial elasticities of the cotton production function. They also studied the restricted joint estimation of the normalized profit and labour demand functions for desi, American and hybrid varieties of cotton. The study revealed that the profit function was decreasing in wage rate and increasing in land and capital inputs. The study also revealed that the share of land in cotton production was the maximum for all varieties of cotton, ranging from 0.42 for desi cotton to 0.54 for American and hybrid cotton. The share of labour decreased due to efficiency gain in cotton production, that is, a given amount of cotton could be produced with fewer amounts of labourers under American and hybrid cotton technology as compared to desi technology.

Responsiveness of Indian agriculture to price changes were studied by Kalirajan (1983) and estimated the elasticity of paddy output supply and variable input demands were derived from the estimated profit function and factor demand functions. The study indicated that within the range of price variability observed in the sample, the complementary relationships among labour, fertilizer, pesticides and animal power were dominant over the possible substitution relationship while the study revealed that the demand for labour with respect to real wage was inelastic and demand for labour, on other hand, was elastic with respect to the price of output. The study also revealed that the demand for fertilizer with respect to its own price and the fertilizer elasticity with respect to the output price was also elastic. Lastly the study showed that the output supply was fairly sensitive to wage rate, its own price and operational holding, though it was also inelastic.

Product supply and input demand equation and supply and demand relationships among six Texas field crops viz. cotton, grain sorghum, wheat, corn, rice and hay and three variable inputs were investigated by Shumway (1983) by using a dual approach. The disaggregated system of eight supply and demand equations derived from normalized quadratic profit function which implied product supply and input demand elasticities which including elasticities for machinery-operating inputs. The study revealed that for product supply, the own price elasticities range from 0.07 for corn to 0.72 for rice while, the input demand elasticities range from -0.37 for machinery operating inputs to -0.70 for fertilizer and the cross-price elasticities with other products and inputs range from -0.88 to 0.75.

The aggregate technical and economic relationship characterising agricultural production in North and South Dakota for spring wheat was measured by Weaver (1983) by using the translog profit function and estimated the elasticities of choice, return to size and bias in technology. The results indicated decreasing return to size.

The structure of U.S. technology for 1910-78 was studied by Antle (1984) with a statistical methodology was developed for estimating input demand and output supply elasticities and measures of the effects on cost shares of both biased technical change and scale were devised based on the translog profit function. The study revealed that the postwar aggregate technology was characterized by inelastic input demand and output supply functions and all own price demand elasticities were negative as theory predict and most elasticities were absolutely less than one. The study further revealed that for 1910-46 and 1947-78, the supply elasticities under restriction were 2.485 and 1.440 compared to 1.349 and 0.427 without the restriction. Thus, imposing homotheticity makes the technology appear more prices responsive.

A system of output supply and factor demand equations for semi-arid and tropical India were estimated by Bapna et al (1984), the estimates were obtained separately for superior cereals, coarse cereals, pulses, oil seeds and other crops. The data pertaining to area, production, yield, prices and inputs were assembled for 93 districts of Andhra Pradesh, Karnataka, Tamilnadu and Madhya Pradesh for the years 1955-56 to 1973-74. The normalized quadratic and Leontief functions were used to estimate the system of output supply and factor demand equations. This was a pioneering study where the cross price effects of output price on each other were studied. The symmetry and convexity constraints on the profit function were accepted only at the most aggregate level. The study revealed that the elasticity for fertilizer ranged from -0.62 to 0.90 while the supply wheat and rice was 0.33 and 0.37 respectively. The results favoured the use of normalized quadratic function over the generalized Leontief profit function.

By using the estimated parameters of profit function, the elasticities for sugarcane supply and factor demand for sugarcane crop were estimated jointly by Kumar (1984) using Zellner's method of SURE estimation. The study revealed that there were no changes in sugarcane acreage, use of bullock labour and fixed inputs per hectare and that factor price inflation in wages, fertilizer, irrigation water, bullock labour and fixed factors will continue in future. The study further revealed that cost-push inflation in the production of sugarcane were 7.35 per cent per annum and sugarcane price should be adjusted upwards at the rate of 7.35 per cent per year and for maintaining constant net income, sugarcane price needs to be adjusted at the rate of only 6.30 per cent per crop season.

By using multiproduct or output profit function formulation Lopez (1984) estimated the output supply and factor demand responses for Canadian agriculture. The results indicated the complementary nature of hired and operator labour rather than being substitutes. This intern necessitated considering separately hired and operator labour as two distinct inputs. Another important empirical result of jointness of crop and annual outputs were observed.

The effects of price and non price factors on factor demand, output supply and crop net income were evaluated by Kumar et al (1985) and stimulate the model to suggest the adjustments needed in the price and non price factors. The price factors include factor price, irrigation, capital inputs and acreage while the non price factors includes the growth in productivity through technology, consumer income, population, procurement and seed and other uses. The estimated model provided the elasticities of price and non price factors indicated the direct partial effects of each one of them on factor demand, output supply and crop net income. The study revealed that the rising costs discourage input use and hence reduce output supply. The decline in output supply raised food prices and causes hardship to the consumers. The rise in food prices should be sufficiently high not only to counteract the rising costs but also to leave a rate of profit conductive to investment in agriculture.

The effects of input and output prices on inputs demand in Punjab agriculture were estimated by Chand Ramesh (1986) by using a profit function approach. This study was undertaken; to estimate the systems of input demand equation for major crops of Punjab; to compare the inter and intercrop effects of changes in input-output prices and some other exogenous variables in input use, and to study the effects of price changes on growth of input demand. In this study the regression coefficient of factor demand equation indicated that all the coefficient of own price were negative and in most of cases statistically significant. Among the fixed factors land under the crop had a large significant effect on factor demand, all own price elasticities of demand have negative sign except for labour demand function in cotton and gram and bullock labour demand in gram. The elasticity of factor demand with respect to output price was positive.

Input demand and output supply equation for Irish farms using cross section data was estimated by Higgins (1986), a transcendental logarithmic form of profit function was used to estimate these equations. The results indicated negative price elasticities for all inputs. In case of milk, an increase in purchased price of concentrate feed had reasonably a strong negative effect on output (-0.58). However, an increase in fertilizer price had somewhat weaker effect (-0.33). Further, the results indicated close positive relationship between cattle and sheep output and the stock of livestock. The share of crop output was positively related to land area and negatively to livestock capital.

Labour demand and supply responsiveness of Cotton in Madurai District, Tamil Nadu was studied by Subramaniyan (1986). Cotton supply and input demand elasticities were estimated by using profit function analysis for a sample of farmers producing MCU-5 and LRA-5166 varieties of cotton in Theni and Andipatti blocks of Madurai District. The study revealed that the supply of output and labour demand were found to be highly elastic to changes in cotton price in the case of both varieties of cotton. An increased in the prices of variable inputs resulted in a fall in the output supply and labour demand. On other hand, increase in the fixed factors led to an increase in the output supply and demand for labour with respect to two varieties of cotton. With respect to labour demand, the study revealed that the demand for labour was highly elastic to wage changes, and that a rightward shift in the supply function of labour may easily be absorbed by reducing the wage rate.

The supply equation for five groups and demand equations for four input groups in ten regions of United States were estimated and evaluated by Shumway and Alexander (1988) by conducting the econometric estimation for complete regional product supply and input demand systems. The study revealed that the number of regions in each parameter was statistically significant. All temporal parameters were significant in at least seven of the ten regions. Two own price parameters of energy demand and livestock supply were significant in seven or more regions. Six of the eight own price parameters were significant in at least half the region. The machinery demand and food grains supply were significant in four regions. Only two cross price parameters between feed grains and energy and between oil crops and livestock were significant in at least half the regions. The study also revealed that the output of feed grains, oil crops and other crops were positively associated with rainfall, while livestock output was negatively associated with rainfall; other crops output were positively associated with temperature and output of food grains and other crops were negatively associated with changes in the effective diversion payment.

The Normalized quadratic profit function approach for output supply and input demand for U. S. agriculture for the period 1951-82 were employed by Shumway et al (1988) indicated the complementary relationship between real estate and variable inputs, while some others were completing family and other variable inputs. In case of aggregated estimate, nearly all output relationships were competitive. All five output relationship had direct relationship with real estate while food grains and feed grains had shown inverse relationship with input prices. Oil crops with same variable input prices had increasing tendency with others. All variable input relationships were competitive in nature. It was concluded that the total output supply and input demand relationship were similar and highly inelastic.

Factor demand, output supply and constraints to dry land rice production in Ranchi district of Bihar were studied by Singh et al (1989), a two stage random sampling design was used to select 75 cultivators consisting of 30 marginal (less than 1 ha.), 25 small (1 to 2 ha.) and 20 other size group (above 2 ha.) farmers from Kanke block. Primary data on use and application of various inputs, production and prices of paddy crop, etc. were collected by survey method for year 1984-85. The study revealed that the own and cross price elasticities of human labour demand had the anticipated sign for all the three categories of farms. The absolute values of employment elasticities were found to be greater than unity on all three categories of farms, indicated there was an elastic response of human labour utilization to wage rate, one per cent increase in the wage rate, reduced labour employment by 2.86 per cent on marginal farms, 2.69 per cent on small farms and 1.31 per cent on other size group of farms. The cross price elasticities of human demand with respect to fertilizer price and fertilizer demand with respect to human labour were negative confirmed the complementarity between them in rice production. The study also indicated that the wage rate exerts greater influence on paddy supply than fertilizer price.

The demand for fertilizer and output response for Malawi's smallholder farmers was estimated by Chembezi (1990), the econometric analysis revealed that the response of fertilizer demand and output supply to own prices was much higher than cross-price responses. This study recorded insignificant statistical effect of fertilizer price on maize and tobacco outputs. However, the prices of these products significantly influence fertilizer consumption.

Farm prices and input demand on wheat farms in Haryana were studied by Goyal and Singh (1990) by using the data on cost of cultivation of wheat crop were collected from the comprehensive scheme in Haryana for the period 1984-85 to 1986-87. The study revealed that the profit function was decreasing with the increased in the prices of variable inputs and increasing with the increasing in the quantity of fixed inputs. The study further revealed that the effect of bullock labour price on human labour and fertilizer demand was -0.099 and 0.029 per cent respectively. This means that there was little effect of bullock labour price on the demand of human labour and fertilizers. However, as expected effect of wage rate on bullock labour demand was negative being -0.2970 per cent because labour cannot be used without human labour.

The human labour demand function with per hectare human labour used as dependent variable and farm size, use of pesticide, use of weedicides, irrigation intensity, level of production, wage rate and source of draft power i.e. tractor hours and bullock hours as independent variables by using two simultaneous equation model were estimated by Sidhu and Grewal (1990) revealed that the farm size had negative relationship with labour use in all zones as well as the State. The elasticity of human labour for farm size was -0.05, -0.06 and -0.02 respectively for different zones and the states as a whole. The study also revealed that the effect of tractor use on labour was not to be labour displacing in nature in the Punjab State, where as the use of weedicides in place of hoeing was labour saving in nature. One percent increase in the wage rate decreased human labour employment by 0.79 per cent in zone I, by 0.54 per cent in zone II, by 0.22 per cent in zone III and by 0.46 per cent for the whole state. The demand for human labour was decreased in these zones due to increased in the wage rate because farmers might have opted for mechanization and higher use of weedicides.

By using the translog cost function, the structure of agriculture in India were analysed by Paul and Mehta (1991) measured the factor demand, elasticities of substitution and biases of technical change for the period 1960-61 to 1982-83. The study revealed that the agricultural technology had been biased towards the use of labour and capital and towards the saving of fertilizer and other inputs. The study showed that there exist strong substitution possibilities between labour and capital and between capital and fertilizer but the demand for labour with respect to the wage rate was quite inelastic. The decomposition of changes over time in the factor input demand revealed that technological change had contributed significantly to the per year increase in labour and capital demand however the output effect had contributed most to the annual change in demand for fertilizer and other inputs in Indian agriculture.

A variable profit function with a view to determining the impact of input prices on profits and the consequent supply response of the farmers were estimated by Acharya (1992) by using Zellner's SURE iterative estimation method for a system of six equations which would require for joint estimation for obtaining efficient estimates. The study revealed that the own price elasticities of all the inputs with respect to profits from the crops possess the right sign except cotton seeds, but then it was statistically not significant. The study further revealed that the manure for sugarcane and bullock labour and seed for mustard were statistically insignificant while the human and animal labour price elasticities with respect to the variable profit were generally high for rainfed crops like groundnut, bajra, moong and gram compared to other crops.

Input costs, output prices and income policy simulation for major crops in Assam were studied by Talukdar (1994) by using the data from comprehensive scheme on cost of cultivation for Rice, jute, rapeseed and mustard. Time series data were collected compiled and analysed from the published report of the scheme pertaining from 1971-72 to 1986-87. The study revealed that the cost of production elasticities with respect to factor and production prices were positive and inelastic while the factor price elasticities with respect to labour were elastic for all selected crops. The prices of other factors excepting bullock wage in paddy were inelastic.

Farm prices and input demand on minor millets farms in Karnataka and effect of input and output price changes on demand for inputs on Jowar and ragi crops were studied by Reddy and Chengappa (1997) revealed that the variable inputs responded positively to the output price, except for human labour and fertilizer in Jowar. Irrigation expenditure and the endowment of land had positive in ragi, where as irrigation had negligible effect in Jowar. However, input demand was negatively affected by its price in most of the cases in both crops. On other hand, the effect of capital expenditure was more on bullock labour demand i.e.-0.24 than on human labour demand i.e.-0.034 indicating that the capital substitute bullock labour more strongly than human labour.

Farm output supply and input demand elasticities by using the translog profit function approach were estimated by Chaudhary et al (1998) and explored empirically the effects of changes in input output prices on output and employment. These estimates have been derived from a survey data of 484 irrigated farms scattered in rice, cotton and mixed cropping zones in Punjab. The input demand and output supply elasticities have been derived by applying the normalized translog profit function to each and all zones together. The study statistically showed that farmers maximise profit from farming subject to given input and output prices and quantities of fixed factors of production while the study revealed that the elasticities of labour and fertilizers with respect to output were greater than unity with many of them statistically significant and the cross price elasticities of these variables were negative indicated complementary relationship between them.

The normative factor demand equation from the Cobb-Douglas production function to estimate the factor demand was derived by Kumar (2002) revealed that the regression coefficient of concentrate input was positive and significant, but that for green fodder was positive and non-significant for all the breeds of milch animals. The own price elasticities of green fodder and concentrate had negative sign while the cross price elasticities of green fodder and concentrate were positive in all the breeds this confirmed the supplementary relationship between green fodder and concentrate in the milk production process. The study also revealed that the demand for green fodder and concentrate with respect to their price were quite inelastic suggested that a marginal change in the price level of green fodder and concentrate may not enhance consumption substantially in dairy farming.

Supply response and input demand on paddy farms in Haryana were estimated by Goyal and Berg (2003) and the estimated output supply and demand equations were used to obtain a set of own and cross price elasticities with respect to fixed factors for output and variable inputs. The study revealed that the own price elasticity of demand for variable inputs was estimated to be -0.27 for human labour and -0.39 for fertilizer demand. The study also revealed that the own price elasticity of paddy supply was found to be very small (0.10) which indicated that the output supply of paddy was not much influenced by changed in prices.

Input demand and output supply on wheat farms in Haryana State of India were estimated by Goyal and Berg (2004)[b] by using the profit function approach. The empirical results support the hypothesis of profit maximization. The study revealed that the own price elasticities of demand for human labour ranged from -0.46 in zone I to -0.29 in zone III and for fertilizer demand, it ranged from -0.42 in zone III to -0.21 in zone I. The study also revealed that the own price elasticity of wheat supply was found to be very small in the entire zone and land has the strong influence on wheat supply and output demand. The human labour demand was expected to decrease in zone I and zone II at the observed price structure.

The factor demand and output supply elasticities for major food crops in India were estimated by Kumar et al (2010) and these elasticities have been used to predict the domestic supply of major commodities viz. rice, wheat, pulse grains, nine major edible oilseeds and sugarcane. The elasticities provide insights on the responsiveness of output supply and factor demand to changes in product and factor prices. The study revealed that the human labour demand elasticity with respect to wage rate was significant for all crops, except sugarcane while the animal labour demand elasticity with respect to animal wage rate was negative and statistically significant for all crops, except pulse grains and it ranged from -0.15 for pulses to -0.78 for sugarcane. The study also revealed that the own price elasticity of demand for fertilizer was -0.24 for rice, -0.35 for wheat, -0.81 for pulses, -1.12 for oilseeds and -0.43 for sugarcane. Taking all the crops together, with 10 per cent rise in its price, the demand for fertilizer would get reduced by 6.5 per cent on an average.

Mathematical modeling for demand and supply estimation were studied by Shende and Shinde (2010) by using the cross sectional cum time series data of assured rainfall zone (zone VII) of Vidarbha region for soybean crop for the eleven years from 1997-98 to 2007-08 were collected from the Agricultural Prices and Cost scheme, Department of Agricultural Economics and Statistics, Dr. PDKV Akola by keeping in view to study the change in factor and product prices, cost and return and to estimate factor demand and output supply by using normalized Cobb-Douglas profit function. The study revealed that, the gross income from soybean increased at an annual rate of 9.826 percent per annum. The ratio was increased from 0.938 in 1997-98 to 1.559 in 2007-08. The effect of wage rate was more on bullock labour demand (-0.390), while the effect of bullock labour price on human demand was low (-0.167). This indicates the one way complementarity between bullock labour and human labour. The study also revealed that among fixed factor, capital was found to be very effective in increasing the supply of soybean while output supply elasticity with respect to capital was elastic.

2.3. Marketed surplus of selected crops.

The nature of relationship between output and marketable surplus were examined by Rajkrishna (1965). The output was considered to represent farm size. The study revealed that the income as the second most important factor after output influencing marketable surplus. The elasticity of marketable surplus at subsistence level with respect to output was found to be more than unity. The author was of the opinion that any change in farm size in the direction of larger farms increased the marketable surplus.

Krishnan (1965) reiterated inverse relation between prices and marketable surplus. However, the proof provided suggested that distress sales among the farmers had not dwindled.

Price elasticity of the marketed surplus of a subsistence crop was worked out by Behrman (1966) estimated the supply response of food grains in the agricultural sector of less-developed countries. They presented a model for the indirect estimation of the price elasticity of the marketed surplus of a subsistence crop. The model was contracted with an earlier model presented by Raj Krishna and then applied to the case of Thai rice. The study revealed that the model suggested by Behrman gives negative estimate of the price elasticity of the marketed surplus of Punjabi wheat, while Krishna's model gives a positive estimate of price elasticity of the marketed surplus of Punjabi wheat. The study also revealed that there was a statistically significant positive short-run price response in both total and marketed surplus of Thai rice.

Behrman (1968) critically reviewed Rajkrishna model and suggested improvements. The implications of using these models for wheat were discussed. In the model, output was considered price of other crops. The consumption was considered to be a function of income and the own price relative to the aggregate price of other commodities. Income from all the sources was taken as the net income. Behrman model when applied to wheat in Punjab resulted in the elasticity of marketed surplus being negative, whereas, in Rajkrishna model it was not negative.

The marketed surplus of paddy at the farm level in four East Indian villages viz. Golta and Dakshinsiza from West Bengal and Lenda and Pudapalli from Orissa were studied by Mandal and Ghosh (1968). The data for this study were collected in the course of field investigations conducted in 1960 under scheme of continuous village surveys. The study revealed that in each village the elasticity of sale with respect to size of holding was greater than unity while marginal propensity to sell increased with an increased in size of holding. The study also revealed that marketed surplus would increase with an increased in farm size and also output. In spite of the fact that marketed surplus of paddy was responsive to increased in the total receipt of the crop, a substantial amount of net balanced after all disposal was held in stock by the farmers.

Price and output response of marketed surplus of food grains were studied by Bardhan (1970) with the data collected from twenty seven villages of Punjab and Uttar Pradesh related to the marketed proportion of food grain production and some of the major economic factors that might influence it. The study revealed that the linear regression estimates of marketed proportion of production on grain production were positive and significant while for grain price it was negative and significant throughout. The study also revealed that the regression coefficient of the marketed proportion of production on production itself was significantly positive however the negative sign of the price response marketed surplus as a proportion of production. This negative response of marketed proportion of production to changes in food grain price was net of the effect of changes in the price ratio and the output ratio between food grains and other crops.

By using the data from National Sample Survey (N. S. S.) and other official records for constructing the time series of marketed surplus of cereals and consumption, Bardhan and Bardhan (1971) used a log linear equation for empirical analysis of the data. The marketable surplus was considered to be dependent on the price of cereals relative to prices of consumables, other agricultural products and other non price shift parameters. The study revealed that for the period, 1952-53 to 1964-65, the elasticity of marketed proportion of cereals to price of consumables was found positive and near unity. It was negative in relation to prices of commercial crops and technological parameters.

The relationship between marketable surplus and total quantity to be used were examined by Bhargava and Rustogi (1972) by using regression analytical technique. In order to examined the suitable empirical relationship between the production and the marketable surplus, a number of hypothetical models, namely linear, quadratic, Cobb-Douglas and square root functions were fitted to each size group as well as for the totality of the sample cultivators. The study revealed that the variation in the marketable surplus explained by the independent variable, viz. production were 23, 32, 57 and 64 per cent for the four size groups respectively while it was 61 per cent for the aggregate level. The study also revealed that the regression coefficients for each size group as well as at aggregate level were significant and marketable surplus was positively related to the production.

By using farm survey data, a regression analysis of marketed surplus of rice in Philippines were carried out by Toquare et al (1975) indicated that allocation of rice between home consumption and market sale by the producers was not sensitive to price changes. This study supported the phenomenon that the effect of price change on supply of marketable surplus was positive. Further, it was concluded that the marketable surplus increased more than proportionately with increase in output of paddy.

The behavior of marketed surplus of paddy in Taiwan were analysed by Chinn (1976). The total output was decomposed into quantity sold; quantity stored for consumption, quantity paid in kind and stock up to the end of the year. The estimates of price and output elasticity for different components of total marketed surplus and for farm consumption were estimated using simple log linear models. The study revealed that the price elasticity of total market surplus in the short run was 0.22 and for consumption it was -0.35 while, the effect on output was reported to be 0.37 in the long run. The elasticity of marketed surplus included the induced effects.

The various factors responsible for marketable surplus and prices obtained by the farmers to paddy crop in the tribal areas of Bhandara district of Maharashtra State were examined by Deshpande et al (1979) and measures the factors responsible for marketable surplus, a multiple regression equation was fitted to the data. The study found that the small farmers were particularly handicapped due to constraints like capital, their level of technical know-how and their contacts with extension agencies. The study also found that medium and large farmers had received 6.08 per cent and 18.92 per cent more price than that received by the small farmers. Finally the study ascribed reasons for getting low prices to the small farmers were high proportion of quantity marketed with in the first two months after harvesting and sale of produce (5.67 per cent) to the village traders.

The relationship between price and marketed surplus of rice by including stock quantity using the data from Tanjavur district of Tamilnadu for the year 1968-69 were analysed by Pushpangadan (1979). In this study, distinction was made between the price elasticity of marketed distress surplus and marketed commercial surplus. The study concluded that incase of large farmers the price elasticity of marketed surplus without stock behavior was both negative and positive, where as with stock it was positive. The medium size farmers behaved both normally and perversely to price changed. However, the responses of small farmers to price were negative.

The analysis of marketed surplus response to factor price changes were consequently developed by Janvry and Kumar (1981) and then estimated the elasticities of supply response and derived demand for factors for set of farms in the Delhi Union Territory. These estimates were used to calculate the marketed surplus response to factor price changes. The study revealed that the elasticity of marketed surplus with respect to wheat price are negative for all small farms (-0.23) and positive for large farms (0.26), for small farms, the negative elasticity is due to the fact that the marketed surplus adjustment to higher wheat price was dominated by the income effect in consumption, which was negative on the marketed surplus. The study also revealed that on the large farms the income effect was small and the positive output response to higher wheat price dominates the adjustment in marketed surplus.

The marketed surplus of paddy was studied by Harriss (1982) concluded that the 76 per cent of all cultivators with five acre provided 30 per cent of total surplus and 98 per cent of farmers with under 17 acres provided 92 per cent of total surplus. The study also concluded that the cultivators with small families contribute more to the marketed surplus than those with large families.

The marketed surplus of wheat and paddy by farm size in Punjab were studied by Dhindsa and Singh (1983) revealed that the small and medium farmers held a large percentage of their production of food-grains for family needs and other payments compared to the large farmers while large percentage of wheat production was retained at the farm level compared to paddy. The study also found that the small farmers sold a relatively large percentage of their marketed surplus of wheat as compared to large farmers.

The relationship between production, consumption and size of holding with marketable surplus by using regression analysis was analysed by Reddy (1987). A multi-stage random sampling design was used to select three out of six villages and 59 farmers from the three villages. The data were collected by survey method for a period from 1st July 1980 to 30th June 1981. The study revealed that there were positive and significant elasticities for area under paddy and size of operational holding on large size group only while negative elasticities were observed for size of family. In this study the values of coefficient of multiple determinations indicated that there was an 86.47 per cent variation in marketable surplus among small farmers, 90.41 per cent among medium farmers and 91.22 per cent on all farms together. The elasticities also indicated the specified percentage change in the quantity of marketable surplus of paddy for 1:1 change in the particular specified variable.

By using the Janvry and Kumar's marketed surplus model Kumar and Mruthyunjay (1989) measured the effect on factor prices, besides product prices on marketed surplus with specific objective was to analyses the impact of price and non price factors on marketed surplus. The elasticities of output supply, marketed surplus, crop income and consumer demand were also estimated in the study. The study also revealed that the marketed surplus was increase at the rate of 1.13 percent for paddy and 1.23 percent for wheat for every one percent increase in pure inflation. The price elasticity of crop was highly elastic. With one percent increase in product price, the crop income was increase by 2.8 percent for paddy and 2.9 percent for wheat.

The behaviour marketed surplus to change in prices and non-price factors like irrigation, acreage and productivity for formulating agricultural policy were studied by Chavan et al (1999), for the selection of farmers, three stage stratified random sampling was used with Tehsil as primary unit, village as secondary unit and farmer as an ultimate unit. The study revealed that as production increased by one quintal per hectare, the marketed surplus increased by 0.58 quintals. Also as area under paddy increased by one hectare, the marketed surplus increased by 4.57 quintals significantly. The study also revealed that the regression coefficient for home consumption and size of family were negative and significant. This indicated that as home consumption increased by one quintal, the marketed surplus decreased by 0.42 quintals and as family size increased by one, the marketed surplus decreased by 0.69 quintals. For the other variables like size of holding and seeds, the regression coefficients were non-significant.

The marketed surplus response of cereals in Haryana state of India were analysed by Goyal and Berg (2004)[a] by using a model that consider the effect of both factor and output prices on marketed surplus. The study revealed that at the observed price structure, the marketed surplus of wheat was increase almost equal to population growth but in case of paddy it was grow at a very low rate. The study further revealed that besides price adjustment, technological improvement and non-price factors are also of critical importance for increasing output supply and hence marketed surplus.

CHAPTER III

METHODOLOGY

The study has been undertaken to estimate the input demand and output supply for the selected crops in Vidarbha region. The study further attempted to assess the marketed surplus of selected commodities in Vidarbha. The statistical tools and techniques employed in this study are also highlighted. The whole chapter is presented under following subheadings.

3.1. Study area and sample

3.2. Selection of crops

3.3. Definition of variables

3.4. Index of input prices

3.5. Analytical approach

3.6. Specification of model

3.1. Study area and sample

The Agricultural Prices and Cost (APC) scheme under the guidance of government of Maharashtra provides valuable data about agriculture in Maharashtra. The data maintained by APC is made use of in the present study. The APC make use of a three stage stratified random sampling procedure with tahsils as the primary unit, cluster of three villages as the secondary unit and operational holding within the cluster as the third and ultimate unit. The present study used cross sectional cum time series data of Vidarbha region for the selected four principle crops for the ten years i.e. from 1999-00 to 2008-09. Every year 100 farmers were selected for each crop for the present study. The recording of data is done by village level investigators through daily visit of the selected farm families. The scheme is involved in the collection of representative data on input use and yield and there upon estimation of cost of cultivation of principle crops grown in the region.

Data is collected every year and for all the enterprises. Although, the samples for particular year are selected with respect to specified principle crops. The data were collected for all the crops grown on the sample holdings.

For the present study, the data on cotton, paddy, soybean and Sorghum were obtained from the scheme. The relative importance of these crops in Vidarbha region is presented in Table 3.1.

Table 3.1: Area under selected crops in Vidarbha

Crops	Area under selected crops of Vidarbha ("00" ha)		Per cent to GCA		Area under selected crops in Sample		Per cent to GCA	
	1999-00	2008-09	1999-00	2008-09	1999-00	2008-09	1999-00	2008-09
Cotton	16415	11260	26.84	18.93	127.08 (0.77)	99.86 (0.89)	0.21	0.17
Soybean	9569	20403	15.65	34.29	126.73 (1.32)	213.14 (1.04)	0.21	0.36
Paddy	6796	7380	11.11	12.40	141.36 (2.08)	105.73 (1.43)	0.23	0.18
Jowar	7934	2889	12.97	4.86	96.94 (1.22)	59.64 (2.06)	0.16	0.10
Total	40714	41932	66.57	70.48	492.11 (1.21)	478.37 (1.14)	0.80	0.80
GCA	61161	59493	100.00	100.00	-	-	100.00	100.00

(Figures in parentheses indicate per cent to the area under selected crops of Vidarbha)

It is obvious from the table that all crops grown in Vidarbha region during Kharif seasons. The data on input use, yields, input and output prices and information on marketed surplus were obtained for the years 1999-00 to 2008-09.

3.2. Selection of crops

For the present study the four major crops of Vidarbha region were selected. The selected crops occupied about 70 per cent area of the gross cropped area. These crops are Cotton, Soybean, Sorghum and Paddy.

3.3. Definition of variables

A brief description and abbreviation of the variables used in this study are as follows

Q = Physical output of particular crops measured in quintal per hectare. It includes main product as well as by-product. By product were converted into quintals of crop equivalent output by dividing the total value of by-product by the price of the main product.

N = Human labour hours used per hectare for particular crop. It includes both the hired and family labour. Woman hours were converted into man hour's equivalent by treating 1.5 women hours equal to one man hour.

B = Bullock labour in hours of the bullock pairs used per hectare for particular crop. It includes both owned and hired bullock pair labour.

X = Total quantity of plant nutrients ($N + P_2O_5 + K_2O$) measured in kilogram per hectare for particular crop.

F = Farm yard manure per hectare measured in quintals.

S = Total quantity of seed measured in kilogram per hectare for particular crop.

K = A measure of flow of capital services. It includes machinery and depreciation charges, imputed value of interest, seed cost and certain operating expenses not consider else-where.

L = Area planted under the crop measured in hectares.

w.N	=	Total wage bill in rupees per hectare. It includes actual payment made to hired human labour and the imputed value of service of family labour
b.B	=	Total bullock labour wage bill in rupees per hectare for particular crop.
r.X	=	The total fertilizer bill in rupees per hectare for particular crop.
s.S	=	The total cost of seed per hectare for particular crop
m.F	=	The total cost of farm yard manure valued.
w	=	Wage rate in rupees per man hour. It was obtained by dividing total wage bill (w.N) by total human labour hours.
b	=	Total bullock labour rate for a bullock labour hour. It was obtained by dividing total wage bill (b B) by total bullock labour hours.
r	=	Price of plant nutrients in rupees per kilogram. It was obtained by dividing the total cost of fertilizer (r.X) by total quantity of plant nutrients.
s	=	Total rate of the seed in rupees per kilogram. It was obtained by dividing the total cost of seed (s.S) by total quantity of seed.
m	=	Price of FYM per quintal in rupees. It was obtained by dividing the total Cost of farm yard manure by the total quantity of (M) used per hectare for particular crop.

3.4. Index of input prices

To study the temporal variation in input and output prices and cost of cultivation, the simple tabular analysis was carried out by using standard cost concept.

The input price indices are composite indices of prices of individual items of inputs. The indices were constructed using the cost of cultivation data for the period of last ten years with average of first triennium ending as the base year. First, the price indices of inputs of seed, labour, bullock labour, fertilizer, farm yard manure, capital, pesticide, depreciation and rental value of land were constructed.

The composite indices of input prices for Cotton, Paddy, Soybean, and Sorghum crops were constructed as

$$\text{Index of Input Price} = \sum_{i=1}^{9} S_i \left(\frac{P_{it}}{P_{io}} \right)$$

Where,

Si = average share of i^{th} input in total input cost

P_{it}/P_{io} is the price index of i^{th} input in the t^{th} year using average of first triennium as the base year,

i=1stands for Human wage index,

i=2 Bullock wage index,

i=3 Fertilizer price index,

i=4 FYM price index,

i=5 seed price index

i=6 Interest rate index,

i=7 Pesticide expenditure index,

i=8 Depreciation charges index, and

i=9 Rental value of land index.

3.5. Analytical Approach

3.5.1. Changes in input and output prices and cost of cultivation

The data were subjected to tabular analysis to study the changes in input and product prices, cost and returns for cotton, paddy, soybean, and sorghum. Simple tabular analysis has been used to analyze the structural changes in the cost of cultivation of selected crops. Cost structure of each crop was analysed by working out the share of each item of cost in the total cost of cultivation. The changes in the structure of cost of cultivation of crops were assessed by comparing the cost structure of each crop during the latest years with that of early years. The share of total temporal change as assignable to individual cost components has also been ascertained.

The cost of production of the grain yield on per quintal basis has been worked out after the apportionment of total cost of cultivation between the main product and the by-product in proportionate to their contribution to the gross value of output. The cost of production per quintal is obtained by dividing the cost of cultivation attributable to the main product by the grain yield on unit area basis. The compound growth rate of values between the initial year and the later year has also been worked out by using formula

$$Y = ab^t$$

Where,

Y = Quantity / prices of inputs / yield / prices of output / value of output / cost of production.

a = Intercept

b =Regression coefficient

t = Time variable

From the estimated function the compound growth rate was worked out by –

$$CGR\ (r) = [\text{Antilog}\ (\log b) - 1] \times 100$$

Where,

r = Compound growth rate

3.5.1.1: Constant prices

The original data of costs of inputs and prices were adjusted for inflation by using the general price index numbers gives the data at constant prices. The general price index numbers with the base 1993-94 were collected (Table 3.2) spliced and base shifted to selected year (1999-00) as shown in Table 3.3. The inverse of this price index number gives the purchasing power of rupee from which one can derive new series at constant prices.

Table 3.2: General Price Index number

Base year (1993-94)	General price indices
1993-94	100.0
1994-95	109.1
1995-96	123.3
1996-97	130.8
1997-98	139.5
1998-99	145.2
1999-00	154.9
2000-01	162.7
2001-02	167.0
2002-03	176.6
2003-04	193.8
2004-05	201.2
2005-06	210.1
2006-07	216.0
2007-08	237.0
2008-09	247.3

(Source : Ministry of Agriculture, Govt. of India)

Table 3.3. Purchasing power of rupee after splitting and base shifting of general price index number

Year	After splicing	After base shifting	Purchasing power
1999-00	154.9	100.00	1.00
2000-01	162.7	105.04	0.95
2001-02	167.0	107.81	0.93
2002-03	176.6	114.01	0.88
2003-04	193.8	125.11	0.80
2004-05	201.2	129.89	0.77
2005-06	210.1	135.64	0.74
2006-07	216.0	139.44	0.72
2007-08	237.0	153.00	0.65
2008-09	247.3	159.65	0.63

System of Input demand and output supply Equations

A system of output supply, input demand and marketed surplus equations were estimated for fulfilling the objectives of the study. The available knowledge on theory of production highlights two alternatives for estimating the output supply and input demand equations. These possible alternatives are

1) Production function analysis
2) Profit function analysis

3.5.2. Production function analysis

The production analysis runs parallel to the process of firm operations, with the firm seeking to maximize profit or other goals subject to technology and economic environment or prices. The results are derived input demand and output supply which are expressed as a function of prices and technology.

In the production function approach, first the production function is estimated from the physical input and output data. Then the marginal physical products for different factor inputs are calculated from the estimated production function. Marginal value products of these variable inputs are equated with their prices and all the relation of marginal value products are simultaneously solved to provide normative factor demand function, which are expressed in terms of prices and fixed factors. These normative demand functions, when substituted into estimated production function give the normative supply function.

Consider a firm with production function with Neo-classical properties:

$$Q = F(X, Z) \quad \text{-------------------} \quad (1)$$

Where, Q is physical output, X is a vector of variable input quantities and Z is a vector of fixed inputs. The marginal productivity condition for profit maximizing firm is,

$$\frac{\partial F\,(X,Z)}{\partial X} . P = p \text{ ----------------- (2)}$$

Where, p is vector of variable input prices and P is nominal price of output.

The marginal productivity condition in (2) can be solved for the optimal quantities of variable input (x), as a function of product and factor prices and quantities of fixed factor (z). The optimal quantities of variable input (x) are given as

$$X^{*} = X\,(P,\, p,\, Z) \text{ ------------------ (3)}$$

Substituting (3) in production equation (1), the normative supply function will be,

$$Q^{*} = F\,(P,\, p,\, Z) \text{ ------------------ (4)}$$

In the production function specification, the explanatory variables always include both jointly dependent and independent variables. Thus, the production function is one of a system of simultaneous equations. The single equation least square method for estimating the production model yields biased and inconsistent estimates of the parameters. Further derivation of output supply and factor demand equations involved tedious derivations.

3.5.3. Profit function Analysis

The theory of profit function, developed to helps in overcoming the problem of simultaneous equation bias, if present. Another distinct advantage of this approach over production function is that with the help of duality theorem (Shephard, 1953), the variable factor demand function and supply function of products can be derived directly from the estimated profit function. Econometric application of this production theory based on duality between production function and variable profit function is a breakthrough in the theory of production. Shepherd's Lemma (1953) applies equally to profit functions, which states that the partial derivative of profit function with respect to output and input prices give the supply and demand function, respectively.

The duality between production function and normalized profit function has been established under rather general circumstances by Mc. Fadden (1963).

It has been shown that there exist a one to one correspondence between the set of concave production function and set of convex profit functions. Every concave production function which satisfies certain assumption has a dual which is convex profit function and vice-versa.

Lau (1978) has derived properties of the class of normalized profit functions which correspond to the class of production functions and gives proof of assumption, that the production functions { Q= F (X,Z)} is concave in X, continuous and monotonically increasing in X and Z, and twice differentiable in X and differentiable in Z.

The variable profit (or returns to fixed factors) from a crop is equal to total revenue less total variable costs.

$$\pi = P.Q - p' \text{ -------------------- } (5)$$

$$\pi = P.F\ (X, Z) - Xp'$$

$$\pi = P.F\ (X, Z) - Xq' \text{ ----------- } (6)$$

Where,

π is variable profit and P is nominal price of output.

$q_i = p_i/P$, is normalized price of i^{th} variable input and X, Z and q are vectors of X_i's, Z_i's and q's.

It is assumed that the objective of production activity of the firm is maximization of short run profit and that the firm is price taker in output and input markets. Thus the firms maximize profit with respect to use of x taking P, p and z as exogenous. First order conditions for the profit maximization of the firms are obtained as;

$$\frac{\partial \pi}{\partial Xi} = 0, \quad \text{For } i = 1, 2\text{-------}n$$

$$\frac{P.F\,(X,Z)}{Xi} = pi, \text{ For } i = 1, 2\text{-----}\ n \text{ --------------- } (7)$$

Equation (7), when solved for optimal values of xi (i = 1, 2, ------ n) provides the factor demand equation as,

$$X^* = X\,(P, p, Z) \text{ --------------------- } (8)$$

Where, X* are optimal quantities of variable inputs.

By substituting optimal values of xi from (8) into (6) one get profit function

$$\pi = g\,(P, p, Z) \text{ ---------------------- } (9)$$

The profit function (9) gives the maximized value of profit for each set of values (P, p, Z). It is decreasing and convex in p, and increasing in P and Z.

For econometric and theoretical work, it is easier to work with normalized profit function as developed by Lau (1969) because the number of variables is reduced by one and also the choice of functional form is wider. When working with profit function one has to choose functional forms which are homogenous of degree one in all prices, whereas, this is not necessary for normalized profit function. The profit maximizing problem is not attered if both sides of (6) are divided by output price and written as;

$$\pi^* = F\,(X, Z) - Xq' \text{ --------------- } (10)$$

Where $\pi^* = \frac{\pi}{p}$, is normalized profit and $qi = \frac{pi}{P}$, are the normalized factor prices.

One can again derive first order condition of normalized profit maximization and factor demand function as before in terms of relative rather than absolute factor prices. Substituting the optimal quantity of factors, which is given by the equation $X^* = X\ (q, z)$, into equation (10), the normalized profit function in terms of relative prices is obtained as;

$$\pi^* = G\ (q, z) \text{ -------------------- } (11)$$

Once the profit function (11) is estimated, it contains all the information embodied in the production function underlying it.

The usefulness of the normalized profit function arises out of Shephard's (1953) or Hotelling's (1932) Lemma which asserts that the negative of the first derivative of the normalized profit function with respect to the normalized input prices is the optimal input quantity or factor demand function.

$$-\left(\frac{\pi *}{qi}\right) = X_i^* = X_i^*\ (q, z) \text{ ---------------- } (12)$$

$$i = 1, 2, - - - - n$$

In stand of having to solve a system of simultaneous equation as in the case of production function approach; one can get factor demand equations simply as the negative of the first derivative of the normalized profit function with respect to normalized factor prices.

Similarly, from the definition of the normalized profit (10), the output supply equation can be obtained as;

$$Q^* = \pi^* + \sum_{i=0}^{n} qi.xi^*$$

$$= \pi^* \sum_{i=1}^{n} \left(\frac{\pi^*}{qi}\right).qi \text{ ---------- } (13)$$

Thus, given the equation for normalized profit and factor demand, the output supply equation can be obtained from (13).

Output supply functions can also be obtained by taking first derivative of profit function (9) with respect to product price. Shephard's Lemma (1953) also asserts that first derivative of profit function with respect to output price gives output supply function. Thus output supply function will be given as;

$$Q^* = \frac{(P,p,Z)}{P} = Q\ (P, p, Z) \text{------------ } (14)$$

Estimates of all the parameters can be obtained from normalized profit equation (11). Alternatively, one can obtain the parameters of the factor demand, as shown in equation (12). Under the hypothesis of profit maximization and price taking behaviour of the firm, the parameters in equation (11) are equal to corresponding parameters in equation (12). Lau and Yotopoulas (1972) pointed out that due to the presence of common parameters in profit and factor demand equations, they should be estimated jointly imposing the restriction that common parameter in both the equation are equal.

3.6. Specification of the Model

The theory and application of profit function approach have been developed at length by Lau and its various forms were used by researcher workers Lau and Yotopoulas (1972), Sidhu (1974), Janvry and Kumar (1981), Thakur (1982), Das (1985) and Shende and Shinde (2010) have employed Cobb-Douglas formulation of profit function and in the present study also, Cobb-Douglas formulation of the profit function was used.

3.6.1. Formulation of normalized profit functions in Cobb-Douglas version

Let the Cobb-Douglas production function with usual neo-classical properties be written as

$$Q = A \; N^{\alpha 1} B^{\alpha 2} \; X^{\alpha 3} F^{\alpha 4} S^{\alpha 5} K^{\beta 1} L^{\beta 2} \; U \text{ ---------- } (15)$$

Where, (Q) is output of crop, human labour (N), Bullock labour (B), chemical plant nutrients (X) , farm yard manure (F) and seed (S) are the variable input and capital input (K) and Land (L) are fixed input, and U is error term.

When working with profit function one has to choose functional forms which are homogenous of degree one in all prices, whereas this is not necessary for normalized profit function. The profit function formulation suggested by Lau and Yotopoulos (1972) enables us to derive factor demand as a function of normalized input rates and the quantities of fixed inputs.

Invoking the theory of profit function, the normalized profit function for the above production function can be written as below.

$$\frac{\pi}{P} = A^{*} \, (w/P)^{\alpha_1^*} (b/P)^{\alpha_2^*} (r/P)^{\alpha_3^*} (m/P)^{\alpha_4^*} (s/P)^{\alpha_5^*} \, K^{\beta_1^*} L^{\beta_2^*} \, U$$

OR

$$\pi^{*} = A^{*} \, w^{*\alpha_1^*} b^{*\alpha_2^*} \, r^{*\alpha_3^*} m^{*\alpha_4^*} \, s^{*\alpha_5^*} \, K^{\beta_1^*} L^{\beta_2^*} \, U \text{ ----}(16)$$

Where,

$$A^{*} = (1-\alpha)^{\theta} \alpha_1^{\alpha 1} \, \alpha_2^{\alpha 2} \, \alpha_3^{\alpha 3} \alpha_4^{\alpha 4} \alpha_5^{\alpha 5} \text{ -------------- } (17)$$

$$\alpha = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 \quad \theta = (1-\alpha)^{-1}$$

$$\alpha_1^* = -\,\alpha_1 \theta < 0 \text{ ---------------------------- } (18)$$

$$\alpha_2^* = -\alpha_2 \theta < 0 \text{ ---------------------------- } (19)$$

$$\alpha_3^* = -\alpha_3 \theta < 0 \text{ ------------------------- } (20)$$

$$\alpha_4^* = -\alpha_4 \theta < 0 \text{ -------------------------- } (21)$$

$$\alpha_5^* = -\alpha_5 \theta < 0 \text{ -------------------------- } (22)$$

$$\beta_1 = \beta_1\theta > 0 \text{ ----------------------------- } (23)$$

$$\beta_2 = \beta_2\theta > 0 \text{ ----------------------------- } (24)$$

$$\theta = 1 - \alpha_1^* - \alpha_2^* - \alpha_3^* - \alpha_4^* - \alpha_5^*$$

Where $\pi^* = \pi/p$ =normalized profit or output price (UOP) profit, w^* is the normalized wage rate, b^* is the normalized bullock labour price, r^* is the normalized fertilizer price, m^* is the normalized farm yard manure price and s^* is the normalized seed price. The relationship in parameters of production function given above clearly shows that the parameters of production function (15) and normalized profit function (16) are closely related. From the estimated parameters of normalized profit function and by using the identities (18) to (24), one can derive the estimates of production elasticities of human labour, bullock labour, fertilizer, farm yard manure, capital services land and intercept terms of the production function.

3.6.2 Input demand and output supply function

Demand equation for human labour, bullock labour, fertilizer, farm yard manure, and for seed was estimated. Shepherd's Lemma (1953) asserts that the first order negative derivative of the normalized profit equation with respect to normalized wage rate, bullock labour price, fertilizer price, farm yard manure price and seed price respectively, gives the derived factor demand function. The factor demand equation in case of Cobb-Douglas type normalized profit function was given as

i) Human labour demand equation

$$-\frac{\pi^*}{w^*} = -\alpha_1^* \left(\frac{\pi^*}{w^*}\right) = N$$

$$\text{or } \frac{w^* N}{\pi^*} = -\alpha_1^* \text{ -------------------- } (25)$$

ii) Bullock labour demand equation

$$-\frac{\partial \pi^*}{\partial b^*} = -\alpha_2^* \left(\frac{\pi^*}{b^*}\right) = B$$

$$\text{or } \frac{b^* B}{\pi^*} = -\alpha_2^* \text{ ---------------------- (26)}$$

iii) Fertilizer demand equation

$$-\frac{\partial \pi^*}{\partial r^*} = -\alpha_3^* \left(\frac{\pi^*}{r^*}\right) = X$$

$$\text{or } \frac{r^* X}{\pi^*} = -\alpha_3^* \text{ ---------------------- (27)}$$

iv) Farm yard manure demand equation

$$-\frac{\partial \pi^*}{\partial f^*} = -\alpha_4^* \left(\frac{\pi^*}{f^*}\right) = F$$

$$\text{or } \frac{f^* F}{\pi^*} = -\alpha_4^* \text{ ---------------------- (28)}$$

v) Seed demand equation

$$-\frac{\partial \pi^*}{\partial s^*} = -\alpha_5^* \left(\frac{\pi^*}{s^*}\right) = S$$

$$\text{or } \frac{s^* S}{\pi^*} = -\alpha_5^* \text{ ---------------------- (29)}$$

Substituting π* from identity (16) into (25) to (29), the demand equation can be written as:

Labour demand equation

$$N = -\alpha_1^* A^* (w^*)^{\alpha_1^*-1} b^{*\alpha_2^*} r^{*\alpha_3^*} m^{*\alpha_4^*} s^{*\alpha_5^*} K^{\beta_1^*} L^{\beta_2^*} \text{ ---- (30)}$$

Bullock labour demand equation

$$B = -\alpha_2^* A^* w^{*\alpha_1^*} (b^*)^{\alpha_2^*-1} r^{*\alpha_3^*} m^{*\alpha_4^*} s^{*\alpha_5^*} K^{\beta_1^*} L^{\beta_2^*} \text{ ---- (31)}$$

Fertilizer demand equation

$$X = -\alpha_3^* A^* w^{*\alpha_1^*} b^{*\alpha_2^*} (r^*)^{\alpha_3^*-1} m^{*\alpha_4^*} s^{*\alpha_5^*} K^{\beta_1^*} L^{\beta_2^*} \text{ ----- (32)}$$

Farm yard manure demand equation

$$F = -\alpha_4^* A^* w^{*\alpha_1^*} b^{*\alpha_2^*} r^{*\alpha_3^*} (m^*)^{\alpha_4^*-1} s^{*\alpha_5^*} K^{\beta_1^*} L^{\beta_2^*} \text{ ---- (33)}$$

Seed demand equation

$$S = -\alpha_5^* A^* w^{*\alpha_1^*} b^{*\alpha_2^*} r^{*\alpha_3^*} m^{*\alpha_4^*} (s^*)^{\alpha_5^*-1} K^{\beta_1^*} L^{\beta_2^*} \text{ ---- (34)}$$

3.6.3. Output Supply Function

Shepherd's Lemma (1953) asserts that first order derivative of profit function with respect to output price gives output supply function.

$$\frac{\pi}{P} = \theta \left(\frac{\pi}{P}\right) = Q \text{ or } \frac{P.Q}{\pi} = \theta$$

The output supply function in the form of Cobb-Douglas production function was written as

$$Q = A\,\theta P^{\theta-1} w^{*\alpha_1^*} b^{*\alpha_2^*} r^{*\alpha_3^*} m^{*\alpha_4^*} s^{*\alpha_5^*} K^{\beta_1^*} L^{\beta_2^*} \text{ ------ (35)}$$

The above equation was giving the output supply with respect to output prices, wage rate, bullock labour price, fertilizer price, farm yard manure price, seed price and price of capital input.

3.6.4 Joint estimation of Cobb-Douglas profit functions and factor demand

The normalized profit function and factor demand functions for human labour, bullock labour, fertilizer, farmyard manure and seed were jointly estimated using Zellner's method (1962) for estimating 'Seemingly Unrelated Regression Equation (SURE)' by imposing the restriction that α_1^*, α_2^*, α_3^*, α_4^* and α_5^* are equal in both the normalized profit function and relevant factor demand equations.

By using SURE method the coefficient were estimated as

$$\hat{\alpha}_{SURE} = (X' V^{-1} X)^{-1} X' V^{-1} Y$$

Where, X is independent variable and Y is dependent variable

$$V = \Sigma \otimes I_N$$

Where, $\sum$ representing the covariance of residual between the equations, $\otimes$ is the Kronecker product and I_N is the identity matrix of number of observations.

3.6.5. Impact of observed changes

The theory of profit function provides a set of factor demand and output supply equations. The factor demand of selected crop for i^{th} variable factor is as:

$$Xi = X (P_Q, w, b, r, m, s) \qquad i = 1, 2, 3, 4, 5.$$

The output supply equation for selected crops is as

$$Q = Q (P_Q, w, b, r, m, s)$$

Where, P_Q is the output price Suffix i = 1 for human labour, 2 = bullock labour, 3 = Fertilizer, 4 = Farmyard Manure and 5 = Seed.

Taking the total differential of above equations and writing in terms of growth rates.

$$\dot{X}\iota = E_{Xi}^{PQ}.\dot{PQ}+E_{Xi}^{w}.\dot{w}+E_{Xi}^{b}.\dot{b}+E_{Xi}^{r}.\dot{r}+E_{Xi}^{f}.\dot{f}+E_{Xi}^{s}.\dot{s}+E_{Xi}^{K}.\dot{K}+E_{Xi}^{L}.\dot{L} \text{ --- (36)}$$

$$\dot{Q} = E_{Q}^{PQ}.\dot{PQ}+E_{Q}^{w}.\dot{w}+E_{Q}^{b}.\dot{b}+E_{Q}^{r}.\dot{r}+E_{Q}^{f}.\dot{f}+E_{Xi}^{s}.\dot{s}+E_{Q}^{K}.\dot{K}+E_{Q}^{L}.\dot{L} \text{--- (37)}$$

The dot on the variable indicates the rates of change (growth rate) in the variable. E is the parameters of the elasticities of factor demand and output supply. (i.e. E_X^Z denotes elasticity of X with respect to changes in exogenous variable Z). P. Kumar and Mruthyunjay (1989).

3.6.6. Marketed Surplus Model

The response of marketed surplus to product and factor price movements was assessed by using appropriate model.

Rajkrishna (1965) and Behrman (1968) initiated studied relating to marketed surplus response to product price movements. These studies did not take into consideration the effect of price of factors and hence have limited use for meaningful design of policies of product price adjustments.

In the present study, the model of marketed surplus response developed by Janvry and Kumar (1981) was used. The formulation of the model and its estimation are outlined below.

Marketed surplus M in this study is defined as total production less the quantities of output retained for home consumption C.

$$M = Y - C$$

It was assumed that the consumption of paddy, soybean and sorghum depended entirely upon their own price and income from the production of crop.

$$C = C\,(P,\, I)$$

Where P is the price of the crop under consideration and is I the net income from the production of crop. Net income was arrived at by deducting the wage bill including imputed value of family labour, expenditure on chemical fertilizer, bullock labour, FYM expenditure, seed expenditure and capital expenditure.

Janvry and Kumar (1981), developed Marketed surplus model is formulated as follows.

$$M = Y\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p}\frac{s}{p},K,L\right) - C\left[p, I = pY\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p},\frac{s}{p},K,L\right) - wN\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p},\frac{s}{p},K,L\right) -\right.$$

$$\left. bB\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p},\frac{s}{p},K,L\right) - rX\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p},\frac{s}{p},K,L\right) - mF\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p},\frac{s}{p},K,L\right) - sS\left(\frac{w}{p},\frac{b}{p},\frac{r}{p},\frac{m}{p},\frac{s}{p},K,L\right) - K\right]$$

The price of fixed factors does not change the level of factor use, but does influence the level of farm income. Since we deal here with owner operators, the imputed values of rents and interest on own capital do not enter in the determination of income. Taking the total differential of the expression for the marketed surplus with respect to p, w, b, r, m, K, and L, and writing it in terms of relative changes, we obtain.

$$\dot{M} = E_M^p \dot{p} + E_M^w \dot{w} + E_M^b \dot{b} + E_M^r \dot{r} + E_M^m \dot{m} + E_M^m \dot{s} + E_M^K \dot{K} + E_M^L \dot{L}$$

The dot on the variable indicates the rate of change in variable.

E_M^P - Denotes elasticity of M with respect to changes in exogenous variable P.

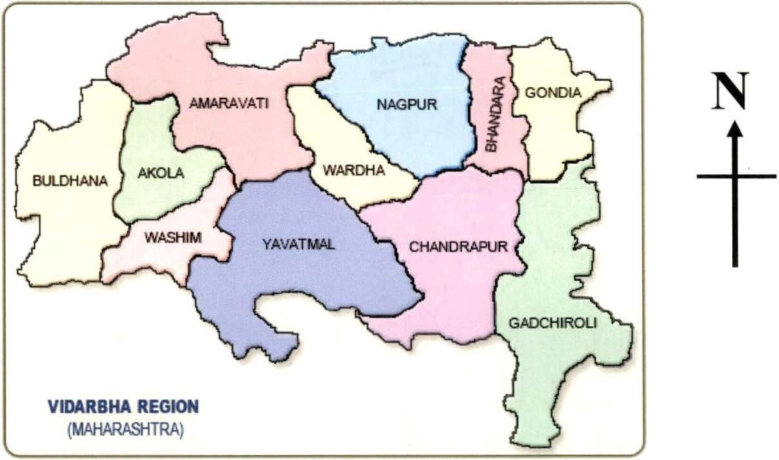

Fig. 1 : Map of Vidarbha Region

CHAPTER IV

SOCIO-ECONOMIC FEATURES OF VIDARBHA REGION

The agro economic conditions differ from place to place. The place in close vicinity may not have identical agro economic conditions. Hence, in every investigation, it is necessary to study the agro-economic aspects related to the area under study, which provides a background for further studies.

Maharashtra state comprises of six revenue divisions *viz.*, Mumbai, Pune, Nasik, Aurangabad, Nagpur and Amravati. Nagpur and Amravati divisions together is known as Vidarbha region, which comprises of Eleven districts namely Buldana, Akola, Amravati, Washim, Yavatmal, Wardha, Nagpur, Bhandara, Chandrapur, Gadchiroli, and Gondia. The districts Buldana, Akola, Washim, Amravati and Yavatmal constitute the Western part of the region. Previously this region was also called as Berar. The districts of Wardha, Nagpur, Bhandara, Chandrapur, Gadchiroli and Gondia constitute the eastern part which was the part of central provinces prior to formation of Maharashtra States. In 1999, Akola and Bhandara district each were further divided into two districts i.e. (i) Akola and Washim (ii) Bhandara and Gondia respectively.

4.1 General features

1) Location, Area and Boundaries

The Vidarbha region has an area of 1, 00,684 sq.km. This is 81.92 per cent of the state area. It is situated between $21^{O}46'$ and $17^{O}56'$ North latitude and $80^{O}50'$ and $70^{O}57'$ South latitude. To the North, the division is bounded by Nimar, Baitul, Chindwara and Balaghat districts of Madhya Pradesh. On the South, Parbhani, Nanded districts and also by some part of Andhra Pradesh State. On the west are the Aurangabad and Jalgaon districts, while on east Vidarbha has Dongargarh district of Madhya Pradesh.

4.2 Topography

Vidarbha is situated more or less in the middle of the Indian peninsula and forms parts of Deccan plateau. The Nagpur Berar plain covers the major portion of the division. The eastern part of Chandrapur, Bhandara and Gadchiroli district are included in Chhattisgarh plain, while the Melghat area of Amravati district forms a part of Satpuda plateau. The Nagpur Berar plain has an elevation ranging between 900 to 2000 feet approximately. The terrain is almost plain and partly hilly. This also applies to the part which is included Chhattisgarh plain. The Melghat range which is in Satpuda plateau has an elevation of 3400 feet. The Gavilgarh hills, the Ajantha hills, the Ramtek hills and the Bastar hills are the important hills in Vidarbha region. A part from the hilly tract of Melghat area and Buldana district which is not an undulating plain, the region is consisting of two natural divisions, that Payanghat, the lower plateau and Balaghat the upper plateau. The dividing lines run from east to west and plateau falls away abruptly into the valley.

4.3 Rivers

The drainage of Vidarbha is formed by the Wardha, the Painganga, Purna and Waingangā rivers. The Tapi River flows along the north eastern boundary of the Amravati district, while the Godawari flows along the southern boundary of Chandrapur district. The Tapi flows from the east to west, while its tributaries on the right bank running north to south and on the left bank running from south to north. Only one large tributary, the Purna runs east to west to the south of the Tapi. On the east, the Tapi valley is separated from Wainganga valley by a high land running north to south. The Indrawati flows along the eastern boundary of the region.

4.4 Climate and rainfall

The climate of the region is tropical monsoon types and climatically there are three seasons in Vidarbha *viz.*, the summer season from the beginning of March to middle of June, the rainy season from the middle of June to middle of October, while the winter season from the middle of October to the end of February. The rainy season as monsoon of Kharif and winter as *Rabi,* where as the summer is hot weather or early Kharif. The precipitation, all over Vidarbha is mainly during rainy season. The winter rains are few. The annual rainfall varies from 690 to 1480 mm distributed over 40 to 70 days in 1999-00 while it varies from 570 to 1210 mm distributed over 40 to 70 days in 2008-09.

Table 4.1: Average Annual Rainfall of Districts of Vidarbha region

Sr. No.	Name of districts	Average annual rainfall (mm)	
		1999-00	2008-09
1.	Buldana	925.30	622.14
2.	Akola	1085.28	567.50
3.	Washim	1039.17	656.95
4.	Amravati	857.97	649.94
5.	Yavatmal	1103.26	690.93
6.	Wardha	1125.79	820.95
7.	Nagpur	691.86	846.71
8.	Bhandara	1104.40	945.07
9.	Gondia	1478.31	1111.99
10.	Chandrapur	1333.36	1029.83
11.	Gadchiroli	-	1209.72

(Source: http//mahaagri.nic.in)

About 80 to 85 per cent of the average annual rainfall is generally received during June to September. Based on precipitation of the region, three zones can be distinctly grouped *viz.*, assured rainfall zone, receiving 720 to 950 mm rainfall, medium rainfall zone with 950 to 1250 mm rains and high rainfall zone having 1250 to 1700 mm rainfall annually. The average annual rainfall in different districts is given in Table 4.1.

4.5 Irrigation

Vidarbha region is predominantly known as dry land agriculture, Western Vidarbha has less than 10 per cent of the gross cropped area covered under irrigation. Irrigation is one of the means to assure protection of crop from failure of monsoon.

Table 4.2: Sources of Water Supply and Area Irrigated there from in each Districts of Vidarbha region

(Area in 00 ha)

Sr. No.	Name of districts	Surface irrigated	Well irrigated	Total net area irrigated	Area irrigated more than one	Gross area irrigated
1.	Buldana	20 (4.31)	375 (80.82)	395 (85.13)	69 (14.87)	464 (100.00)
2.	Akola	53 (13.35)	239 (60.20)	292 (73.55)	105 (26.45)	397 (100.00)
3.	Washim	--	--	--	--	--
4.	Amravati	19 (2.41)	614 (77.82)	633 (80.23)	156 (19.77)	789 (100.00)
5.	Yavatmal	63 (10.75)	444 (75.77)	507 (86.52)	79 (13.48)	586 (100.00)
6.	Wardha	52 (14.25)	205 (56.16)	257 (70.41)	108 (29.59)	365 (100.00)
7.	Nagpur	553 (39.64)	575 (41.21)	1128 (80.86)	267 (19.14)	1395 (100.00)
8.	Bhandara	1658 (75.92)	277 (12.68)	1935 (88.60)	249 (11.40)	2184 (100.00)
9.	Gondia	--	--	--	--	--
10.	Chandrapur	922 (78.80)	141 (12.05)	1063 (90.85)	107 (9.15)	1170 (100.00)
11.	Gadchiroli	508 (87.14)	42 (7.20)	550 (94.34)	33 (5.66)	583 (100.00)
12.	Vidarbha	3848 (48.51)	2912 (36.71)	6760 (85.21)	1173 (14.79)	7933 (100.00)

(Source: http://www.agri.mah.nic.in)

The state Government has sanction number of major, medium and minor irrigation projects to explore the optimum irrigation potential and established Maharashtra Irrigation Commission to streamline and speeding the works. Five irrigation development corporations are formulated in the state and for Vidarbha area, Vidarbha Development Corporation is operating. Districtwise irrigated area in Vidarbha is given in Table 4.2.

It is seen that from above Table 4.2 that the surface irrigation is more in Bhandara district and lowest in the Amravati district. It is increasing from west to east. The well irrigated area is more in Amravati district and lowest in Gadchiroli district. Bhandara has highest total net area irrigated i.e. 1935 hectares and lowest in Wardha district. Nagpur district has highest irrigated area in area irrigated more than one and total gross area irrigated was highest in Bhandara district i.e. 2184 hectares. The Wardha district has lowest gross area irrigated.

4.6 Soil

Soils are classified as vertisols derived from trap rocks. They have varying depth depending upon its physiography. Most of the soils are calcareous, thoroughly base saturated and fairly well supplied with potash and phosphate but low in organic matter and nitrogen. The pH is alkaline and varies from 7.5 to 8.0. Soils deeper than 1.5 meter and clay in texture pose problem of temporary water logging and are saline to certain extent. Such conditions occur in Purna Valley. There are six broad categories of soils in Vidarbha, i.e. very shallow soils, shallow black soils, medium black soils, deep black soils, yellow brown soils and salt affected soils.

1. Very shallow soils

These soils are less than 7.5 cm deep with brown colour. Texture is medium to coarse. The soils are well drained capacity to available water is low. pH ranges from 7 to 8. Organic carbon, N and available P are low while available K is medium.

2. Shallow black soils

These soils are 7.5 to 25 cm deep with dark brown in colour. Texture is medium. The soils are well drained with low available water capacity. PH ranges from 7.5 to 8.5. Organic carbon, N and available P are low while the available K is high.

3. Medium deep black soils

These are 25 to 50 cm deep with dark brown to grayish brown in colour. Moderately well drained with low available water capacity. Texture is medium; pH ranges from 7.5 to 8.5. Organic carbon, N and available P are low whereas available K is high. The soils are calcareous in nature.

4. Deep black soils

These are 50 to 100 cm deep and above with dark grayish to very dark grayish brown colour. Texture is fine. The drainage is restricted with moderately high available water capacity. The pH ranges from 7.5 to 8.5. Organic carbon, N and available P are low to medium while available K is high to very high. These soils are generally calcareous in nature.

5. Yellow brown soils

These soils are moderately deep to deep say 50-100 cm, eroded with low available water capacity. They are well drained. The pH varies from 6.5 to 7.5. N and available P is low while available K is medium to high.

6. Salt affected soils

These soils are mainly found in Purna Valley which is spread over to Amravati, Akola and Buldana districts. These soils exist all along both the sides around 10 to 45 km in width and about 150 km in length affecting about 547 villages in Amravati, Akola and Buldana districts. These soils are very deep with fine texture having imperfect drainage. Water holding capacity is very high. Clay content ranges from 52 to 70 per cent. The pH is 7.7 to 9.4. The soils are mostly normal at surface horizon and the problem of salinity increases with depth. Landform is mainly plain.

Table 4.3: Area covered under major soils types of Vidarbha
(Area in Lakh ha)

Sr. No.	Name of district	Coarse shallow	Medium deep black	Deep black	Laterite lateritic	Yellow brown	Salt affected
1.	Buldana	3.50	2.69	1.13	--	--	0.45
2.	Akola	0.71	6.12	1.44	--	--	1.68
3.	Amravati	1.84	4.58	1.21	-	--	0.61
4.	Yavatmal	5.73	0.91	2.01	--	--	--
5.	Wardha	2.51	2.64	1.78	--	--	--
6.	Nagpur	1.11	1.34	0.34	--	2.87	--
7.	Bhandara	--	--	0.15	--	3.98	--
8.	Chandrapur and Gadchiroli	0.65	0.78	1.32	0.84	2.94	--
9.	Vidarbha	16.05	19.06	9.38	0.84	9.79	2.74
10.	Maharashtra state	55.6	79.89	34.25	9.16	--	--

(Source: State Level Seminar on Soil Health Management for Sustainable Agriculture, 2000)

7. Soil Index

The soil index has been worked out by taking into consideration the important soil characteristics such as soil texture, depth, calcium carbonate percentage, gypsum percentage, salinity, alkalinity, drainage, and soil slope. Based on these characteristics, soil index are worked out and the soils are classified on the basis of their indices as below.

Indices range

100-75	Very suitable
75 – 50	Moderately suitable
50 – 25	Marginally suitable
25 - 0	Unsuitable for cultivation

Based on these indices, it was observed that almost all the districts of Vidarbha region of Maharashtra State are moderately suitable for crop production. However, the crops grown on these soils vary from region to region depending upon climatic conditions prevalent in these regions.

Table 4.4: Districtwise Soil Index in Vidarbha Region

Sr. No.	District	Soil index
1)	Buldana	57.60
2)	Akola	72.60
3)	Amravati	72.20
4)	Yavatmal	64.90
5)	Wardha	72.60
6)	Nagpur	64.80
7)	Bhandara	64.80
8)	Chandrapur	56.70
9)	Gadchiroli	56.60

4.7 Agro-Climatic Zones of Vidarbha

The Vidarbha region is divided into three agro-climatic zones based on rainfall, soil type and vegetation's are as follows.

4.7.1 Western Vidarbha Zone (WVZ) with precipitation between 700 to 950 mm

4.7.2 Central Vidarbha Zone (CVZ) with precipitation between 960 to 1260

4.7.3 Eastern Vidarbha Zone (EVZ) with precipitation between above 1250 mm

4.7.1 Western Vidarbha Zone

There are five sub zones in the Western Vidarbha Zone (WVZ) region.

1) Ghat tract I

This sub zones occupies greater part of Buldana district with nine tahsil *viz.*, Buldana, Chikhali, Lonar, Mehekar, Sinkhed Raja, Malkapur, Motala, Nandura, Jalgaon Jamod elevation varies from 850 to 600 m. Annual rainfall varies from 75 to 85 cm. Soil ranges from very shallow to moderately deep. The topography is rolling and land slopes are around up to seven per cent. In this sub zones sorghum predominates over cotton with some area of Bajra, Safflower forms the part of major cropping pattern. Because of relatively lesser rainfall, low available moisture capacity and shallow depths, crops are often subjected to frequent stress conditions. Some part of this sub zone is classified as drought area.

2) Ghat tract II

This sub zone includes 10 tahsils of part of Akola, Amravati and Yavatmal district *viz.*, Mangrulpir, Manora, Tiwasa, Chandur Rly., Pusad, Umred, Mahagaon, Darwha, Digras and Ner. Spores of Ajantha are spread over this sub zone creating several situations of plateau and villages Soils are predominantly shallow to moderately deep with equal proportion of vertisols, entisols and inceptisols. Land configuration is rolling and slopping. Annual precipitation in this area varies from 850 to 950 mm. Cotton predominates over sorghum. Pulses are important in the cropping system representing 12-20 per cent while ground nut is grown over 4 to 9 per cent area.

3) Black plains

This sub zone spreads over 16 tahsils *viz.*, Khamgaon, Shegaon, Balapur, Patur, Akola, Washim, Risod, Malegaon, Murtijapur, Karanja, Amla, Bhatkuli, Nandgaon Khandeshwar, Achalpur, Chandur Bazar and Morshi comprising of four districts. This is proportion ability the largest sub zone. Annual precipitation varies from 750 to 900 mm. Soils are moderate to deep and predominantly vertisols with several situations of ill drainage and crop suffering from of wet condition during years of relatively higher rains. Irrigation management poses some problem cotton predominates over sorghum.

4) Saline alkali tract

This sub zone includes major parts of six tahsils *viz.*, Akot, Telhara, Sangrampur, Jalgaon, Daryapur and Anjangaon Surji. These soils are vertisols, deep and saline to saline alkali in reaction. Annual precipitation varies between 75 to 85 cm. Open wells in the tract have saline water as a result of which the same cannot be utilized for irrigation purposes. Cotton and Sorghum are the major crops of the tract together with rainfed wheat during the *Rabi* season. Poor drainage during rainy seasons is rampant fields are relatively plain.

5) Melghat tract

This includes three tahsils *viz.*, Melghat, Dharni and Chikhaldara and Northern part of Akot, Anjangaon Surji. The tract is entirely hilly occupied by Melghat range and the land is extremely sloppy. Soils are very shallow to shallow. Annual precipitation varies from 300 to 1500 mm. Forest occupies substantial area. *Kharif* Sorghum, Rice and lesser millets are important crops of the sub zones. The area is inhibited by tribal farmers. This sub zones gives good scope for development of horticultural and forage crops.

4.7.2 Central Vidarbha Zone (CVZ)

Agro-ecological sub zone is independent empty embodying climate edaphic, physiographic and cropping peculiarities in a board ecological zone and is characterized by certain farming situations and farming systems. In the CVZ, seven agro-ecological sub zones have been identified by combining rainfall patterns, geomorphology and soil units and existing crop patterns.

1) Sub zone MR-I

The rainfall in the sub zone varies between 920-950 mm. The soils are shallow to moderate in depth reddish brown to dark brown with frequent strong and gravelly phases. They have moderate intake rate and low available moisture capacity. Cropping is essentially during *Kharif* season. The sub zone is characterized by Cotton, Sorghum based farming system. The two crops form the major crop pattern with 40 to 80 per cent cotton and 30 to 40 per cent sorghum. Associated crops are Red Gram with 4 to 8 per cent. During prolong monsoon breaks, crops suffer from moisture stress.

2) Sub zone MR-II

The sub zone covers Yavatmal, Babhulgaon, Kalamb, Ghatanji, Ralegaon and Pandharkawada, Arvi and rest of Wardha and Deoli tahsils of Wardha districts. Major crop pattern is composed of only two crops namely Cotton and Sorghum, having 38 to 45 per cent area respectively. Important associated crops are Tur (5.8 per cent) and Ground nut (4 to 6 per cent) Cropping in *Kharif* is bound to the extent of 90 per cent. Soils are shallow to deep medium having reddish brown to black colour with rolling topography and this zone to erosion and having bed rock at shallow depth having lower water holding capacity. Annual rainfall varies between 91 to 112 cm.

3) Sub zone MR-III

In this zone, the Katol, Narkhed, Saoner, Kalmeshwar, Hingna, Kampthee tahsils of Nagpur districts are covered. Cropping is predominantly *Kharif* with *Rabi* cropping to the extent 10 to 15 per cent. Soils are moderately deep to deep partly eroded reddish brown mostly gravel increasing with depth, medium available moisture capacity and moderate intake rate. Annual rainfall varies between 950 to 1050 mm.

4) Sub zone MR-IV

This sub zone covers Nanded, Nandgaon Bhokar, Kandhar tahsils of Nanded district and most of Hingoli district. Soils are moderate to deep brown to deep colour clayey to clay loam predominantly moderate to poor intake rate. Cropping pattern is dominated by *Kharif* sorghum with 35 to 55 per cent followed by cotton having 15 to 25 per cent. Annual rainfall varies between 950-1150 mm.

5) Sub zone MR-V

This zone covers Hinganghat, Seloo, Samudrapur and part of Wardha and Deoli tahsils of Wardha district. In addition to Cotton and Sorghum, Wheat crop occupies 12 to 14 per cent of total cropped area. Performance of cotton and *Kharif* Sorghum is to the extent of 35 to 40 per cent and 25 to 30 per cent, respectively. The soils are relatively heavy varying from loam to clay with lower intake capacity. Annual precipitation varies between 1100-1150 mm.

6) Sub zone MR-VI

This zone covers Parseoni, Ramtek, Mouda, Kuhi and parts of Umred and Bhiwapur tahsils of Nagpur district. Important crops grown are *Kharif* Sorghum 12 to 18 per cent, *Rabi* Sorghum 15 to 18 per cent, Wheat 15 to 16 per cent, Rice 10 to 15 per cent, Chilli 2 to 8 per cent and Tur 5 to 10 per cent. The soils are light loamy to heavy with shallow to moderately deep rooting depth, pour intake rate, west soils situation persists for long time. Annual precipitation varies from 1200 to 1240 mm.

4.7.3 Eastern Vidarbha Zone (EVZ)

There are four sub zones of EVZ based on climate, soils and crop pattern. They are briefly described as –

1) Rice pulses sub zone

This sub zone covers Gondia and Sakoli taluka of Bhandara districts having shallow gray soils with annual precipitation varying from 1400 to 1650 mm. The net sown, gross cropped area and geographical area of this sub zone are 2.57, 3.58 and 6.70 lakh ha, respectively. Rice is the predominant crop grown over 60 per cent of the gross cropped area followed by *Rabi* pulses with more than 20 per cent of the gross cropped area.

2) Rice *Rabi* sorghum sub zones

This includes Bramphpuri, Sironcha and Gadchiroli and Chandrapur district and Bhandara district. Soils are yellowish brown with shallow soils. The net sown area, gross cropped area and geographical area of the sub zone are 3.62, 4.32 and 17.80 lakh ha, respectively. The sub zone of rich forest occupying accounting about 20 per cent of geographical area. Rice is grown on 50 per cent of the sub zone and pulses account for around 20 per cent.

3) *Rabi* sorghum rice sub zone

This zone is represented by Chandrapur district with total geographical area, net sown area and gross cropped area of 3.37, 1.29, 1.34 lakh ha. The forest accounts for 40 per cent of the geographical area. Annual precipitation varies from 1250 to 1400 mm. The sub zone is characterized by predominance of *Rabi* sorghum over Rice during *Kharif* season and Seasamum as *Rabi* crop.

4) Multicrop *Rabi* dominated sub zone

This sub zone is represented by Umred taluka of Nagpur district. The total geographical area, net sown area and gross cropped area of the sub zone are 2.51, 1.44, 1.49 lakh ha, respectively. Annual rainfall varies from 1250 to 1300 mm. Soils are medium deep black with patches of shallow grey types. The zone is characterized by about six crops. The major crop pattern includes *Rabi* Sorghum 20 per cent, Wheat 15 per cent, *Kharif* Sorghum 10 per cent, Chill 10 per cent, Rice 9 per cent and Linseed 8 per cent respectively.

4.8 Population

As per census of 2001, total population of Vidarbha is 204.66 lakhs which is 21 per cent of the state. The rural population varies from

35.64 per cent in Nagpur district to 93.07 per cent in Gadchiroli. Overall, it is 73.87 per cent indicating that Vidarbha is predominantly depend on agriculture. The overall child population ranges from 12.20 to 15.68 per cent of the total population. Literacy percentage varies from minimum of 50.87 per cent in Gadchiroli district to maximum 73.56 per cent in Nagpur district. Density of population is minimum with 67 persons per sq.km. in Gadchiroli to 410 persons in Nagpur district. Number of cultivators, agriculture labours and labours in allied agricultural activities are 21.40, 35.60 and 24.79 per cent respectively for Vidarbha as compare to the state figures.

Table 4.5: Population statistics of various districts of Vidarbha in 2001

Name of districts	Populations (Lakhs)	Rural population percentage	Literacy percentage	Persons per sq.km.	No. of cultivators	No. of agricultural labours	No. of labours in allied agricultural activities
Buldana	22.26	78.74	64.80	230	3,29,063	3,66,758	8,068
Akola	16.29	61.60	70.20	301	2,41,226	4,69,292	7,984
Washim	10.19	82.54	62.64	197			
Amravati	26.06	65.50	71.9	213	1,91,194	4,65,474	13,077
Yavatmal	24.60	81.67	63.24	181	2,49,570	4,94,163	12,946
Wardha	12.30	73.60	70.66	195	1,25,214	2,07,916	7,200
Nagpur	40.51	35.64	73.56	410	2,14,646	2,80,181	23,424
Bhandara	12.00	84.56	68.27	323	3,83,544	3,15,159	18,008
Gondia	9.69	88.05	67.67	172			
Chandrapur	20.77	67.63	63.52	195	2,42,426	2,64,959	18,076
Gadchiroli	9.99	93.07	50.87	65	2,01,192	1,03,151	8,198
Vidarbha	204.66	73.87	63.30	209	21,78,075 (21.40)	29,67,053 (35.60)	1,16,981 (24.79)
Maharas-htra	967.52	57.60	77.27	314	1,01,72,100	83,13,223	4,71,731

(Figures in parentheses are percentages of the state (Source: Directorate of Census Publication - 2002)

4.9 Land use classification

Land utilization statistics of Vidarbha is given in Table 6. It is evident from the table that the total geographical area of Vidarbha is 97223 lakh ha as against 307.58 lakh ha of the state, i.e. 31.28 per cent of the state area. The net area sown is 51.46 per cent during 2001-02 to the total geographical area.

Table 4.6: Land use classification of Vidarbha in the year 2007-08 (Area in '00' ha)

Sr. No.	Particular	Nagpur division	Amravati division	Vidarbha Region
1.	Total geographical area	51266	45967	97233 (100.00)
2.	Forest	19846	7059	26905 (27.66)
3.	Barren and uncultivable land	1001	1299	2300 (2.36)
4.	Land put to non agricultural use	3974	2189	6163 (6.34)
5.	Cultivable waste land	1408	670	2078 (2.13)
6.	Permanent pasture and other grazing land	3321	1794	5115 (5.25)
7.	Land under miscellaneous tree crops and grooves not included in the net area sown	395	277	672 (0.69)
8.	Current fallows	1598	1126	2724 (2.80)
9.	Other fallows	739	799	1538 (1.58)
10.	Net area sown	18984	30804	49778 (51.19)
11.	Area sown more than once	2713	9462	12175 (12.52)
12.	Total cropped area	21697	40266	61963 (63.73)

(Figures in parentheses are percentage to the total geographical area) (Source: http: //www. agri .mah.nic.in)

This is followed by the land under forest (27.62 per cent), permanent pasture and grazing land (5.23 per cent) and land put to non agricultural use (6.13 per cent). The barren and uncultivable land accounts for 2.35 per cent, cultivable waste land 2.16 per cent, current fallows 2.79 per cent, other fallows 1.59 and the land under miscellaneous tree crops and grooves 0.66 per cent. The total cropped area accounts 62.79 per cent of the total geographical area of Vidarbha.

Land Utilization Statistics of two different regions i.e. Amravati and Nagpur along with the State is given in Table to know the inherent differences. The noteworthy feature is that the forest in Amravati division is around 15 per cent as against 39 per cent in Nagpur division. The area under forest in Maharashtra state is around 17 per cent as against 28 per cent in Vidarbha. Vidarbha is rich in forest. Similarly gross cropped area in Amravati division is around 87 per cent as against 41 per cent in Nagpur division while state figures are 73 per cent to the geographical area of the respective division and the state during is period (2001-02).

4.10 Use of fertilizes

The use of fertilizers (N, P, and K) consumption is more in Amravati division as compare to Nagpur division. In Buldana district N and P consumption is highest while Yavatmal district has highest K consumption. In Gadchiroli district total N, P and K consumption are lowest.

Table 4.7: District wise fertilizer consumption during 2008-09 (tonnes)

Sr. No.	District	Total Consumption of fertilizers			Total
		N	P	K	
1.	Buldana	56029	33015	16360	150404
2.	Akola	23939	21937	7903	53779
3.	Washim	9981	8281	2002	20264
4.	Amravati	32612	28361	12630	73603
5.	Yavatmal	44865	22335	11808	79008
6.	Wardha	25201	19070	7984	52255
7.	Nagpur	30253	23760	7930	61943
8.	Bhandara	14030	4622	650	19302
9.	Gondia	14568	4434	701	19703
10.	Chandrapur	23880	11699	2505	38084
11.	Gadchiroli	8729	2480	1036	12245
	Amravati division	167426	113929	50703	377058
	Nagpur division	116661	66065	20806	203532
	Vidarbha	284087 (21.19)	179994 (24.08)	71509 (14.97)	580590 (22.63)
	Maharashtra	1340899	747462	477751	2566112

(Source: Fertilizer Statistics 2008-09)

4.11 Cropping pattern

The usual cropping pattern is determined by a large number of factors. The most important factors are climate, soil, topography, customs and distance to the market. Data of cropping pattern of Vidarbha region is presented in Table 4.8.

Area under Soybean crop is highest, which contributes about 20403 hectare (34.29%) to the total gross cropped area. The area under Cotton, Rice, Jowar *Kharif*, Gram, Moong i.e. 18.93 per cent, 12.40 per cent, 4.44 per cent, 6.98 per cent and 3.02 per cent respectively.

Table 4.8: Cropping pattern of Vidarbha region in the year 2008-09

(Area in 00 ha)

Sr. No.	Name of crops	Area	Per cent to gross cropped area
1.	Rice	7380	12.40
2.	Wheat	2808	4.72
3.	Jowar (*Kharif*)	2641	4.44
4.	Jowar (*Rabi*)	248	0.42
5.	Bajra	68	0.11
6.	Maize	642	1.08
7.	Other cereals	76	0.13
8.	Total cereals	13863	23.30
9.	Tur	5223	8.78
10.	Gram	4152	6.98
11.	Moong	1794	3.02
12.	Udid	978	1.64
13.	Other pulses	588	0.99
14.	Total pulses	12735	21.41
15.	Sugar cane	146	0.25
16.	Cotton	11260	18.93
17.	Soybean	20403	34.29
18.	Ground Nut (*Kharif*)	85	0.14
19.	Ground Nut (Summer)	85	0.14
20.	Safflower	74	0.12
21.	Sunflower	453	0.75
22.	Sesamum	107	0.18
23.	Linseed	238	0.40
24.	Mustard	17	0.03
25.	Castor	27	0.05

CHAPTER V

RESULTS AND DISCUSSION

The present study was conducted in Vidarbha region of Maharashtra State and four crops viz. cotton, paddy, soybean and sorghum were selected. For to study the temporal variation in input and output prices and cost of cultivation and for estimation of input demand and output supply these four crops were selected while the response of marketed surplus to product and factor price movement were also assessed for cotton, paddy, soybean and sorghum crops.

This study will provide useful information which can be used to project the direction and extent of the response of farmers to changes in input and output prices. Results of this study would help the policy makers to formulate policies pertaining to the various aspects of changing these prices.

5.1. Temporal variation in input and output prices and cost of cultivation.

5.1.1. Changes in input and output prices

Transformation of agriculture from subsistence to profitable farm business is a techno-organizational process, the success of which largely depends on the relative prices of various inputs and outputs. Therefore, it would be interest to examine the changes in prices of inputs and outputs.

5.1.1.1 Compound growth rates of input and output prices at current prices

The rate of growth of average input prices and output prices for selected crops at current prices are presented in Table 5.1.1.1.

Table 5.1.1.1 reveals that prices of all inputs showed an increasing trend during the period 1999-00 to 2008-09. The compound growth rate of input prices for cotton were highest for seed prices

(13.80 per cent per annum) followed by prices of Farm Yard Manure (10.51 per cent per annum). The per cent growth rates in wage rate and bullock labour prices were observed to be 8.42 per cent and 5.80 per cent per annum respectively. The output prices increased at an annual compound rate of 2.20 per cent per annum for cotton during the period under study.

Table 5.1.1.1: Compound growth rates of input and output prices at current prices

Items	Cotton	Paddy	Soybean	Sorghum
Input Prices				
i) Wage rate	8.42***	3.17**	7.56***	5.15***
ii) Bullock labour price	5.80***	6.27***	3.17***	5.60***
iii) FYM price	10.51***	2.76	11.18***	12.31*
iv) Fertilizer price	3.97*	4.27**	3.80*	-0.43
v) Seed price	13.80***	2.27**	7.11**	4.06***
2) Output Price	2.20*	5.74***	8.17***	7.06***

(***, **,*denotes significant at 1%, 5% and 10% level)

The compound growth rate of input prices for paddy were highest for bullock labour prices (6.27 per cent per annum) followed by prices of Fertilizer (4.27 per cent per annum). The per cent growth rates in wage rate and seed prices were observed to be 3.17 per cent and 2.27 per cent per annum respectively. The output prices increased at an annual compound rate of 5.74 per cent per annum for paddy during the period under study.

The compound growth rate of input prices for soybean were highest for Farm Yard Manure (11.18 per cent per annum) followed by prices of human wage rate (7.56 per cent per annum). The per cent growth rate in seed and fertilizer prices were observed to be 7.11 per cent and 3.80 per cent per annum respectively. The output prices increased at an annual compound rate of 8.17 per cent per annum for soybean during the period under study. (Shende and Shinde 2010 also reported that the output price for soybean increased at an annual compound growth rate of 9.82 per cent per annum in Assured Rainfall Zone (Zone VII) of Vidarbha region)

The compound growth rate of input prices for sorghum were highest for Farm Yard Manure (12.31 per cent per annum) followed by prices of bullock labour (5.60 per cent per annum). The per cent growth rates in prices of human wage rate and seed were observed to be 5.15 per cent and 4.06 per cent per annum respectively. The output prices increased at an annual compound rate of 8.06 per cent per annum for sorghum during the period under study.

5.1.1.2 Compound growth rates of input and output prices at constant prices

The rate of growth of average input prices and output prices for selected crops at constant prices are presented in Table 5.1.1.2.

Table 5.1.1.2: Compound growth rates of input and output prices at constant prices

Items	Cotton	Paddy	Soybean	Sorghum
Input Prices				
i) Wage rate	2.89*	-2.10	2.07**	-0.22
ii) Bullock labour price	0.40	0.84	-2.10**	0.21
iii) FYM price	4.87	-2.48	5.50	6.57
iv) Fertilizer price	-1.34	-1.06	-1.50	-5.52***
v) Seed price	7.94*	-2.95**	1.64	-1.26
2) Output Price	-3.04**	0.34	2.64**	1.59

(***, ** and * denotes significant at 1%, 5% and 10% level)

Table 5.1.1.2 shows the compound growth rates of seed prices for cotton increased at an annual rate of 7.94 per cent per annum, while for paddy seed price shows negative growth which was significant at 5 per cent level. For soybean crop the human wage rate on an average basis at constant prices increased at an annual rate of

2.07 per cent per annum, while the fertilizer price for sorghum show significantly negative growth during the period of study.

The output price for soybean at constant prices increased at an annual rate of 2.64 per cent per annum over the period of time.

5.1.2. Parity between prices received for products and prices paid for inputs

Parity prices for farm products are those prices which would give the same purchasing power to the producer as prevailed in the base year. In order to examine the parity between the prices received for output and prices paid for agricultural inputs, parity indices were computed by deflating output price indices by the input price indices.

5.1.2.1. Parity between output price index and input price index for cotton

Table 5.1.2.1 presents input-output price indices for cotton crop. It is evident from the table that between 1999-00 to 2008-09, the input price index for cotton increased by 94 per cent, while the increase in output price was only 37 per cent.

Table 5.1.2.1: Parity between output price index and input price index for cotton

(Base year- Average of Triennium Ending – 1999-00 to 2001-02)

Years	Input price Index	Output price Index	Parity Index
1999-00	102.99	100.91	97.98
2000-01	90.19	101.90	112.98
2001-02	106.82	97.19	90.99
2002-03	90.89	102.73	113.03
2003-04	116.93	122.99	105.18
2004-05	97.14	105.89	109.00
2005-06	149.14	97.10	65.11
2006-07	163.63	101.62	62.10
2007-08	131.88	116.69	88.48
2008-09	194.56	136.79	70.31

Further, the output-input price parity were decreased during year 1999-00, 2001-02 and from 2005-06 to 2008-09, increased in the subsequent years, indicating thereby in the year 1999-00, 2001-02 and from 2005-06 to 2008-09, the output price were lower than input price and term of trade was unfavourable for cotton growers. However, the term of trade was favourable for the cotton growers in the remaining years.

5.1.2.2. Parity between output price index and input price index for paddy

Table 5.1.2.2 presents input-output price indices for paddy crop. It is evident from the table that between 1999-00 to 2008-09, the input price index for paddy increased by 29 per cent, while the increase in output price was 90 per cent. Further, the output-input price parity were decreased during year 2001-02 to 2003-04 and in year 2005-06, increased in the subsequent years, indicating thereby up to the year 2001-02 to 2003-04, and in year 2005-06, the output price were lower than input price and term of trade was unfavourable for paddy growers. However, the term of trade was favourable for the paddy growers afterward.

Table 5.1.2.2: Parity between output price index and input price index for paddy

(Base year- Average of Triennium Ending – 1999-00 to 2001-02)

Years	Input price Index	Output price Index	Parity Index
1999-00	98.52	104.00	105.56
2000-01	97.73	98.11	100.39
2001-02	105.46	97.89	92.82
2002-03	109.57	102.90	93.91
2003-04	120.47	109.30	90.72
2004-05	108.63	109.30	100.62
2005-06	145.91	115.86	79.40
2006-07	115.46	126.94	109.94
2007-08	125.50	145.02	115.56
2008-09	129.46	190.30	147.00

5.1.2.3. Parity between output price index and input price index for soybean

Table 5.1.2.3 presents input-output price indices for soybean crop. It is evident from the table that between 1999-00 to 2008-09, the input price index for soybean increased by 69 per cent, while the increase in output price was 97 per cent. (Shende and Shinde 2010 also reported that between 1997-98 to 2007-08, the input price index for soybean increased by 29 per cent, while the increase in output price was 87 per cent)

Further, the output-input price parity were decreased during year 1999-00 to 2000-01, increased in the subsequent years, indicating thereby from the year 1999-00 to 2000-01, the output price were lower than input price and term of trade was unfavourable for soybean growers. However, the term of trade was favourable for the soybean growers afterward.

Table 5.1.2.3: Parity between output price index and input price index for soybean

(Base year- Average of Triennium Ending – 1999-00 to 2001-02)

Years	Input price Index	Output price Index	Parity Index
1999-00	91.91	89.25	97.10
2000-01	104.56	104.18	99.64
2001-02	103.80	106.56	102.66
2002-03	110.20	138.92	126.06
2003-04	131.51	141.60	107.67
2004-05	128.05	143.09	111.74
2005-06	119.88	127.58	106.42
2006-07	146.09	148.38	101.57
2007-08	169.97	195.20	114.85
2008-09	169.12	197.61	116.85

5.1.2.4. Parity between output price index and input price index for sorghum

Table 5.1.2.4 presents input-output price indices for sorghum crop. It is evident from the table that between 1999-00 to 2008-09, the input price index for sorghum increased by 28 per cent, while the increase in output price was 88 per cent. Further, the output-input price parity were decreased during year 2001-02 and 2003-04, increased in the subsequent years, indicating thereby up to the year 2001-02 and in 2003-04, the output price were lower than input price and term of trade was unfavourable for sorghum growers. However, the term of trade was favourable for the sorghum growers afterward.

Table 5.1.2.4: Parity between output price index and input price index for sorghum

(Base year- Average of Triennium Ending – 1999-00 to 2001-02)

Years	Input price Index	Output price Index	Parity Index
1999-00	111.77	119.19	106.64
2000-01	92.98	108.37	116.55
2001-02	97.07	72.44	74.63
2002-03	100.63	104.54	103.88
2003-04	103.89	102.98	99.12
2004-05	110.90	116.99	105.50
2005-06	118.09	124.55	105.47
2006-07	115.26	150.24	130.35
2007-08	130.44	162.18	124.33
2008-09	128.72	188.64	146.56

5.1.3. Changes in cost of cultivation of selected crops

5.1.3.1. Changes in cost of cultivation of cotton

The results in Table 5.1.3.1 show the changes in the cost of cultivation of cotton in Vidarbha. The total cost of cultivation of cotton has gone up from ₹ 13660.61 per hectare in 1999-00 to ₹ 24737.14 per hectare in 2008-09 depicting an increase by 1.82 times during a period of study. The increase has occurred in all major items of cost like hired human labour, family labour, bullock labour, machine labour, seed, fertilizer, farm yard manure, insecticide, rental value of owned land and interest on working capital but the costs of interest on fixed capital and depreciation cost was found to have declined. The cost of human labour, machine labour, seeds, Fertilizer and cost of bullock labour has increased at a faster rate. Among operational cost items, hired human labour (21.04) recorded the maximum share followed by seed (14.23) and family labour (11.21) in the increase in cost of cultivation over time.

Out of the total increase of ₹ 11076.53 in the total cost of cultivation per hectare the operational cost items contributed about 82.33 per cent and the remaining 17.67 per cent by fixed cost items. The increase in fertilizer, farm yard manure and insecticide charges has been to the tune of 6.24 per cent, 4.30 per cent and 1.87 per cent respectively of the total increase in cost of cultivation.

The relative shares of different inputs in the cost of cultivation of cotton at two points of time are also given in Table 5.1.3.1. The share of operational cost has remained around 74.76 per cent in 2008-09, which was higher than that in 1999-00. But with in operational cost, the share of machine labour in the total cost increased from 1.74 per cent in 1999-00 to 4.16 per cent in 2008-09 and the share of bullock labour in the total cost decreased from 11.49 in 1999-00 to 10.10 in 2008-09. The decrease in the share of bullock labour is on account of substitution by machine labour also the share of fertilizers in the total cost decreased from 7.21 per cent in 1999-00 to 6.78 per cent in 2008-09, (Gurjar and Varghese 2005 reported that the share of fertilizer in total cost decreased from 12.57 per cent in 1981-82 to 7.27 per cent in 1999-00 for wheat crop in Rajasthan) though the absolute cost due to fertilizers and bullock labour has increased over the years. Out of the fixed cost items, the rental value of land accounted highest share (i.e. 20.88 per cent) which is followed by land revenue and taxes.

Table 5.1.3.1: Changes in cost of cultivation of cotton

Sr. No	Particulars	Cost of cultivation				Change in 2008-09 over 1999-00		Share in total change (per cent)
		1999-00		2008-09				
		₹/ha	Per cent	₹/ha	Per cent	₹/ha	Per cent	
A)	Operational costs							
	Hired human labour	2551.56	18.68	4882.19	19.74	2330.63	91.34	21.04
	Family labour	1158.84	8.48	2400.68	9.70	1241.84	107.16	11.21
	Bullock labour	1568.95	11.49	2498.09	10.10	929.14	59.22	8.39
	Machine labour	238.19	1.74	1028.88	4.16	790.69	331.95	7.14
	Seed	1249.30	9.15	2825.49	11.42	1576.20	126.17	14.23
	F. Y. M.	461.24	3.38	937.56	3.79	476.33	103.27	4.30
	Fertilizer	985.26	7.21	1676.36	6.78	691.11	70.14	6.24
	Insecticides	31.79	0.23	238.70	0.96	206.91	650.97	1.87
	Incidental charges	366.77	2.68	900.39	3.64	533.63	145.49	4.82
	Repairs	53.09	0.39	187.99	0.76	134.90	254.11	1.22
	Interest on working capital	709.10	5.19	916.78	3.71	207.68	29.29	1.87
	Sub-total (A)	9374.07	68.62	18493.12	74.76	9119.05	97.28	82.33
B)	Fixed costs							
	Land revenue and taxes	20.53	0.15	24.95	0.10	4.42	21.53	0.10
	Depreciation	322.69	2.36	242.30	0.98	-80.38	-24.91	-0.73
	Rental value of Land	3228.31	23.63	5541.48	22.40	2313.17	71.65	20.88
	Interest on fixed capital	715.01	5.23	435.29	1.76	-279.72	-39.12	-2.53
	Sub-total (B)	4286.54	31.38	6244.02	25.24	1957.48	45.67	17.67
C)	(Total cost) Cost C (A+B)	13660.61	100.00	24737.14	100.00	11076.53	81.08	100

Table 5.1.3.2: The extent of changes in physical inputs, input prices, physical output, output prices and gross return for cotton

Sr. No.	Particulars	1999-00 (base year)	2008-09 (current year)	Percent change in 2008-09 over base year	Growth rate per annum (per cent)
A)	Quantity of inputs				
1	Seed (Kg/ha)	3.67	1.93	-47.41	- 6.15
2	Fertilizer (Kg/ha)	74.23	99.22	33.67	1.92
3	Manure (qtl/ha)	13.38	16.13	20.55	3.15
4	Human labour (hrs/ha)	938.78	1218.83	29.83	3.28**
5	Bullock labour (hrs/ha)	130.29	124.04	-4.78	- 0.04
B	Prices of inputs				
1	Seed (₹/kg)	340.62	1466.45	330.52	21.21**
2	Fertilizer (₹/kg)	13.27	16.90	27.35	2.01***
3	Manure (₹/qtl)	34.47	58.12	68.61	7.15***
4	Human labour (₹/hrs)	3.95	5.98	51.39	4.99***
5	Bullock labour (₹/hrs)	12.04	20.14	67.28	5.84***
C	Yield (qtl/ha)				
1	Main product	6.60	12.56	90.30	7.91***
2	By-product	0.00	0.00	0.00	0.00
D	Price of output (₹/qtl)				
1	Main product	1969.29	2658.12	34.98	2.20*
2	By-product	0.00	0.00	0.00	0.00
E	Value of output (₹/ha)				
1	Main product	13019.01	33385.99	156.44	10.25***
2	By-product	0.00	0.00	0.00	0.00
3	Gross return	13019.01	33385.99	156.44	10.25***
F	Cost of production (₹/qtl)	2069.79	1969.52	-4.84	-0.94
G	Minimum Support Price	1675	2750	64.18	3.49**

(***, **, *denotes significant at 1%, 5% and 10% level)

The extent of change in physical inputs and their prices along with changes in physical output and their prices and gross return for cotton over time is given in Table 5.1.3.2. It is remarkable to note that the seed rate in physical term has come down for cotton crop over the years. There for, the positive change in the cost of seed could be exclusively attributable to large increase in the prices of seed over time. The prices of seed increased at a high rate, it may be due to introduction of BT cotton in Vidarbha region from the years 2001-02. As far as fertilizer is concerned, the positive change in the cost of cultivation of cotton was mainly due to the increase in physical quantity of fertilizer applied for cotton. The large increase in the share of cost in cotton due to bullock labour is attributable to increase in wage rate as the use of bullock labour has declined for cotton.

The gross return for cotton crop has recorded an increase of 156.44 per cent during the period study. This is attributable to the increase in the prices of main product. The cost of production of cotton has decreased from ₹ 2069.79 in 1999-00 to ₹ 1969.52 in 2008-09. In terms of annual growth rate of the estimated parameters of cotton during the period, the cost of seed has increased by 21.21 per cent per annum. Due to increase in the cost of seed the physical quantity of seed has declined i.e. -6.15. The price and physical quantity of manure has increased by 7.15 and 3.15 per cent per annum respectively while the minimum support prices had increased 3.49 per cent per annum which recorded an increase of 64.18 per cent over the period of time.

5.1.3.3. Changes in cost of cultivation of Paddy

The results in Table 5.1.3.3 indicate the changes in the cost of cultivation of paddy in Vidarbha. The cost of cultivation of paddy increased from ₹ 14031.21 per hectare in 1999-00 to ₹ 19976.26 per hectare in 2008-09 showing an increase of 1.42 times during the period of study. The increase in total cost is attributable to cost items such as hired human labour, family labour, bullock labour, machine labour, seed, fertilizer, and farm yard manure, interest on working capital and, interest on fixed capital. The costs of rental value of own land, and depreciation cost was found to have declined. The highest share in total cost was due to hired human labour, bullock labour, machine labour, and fertilizer.

Out of total increase of ₹ 5945.05 in the cost of cultivation of paddy per hectare, 93.01 per cent was contributed by operational cost items and remaining 6.99 per cent to fixed cost items. Among the items of operational cost hired human labour, bullock labour, machine labour and fertilizer accounted for 23.54, 16.14, 13.85 and11.61 per cent respectively of the increase in total cost. The share of seed and farm yard manure in the increase in total cost was 6.72 and 2.72 per cent respectively, while the share of rental value of own land, and share of depreciation was found to have declined.

The share of interest on fixed capital and share of interest on working capital was 8.83 per cent and 4.58 per cent respectively.

Table 5.1.3.3: Changes in cost of cultivation of paddy

Sr. No	Particulars	Cost of cultivation				Change in 2008-09 over 1999-00		Share in total change (per cent)
		1999-00		2008-09				
		₹/ha	Per cent	₹/ha	Per cent	₹/ha	Per cent	
A)	Operational costs							
	Hired human labour	2841.35	20.25	4241.08	21.23	1399.73	49.26	23.54
	Family labour	2048.08	14.60	2206.47	11.05	158.39	7.73	2.66
	Bullock labour	1345.60	9.59	2304.97	11.54	959.37	71.30	16.14
	Machine labour	37.59	0.27	861.15	4.31	823.56	2190.65	13.85
	Seed	753.74	5.37	1153.14	5.77	399.41	52.99	6.72
	F. Y. M.	561.33	4.00	722.85	3.62	161.52	28.77	2.72
	Fertilizer	1002.75	7.15	1692.94	8.47	690.19	68.83	11.61
	Insecticides	54.74	0.39	330.74	1.66	275.99	504.16	4.64
	Incidental charges	71.00	0.51	290.73	1.46	219.73	309.48	3.70
	Repairs	107.80	0.77	276.55	1.38	168.75	156.54	2.84
	Interest on working capital	440.44	3.14	713.00	3.57	272.56	61.88	4.58
	Sub-total (A)	9264.42	66.03	14793.62	74.06	5529.20	59.68	93.01
B)	Fixed costs							
	Land revenue and taxes	11.80	0.08	24.31	0.12	12.50	105.91	0.20
	Depreciation	580.06	4.13	503.89	2.52	-76.17	-13.13	-1.28
	Rental value of Land	3681.48	26.24	3635.90	18.20	-45.57	-1.24	-0.77
	Interest on fixed capital	493.45	3.52	1018.54	5.10	525.09	106.41	8.83
	Sub-total (B)	4766.79	33.97	5182.64	25.94	415.84	8.72	6.99
C)	(Total cost) Cost C (A+B)	14031.21	100.00	19976.26	100.00	5945.04	42.37	100

Table 5.1.3.4: The extent of changes in physical inputs, input prices, physical output, output prices and gross return for paddy

Sr. No.	Particulars	1999-00 (base year)	2008-09 (current year)	Percent change in 2008-09 over base year	Growth rate per annum (per cent)
A)	Quantity of inputs				
1	Seed (Kg/ha)	96.26	91.50	-4.94	-1.68*
2	Fertilizer (Kg/ha)	86.50	113.67	31.41	2.06
3	Manure (qtl/ha)	28.66	24.86	-13.26	1.40
4	Human labour (hrs/ha)	1083.47	1074.50	-0.83	0.56
5	Bullock labour (hrs/ha)	154.82	121.97	-21.22	-1.56
B	Prices of inputs				
1	Seed (₹/kg)	7.83	12.60	60.92	4.01***
2	Fertilizer (₹/kg)	11.59	14.89	28.47	2.16***
3	Manure (₹/qtl)	19.59	29.08	48.44	1.35
4	Human labour (₹/hrs)	4.51	6.00	33.04	2.59***
5	Bullock labour (₹/hrs)	8.69	18.90	117.49	7.95***
C	Yield (qtl/ha)				
1	Main product	22.83	19.69	-13.75	0.47
2	By-product	27.10	22.09	-18.49	-0.97
D	Price of output (₹/qtl)				
1	Main product	588.43	1043.78	77.38	5.74***
2	By-product	47.74	63.68	33.39	1.29
E	Value of output (₹/ha)				
1	Main product	13434.07	20554.41	53.00	6.32***
2	By-product	1293.71	1407.02	8.76	0.31
3	Gross return	14727.78	21961.43	49.12	5.84***
F	Cost of production (₹/qtl)	614.60	1014.54	65.07	3.52
G	Minimum Support Price	520	880	69.23	4.30***

(***, **, *denotes significant at 1%, 5% and 10% level)

The relative shares of different inputs in the change of cost of cultivation of paddy in 1999-00 and 2008-09 are given in Table 5.1.3.3. The share of operational cost items in the total cost of cultivation has been 74.06 per cent in 2008-09 which is higher than that in 1999-00. But within the operational cost, the share of farm yard manure was found to decrease i.e. from 4.00 per cent in 1999-00 to 3.62 per cent in 2008-09 respectively. The operational cost items for which the relative share has increased are hired human labour, bullock labour, machine labour, seed and fertilizer for paddy but the share of family labour has found to have decrease i.e. from 14.60 per cent in 1999-00 to 11.05 per cent in 2008-09 respectively.

The extent of change in physical inputs and their prices along with changes in physical output and their prices and gross return from paddy over time is given in Table 5.1.3.4. It is remarkable to note that the physical quantity of bullock labour, human labour, manure and seed has come down for paddy due to increase in the wage rate of bullock labour and human labour and prices of manure and seed. Only physical quantity of fertilizer is increase due to increase in the price of fertilizer. The gross return for paddy has recorded an increase of 49.12 per cent during period of study. This is attributable to the increase in the prices of main product and by-product as the yield has marginally declined. The cost production of paddy has increased from ₹ 614.60 in 1999-00 to ₹ 1014.54 in 2008-09, While, the cost of production of paddy was recorded an increase of 3.52 per cent per annum during period of study.

In terms of annual growth of the estimated parameters of paddy during the period, the physical quantity of human labour and bullock labour has declined while the price of bullock labour for paddy has increased by 7.95 percent per annum.

The gross return has also increased by 5.84 per cent per annum; it is mainly due to increase the price of main product and the price of by-product has increased by 1.29 per cent per annum. The minimum support prices had increased by 4.30 per cent per annum which recorded an increase of 69.23 per cent over the period of time.

5.1.3.5. Changes in cost of cultivation of Soybean

The results in Table 5.1.3.5 indicate the changes in the cost of cultivation of soybean in Vidarbha. The cost of cultivation of soybean increased from ₹ 9334.06 per hectare in 1999-00 to ₹ 17397.13 per hectare in 2008-09 showing an increase of 1.86 times during the period of study. The increase in total cost is attributable to cost items such as hired human labour, family labour, bullock labour, machine labour, seed, fertilizer, farm yard manure, insecticide, rental value of owned land , interest on working capital and interest on fixed capital only value of depreciation was found to have declined. The highest share in total cost was due to seed, hired human labour and machine labour.

Out of total increase of ₹ 8063.07 in the cost of cultivation of soybean per hectare, 81.79 per cent was contributed by operational cost items and remaining 18.21 per cent to fixed cost items. Among the items of operational cost the share of seed, hired human labour and machine labour accounted for 21.63, 16.80 and 13.42 per cent respectively, of the increase in total cost. The share of bullock labour and insecticide in the increase in total cost was 5.99 and 4.17 per cent respectively while the share of fertilizer in the increase in total cost was 4.22 per cent. The share of rental value of own land accounted for 15.52 per cent of the increase in total cost.

The relative shares of different inputs in the change of cost of cultivation of soybean in 1999-00 and 2008-09 are given in Table 5.1.3.5. The share of operational cost items in the total cost of cultivation has been 74.86 per cent in 2008-09 which is higher than that in 1999-00. But within the operational cost, the share of bullock labour, farm yard manure, fertilizer, hired human labour and family labour was found to decrease. The operational cost items for which the relative share has increased are seed, machine labour and insecticide for soybean.

The extent of change in physical inputs and their prices along with changes in physical output and their prices and gross return from soybean over time is given in Table 5.1.3.6.

When the extent of changes in physical input over time for soybean is compared with the change in cost, it could be concluded that the quantity of manure has decreased due to increase in the cost of manure. The use of fertilizer has increased i.e. from 34.17 kg/ha in 1999-00 to 54.59 kg/ha in 2008-09 due to slight change in the prices of fertilizers. The positive change in the cost of seed is attributable to marginal increase in physical seed rate and large increase in the prices of seed over time. Similarly, the change in cost of human labour for soybean is due to physical quantity of human labour used for soybean as well as its prices over the years. The use of human labour is increase and the price of human labour is also increase due to less use of quantity of bullock labour.

The gross return for soybean crop has recorded an increase of 142.13 per cent during the period of study. The increase in gross return from soybean is attributable to the increase in the main and by-product of soybean as well as increase in their prices over the years. It is worth mentioning that the rate of increase in the prices of main product and by-product of soybean has been much higher compared to the increase in the physical yield of main product and by-product. The cost of production of soybean has increased from ₹ 861.08 per quintal in 1999-00 to ₹ 1504.54 per quintal in 2008-09. While the cost of production has recorded an increase of 74.77 per cent during the period being study.

Table 5.1.3.5: Changes in cost of cultivation of soybean

Sr. No.	Particulars	Cost of cultivation				Change in 2008-09 over 1999-00		Share in total change (per cent)
		1999-00		2008-09				
		₹/ha	Per cent	₹/ha	Per cent	₹/ha	Per cent	
A)	Operational costs							
	Hired human labour	1668.42	17.87	3023.02	17.38	1354.60	81.19	16.80
	Family labour	644.83	6.91	1061.32	6.10	416.48	64.59	5.17
	Bullock labour	1206.58	12.93	1689.21	9.71	482.63	40.00	5.99
	Machine labour	686.59	7.36	1769.02	10.17	1082.43	157.65	13.42
	Seed	1055.46	11.31	2799.57	16.09	1744.11	165.25	21.63
	F. Y. M.	199.94	2.14	312.64	1.80	112.70	56.37	1.40
	Fertilizer	506.84	5.43	846.94	4.87	340.10	67.10	4.22
	Insecticides	23.44	0.25	359.40	2.07	335.96	1433.10	4.17
	Incidental charges	25.65	0.27	232.72	1.34	207.06	807.24	2.57
	Repairs	57.24	0.61	247.13	1.42	189.89	331.74	2.36
	Interest on working capital	353.66	3.79	682.67	3.92	329.01	93.03	4.08
	Sub-total (A)	6428.67	68.87	13023.64	74.86	6594.97	102.59	81.79
B)	Fixed costs							
	Land revenue and taxes	18.49	0.20	22.62	0.13	4.12	22.30	0.05
	Depreciation	390.63	4.19	319.78	1.84	-70.85	-18.14	-0.88
	Rental value of Land	2026.13	21.71	3277.82	18.84	1251.69	61.78	15.52
	Interest on fixed capital	470.14	5.04	753.27	4.33	283.13	60.22	3.51
	Sub-total (B)	2905.39	31.13	4373.49	25.14	1468.10	50.53	18.21
C)	(Total cost) Cost C (A+B)	9334.06	100.00	17397.13	100.00	8063.07	86.38	100

Table 5.1.3.6: The extent of changes in physical inputs, input prices, physical output, output prices and gross return for soybean

Sr. No.	Particulars	1999-00 (base year)	2008-09 (current year)	Percent change in 2008-09 over base year	Growth rate per annum (per cent)
A)	Quantity of inputs				
1	Seed (Kg/ha)	74.98	87.09	16.15	1.20**
2	Fertilizer (Kg/ha)	34.17	54.59	59.76	2.52
3	Manure (qtl/ha)	6.28	4.29	-31.69	4.09
4	Human labour (hrs/ha)	502.76	560.45	11.47	1.77*
5	Bullock labour (hrs/ha)	79.64	76.34	-4.14	-0.67
B	Prices of inputs				
1	Seed (₹/kg)	14.08	32.15	128.34	5.88**
2	Fertilizer (₹/kg)	14.83	15.51	4.59	1.25**
3	Manure (₹/qtl)	31.81	72.85	129.02	6.81***
4	Human labour (₹/hrs)	4.60	7.29	58.48	5.69***
5	Bullock labour (₹/hrs)	15.15	22.13	46.07	3.87***
C	Yield (qtl/ha)				
1	Main product	10.84	11.56	6.64	2.39
2	By-product	5.18	6.68	28.96	1.09
D	Price of output (₹/qtl)				
1	Main product	729.71	1615.55	121.40	8.17***
2	By-product	51.47	171.33	232.87	8.76***
E	Value of output (₹/ha)				
1	Main product	7911.81	18657.84	135.82	10.76***
2	By-product	266.66	1144.78	329.30	9.94**
3	Gross return	8178.47	19802.26	142.13	10.76***
F	Cost of production (₹/qtl)	861.08	1504.54	74.77	4.25*
G	Minimum Support Price	800	1370	71.25	4.47***

(***, **, *denotes significant at 1%, 5% and 10% level)

In terms of annual growth rate of the estimated parameter of soybean during the period, the cost of production of soybean has increased by 4.25 per cent per annum where as the gross return on unit area basis has increased by 10.76 per cent per annum. (Shende and Shinde 2010 also reported that gross income from soybean increased at an annual rate of 9.826 per cent per annum in Zone VII of Vidarbha region) The minimum support prices had increased by 4.47 per cent per annum which recorded an increase of 71.25 per cent over the period of time.

5.1.3.7. Changes in cost of cultivation of Sorghum

The results in Table 5.1.3.7 indicate the changes in the cost of cultivation of sorghum in Vidarbha. The cost of cultivation of sorghum increased from ₹ 12205.43 per hectare in 1999-00 to ₹ 14227.29 per hectare in 2008-09 showing an increase of 1.17 times during the period of study. The increase in total cost is attributable to cost items such as hired human labour, family labour, bullock labour, machine labour, seed, fertilizer, farm yard manure, interest on working capital and insecticide. The costs of rental value of own land, cost of depreciation and value of interest on fixed capital was found to have declined. The highest share in total cost was due to hired human labour, bullock labour and machine labour.

Out of total increase of ₹ 2021.86 in the cost of cultivation of sorghum per hectare, 172.25 per cent was contributed by operational cost items and remaining i.e. -72.25 per cent to fixed cost items. Among the items of operational cost hired human labour, bullock labour and machine labour accounted for 57.06, 44.42 and 33.84 per cent respectively, of the increase in total cost. The share of seed and fertilizer in the increase in total cost was 7.29 and 7.16 per cent respectively, while the share of rental value of own land, share of interest on fixed capital and share of depreciation was found to have declined.

Table 5.1.3.7: Changes in cost of cultivation of sorghum

Sr. No	Particulars	Cost of cultivation				Change in 2008-09 over 1999-00		Share in total change (per cent)
		1999-00		2008-09				
		₹/ha	Per cent	₹/ha	Per cent	₹/ha	Per cent	
A)	Operational costs							
	Hired human labour	1810.16	14.83	2963.82	20.83	1153.67	63.73	57.06
	Family labour	1350.59	11.07	1390.74	9.78	40.15	2.97	1.99
	Bullock labour	1219.34	9.99	2117.36	14.88	898.01	73.65	44.42
	Machine labour	712.60	5.84	1396.89	9.82	684.30	96.03	33.84
	Seed	494.74	4.05	642.07	4.51	147.33	29.78	7.29
	F. Y. M.	214.40	1.76	238.53	1.68	24.13	11.26	1.19
	Fertilizer	1089.25	8.92	1234.06	8.67	144.82	13.30	7.16
	Insecticides	45.40	0.37	208.47	1.47	163.06	359.14	8.07
	Incidental charges	14.00	0.11	12.17	0.09	-1.83	-13.05	-0.09
	Repairs	88.49	0.72	155.86	1.10	67.37	76.14	3.33
	Interest on working capital	368.48	3.02	538.16	3.78	169.69	46.05	8.39
	Sub-total (A)	7407.44	60.69	10898.14	76.60	3490.70	47.12	172.65
B)	Fixed costs							
	Land revenue and taxes	24.17	0.20	24.66	0.17	0.49	2.04	0.10
	Depreciation	606.22	4.97	243.28	1.71	-362.95	-59.87	-17.95
	Rental value of Land	3173.21	26.00	2648.34	18.61	-524.88	-16.54	-25.96
	Interest on fixed capital	994.38	8.15	412.88	2.90	-581.50	-58.48	-28.76
	Sub-total (B)	4797.99	39.31	3329.15	23.40	-1468.84	-30.61	-72.65
C)	(Total cost) Cost C (A+B)	12205.43	100.00	14227.29	100.00	2021.87	16.57	100

Table 5.1.3.8: The extent of changes in physical inputs, input prices, physical output, output prices and gross return for sorghum

Sr. No.	Particulars	1999-00 (base year)	2008-09 (current year)	Percent change in 2008-09 over base year	Growth rate per annum (per cent)
A)	Quantity of inputs				
1	Seed (Kg/ha)	8.06	8.41	4.21	0.81
2	Fertilizer (Kg/ha)	93.04	71.84	-22.75	-3.45***
3	Manure (qtl/ha)	8.36	3.35	-59.93	1.52
4	Human labour (hrs/ha)	681.57	610.59	-10.41	0.72
5	Bullock labour (hrs/ha)	107.34	97.93	-8.77	-1.06
B	Prices of inputs				
1	Seed (₹/kg)	61.33	76.37	24.52	3.26**
2	Fertilizer (₹/kg)	11.71	17.18	46.71	3.13***
3	Manure (₹/qtl)	25.66	71.28	177.79	10.65***
4	Human labour (₹/hrs)	4.64	7.13	53.66	4.41***
5	Bullock labour (₹/hrs)	11.36	21.62	90.32	6.73***
C	Yield (qtl/ha)				
1	Main product	20.17	15.50	-23.15	-1.04
2	By-product	36.82	31.70	-13.91	-0.05
D	Price of output (₹/qtl)				
1	Main product	458.43	726.11	58.39	7.06***
2	By-product	96.83	151.00	55.94	5.01***
E	Value of output (₹/ha)				
1	Main product	9246.54	11256.27	21.73	5.83**
2	By-product	3565.42	4786.73	34.25	4.94***
3	Gross return	12811.96	16043.00	25.22	5.49***
F	Cost of production (₹/qtl)	605.13	917.77	51.67	7.24
G	Minimum Support Price	415	840	102.41	5.75***

(***, **, *denotes significant at 1%, 5% and 10% level)

The relative shares of different inputs in the change of cost of cultivation of sorghum in 1999-00 and 2008-09 are given in Table 5.1.3.7. The share of operational cost items in the total cost of cultivation has been 76.60 per cent in 2008-09 which is higher than that in 1999-00. But within the operational cost, the share of family labour, fertilizer, and farm yard manure was found to decrease. The operational cost items for which the relative share has increased are hired human labour, bullock labour, machine labour, seed and insecticide for sorghum.

The extent of change in physical inputs and their prices along with changes in physical output and their prices and gross return from sorghum over time is given in Table 5.1.3.8. It is remarkable to note that the physical quantity of bullock labour, human labour, manure and fertilizer has come down for sorghum due to increase in the wage rate of bullock labour and human labour and prices of manure and fertilizer. Only physical quantity of seed is increase due to increase in the price of seed. The gross return for sorghum has recorded an increase of 25.22 per cent during period of study. This is attributable to the increase in the prices of main product and by-product as the yield has marginally declined. The cost production of sorghum has increased from ₹ 605.13 in 1999-00 to ₹ 917.77 in 2008-09, While, the cost of production of sorghum was recorded an increase of 7.24 per cent per annum during period of study.

In terms of annual growth of the estimated parameters of sorghum during the period, the physical quantity of fertilizer and bullock labour has declined while the price of manure for sorghum has increased by 10.65 per cent per annum. The gross return has increased by 5.49 per cent per annum. However the physical quantity of main product and by product has also declined. (i.e. -1.04 per cent per annum of main product and -0.05 per cent per annum of by product), the minimum support prices had increased by 5.75 per cent per annum which recorded an increase of 102.41 per cent over the period of time.

5.1.3.9. Comparative Economic Advantage of Selected Crops

The costs and return of selected crops in 1999-00 and 2008-09 are given in Table 5.1.3.9. During 1999-00, the return over cost A was highest for paddy crop followed by sorghum and cotton and lowest for soybean. The return over cost C was highest for paddy followed by sorghum but the return over cost C for soybean and cotton found negative. There for paddy crop had comparative economic advantage as compared to other selected crops of Vidarbha in 1999-00.

Table 5.1.3.9: Costs and returns of selected crops of Vidarbha

(₹/ha)

Sr. No.	Particulars	Groups			
		Cotton	Paddy	Soybean	Sorghum
A)	1999-00				
	Cost A	8558.45	7808.20	6192.96	6687.24
	Cost C	13660.61	14031.21	9334.06	12205.43
	Gross value	13019.01	14727.78	8178.47	12811.96
	Profit over A	4460.56	6919.58	1985.51	6124.72
	Profit over C	-641.60	696.57	-1155.59	606.53
B)	2008-09				
	Cost A	16359.69	13115.35	12304.72	9775.34
	Cost C	24737.14	19976.26	17397.13	14227.29
	Gross value	33385.99	21961.43	19802.26	16043.00
	Profit over A	17026.30	8846.08	7497.54	6267.66
	Profit over C	8648.85	1985.17	2405.13	1815.71

During 2008-09, return over cost A was highest for cotton crop followed by paddy, soybean and sorghum. The return over cost C was highest for cotton followed by soybean and paddy crop. There for cotton crop had comparative economic advantage among the selected crops of Vidarbha in 2008-09. Cotton and paddy are the important crops of

Vidarbha. These crops are more profitable as compared to other crops of Vidarbha, but now the area under cotton was replaced by soybean due to high cost of cultivation of cotton. Hence soybean area is likely to dominate day by day.

5.1.4. Changes in Costs

The cost of production per unit of output depends on the per hectare cost of cultivation and yield. For computing the cost of production at constant factor prices, the unit cost of production at current prices was deflated by an input price index series taking initial triennium ending average as the base year.

5.1.4.1. Changes in cost of cotton

The cost of production at current and constant prices for cotton is presented in Table 5.1.4.1. The Table revealed that, the increase in yield in the years 2003-04, from 2005-06 to 2006-07 and in year 2008-09, resulted in substantial fall in the cost per unit of output of cotton at current prices. Again in years 2000-01 to 2002-03, 2004-05 and in 2007-08, a fall in yield per hectare brought about a further sharp escalation in per unit cost of output.

The examination of cost of production at constant price did not indicate any clear trend, neither upward nor downward. The remaining variation in unit cost could be explained in term of yield fluctuation over the year. It was further observed that, whenever there was any improvement in the yield, it brought down the cost of production per quintal. The average cost of production varied from ₹ 1930.12 with an average yield of 10.13 quintal in the year 2006-07 to ₹ 2536.83 per quintal with an average yield 5.61 quintal in the year 2001-02. This clearly indicates that technological breakthrough in the cultivation of cotton has compensated the cost push inflation. Therefore per unit cost of output did not decline over time. It has been hypothesized that with the improvement in productivity of crops the production function must shift upward and cost of production at constant prices must decline. The analysis revealed that the cost of production did not decline. Thus it can be concluded that the technological development in cotton has shown its impact in reducing the cost of production in Vidarbha.

Table 5.1.4.1: Cost of Production of cotton

Years	Cost C per qt. At current price (₹)	Input price index	Cost C per qt. At constant price (₹)	Yield per hectare (qt.)	MSP at constant prices
1999-00	2069.79	102.99	2009.70	6.60	1675.00
2000-01	2255.60	90.19	2500.95	5.42	1638.75
2001-02	2536.83	106.82	2374.86	5.61	1650.75
2002-03	2040.79	90.89	2245.34	5.92	1562.00
2003-04	1957.56	116.93	1674.13	7.83	1460.00
2004-05	2025.34	97.14	2084.97	6.22	1432.20
2005-06	1981.85	149.14	1328.85	9.07	1383.80
2006-07	1930.12	163.63	1179.56	10.13	1353.60
2007-08	2066.17	131.88	1566.70	8.06	1244.75
2008-09	1969.52	194.56	1012.29	12.56	1732.50
CGR (%)	-1.49*		-8.30***		-1.80

5.1.4.2. Changes in cost of paddy

The cost of production at current and constant prices for paddy is presented in Table 5.1.4.2. The Table revealed that, the increase in yield from 1999-00 to 2005-06, resulted in substantial fall in the cost per unit of output of paddy at current prices. Again in years 2006-07, a fall in yield per hectare brought about a further sharp escalation in per unit cost of output.

The examination of cost of production at constant price did not indicate any clear trend, neither upward nor downward. The remaining variation in unit cost could be explained in term of yield fluctuation over the year. It was further observed that, whenever there was any improvement in the yield, it brought down the cost of production per quintal.

Table 5.1.4.2: Cost of Production of paddy

Years	Cost C per qt. At current price (₹)	Input price index	Cost C per qt. At constant price (₹)	Yield per hectare (qt.)	MSP at constant prices
1999-00	614.60	98.52	623.83	22.83	520.00
2000-01	732.86	97.73	749.88	19.59	513.00
2001-02	608.23	105.46	576.74	26.30	520.80
2002-03	618.39	109.57	564.38	28.43	492.80
2003-04	626.60	120.47	520.13	29.06	464.00
2004-05	724.74	108.63	667.17	21.26	454.30
2005-06	658.22	145.91	451.11	33.80	444.00
2006-07	715.01	115.46	619.27	24.15	439.20
2007-08	696.98	125.50	555.36	27.32	438.75
2008-09	1014.54	129.46	783.67	19.69	554.40
CGR (%)	3.26**		-0.07		-1.03

The average cost of production varied from ₹ 608.23 with an average yield of 26.30 quintal in the year 2001-02 to ₹ 1014.54 per quintal with an average yield 19.69 quintal in the year 2008-09. This clearly indicates that technological breakthrough in the cultivation of paddy has not compensated the cost push inflation. Therefore per unit cost of output did not decline over time. It has been hypothesized that with the improvement in productivity of crops the production function must shift upward and cost of production at constant prices must decline. The analysis revealed that the cost of production did not decline. Thus it can be concluded that the technological development in paddy has not shown its impact in reducing the cost of production in Vidarbha.

5.1.4.3. Changes in cost of soybean

The cost of production at current and constant prices for soybean is presented in Table 5.1.4.3. The Table revealed that, the increase in yield from 1999-00 to 2003-04 and from 2005-06 to 2007-08 resulted in substantial fall in the cost per unit of output of soybean at current prices. Again in 2004-05, a fall in yield per hectare brought about a further sharp escalation in per unit cost of output.

The examination of cost of production at constant price did not indicate any clear trend, neither upward nor downward. The remaining variation in unit cost could be explained in terms of yield fluctuation over the year. It was further observed that, whenever there was any improvement in the yield, it brought down the cost of production per quintal. The average cost of production varied from ₹ 859.83 with an average yield of 15.79 quintal in the year 2003-04 to ₹ 1504.94 per quintal with an average yield 11.56 quintal in the year 2008-09. This clearly indicates that technological breakthrough in the cultivation of soybean has not compensated the cost push inflation. Therefore per unit cost of output did not decline over time.

It has been hypothesized that with the improvement in productivity of crops the production function must shift upward and cost of production at constant prices must decline.

Table 5.1.4.3: Cost of Production of soybean

Years	Cost C per qt. At current price (₹)	Input price index	Cost C per qt. At constant price (₹)	Yield per hectare (qt.)	MSP at constant prices
1999-00	861.08	91.91	936.87	10.84	800.00
2000-01	1017.49	104.56	973.11	10.77	779.00
2001-02	926.86	103.80	892.93	11.77	781.20
2002-03	951.74	110.20	863.65	12.09	739.20
2003-04	859.83	131.51	653.82	15.79	708.00
2004-05	1355.87	128.05	1058.86	9.90	731.50
2005-06	1063.01	119.88	886.73	12.05	706.70
2006-07	976.87	146.09	668.68	14.94	691.20
2007-08	1100.56	169.97	647.50	15.65	637.00
2008-09	1504.94	169.12	889.87	11.56	863.10
CGR (%)	4.09**		-2.51		-0.87

The analysis revealed that the cost of production did not decline. Thus it can be concluded that the technological development in soybean has not shown its impact in reducing the cost of production in Vidarbha.

5.1.4.4. Changes in cost of sorghum

The cost of production at current and constant prices for sorghum is presented in Table 5.1.4.4. The Table revealed that, the increase in yield from 1999-00 to 2005-06, resulted in substantial fall in the cost per unit of output of sorghum at current prices. Again in years 2006-07, a fall in yield per hectare brought about a further sharp escalation in per unit cost of output.

The examination of cost of production at constant price did not indicate any clear trend, neither upward nor downward. The remaining variation in unit cost could be explained in term of yield fluctuation over the year. It was further observed that, whenever there was any improvement in the yield, it brought down the cost of production per quintal.

The average cost of production varied from ₹ 514.53 with an average yield of 22.24 quintal in the year 2002-03 to ₹ 917.77 per quintal with an average yield 15.50 quintal in the year 2008-09. This clearly indicates that technological breakthrough in the cultivation of paddy has not compensated the cost push inflation. Therefore per unit cost of output did not decline over time.

Table 5.1.4.4: Cost of Production of sorghum

Years	Cost C per qt. At current price (₹)	Input price index	Cost C per qt. At constant price	Yield per hectare (qt.)	MSP at constant prices
1999-00	605.13	111.77	541.40	20.17	415.00
2000-01	602.70	92.98	648.21	17.55	422.75
2001-02	577.20	97.07	594.63	18.50	451.05
2002-03	514.53	100.63	511.31	22.24	426.80
2003-04	605.33	103.89	582.67	19.44	404.00
2004-05	610.13	110.90	550.16	20.29	396.55
2005-06	550.47	118.09	466.15	23.53	388.50
2006-07	715.27	115.26	620.57	17.38	388.80
2007-08	733.04	130.44	561.97	19.53	390.00
2008-09	917.77	128.72	712.99	15.50	529.20
CGR (%)	2.57*		3.95**		0.35

It has been hypothesized that with the improvement in productivity of crops the production function must shift upward and cost of production at constant prices must decline. The analysis revealed that the cost of production did not decline. Thus it can be concluded that the technological development in sorghum has not shown its impact in reducing the cost of production in Vidarbha.

5.1.5. Changes in Returns

5.1.5.1. Change in cost and returns from cotton

The data on cost and returns from cotton at different point of time are presented in Table 5.1.5.1. The result reveals the gross income from cotton increased at an annual rate of 10.25 per cent per annum between 1999-00 to 2008-09.

Table 5.1.5.1: Change in cost and returns from cotton

Years	Input price Index	Output price Index	Gross income per ha.	Cost C per ha.	Net income per ha.	Output-cost ratio
1999-00	102.99	100.91	13019.01	13660.61	-641.60	0.953
2000-01	90.19	101.90	10786.88	12235.45	-1448.57	0.882
2001-02	106.82	97.19	10644.64	14236.41	-3591.77	0.748
2002-03	90.89	102.73	11876.42	12089.09	-212.67	0.982
2003-04	116.93	122.99	18786.65	15322.35	3464.29	1.226
2004-05	97.14	105.89	12844.07	12588.42	255.65	1.020
2005-06	149.14	97.10	17191.46	17979.98	-788.52	0.956
2006-07	163.63	101.62	20079.80	19542.61	537.19	1.027
2007-08	131.88	116.69	18359.30	16658.07	1701.24	1.102
2008-09	194.56	136.79	33385.99	24737.14	8648.85	1.350
CGR (%)	7.42*	8.66***	10.25***	6.30***		

(***, **, *denotes significant at 1%, 5% and 10% level)

The increased in gross income may be attributed to increase in output price as well as increase in yield of main product. However, the rate of increase in cost of cultivation per hectare was 6.30 per cent. This resulted in an improvement in the net income per hectare of cotton crop over the years. This was further reflected by output-cost ratio, which increased from 0.953 in 1999-00 to 1.350 in 2008-09. However, from the year 1999-00 to 2002-03 and in 2005-06 the output-cost ratio was not very impressive mainly due to low productivity per unit area. It is reveals from the table that the input price index for cotton crop increased at an annual compound growth rate of 7.42 per cent per annum while the output price index increased at an annual rate of 8.66 per cent per annum.

5.1.5.2. Change in cost and returns from paddy

The data on cost and returns from paddy at different point of time are presented in Table 5.1.5.2. The result reveals the gross income from paddy increased at an annual rate of 5.83 per cent per annum between 1999-00 to 2008-09. The increased in gross income may be attributed to both increase in output price as well as increase in yield of main product and by product.

However, the rate of increase in cost of cultivation per hectare was 3.75 per cent. This resulted in an improvement in the net income per hectare of paddy crop over the years. This was further reflected by output-cost ratio, which increased from 1.050 in 1999-00 to 1.099 in 2008-09. However, in the year 2000-01 to 2001-02 and 2004-05, the output-cost ratio was not very impressive mainly due to low productivity per unit area while in 2007-08, the output-cost ratio was increased i.e. 1.217.

Table 5.1.5.2: Change in cost and returns from paddy

Years	Input price Index	Output price Index	Gross income per ha.	Cost C per ha.	Net income per ha.	Output-cost ratio
1999-00	98.52	104.00	14727.78	14031.21	696.56	1.050
2000-01	97.73	98.11	12098.35	14357.06	-2258.71	0.843
2001-02	105.46	97.89	15781.00	15998.12	-217.12	0.986
2002-03	109.57	102.90	18096.59	17579.02	517.58	1.029
2003-04	120.47	109.30	18548.51	18208.86	339.65	1.019
2004-05	108.63	109.30	14563.37	15404.54	-841.17	0.945
2005-06	145.91	115.86	23049.62	22246.06	803.56	1.036
2006-07	115.46	126.94	18254.04	17267.53	986.50	1.057
2007-08	125.50	145.02	23174.57	19043.79	4130.78	1.217
2008-09	129.46	190.30	21961.43	19976.26	1985.17	1.099
CGR (%)	3.34***	3.68***	5.83***	3.75**		

(***, **, *denotes significant at 1%, 5% and 10% level)

It is reveals from the table that the input price index for paddy crop increased at an annual compound growth rate of 3.34 per cent per annum while the output price index increased at an annual rate of only 3.68 per cent per annum.

5.1.5.3. Change in cost and returns from soybean

The data on cost and returns from soybean at different point of time are presented in Table 5.1.5.3. The result reveals the gross income from soybean increased at an annual rate of 10.75 per cent per annum between 1999-00 to 2008-09.

The increased in gross income may be attributed to both increase in output price as well as increase in yield of main product and by product. However, the rate of increase in cost of cultivation per hectare was 6.59 per cent. This resulted in an improvement in the net income per hectare of soybean crop over the years. This was further reflected by output-cost ratio, which increased from 0.876 in 1999-00 to 1.138 in 2008-09.

Table 5.1.5.3: Change in cost and returns from soybean

Years	Input price Index	Output price Index	Gross income per ha.	Cost C per ha.	Net income per ha.	Output-cost ratio
1999-00	91.91	89.25	8178.47	9334.06	-1155.59	0.876
2000-01	104.56	104.18	9617.83	10957.48	-1339.65	0.878
2001-02	103.80	106.56	10771.26	10906.66	-135.40	0.988
2002-03	110.20	138.92	14336.62	11506.85	2829.77	1.246
2003-04	131.51	141.60	19057.40	13578.85	5478.55	1.403
2004-05	128.05	143.09	12034.51	13423.95	-1389.44	0.896
2005-06	119.88	127.58	13106.91	12807.00	299.91	1.023
2006-07	146.09	148.38	18763.95	14590.00	4173.95	1.286
2007-08	169.97	195.20	25587.84	17219.39	8368.46	1.486
2008-09	169.12	197.61	19802.62	17397.13	2405.49	1.138
CGR (%)	6.78***	7.07***	10.75***	6.59***		

(***, **, *denotes significant at 1%, 5% and 10% level)

However, in the year 1999-00 to 2001-02 and 2004-05, the output-cost ratio was not very impressive mainly due to low productivity per unit area while in 2007-08, the output-cost ratio was increased i.e. 1.486. It is reveals from the table that the input price index for soybean crop increased at an annual compound growth rate of 6.78 per cent per annum while the output price index increased at an annual rate of only 7.07 per cent per annum.

5.1.5.4. Change in cost and returns from sorghum

The data on cost and returns from sorghum at different point of time are presented in Table 5.1.5.4. The result reveals the gross income from sorghum increased at an annual rate of 5.49 per cent per annum between 1999-00 to 2008-09.

Table 5.1.5.4: Change in cost and returns from sorghum

Years	Input price Index	Output price Index	Gross income per ha.	Cost C per ha.	Net income per ha.	Output-cost ratio
1999-00	111.77	119.19	12811.96	12205.43	606.53	1.050
2000-01	92.98	108.37	10358.33	10545.49	-187.16	0.982
2001-02	97.07	72.44	8919.40	10678.29	-1758.89	0.835
2002-03	100.63	104.54	12985.23	11322.9	1662.33	1.147
2003-04	103.89	102.98	11289.37	11827.7	-538.32	0.954
2004-05	110.90	116.99	13373.74	12368.24	1005.50	1.081
2005-06	118.09	124.99	15867.19	12967.27	2899.93	1.224
2006-07	115.26	150.24	14852.00	12418.84	2433.16	1.196
2007-08	130.44	162.18	17026.49	14211.18	2815.30	1.198
2008-09	128.72	188.64	16043.00	14227.29	1815.71	1.128
CGR (%)	3.96***	5.96***	5.49***	2.87***		

(***, **, *denotes significant at 1%, 5% and 10% level)

The increased in gross income may be attributed to both increase in output price as well as increase in yield of main product and by product. However, the rate of increase in cost of cultivation per hectare was 2.87 per cent. This resulted in an improvement in the net income per hectare of sorghum crop over the years. This was further reflected by output-cost ratio, which increased from 1.050 in 1999-00 to 1.128 in 2008-09. However, in the year 2000-01 to 2001-02 and 2003-04, the output-cost ratio was not very impressive mainly due to low productivity per unit area while in 2005-06, the output-cost ratio was increased i.e. 1.224. It is reveals from the table that the input price index for sorghum crop increased at an annual compound growth rate of 3.96 per cent per annum while the output price index increased at an annual rate of only 5.96 per cent per annum.

5.2. Input demand and output supply of selected crops

5.2.1. Input Demand Function

A system of factor demand equations were derived from the estimated normalized profit function. The results of human labour, bullock labour, fertilizer, farm yard manure and seed demand equation for selected crops are presented below and the degree of responsiveness of input and output price movements on the use of inputs are discussed. This information is of crucial importance in the formulation of effective price policies for crops to reach specified production goals.

5.2.1.1. Input Demand Function for cotton

Table 5.2.1.1 revealed that demand elasticities with respect to own price had anticipated negative signs indicating that the results were in accordance with the theory of demand.

Table 5.2.1.1: Input demand function for cotton crop

Variables	Human Labour	Bullock Labour	Fertilizer	F.Y.M.	Seed
Intercept	0.501	0.571	1.838	0.379	-0.625
Output price	1.102	1.557	2.415	0.750	0.847
Wage rate	-1.296	-0.079	-0.602	-0.558	0.260
Bullock labour price	0.134	-1.343	0.005	-0.014	0.057
Fertilizer price	0.018	0.046	-2.093	-0.042	-0.006
F.Y.M. price	-0.019	-0.008	-0.041	-0.155	0.0004
Seed Price	0.034	0.092	0.101	-0.002	-1.665
Capital	0.227	-0.112	0.243	0.218	0.513
Land	-0.167	-0.153	-0.028	-0.196	-0.006

The absolute value of own price elasticity of human labour, bullock labour, fertilizer and seed were greater than unity indicating there by an elastic response of input utilization to their own price. One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.296 per cent, bullock labour demand 1.343 per cent, fertilizer demand 2.093 per cent and seed demand 1.665 per cent in cotton crop.

A negative sign of cross price elasticity with respect to the price of other variable inputs shows that the pair is complement and a positive sign is an indicator of substitutive relationship. However, the positive sign of cross price elasticity with respect to quantities of fixed inputs indicates complementarity and negative sign indicates substitutive relationship.

Table 5.2.1.1 shows that the human labour and bullock had a substitutive relationship for cotton (Kumar *etal* 2010 reported that there was a substitutive relationship between human labour and bullock labour for wheat and sugarcane) while there was a complementarity between human labour and farm yard manure.

5.2.1.2. Input Demand Function for paddy

Table 5.2.1.2 revealed that demand elasticities with respect to own price had anticipated negative signs indicating that the results were in accordance with the theory of demand. The absolute value of own price elasticity of human labour and seed were greater than unity indicating there by an elastic response of input utilization to their own price.

One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.079 per cent and seed demand 1.616 per cent in paddy crop.

Table 5.2.1.2: Input demand function for paddy crop

Variables	Human Labour	Bullock Labour	Fertilizer	F.Y.M.	Seed
Intercept	0.216	-1.182	-0.393	0.243	0.830
Output price	0.993	1.064	-0.083	0.576	0.999
Wage rate	-1.079	-0.114	-0.762	-0.597	0.395
Bullock labour price	-0.071	-0.691	-0.104	0.066	0.050
Fertilizer price	0.026	-0.035	0.200	0.049	0.033
F.Y.M. price	0.007	0.043	-0.041	-0.168	0.026
Seed Price	0.080	0.168	0.180	-0.153	-1.616
Capital	0.060	-0.330	0.626	0.446	0.148
Land	-0.016	-0.105	-0.016	-0.220	-0.034

A negative sign of cross price elasticity with respect to the price of other variable inputs shows that the pair is complement and a positive sign is an indicator of substitutive relationship. However, the positive sign of cross price elasticity with respect to quantities of fixed inputs indicates complementarity and negative sign indicates substitutive relationship.

The effect of wage rate was more on bullock labour demand (-0.114), while the effect of bullock labour price on human labour demand was low (-0.071). This indicates the one way complementarity between human labour and bullock labour. Obviously, without human labour, bullock labour cannot be used, where as the reverse is not true. The demand for all input responded positively to increase in output price for paddy crop. (Shende and Shinde 2010 reported that there was a complementarity between bullock labour and human labour for soybean in Vidarbha)

5.2.1.3. Input Demand Function for soybean

Table 5.2.1.3 revealed that demand elasticities with respect to own price had anticipated negative signs indicating that the results were in accordance with the theory of demand. The absolute value of own price elasticity of human labour, bullock labour and seed were greater than unity indicating there by an elastic response of input utilization to their own price.

Table 5.2.1.3: Input demand function for soybean crop

Variables	Human Labour	Bullock Labour	Fertilizer	F.Y.M.	Seed
Intercept	0.560	0.615	0.921	0.055	0.041
Output price	1.321	1.903	0.856	0.819	0.838
Wage rate	-1.340	-0.214	-0.908	-0.192	0.045
Bullock labour price	0.060	-1.242	-0.172	-0.092	0.027
Fertilizer price	-0.001	-0.019	-0.015	-0.039	-0.007
F.Y.M. price	-0.032	0.067	-0.013	-0.244	-0.006
Seed Price	-0.086	0.031	-0.294	-0.396	-1.030
Capital	0.101	-0.386	0.420	0.282	0.162
Land	-0.086	-0.138	-0.126	-0.138	0.001

One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.340 per cent, bullock labour demand 1.242 per cent and seed demand 1.030 per cent in soybean crop.

A negative sign of cross price elasticity with respect to the price of other variable inputs shows that the pair is complement and a positive sign is an indicator of substitutive relationship. However, the positive sign of cross price elasticity with respect to quantities of fixed inputs indicates complementarity and negative sign indicates substitutive relationship.

Table 5.2.1.3 shows that the effect of bullock labour price was more (-0.172) on fertilizer demand, while the effect of fertilizer price on bullock labour demand was low (-0.019). This indicates the complementarity between fertilizer and bullock labour. (Kumar P. *et al* 2010 reported that fertilizer had a strong complementary relationship with bullock labour)

5.2.1.4. Input Demand Function for sorghum

Table 5.2.1.4 revealed that demand elasticities with respect to own price had anticipated negative signs indicating that the results were in accordance with the theory of demand. The absolute value of own price elasticity of human labour, bullock labour and seed were greater than unity indicating there by an elastic response of input utilization to their own price.

Table 5.2.1.4: Input demand function for sorghum crop

Variables	Human Labour	Bullock Labour	Fertilizer	F.Y.M.	Seed
Intercept	0.561	0.292	-1.252	-0.381	0.042
Output price	1.013	0.993	0.246	0.641	1.010
Wage rate	-1.260	0.018	-0.347	-0.360	0.061
Bullock labour price	0.128	-1.134	-0.486	-0.149	-0.018
Fertilizer price	0.020	0.020	0.292	-0.078	-0.002
F.Y.M. price	0.038	0.038	-0.048	-0.154	-0.001
Seed Price	0.064	0.208	-0.058	-0.109	-1.080
Capital	0.143	-0.024	0.384	0.202	0.114
Land	-0.146	-0.120	0.018	0.006	-0.083

One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.260 per cent, bullock labour demand 1.134 per cent and seed demand 1.080 per cent in sorghum crop.

A negative sign of cross price elasticity with respect to the price of other variable inputs shows that the pair is complement and a positive sign is an indicator of substitutive relationship. However, the positive sign of cross price elasticity with respect to quantities of fixed inputs indicates complementarity and negative sign indicates substitutive relationship.

5.2.2. Output supply equation for selected crops

The output supply equations for selected crops of Vidarbha were derived from the estimated profit function. The output supply equation given in Table 5.2.2.1 gives the estimates of the responses of own output price, variable prices and fixed factors on output supply of selected crops.

It can be observed from the study that own prices had negative Impact on supply of selected crops. However, the output supply response was inelastic to the own prices i.e. (-0.260 for cotton) and (-0.756 for paddy). However there was elastic response for soybean (-1.292) and sorghum (-1.026) to the own prices.

Table 5.2.2.1: Output supply function for selected crops

Variables	Elasticity			
	Cotton	Paddy	Soybean	Sorghum
Intercept	-0.798	0.246	0.226	-0.008
Output price	-0.260	-0.756	-1.292	-1.026
Wage rate	0.415	0.322	-0.092	0.215
Bullock Labour price	0.174	-0.126	-0.080	-0.020
Fertilizer price	0.009	0.010	0.021	0.014
Farm yard Manure price	-0.001	0.196	0.047	0.054
Seed Prices	0.074	0.142	-0.458	0.039
Capital Input	0.291	0.221	0.482	0.458
Land	-0.122	0.019	-0.040	-0.042

The table reveals that for the cotton, variable inputs responded positively to the output price, except farm yard manure. The input response elasticities were highly inelastic, nearly zero. The elasticity with respect to farm yard manure price was -0.001, resulted that a 1 per cent increase in farm yard manure price were associated with about 0.001 per cent per cent decline in crop output. Among the variable factors, human wage rate, bullock labour price, fertilizer price and seed price had positive impact on the supply of cotton, while among the fixed factor, capital was found to be effective in increasing the supply of cotton. The output supply elasticity with respect to capital was (0.291). Capital input had positive impact on the supply of cotton.

For paddy, all variable input responded positively to the output price, except bullock labour price. The elasticity with respect to bullock labour price for paddy was -0.126 resulted that a 1 per cent increase in bullock price was associated with about 0.126 per cent decline in crop output. Among the variable factors, human wage rate, fertilizer price, farm yard manure price and seed price had positive impact on the supply of paddy, however, among the fixed factor capital was found to be effective in increasing the supply of paddy. Capital input had positive impact (0.221) on the supply of paddy.

It can be observed from the table that, for soybean variable inputs except labour prices and seed price responded positively to the output price. The elasticity with respect to wage rate, bullock labour price and seed price were -0.092, -0.080 and -0.458, resulted that the 1 per cent increase in wage rate, bullock labour price and seed price were associated with about 0.092, 0.080 and 0.45 per cent decline in crop output. However, capital had positive impact (0.482) on supply of soybean.

For the sorghum, variable inputs responded positively to the output price except bullock labour price. (Reddy and Chengappa 1997 observed that the variable inputs responded positively to the output price except human labour and fertilizer price) The elasticity with respect to bullock labour price for sorghum was -0.02 resulted that a 1 per cent increase in bullock price was associated with about 0.02 per cent decline in crop output. However, among the fixed factor capital was found to be effective in increasing the supply of sorghum. Capital input had positive impact (0.458) on the supply of sorghum.

5.2.3. Joint estimation of the Normalized profit function and factor share for variable inputs

Lau and Yotopoulas (1972) pointed out that due to the presence of common parameters in profit and factor demand equation; they should be estimated jointly imposing the restriction that common parameters in both equations are equal. The five equations - UOP profit function, human labour, bullock labour, fertilizer, farm yard manure and seed demand functions were estimated jointly using Zellner's method (1962) for estimating 'Seemingly Unrelated Regression Equation (SURE)' by imposing appropriate restrictions.

5.2.3.1. Joint estimation of the Normalized profit function and factor share for variable inputs for selected crops

Table 5.2.3.1 reveals that for the cotton crop, the profit function was decreased in prices of Farm yard manure and prices of seed. Among the variable factors, normalized seed price in general had the highest negative impact on variable profit for cotton crop followed by farm yard manure price. While in paddy, the profit function was decreased in the prices of Labour, Fertilizer and seed. Among the variable factors, normalized wage rate in general had the highest negative impact on variable profit followed by seed price and bullock labour price.

The Table also shows that the, profit function for soybean was decreased in prices of human labour and prices of farm yard manure.

Among the variable factors, normalized human wage rate in general had the highest negative impact on variable profit followed by farm yard manure price.

Table 5.2.3.1: Joint estimation of the Normalized profit function and factor share for variable inputs for selected crops

Variable	Paramaters	SURE estimated Values			
		Cotton	Paddy	Soybean	Sorghum
Normalized profit (dependent variable)	$\ln\frac{\pi}{p}$				
Wage rate	$\ln\frac{w}{p}$ (α_1^*)	0.525**	-0.142***	-0.176	0.183***
Bullock labour price	$\ln\frac{b}{p}$ (α_2^*)	0.004	-0.087	0.044	-0.118
Fertilizer price	$\ln\frac{r}{p}$ (α_3^*)	0.089	-0.011	0.001	-0.009
Farm yard manure price	$\ln\frac{m}{p}$ (α_4^*)	-0.089***	0.042	-0.052	0.052
Seed	$\ln\frac{s}{p}$ (α_5^*)	-0.119**	-0.098*	0.057	0.197***
Capital input	lnK (β_1)	0.562***	0.139***	0.139*	0.439***
Land	ln L (β_2)	-0.198***	-0.031	-0.065	-0.056**

(***, **, * denotes significance at 1%, 5% and 10% level)

While for sorghum the profit function was decreased in prices of bullock labour and fertilizer. Among the variable factors, normalized bullock labour price in general had the highest negative impact on variable profit followed by fertilizer price.

5.2.4. Impact of Observed Changes

The impacts of observed changes in input-output price structure on factor demand and output supply were presented in Table 5.2.4.1. Under the assumption that the input output prices continue to change in future at the same rate as was observed in the last decade and also there is no change in the endowment of fixed factors. The partial effects of price changes on the growth of factor demand and output supply were computed.

Table 5.2.4.1: Impact of observed changes in input-output price structure on factor demand and output supply of selected crops

Particulars	Per cent Growth			
	Cotton	Paddy	Soybean	Sorghum
Human Labour	-7.23	2.68	0.29	2.34
Bullock Labour	-3.25	2.19	11.10	2.82
Fertilizer	-9.84	0.80	-2.74	15.32
Farm Yard Manure	-4.95	6.48	-3.54	-0.86
Seed	-34.64	-15.00	-19.01	-15.69
Out put	5.04	-2.92	-14.35	-5.94

Table 5.2.4.1 shows that assuming no change in fixed factors or the level of technology, the input-output price structure has resulted in an appreciable change in human labour employment, bullock labour employment, fertilizer, farm yard manure and seed demand in the production of cotton crop. However, in case of paddy the input-output price structure has not resulted in an appreciable increase in human labour employment, bullock labour employment and fertilizer demand in the production of paddy but the input-output price structure has resulted in an appreciable change in seed demand for paddy.

The table also shows that in case of soybean crop, the input-output price structure has not resulted in an appreciable change in human labour employment while the impact of input-output price on bullock labour employment significantly increased in the production of soybean crop under study. The input-output price structure has resulted in an appreciable change seed demand, farm yard manure demand and fertilizer demand. In case of sorghum crop, the input-output price structure has not resulted in an appreciable increase in human labour employment as well as bullock labour employment in the production process.

The impact of input-output price on demand for farm yard manure and demand for fertilizer significantly increased in the production of paddy and sorghum respectively.

Similarly it would be interesting to look at the price policies followed during recent years on the output supply. The results revealed that the price observed during the last decade were better to maintain the growth in cotton supply by 5.04 per cent per annum.

5.3. Marketed surplus of selected crops

The response of marketed surplus to product and factor price movements was assessed by using appropriate model. Rajkrishna (1965) and Behrman (1968) initiated studied relating to marketed surplus response to product price movements. These studies did not take into consideration the effect of price of factors and hence have limited use for meaningful design of policies of product price adjustments. In the present study, the model of marketed surplus response developed by Janvry and Kumar (1981) was used.

Marketed surplus is the quantity of the produce which the producer-farmer actually sells in the market, irrespective of his requirement for family consumption, farm need and other payments. The response of marketed surplus to changes in prices and non-price factors is important for forecasting the supply of food grains and formulating agricultural price policy. For crops which are wholly or almost wholly marketed, the elasticities of output and marketed supply will be approximately equal. But in crops such as paddy and Jowar, where a substantial part of output is retained by the farmers for home consumption, the responsiveness of the marketed surplus must be measured separately.

Table 5.3.1: Elasticities of Marketed surplus with respect to Input and output prices for selected crops

Elasticities of marketed surplus with respect to	Cotton	Paddy	Soybean	Sorghum
Output price	0.744	0.104	-0.577	-0.081
Human wage rate	0.417	0.192	-0.220	0.220
Bullock labour price	0.174	-0.126	-0.127	-0.138
Farm yard manure price	0.009	0.001	0.016	0.003
Fertilizer price	-0.001	0.213	0.053	0.000
Seed	0.074	0.101	-0.603	0.164
Capital	0.290	0.294	0.522	0.099
Land	0.878	1.090	0.969	0.585

Table 5.3.1 shows that the elasticities of marketed surplus with respect to input and output prices for Cotton, paddy, soybean and sorghum. The table reveals that the elasticities of marketed surplus with respect to soybean (-0.577) and sorghum (-0.081) prices were negative while it was positive for cotton (0.744) and paddy (0.104). For soybean and sorghum crop, the negative elasticity is due to the fact that the marketed surplus adjustment to higher sorghum prices is dominated by the income effect in consumption of sorghum. The positive response to higher cotton and paddy prices dominates the adjustment in marketed surplus.

The table also shows that the elasticities of marketed surplus with respect to bullock labour prices were negative for sorghum, soybean and paddy. In this case, the negative output and marketed surplus response to higher factor prices far dominate the positive effect on marketed surplus. As to fixed factors, an increase in their prices leads to an increase in marketed surplus for all selected crops. This effect was more on soybean (i.e. 0.522) which is followed by paddy, cotton and sorghum.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The present research study entitled "Input demand and output supply of selected crops of Vidarbha - profit function approach was undertaken with following objectives.

1) To study the temporal variation in input and output prices and cost of cultivation.
2) To estimate the input demand and output supply of selected crops.
3) To estimate Marketed surplus of selected crops.

Vidarbha region of Maharashtra state was purposively selected for present study and four crops viz. cotton, paddy, soybean and sorghum were selected. The response of marketed surplus to product and factor price movements was also assessed cotton, paddy, soybean and sorghum. These four selected crops occupied about 70 per cent area of the gross cropped area. The present study used cross sectional cum time series data of Vidarbha region for selected crops for ten years from 1999-00 to 2008-09. Every year's 100 farmers were selected purposively for the present study except 85 farmers for sorghum in year 2008-09 and 82 farmers for soybean in year 1999-00 due to availability of data.

The compound growth rates of inputs and output prices showed that the all input prices were increased during the period of study except prices of FYM for paddy and Fertilizer prices for sorghum. The output prices for soybean increased at an annual rate of 8.17 per cent followed by sorghum and paddy.

The output-input price parity for cotton reveals that the parity were decreased during year 1999-00, 2001-02 and from 2005-06 to 2008-09, increased in the subsequent years, indicating thereby in the year 1999-00, 2001-02 and from 2005-06 to 2008-09, the output price were lower than input price and term of trade was unfavourable for cotton growers. However, the term of trade was favourable for the cotton growers in the remaining years.

For paddy crop in the years 2001-02 to 2003-04, and in 2005-06 the output price were lower than input price and term of trade was unfavourable for paddy growers. However, the term of trade was favourable for the paddy growers afterward.

The input price index for soybean was increased by 69 per cent, while the increase in output price was 97 per cent. The output-input price parity were decreased during year 1999-00 to 2000-01 and increased in the subsequent years, indicating thereby in the year 1999-00 to 2000-01, the output price was lower than input price and term of trade was unfavourable to soybean growers. However, the term of trade was favourable for the soybean growers afterward.

For years 2001-02 and in 2003-04, the output price was lower than input price and term of trade was unfavourable for sorghum growers. However, the term of trade was favourable for sorghum growers afterward.

The total cost of cultivation of cotton has gone up from ₹ 13660.61 per hectare in 1999-00 to ₹ 24737.14 per hectare in 2008-09 depicting an increase by 1.82 times during a period of study.

Among operational cost items, hired human labour (21.04) recorded the maximum share followed seed (14.23) and family labour (11.21) in the increase in cost of cultivation of cotton over time.

It is remarkable to note that the seed rate in physical term has come down for cotton crop over the years. There for, the positive change in the cost of seed could be exclusively attributable to large increase in the prices of seed over time.

The gross return for cotton crop has recorded an increase of 156.44 per cent during the period study. This is attributable to the increase in the prices of main product.

The cost of cultivation of paddy increased from ₹ 14031.21 per hectare in 1999-00 to ₹ 19976.26 per hectare in 2008-09 showing an increase of 1.42 times during the period of study.

Among the items of operational cost hired human labour, bullock labour, machine labour and fertilizer accounted for 23.54, 16.14, 13.85 and 11.61 per cent respectively of the change in total cost. The share of seed and farm yard manure in the change in total cost was 6.72 and 2.72 per cent respectively, while the share of rental value of own land, and share of depreciation was found to have declined in paddy.

It is remarkable to note that the physical quantity of bullock labour, human labour, manure and seed has come down for paddy due to increase in the wage rate of bullock labour and human labour and prices of manure and seed.

The cost of cultivation of soybean increased from ₹ 9334.06 per hectare in 1999-00 to ₹ 17397.13 per hectare in 2008-09 showing an increase of 1.86 times during the period of study.

Among the items of operational cost the share of seed, hired human labour and machine labour accounted for 21.63, 16.80 and 13.42 per cent respectively, of the change in total cost of soybean.

For the soybean, the quantity of manure has decreased due to increase in the cost of manure. The use of fertilizer has increased i.e. from 34.17 kg/ha in 1999-00 to 54.59 kg/ha in 2008-09 due to slight change in the prices of fertilizers.

The gross return for soybean crop has recorded an increase of 142.13 per cent during the period of study, where as the gross return on unit area basis has increased by 10.76 per cent per annum.

The cost of cultivation of sorghum increased from ₹ 12205.43 per hectare in 1999-00 to ₹ 14227.29 per hectare in 2008-09 showing an increase of 1.17 times during the period of study.

Among the items of operational cost hired human labour, bullock labour and machine labour accounted for 57.06, 44.42 and 33.84 per cent respectively, of the change in total cost of sorghum.

It is remarkable to note that the physical quantity of bullock labour, human labour, manure and fertilizer has come down for sorghum due to increase in the wage rate of bullock labour and human labour and prices of manure and fertilizer. Only physical quantity of seed is increase due to increase in the price of seed.

The gross return for sorghum has increased by 5.49 per cent per annum. However the physical quantity of main product and by product has also declined. (i.e. -1.04 per cent per annum of main product and -0.05 per cent per annum of by product)

During 1999-00, the return over cost C was highest for paddy followed by sorghum but the return over cost C for soybean and cotton found negative where as during 2008-09, the return over cost C was highest for cotton followed by soybean and paddy crop. There for cotton crop had comparative economic advantage among the selected crops of Vidarbha in 2008-09.

The average cost of production for cotton varied from ₹ 1930.12 with an average yield of 10.13 quintal in the year 2006-07 to ₹ 2536.83 per quintal with an average yield 5.61 quintal in the year 2001-02.

The average cost of production for paddy varied from ₹ 608.23 with an average yield of 26.30 quintal in the year 2001-02 to ₹ 1014.54 per quintal with an average yield 19.69 quintal in the year 2008-09.

The average cost of production for soybean varied from ₹ 859.83 with an average yield of 15.79 quintal in the year 2003-04 to ₹ 1504.94 per quintal with an average yield 11.56 quintal in the year 2008-09.

The average cost of production for sorghum varied from ₹ 514.53 with an average yield of 22.24 quintal in the year 2002-03 to ₹ 917.77 per quintal with an average yield 15.50 quintal in the year 2008-09.

The output-cost ratio for cotton increased from 0.953 in 1999-00 to 1.350 in 2008-09. However, from the year 1999-00 to 2002-03 and in 2005-06, the output-cost ratio was not very impressive mainly due to low productivity per unit area and the gross income from cotton increased at an annual rate of 10.25 per cent per annum between 1999-00 to 2008-09.

The output-cost ratio for paddy increased from 1.050 in 1999-00 to 1.099 in 2008-09. However, from the year 2000-01 to 2001-02 and 2004-05, the output-cost ratio was not very impressive mainly due to low productivity per unit area while in 2007-08, the output-cost ratio was increased i.e. 1.217 and the gross income from paddy increased at an annual rate of 5.83 per cent per annum between 1999-00 to 2008-09.

The output-cost ratio for soybean increased from 0.876 in 1999-00 to 1.138 in 2008-09. However, from the year 1999-00 to 2001-02 and in 2004-05, the output-cost ratio was not very impressive mainly due to low productivity per unit area while in 2007-08, the output-cost ratio was increased i.e. 1.486 and the gross income from soybean increased at an annual rate of 10.75 per cent per annum between 1999-00 to 2008-09.

The output-cost ratio for sorghum increased from 1.050 in 1999-00 to 1.128 in 2008-09. However, from the year 2000-01 to 2001-02 and in

2004-05, the output-cost ratio was not very impressive mainly due to low productivity per unit area while in 2005-06, the output-cost ratio was increased i.e. 1.224 and the gross income from sorghum increased at an annual rate of 5.49 per cent per annum between 1999-00 to 2008-09.

The absolute value of own price elasticity of human labour, bullock labour and seed demand were greater than unity indicating there by an elastic response of input utilization to their own price. One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.296 per cent, bullock labour demand 1.343 per cent and seed demand 1.665 per cent in cotton crop.

The absolute value of own price elasticity of human labour and seed demand were greater than unity indicating there by an elastic response of input utilization to their own price. One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.079 per cent, seed demand at 1.616 per cent in paddy crop.

The effect of wage rate was more on bullock labour demand (-0.114), while the effect of bullock labour price on human labour demand was low (-0.071). This indicates the one way complementarity between human labour and bullock labour. Obviously, without human labour, bullock labour cannot be used, where as the reverse is not true. The demand for all input responded positively to increase in output price for paddy crop.

The absolute value of own price elasticity of human labour, bullock labour and seed demand were greater than unity indicating there by an elastic response of input utilization to their own price. One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.340 per cent, bullock labour demand 1.242 per cent and seed demand at 1.030 per cent in soybean crop.

The absolute value of own price elasticity of human labour, bullock labour and seed demand were greater than unity indicating there by an elastic response of input utilization to their own price. One per cent increase in own price, holding other prices constant, will reduce human labour employment at 1.260 per cent, bullock labour demand 1.134 per cent and seed demand 1.080 per cent in sorghum crop.

The elasticity with respect to farm yard manure price was -0.001 resulted that a 1 per cent increase in farm yard manure price were associated with about 0.001 per cent decline in crop output for cotton. Among the fixed factor, capital was found to be effective in increasing the supply of cotton. The output supply elasticity with respect to capital was (0.291). Capital input had positive impact on the supply of cotton.

The elasticity with respect to bullock labour price for paddy was -0.126 resulted that a 1 per cent increase in bullock price was associated with about 0.126 per cent decline in crop output. However, among the fixed factor capital was found to be effective in increasing the supply of paddy. Capital input had positive impact (0.221) on the supply of paddy.

The elasticity with respect to wage rate, bullock labour price and seed price for soybean were -0.092, -0.080 and -0.458, resulted that the 1 per cent increase in wage rate, bullock labour price and seed price were associated with about 0.096, 0.080 and 0.045 per cent decline in crop output. However, capital had positive impact (0.482) on supply of soybean.

The elasticity with respect to bullock labour price for sorghum was -0.020 resulted that a 1 per cent increase in bullock price was associated with about 0.020 per cent decline in crop output. However, among the fixed factor capital was found to be effective in increasing the supply of sorghum. Capital input had positive impact (0.485) on the supply of sorghum.

The profit function for cotton was decreased in price of farm yard manure and prices of seed. Among the variable factors, normalized seed price in general had the highest negative impact on variable profit for cotton crop followed by prices of farm yard manure.

The profit function for paddy was decreased in prices of labour and fertilizer and seed. Among the variable factors, normalized wage rate in general had the highest negative impact on variable profit followed by seed price and fertilizer price.

The profit function for soybean was decreased in prices of labour and farm yard manure. Among the variable factors, normalized wage rate in general had the highest negative impact on variable profit followed by prices of farm yard manure.

The profit function for sorghum was decreased in prices of bullock labour and fertilizer. Among the variable factors, normalized bullock labour price in general had the highest negative impact on variable profit followed by fertilizer price.

The price observed during the last decade was better to maintain the growth in cotton supply by 5.04 per cent per annum. The growth in supply of cotton is more than the growth in population.

The elasticities of marketed surplus with respect to bullock labour prices were negative for sorghum (-0.138), soybean (-0.127) and paddy (-0.126).

As to fixed factors, an increase in their prices leads to an increase in marketed surplus for all selected crops. This effect was more on soybean (i.e. 0.522) which is followed by paddy, cotton and sorghum.

Conclusions

1) The compound growth rates of inputs and output prices showed that the all input prices were increased during the period of study except prices of FYM for paddy and Fertilizer prices for sorghum. The output prices for soybean increased at an annual rate of 8.17 per cent followed by sorghum and paddy.
2) From the year 2006-07 to 2008-09, the term of trade was favourable to the paddy, soybean and sorghum growers.
3) The cost of cultivation for cotton, paddy, soybean and sorghum has depicting an increase by 1.82 times, 1.42 times, 1.86 times and 1.17 times during the period under study.
4) The gross income from cotton, paddy, soybean and sorghum increased at an annual rate of 10.25 per cent, 5.84 per cent, 10.76 per cent and 5.49 per cent per annum, it may be attributed to both, the increase in output prices as well as increase in yield.
5) An examination of change in returns from cotton showed that the profitability was increased over the years. The output cost ratio was increased from 0.748 in 2001-02 to 1.350 in 2008-09. This clearly indicates that the technological breakthrough in the cultivation of cotton has compensated the cost push inflation.
6) The analysis of factor demand equation showed that the demand elasticities with respect to own prices had the expected negative signs indicating that the results were in accordance with the theory of demand.
7) The effect of wage rate was more on bullock demand (-0.114), while the effect of bullock labour price on human labour demand was low (-0.071). This indicates the one way complementarity between bullock labour and human labour in paddy cultivation.
8) The output supply equation revealed that among the fixed factor, capital was found to be effective in increasing the supply of cotton,

paddy, soybean and sorghum. Capital inputs had positive impact on the supply of all selected crops.

9) Assuming no change in fixed factors or level of technology, the input-output price structure has not resulted in a appreciable increase in human labour employment, bullock labour employment and fertilizer demand in the production of paddy crop.

10) The impact of input-output price on demand for farm yard manure and demand for fertilizer significantly increased in the production of paddy and sorghum respectively.

11) The price observed during the last decade was better to maintain the growth in cotton supply by 5.04 per cent per annum.

12) The elasticities of marketed surplus with respect to bullock labour prices were negative for sorghum (-0.138), soybean (-0.127) and paddy (-0.126).

13) As to fixed factors, an increase in their prices leads to an increase in marketed surplus for all selected crops. This effect was more on soybean (i.e. 0.522) which is followed by paddy, cotton and sorghum.

CHAPTER VII

IMPLICATIONS

The present study entitled "Input demand and output supply of selected crops of Vidarbha – profit function approach is to study the temporal variation in input and output prices and cost of cultivation, to estimate the input demand and output supply and to estimate the marketed surplus of selected crops emerging some implications which are reported in this section are as follows.

Increase in gross income from the selected crops was not sufficient to cover the increased cost of inputs used in the production process. It is therefore suggested that the efforts are required to be made to maintain parity between input-output prices so that the producers may not lose their interest in growing such crops.

The low value of price elasticity of demand for fertilizer in case of paddy, soybean and sorghum is also of clear importance. It suggests that a marginal change in its price level (through fertilizer subsidy or other policy measures) is not likely to affect its consumption substantially in Vidarbha agriculture.

The policy maker thus faces a dilemma between deciding a higher or lower product prices. If the higher prices are fixed, there will be more marketed surplus but there will neither be effective demand for the product on account of lower purchasing power of domestic consumers nor possibilities for export on account of higher cost of production.

If lower prices are fixed, the growth in marketed surplus will be insufficient to meet the needs of the growing population, crop income will be low, financial ability of farmers to make investments in agricultural will be weak, there will be excessive pressure on financial institutions for increased supply of credit and these will lead to lower growth in agricultural production.

Thus, a policy of attempting to stimulate output through higher prices will be consistent with eliciting a larger proportion of the output produced for non-farm population.

CHAPTER VIII

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