AN ECONOMIC ANALYSIS OF TRACTORISATION IN SIRSA DISTRICT OF HARYANA

By

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CERTIFICATE - I

This is to certify that this thesis entitled, "**An economic analysis of tractorisation in Sirsa district of Haryana**", submitted for the degree of master of science, in the subject of agricultural economics to the CCS Haryana Agricultural University, is a bonafide research work carried out by Kuldeep Chand, Admission No. 2009A04M under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE - II

This is to certify that this thesis entitled, **"An economic analysis of tractorisation in Sirsa district of Haryana",** submitted by Kuldeep Chand**,** Admission No. **2009A04M** to the CCS Haryana Agricultural University in partial fulfillment of the requirement for the degree of **Master of Science,** in the subject of **Agricultural Economics,** has been approved by the Student's Advisory Committee after an oral examination on the same.

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A precious debt as that of learning is the only debt that is not only difficult but also impossible to repay except perhaps through gratitude.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER-I

INTRODUCTION

Agriculture plays an important role in Indian economy. Agriculture is an important occupation in India with over 70 per cent of her population depending on it directly or indirectly for livelihood. It provides the bulk of employment, income and food for the rapidly growing population as well as supplying raw materials for agro-based industries. Modern agriculture is dependent on high yielding varieties, chemicals, increased use of fertilizers, pesticides, irrigation and farm mechanization. Farm machines have played a paramount role in increasing the agriculture production and have grown in to a sizable industry in India. The level of adoption of new technology including farm mechanization by Indian farmers is still low. In developed countries, the farmers have adopted highly advanced, efficient and labour saving agricultural equipments. However, in India the mechanization of agricultural farms leaves much be desired. Tractor is the basic unit of farm mechanization, its adoption in a region is an index of the level of farm mechanization of that area. Use of tractors ensures better quality of work in farm operations, timely completion of farm activities, better management and supervision.

The rate of growth of agricultural production in India should increase appreciably in order to mitigate hunger, starvation, diseases, raw materials, dependence on foreign sources and food importation, as well as to improve on the quantity and quality of food per person and the well-being of the farmer and his family. This can be done by increasing agricultural productivity through mechanization. This has been done in such other countries like in China (Li, 2005) and in Oman (Ampratwum *et al.*, 2004). Mechanization of agriculture helped transform American agriculture from the situation where one farmer fed 5 people in 1880 to that where one farmer could feed 80 people in 1982 (Ani and Onwualu, 2002). Agricultural mechanization has been accepted as the crucial input not only for increasing agricultural productivity and promoting industrialization of the rural sector, but also for promoting overall economic development of the nation. The key to economic development lies in raising agricultural productivity which directly involves the utilization of more energy resources (Jekayinfa, 2006).

Today, tractor is one of the most important power sources in agriculture. Effect of tractor power on agriculture is considerable. The use of modern technology during later decades resulted in rapid growth of farm production. Tractors and farm machinery are important examples of this

modern technology. The quality of inputs of mechanization may differ considerably in land and labor productivity (Bakht *et al.,* 2009).

Tractorisation is a debatable issue particularly in an over populated country like India. Although we have abundant labour at our disposal, yet labour shortage is felt at the time of peak period particularly during threshing. This not only forces the farmer to leave most of the land uncultivated but also compels to perform most of agricultural operation untimely resulting in low production and poor yield. Further, the continuously rising wage trend of agricultural labour pushed the cost of cultivation very high, leaving narrow margin of profit for farmer himself. Tractorisation results in lowering the cost of production and affects agriculture in two ways first, by increasing the output and thereby reducing per unit cost of production and secondly by reducing labour input per hectare of cropped area. Tractors came to India through imports and later on were indigenously manufactured with the help of foreign collaborations. The manufacturing process started in 1961-62. Indian tractor industry is relatively young but now has become the largest market worldwide.

Different views have been expressed by the economists and others concerned with the field of agriculture regarding the use of tractor since its adoption in early fifties. It was believed that the use of tractor would displace farm labour and might create the problem of unemployment in a labour surplus country as ours. It was felt that heavy investment on tractor might not be economical under our conditions where a big chunk of the operational holdings was relatively small. At the same time, it was realized that in order to reap the benefits of seed-water-fertilizer technology, farm mechanization, especially tractorisation was essential to cope with the draft power needs of intensive agriculture for further enhancing output. The labour displacement hypothesis was largely misplaced because, in the initial stages, the introduction of tractors prompted labour use through an increase in cropping intensity and production and even in the long run. Although, it affected labour use on the farm, it substantially off-set this loss by creating off-farm employment in several directions.

Higher productivity and greater output are the two major contributions of farm mechanization. Tractors form an integral part of farm mechanization and have a crucial role to play in increasing agricultural productivity. Tractor is a highly versatile piece of machinery having a multitude of uses. It is used in agriculture both for land reclamation and for carrying out cultivation of various crops. It is also employed for carrying out various operations connected with raising the crops by attaching suitable implements and to provide the necessary energy for

performing various crop production operations involved in the production of agricultural crops. Tractors are capital intensive, labour displaying, used as a mode of transport, in electricity generation, in construction industry and for haulage operation. It has now become an integral part of farm structure. The application of tractor for agricultural activities which swept India during the last twenty years has eased the problem of farmers

India's gross cropped area is next only to United States of America and Russia and along with fragmented land holdings has helped India to become the largest tractor market in the world. But it drops to eighth position in terms of total tractor in use in the country when compared to international figures, India accounts for only 3 per cent of total tractors used all over the world. It is to be noted that while the overall automobile industry is facing recession the tractor industry is growing at 9 per cent. About 20 per cent of world tractor production is carried out in our country only. The only arable land in India is high as 12 per cent of the total arable land in the world. Tractor market in India is about ` 6,000 crores. On an average around 4,00,000 tractors are produced and their sale is 2,60,000. Uttar Pradesh is the largest tractor market in our country. One out of every four tractors is being purchased here (Anonymous, 2006). The Indian tractor market is the largest in the world accounting for approximately one third of global production. Until 1960, the demand of tractors was met entirely through imports. Indigenous manufacturing of tractors began in 1961, but India continued to import tractors to bridge the total needs up to late 1970s. The Indian tractor industry has come a long way since then. The sales volume growth of tractor industry in the past about two decades shows a compound annual growth rate of 5.81 per cent, despite seasonal variations that cause natural fluctuations in the demand of tractors (Bhalla, 2007).

States of Punjab, Haryana, Uttar Pradesh together account for about 60 percent of total number of tractors in India (Singh and Tondon, 1987). Haryana is considered to be one of the most mechanized states in the country. Its tractor population increased from 4,803 (1966-67) to an estimated 2,59,030 in the year 2009-10. The sale of tractors in Haryana ranges from 15,000 to 20,000 units per year.

After the initiation of green revolution, Haryana has made a tremendous progress in the field of agriculture. The state which was a deficient even in its food requirements, not only became self-sufficient, but also made large contribution to the food grain pool of the country. This was due to the adoption of new technology by the farmers of the state, particularly through the increased use of HYV seeds, chemical fertilizers, and irrigation water and farm

mechanization. Mechanization has led to the proper utilization of inputs like fertilizers, pesticides and water. It is well established that with the use of modern equipments, the utilization efficiency of these inputs has substantially increased. In fact, farm mechanization has enabled the farmers to cultivate larger holdings and to practice intensive cropping system.

It is important to study the factors affecting the demand of tractors in general and productive input in particular because this decides the fate of production and productivity in the country. The increasing demand of tractors will help the producers of tractors to manage finance and other factors of production in time to fulfill the future demand. Further, it will help the producer to use the resources judiciously and avoid wastage of resources. It is generally believed that liberal loaning policy of the banks is one of the main reasons for an increase in the number although the tractors purchased by most of the farmers remain under-utilized. Also, investment on tractors which seems irrational from the societal view point may not be so when look at from an individual farmers view point. Also, it has commonly been observed that proper facilities for services of new technologies are not available. It is therefore, important to study the problems of the kind in the rural areas. Further, the financial and infrastructural problems are required to be studied to solve the problems in increasing the use of tractors Mostly the use of tractor depends on factors like total cropped area, gross irrigated area, area under high yielding varieties, cropping intensity, cropping pattern, price of crop, price of tractor and fuel, etc. The use of tractor has increased considerably in Indian agriculture over the last decades. Taking all these facts and problems into consideration a comprehensive study on different aspects of tractorisation is, therefore, considered very essential to have an understanding the problem in perspective. Hence, the present study was carried out with the following specific objectives:

1. To examine the magnitude and utilization pattern of tractors
2. To work out economics of tractorisation.
3. To study the factors affecting demand of tractors
4. To identify the problems faced by farmers in the purchase and use of tractors

CHAPTER-II

REVIEW OF LITERATURE

In the process of agricultural development, farm mechanization plays a significant role. The main objectives of agricultural mechanization have been to increase the productivity per worker and per unit land, changing the character of farm work, making it less arduous and more attractive. The tractors have contributed significantly in realizing these objectives. The tractors have progressed from its original primary use as a substitute for animal power to the present units designed for multiple uses.

The use of improved technology especially tractors in the field of agriculture has opened new vistas of hope and optimism for cultivators in particular and economy in general. Recently there has been phenomenal increase in the use of tractors and its accessories. A great amount of concern is expressed regarding the favourable and unfavourable effect of tractorisation, especially on utilization, factors affecting demand of tractors, problems faced by farmers in the purchase and use of tractors, economic feasibility of tractor advances, gross income, net returns and employment situation of available and potential agriculture labour force.

In this chapter an attempt has been made to review critically the studies conducted by different research workers on the above aspects of tractorisation. The available literature could be grouped into following categories:

4.1 Magnitude and utilization pattern of tractors

4.2 Economics of tractorisation

4.3 Factors affecting demand of tractors

4.4 Problems in purchase and use of tractors

2.1. Magnitude and utilization pattern of tractors

Umesh and Mathew (1990) in their study "Progress of tratorisation in Indian agriculture", revealed that the growth (in compound growth rate items) rate in the production of tractor was 16.81 per cent between 1961-61 and 1987-88. The number of tractors produced in country were only 880 during 1961-62, it increased to 90092 in 1987-88, thereby showing an increase of 12.67 per cent per annum. The availability of tractor per million hectares of gross cropped area was only 25 (1961-62) and it increased to 509 (1987-88) with the growth rate of 12.4 per cent per annum.

Chatha and Grewal (1991) conducted a study entitled "A study of tractorisation in Punjab" and observed that a vast majority of farmers were making sub-optimal use of tractors. The average use per annum worked out to about 450 hours against the recommended level of 1000 hours. Also, the available tractor horse power per hectare turned out to be 4.20 as against the optimum requirement of 2.16 H.P.

Shyam (1992) conducted a survey on farm tractor utilization in selected districts of Madhya Pradesh. Data collected from 49 tractor owning farmers in Bhopal and Raisen districts of Madhya Pradesh indicated that most farmers possessed a tractor of 18 to 30 HP, a trailer, a cultivator, a seed drill, a crop thresher and electric pump sets. Use of tractors for operation other than tillage, sowing and transportation was found very limited. Almost all the farmers had taken bank loan for purchasing a new tractor. About one third of farmers used their tractors for custom hiring jobs. Average annual use was reported to be around 1000 hrs. Very limited repair facilities were reported to be available in rural areas. Most farmers did not avail services of the authorized dealers for repair of their tractors. Farmers, in general, were found satisfied with their tractors.

Singh *et al.,* (1992) conducted studies on farm power and machinery availability and utilization in a selected village of Punjab, to assess the availability and utilization pattern of farm machinery and tractors. The farmers of the village were interviewed for the possession of farm machinery and their utilization in crop production system. The average annual use of tractor in crop production was 165 hrs. which was less than the expected use. Tractors were also used on custom hiring basis and for transportation of non-agricultural items which were not considered in this study. Annual use of tractor drawn cultivator, disc harrow and seed drill was 38, 170 and 23 hours, respectively.

Yadav (1994) conducted a study on utilization of tractors in tea estates and observed that the average annual utilization of tractors on these plantations ranged from 1521 to 1672 hours. It was observed that procurement of spare parts was easy at those tea plantations where tractors of

same make and model were owned. Thus, the annual utilization of tractors on these farms was better than those where odd makes of tractors were used.

Pandey *et al.,* (1998) observed that the total number of tractors in Haryana has shown a rapid increase since the inception of state. In mid sixties, there were only 4.85 thousand tractors, which increased to 32 thousands in late eighties and to 153.97 thousand in mid-nineties. As a consequence, there has also been a significant increase in the number of tractors per hundred hectares of net sown area in the State. Indeed, it has increased from 0.14 in 1966 to 1.78 in 1982 and further to 4.38 in 1995.

Duggal and Malhi (1999) carried out the study on tractor use pattern in Patiala district of Punjab. Informations on make, model, HP, hours of annual use, farm size etc. was collected from 116 farmers of the different villages having 123 tractors. The data revealed that about 35 per cent of the farmers are making the optimal use (more than 800 hours per year) of tractors. The average annual use of tractor by sample farmers is worked out to be 707.8 hours. It is interesting to mention that a farmer with five acres of land operates a tractor of 35 HP for more than 3000 hours per year due to custom hiring. The total cost for operating a tractor was estimated to be ` 80 to ` 82 per hour as the tractor use 1000 hours per year. The optimum HP requirement is 2.16 HP per hectare.

Suman (2004) conducted a study and found that the average annual use of farm tractors was 449 hour. For 53 per cent of the time, the tractors were deployed for custom hiring and 47 per cent for their own work. Maximum use of tractor was recorded to be in tillage operations (20 per cent), followed by threshing as well as sowing (19 per cent).

Shrivastava and Nilatkar (2005) conducted a survey and analysis on the energy and machinery use pattern at a farm in Jabalpur. Average annual use of tractors at the farm was 1245 hours. Tractors were used for maximum period of time (10.75 per cent) for transportation work. Output-input energy ratio was highest for wheat (2.84). Total energy consumed at the farm was 1853 GJ. Total cultivated area of the farm was 80 ha and cropping intensity was 156 per cent.

Bector *et al.,* (2008) observed that a wide choice of competitive models, ranging from 12 to 75 hp, is now available, to the Indian farmers. Although the most favorable tractor power segment among the farmers in present scenario is 31-40 hp which is contributing almost 50 per cent of the total tractor industry. In the last few years, a substantial shift has been observed to 41-60 hp segment due to better products/technologies made available by multinational and global tractor manufacturers at competitive pricing, precision farm technologies and trend of

cooperative farming, larger land holdings and increase in revenue. The tractor population of 41-60 hp segment has increased from 54,685 (22.8 per cent of total no. of tractors in a year) in 2000-01 to 91,741 (31.5 per cent) in 2005-06. Usage of higher hp tractors (>60 hp) has also increased from 265 tractors in 2000-01 to 2068 in 2003-04. Such steady trends in 31-40 hp and increasing trends in 41-60 hp & above 60 hp segments has made the 21-30 hp segment, observe a downfall from 54,441 tractors (22.7 per cent of total no. of tractors) in 2000-01 to 50,135 (17.2 per cent of total no. of tractors) in 2005-06.

4.2. Economics of tractorisation

AERC (1970 & 1971) conducted a series of studies related to the economics of mechanization. These studies revealed that the gross income was higher on mechanized farms than non-mechanized farms. The gross crop output per cultivated hectare was reported to be ` 3144 for tractor operated farms as compared to ` 2677 for bullock operated farms.

NCAER (1974) reported that the tractor farms secured 21 per cent more income per hectare of gross cultivated area compared to bullock farms. The net return per hectare of gross cropped area or net cultivated area was higher for tractorised farms than non-tractorised farms as a result of better utilization of resources. Another study by NCAER (1980) revealed that the tractor owners and users derived higher per hectare gross income compared to bullock farms. The gross income per hectare of an average tractor owned household was 63 per cent higher than that of a household using only bullock labour. The gross income per hectare of tractor using household as a group exceeded that of the bullock farms by 31 per cent. The average net return from a tractor owning farm on a cropped hectare exceeded that of a bullock farm by 152 per cent. A tractor using farm also derived a net additional income of 84 per cent over a bullock farm. A tractor owning farm spent 57 per cent more than bullock on material inputs and 62 per cent more on human labour. An average tractor owner and user, in spite of spending more on cultivation expenses, derived higher net income on a cropped hectare compared to bullock farm. However, this should not be attributed entirely to tractor usage as other factors such as hybrid seeds, fertilizers and irrigation also contributed to it.

Khan *et al.,* (1984) developed a computer program of agricultural machinery management to determine the optimum farm size and minimum power requirement for a given cropping pattern. It has been used to calculate the economics of using tractors of various sizes and to select a particular size of tractor giving the best economic performance for a sufficiently large farm. The results of a typical cropping pattern for a farm size of 240 ha and 10 different

sizes of Massey Ferguson ranging from about 12 to 120 KW indicate that the small tractors (less than 35 KW) are not economical though they improve timeliness of operations. The tractors in the medium range (35 to 70 KW) gave the best economic performance and should normally be preferred as compared to very large models (70 KW and above) because they guarantee more work reliability. It is reported that the improvement in timeliness of operations is achieved at the expense of increased initial investment for using relatively small tractors on large farms.

Ojha and Pandey (1986) worked out the graphical determination of cost of operation on agricultural machines. A set of monographs has been designed and presented for determination of hourly cost of operation of agricultural machines. The annual use and total life of machines, interest rates, maintenance as a function of life of machine, fuel consumption, labour/operator requirements and rates of fuel and labour have been taken as variables to cover a wide range of agricultural machines and situations under which these are operated.

In the study in an irrigated area of Ahmednagar district of Maharashtra, Patil and Sirohi (1987) reported that, on an average, the gross return were higher by about 33 to 34 per cent on tractor-owning farms than those on bullock operated farms.

Balishter *et al.,* (1991) reported that net return per hectare from mechanized farms having tubewells and tractors and partially mechanized farms having only tubewells were 49 per cent and 29 per cent higher respectively than that from non-mechanized farms.

On the basis of a study covering 203 farmers having 218 tractor in different districts of Punjab (Singh and Jindal, 1993), it was brought out that the total use of the tractor, which on average came out 397 hours per annum is much less than the possible extent of 1000 hours. The cost per hour turned out to be very high due to high fixed cost, which can be reduced by increasing the hours of working of the tractor. If it finds work for 600 or more hours per annum, the cost per hour can be lowered significantly. The overall average cost/hour, which was ` 103.04 by its existing quantum of work ,*i.e.,* 397 hours declines to ` 91.77, ` 86.26 and ` 82.97 by working per 600, 800 and 1000 hours per annum. The machine becomes more economical only if it is gainfully employed for rather than accounting for its unproductive use. Custom servicing increases annual use of farm machinery.

Singh and Dhawan (1994) conducted a study on an economic analysis of tractorisation in Punjab. This study was based on a sample of 113 tractor owner farmers and showed that the average power availability per hectare was 3.61 HP on the sample farms. The crop wise use of tractor showed that paddy and wheat were the main crops and the tractor use accounted for 33.96

per cent and 39.60 per cent, respectively of its total use on tractor owning farms. The fixed and variable cost of tractor use was ` 95.66/hr. It was almost at par with the custom hiring rates in the state. About 37.2 per cent of the tractors were being used for less than 300 hr/annum and their use could be considered uneconomical. An equal number was operated between 400-1000 hr/annum and was regarded within economically safe range, while 25 per cent were operating just at break-even point.

Singh and Tewari (1994) in their study "Farm investment in tractor in Bihar", revealed that a larger farm holding is required for economically owning a tractor with decline in rental market for tractor services. The renting and own farm use of tractor, a relatively larger minimum farm size is required for economically owning a tractor when it is purchased with borrowed funds than when it is purchased with equity capital. The result also suggest that farmers who possess land holding less than about 10 ha should not go for tractor purchase with borrowed funds under the existing pattern of tractor use observed in the study area.

Singh *et al.,* (2004) observed that Indian agriculture continues to be dependent upon human and draught animal power. Animate power contributed 92 per cent of the total farm power in 1960–61 and mechanical and electrical together contributed only 8 per cent. By 1999–2000, the contribution of animate power came down to only 19 per cent and from rest of the sources such as tractors, power tillers, electric motors and diesel engines; it increased to 81 per cent. Potential farm power available per unit cultivated land from all sources (animate and mechanical) increased form 0.32 kW/ha in 1965–66 to 1.15 kW/ha (net-cropped area basis) in 1997–98. Even with not much increase in cropping intensity and area under irrigation, the land productivity (for food grains only) has gone up by 144 per cent since 1965–66 from 0.636 t/ha in 1965–66 to 1.554 t/ha in 1997–98. This was possible due to introduction of high yielding varieties and need based farm mechanization.

Tyagi *et al.,* (2010) in their study accepted fact that higher levels of production in agriculture need higher levels of power availability. In the absence of adequate power supply, agricultural operations cannot be completed in time and yields would be adversely affected. Availability of adequate farm power is very crucial for timely farm operations for increasing production and productivity and handling the crop produce to reduce losses. With the increase in intensity of cropping the turnaround time is drastically reduced and it is not possible to harvest and thresh the standing crop, on one hand, and prepare seed bed and do timely sowing operations of subsequent crop, on the other hand, in the limited time available, unless adequate farm power

is available. As such there is a strong need for more authentic figures relating to the items pertaining to agricultural implements and machinery.

4.3. Factors affecting demand of tractors

Singh and Jain (1981) estimated the utilization of tractor in Punjab and observed that the utilization of tractor was positively correlated with irrigation facilities and it was estimated that the increase in irrigation facilities by 25 per cent could lead to an increase in the tractor use by about 6 per cent and when irrigation facilities were doubled, the tractor use increased to about 9 per cent. The study concluded that the tractor density was higher in those areas where relatively more irrigation facilities were available.

Gajja *et al.,* (1985) studied the determinants of tractorisation in arid areas of Western Rajasthan and found that the agricultural productivity, size of holding, labour density, draught animal density and rural literacy were important factors that had a positive impact on the tractorisation in the area. It was suggested that a concrete policy to provide sufficient tractors would help to increase agricultural productivity without replacing human labour and draught animal power.

Shukla and Jain (1991) conducted survey on the trends in tractor sales in Ludhiana District of Punjab, for establishing the recent trends in tractor sales and factors influencing the decisions of the farmers who purchased new tractors. The survey of new tractor owners for the period Jan-1, 1990 to Jan-31, 1991, covering 21 villages in three blocks was conducted. A questionnaire was used for the survey. The analysis of data showed that 35 HP tractor as most popular and two third of the purchase was replacement sale, November was the peak month of tractor sales while May and June had the least sale. Farmers with operational land holding up to 12 HP gave more weightage to maintenance cost, initial cost, fuel efficiency while deciding the purchase of new tractor. However, all the farmers considered timeliness of operation as the most important factor.

Singh and Singh (1993) in their study "Demand for tractors in Punjab", estimated that annual replacement demand by the year 2000 would be more than 11,000 and annual total demand would be above 20,000. The liberal estimates push this demand figure to be even above 25,000.

Kumar (1995) in their study observed that growth in tractors during 1967-72 was attributed to uprise of wheat high-yielding variety seeds in Punjab; however, the latest increase in

tractors was due to the steady adoption of mechanized field ploughing by small and marginal farmers by hiring-in tractors.

Bhalla (1998) conducted a study on factors influencing farmers' decision for purchase of a specific tractor. Such factors have been identified through an opinion survey of tractor owners in district Gurgaon of Haryana State. The dominant characteristics of different make and model of tractor which have influenced the tractor owners' decision have also been identified.

Singh and Jindal (1998) conducted a study to find out the various aspects of utilization of existing tractors in Punjab agriculture. The study revealed that more than 80 per cent of the tractor use was made for productive purposes on the own farm and 8.09 per cent of its total use was made for custom hiring work while 6.60 per cent of its use was made for social purposes. It was found that tractor use was dependent mainly on the cropping pattern of the area, farm size, type of soil, cropping intensity etc. and nearly 30 per cent of its use was made for ploughing operation alone. Marketing, planking and sowing together also accounted for about one third of the total use.

Grover and Sharma (2000) in their study "Demand for tractors in India", projected demand for tractors in India which showed that total demand in India during coming years would vary between 17,01,465 tractors in the year 1997-98 to 22,58,028 tractors in 2024-25. The gross irrigated area, demand for tractors in previous year (which explained in a way the demonstration effect) and real price were significant variable, which positively influenced the demand for tractors in India.

Tyagi *et al.,* (2010) stated that in the changing scenario, it has become more important to have projection estimates of total number of tractors, power tillers, diesel engines, electric pumps and other power-operated agricultural machinery and implements for the future years. Making use of available yearly data, the projected population of agricultural machinery and implements for future years at All-India level has been worked out in this study.

4.4. Problems in purchase and use of tractors

Maggu (1982) reported the reasons for non-purchase of tractor across the six states in the survey. It is evident that non-availability of a particular brand of tractor is a very important factor, especially in the relatively affluent states. This further supports the contention that those deciding to buy are forced to purchase a tractor which does not suit their requirements. Lack of funds is another major constraint on the purchase decision. Almost 50 per cent of tractor owners reported that they had purchased the tractor through bank borrowings. The percentage of the

respondents who feel that a tractor is unprofitable is not very high considering the fact that most of these respondents had not gone in for other changes in a long time. The last category of "other reasons," broadly consisted of socio-cultural reasons for non-purchase of tractors.

Verma *et al.,* (1994) cited the three chief bottlenecks of farm mechanization under the three heads: i) Research development and testing of farm machinery and equipment, particularly suitable to small farms, dry farming, for operations such as paddy transplanting, sugarcane and fodder harvesting, spraying tall plants such as fruit and forest trees, cotton, sugarcane etc., sugarcane planter, cotton picking and so on, ii) Manufacture, standardization and quality control: Poor quality and lack of matching and standard designs of equipment and acute shortage of testing facilities, and iii) Education, training and popularization of farm equipment: Inadequate training facilities for farmer-users and artisans, inadequate service centers and lack of regulations on custom hiring services.

Pandey *et al.,* (2002) made an attempt to know the motivating factors for purchasing the farm machineries. They found that the tractor was perceived as the cheaper source for meeting the farm operational requirements by the majority of the total farmers (88.88 per cent). Suitability of tractor to the farm needs (77.77 per cent), reputation of tractor for good performance (76.92 per cent) and status symbol (64.95 per cent) were the other main reasons for purchase of tractor. Small farmers had the motive of earning money by hiring out the services of their tractor (94.28 per cent).

Suman (2004) conducted a study on adoption and constraints in farm machinery and soil conservation practices in Tejpura and Lakara karari watershed of India and revealed that poor financial condition (92 per cent), inadequate repair and maintenance facility (90 per cent), lack of risk bearing attitude (85 per cent), unavailable information on improved implements, lack of motivation and co-operation (60 per cent) and a non-enthusiastic attitude (60 per cent) are some of the major constraints in adoption of improved production processing practices.

CHAPTER-III

METHODOLOGY

In this chapter, an attempt has been made to describe the methodology adopted for the study viz., selection of district, tehsils, villages and tractor owner farmers, method of data collection and techniques used for the analysis of data.

3.1 Selection of Study Area

3.1.1 Selection of District

The present study was confined to Sirsa district of Haryana state, as this district ranked first in respect of number of tractors in the state (table 3.1).

Table 3.1: District wise number of tractors in Haryana during 2007-08

Districts	Number of tractors
Ambala	8,813
Panchkula	2,100
Yamunanagar	12,234
Kurukshetra	13,480
Kaithal	11,754
Karnal	17,851
Panipat	10,161
Sonipat	15,876
Rohtak	12,241
Jhajjar	15,548
Faridabad	12,216
Gurgaon	4,740
Mewat	10,743
Rewari	7,975
Mahendergarh	4,914
Bhiwani	22,230
Jind	13,660
Hisar	18,263
Fatehabad	14,166
Sirsa*	32,022
State	**2,60,987**

* Selected district Source: Statistical Abstract of Haryana 2007-08

3.1.2 Selection of Tehsils

Among the four tehsils of Sirsa district, Dabwali and Sirsa tehsils were selected purposively for this study as these two tehsils ranked first and second in respect of number of tractors in the district (table 3.2).

Table 3.2: Number of tractors in different tehsils of Sirsa district during 2007-08

Tehsils	No. of tractors
Dabwali*	14,418
Sirsa*	9,423
Ellenabad	4,201

Rania	3,980
Total	32,022

* Selected tehsils of the district Source: Directorate of Agriculture, Sirsa

3.1.3 Selection of Villages

Choutala and Asakhera villages in Dabwali tehsil and Randhawa and Arniawali villages in Sirsa tehsil were selected with random sampling method (table 3.3).

Table 3.3: Tehsils and Villages Selected for the Study

Tehsils	Villages
1. Dabwali	1. Choutala
	2. Asakhera
2. Sirsa	1. Randhawa
	2. Arniawali

3.1.4 Selection of Tractor Owner Farmers

Further a list of tractor owner farmers for each selected village was prepared and then, 20 farmers from each village were selected randomly to form a sample of 80 farmers for the study.

3.2 Collection of Data

Both primary and secondary data were collected for the present study. Primary data required for the study were collected from the sampled respondents by personal interview method using well structured schedules, which were developed specially for the purpose of study. Secondary data were collected from various issues of the Statistical Abstract of Haryana, Directorate of Economics & Statistics and Directorate of Agriculture, Government of Haryana, Chandigarh and other published and unpublished sources. The collected data pertained to the agricultural year 2009-10.

3.3 Analysis of Data

The collected data were thoroughly checked for consistency and accuracy and then the same were transferred on master sheet for having a clear view and subjecting them to further classification and analysis.

3.3.1 Magnitude and Utilization Pattern

To examine the magnitude of tractorisation, time series data on number of tractors in Haryana over the past years and district wise number of tractors in Haryana was collected from Statistical Abstract of Haryana. For determining the utilization pattern of tractor, the data was

collected through schedules from the selected farmers for various operations. Then data was tabulated and analyzed for determining the average annual use of farm tractor in various agricultural operations.

3.3.2 Economics of Tractorisation

Concepts and definition of terms and variables used in the study

A. Labour:

1. Hired/casual/permanent labour: This category included the hired/casual/permanent labour employed in operating tractor. The tractor owners were employing permanent labour for hired out farm and non-farm operations.

2. Family labour: It contains the actual work carried out by family members for operating tractor. This labour has been valued at the prevailing market rates.

B. Interest on Investment: Interest on investment has been charged at the rate of 12 per cent annually.

C. Insurance and taxes: These included interest and tax on investment.

D. Depreciation: It is a decline in the value of a given asset as a result of use, wear and tear, accidental damage and time obsolescence. Items on which depreciation was computed were the same as included for the calculation of interest on tractors and its machinery.

$$\text{Depreciation} = \frac{\text{Cost of initial investment} - \text{Salvage value}}{\text{Useful life (in years)}}$$

Note:

- Cost of initial investment included prices of tractor, trolley, harrow, cultivator and seed drill at the market prices of year 2008, which was ` 4,95,000.
- Salvage value was taken as ` 1,00,000.
- Useful life of tractor was taken for 15 years.

Cost concepts

Since the structure of cost for operating tractor is quite different to the traditional crop farming. The following cost concepts were devised. They were of two type *viz.*, fixed cost and variable cost.

A. Fixed cost

Fixed cost included interest on investment, insurance and taxes, depreciation of the tractor.

B. Variable cost

Variable cost included the expenses on items like diesel oil, engine oil, gear oil, grease, driver labour (Family drive labour plus hired drive labour), repair and maintenance of tractor machinery.

Net Returns

It is the residue after deducting all cost items *i.e.* total costs from the gross returns. The inputs and service charges have been valued at prevailing market price of service charge. The sources of returns were both agricultural and non-agricultural.

Techniques of Economic Evaluation

The data on cost incurred and returns obtained from operation of tractor was taken for the year 2009-10. The tractors for which data were taken belonged to various models, this provided a stream of costs and returns for whole life of the tractor bearing variations in price of the inputs and income over the period of life.

In order to assess the capital productivity or to evaluate the economic viability of such long term investment, following indicators were used for measuring the performance of the investment in the project.

Benefit-Cost Ratio (BCR)

Benefit-cost ratio is used to measure the profitability of a project. Benefit-cost ratio is the ratio of the present value of benefit stream to the present value of cost stream of a project. For an economically viable project benefit-cost ratio should be more than unity.

$$BCR = \sum_{j=1}^{n} \frac{B_j}{(1+i)^j} \Big/ \sum_{j=1}^{n} \frac{C_j}{(1+i)^j}$$

Where

BCR = Benefit cost ratio

i = Rate of interest used for discounting

B_j = Gross returns in the j^{th} year

C_j = Cost in the j^{th} year

j = 1,2,3,-------n

Net present worth (NPW)

Net present value is calculated by subtracting the sum of discounted cost from sum of discounted gross returns.

$$NPW = \sum_{j=1}^{n} \frac{B_j}{(1+i)^j} - \sum_{j=1}^{n} \frac{C_j}{(1+i)^j}$$

Where

NPW = Net present worth

i = Rate of interest used for discounting

B_j = Gross returns in the j^{th} year

C_j = Cost in the j^{th} year

j = 1,2,3,-------n

Internal Rate of Return (IRR)

It is the rate of discounting which makes the present value of the net returns (*i.e.* NPW) zero. It gives the earning power of investment.

$$\sum_{j=1}^{n} \frac{B_j}{(1+i)^j} - \sum_{j=1}^{n} \frac{C_j}{(1+i)^j} = 0$$

Where

i = Internal rate of return (IRR)

i = Rate of interest used for discounting

B_j = Gross returns in the j^{th} year

C_j = Cost in the j^{th} year

j = 1,2,3,-------n

Pay Back Period (PBP)

It measures the length of time period required to cover initial outlay. It was calculated by the deducting sum of undiscounted net returns from initial investment until the difference of these two became zero.

$$PBP = \sum_{}^{n*} C_j \leq \sum_{}^{n*} Bj$$

$$j=1 \qquad j=1$$

Where

PBP = Pay Back Period

i = Rate of interest used for discounting

B_j = Gross returns in the j^{th} year

C_j = Cost in the j^{th} year

j = 1,2,3,-------n

n* = Lowest value of 'j' for which equality holds

Sensitivity Analysis

Sensitivity analysis shows how the value of the criterion change with change in the value of any variable in discounted cash flow. It is particularly associated with cost-benefit analysis, where the most common form is the use of alternative discount rates. The purpose of the analysis is to identify the important assumption upon which the analysis is based on those to which the outcome is sensitive. In simple words, the yield of the project will be affected by changes in price of inputs and outputs.

The general price level (GPL) in India is increasing and along with it the price of all inputs used in and services produced by the tractor are also increasing. This increase in price of inputs and services produced affects the viability of tractor investment. Therefore, an attempt was made to study the impact of increase in cost and/or benefits on viability of tractor investment by increasing them by 5 and 10 per cents.

The discount rates were calculated in the following three different combinations of cost and revenues.

a) Between the present revenue and increasing costs,

b) Between the increased revenue and present costs,

c) Between the increased revenue and increased cost.

3.3.3 Factors Affecting Demand of Tractors

This part of the study was mainly based on secondary data keeping in view the objective of study. The data on different variables such as number of tractors, total cropped area, irrigated area, cropping pattern, area under high yielding varieties, cropping intensity and prices of major agricultural commodities of the study area, such as wheat, cotton, mustard and price of tractor were collected from the various issues of Statistical Abstract of India, Statistical Abstract of

Haryana and Economic Surveys. In order to complete the time series data on number of tractors in the vital agricultural statistics of Haryana was used.

The production function model for the study

The factors affecting demand of tractors in the state was studied with the help of following power function model. The ordinary least squares technique was used for estimation of parameters

$$\text{Log } Y = \text{Log } a + b_1 \text{Log} X_1 + b_2 \text{Log} X_2 + b_3 \text{Log} X_3 + b_4 \text{Log} X_4 + b_5 \text{Log} X_5 + b_6 \text{Log} X_6 + b_7 \text{Log} X_7 + b_8 \text{Log} X_8 + U$$

Where

Y = Number of tractors demanded

a = constant term

$b_1, b_2, \ldots b_8$ = Elasticities with respect to different explanatory variables

$X_1, X_2, \ldots X_8$ = Explanatory variables

U = Disturbance term

X_1 = Total cropped area (in lakh hectares)

X_2 = Gross irrigated area (in lakh hectares)

X_3 = Area under high yielding varieties (in lakh hectares)

X_4 = Cropping intensity (per cent)

X_5 = Cropping pattern (area under wheat, mustard and cotton taken together) (per cent)

X_6 = Weighted average price of major agricultural crops (wheat, mustard and cotton)

$$\text{Weighted average price} = \frac{\text{PW X Production} + \text{PC X Production} + \text{PM X Production}}{\text{Total production of wheat + Cotton + Mustard}}$$

Where

PW, PC and PM refer to price of wheat, cotton and mustard. The weighted average price thus calculated, was deflated using price index of all commodities to remove the effect of inflationary trend in the series.

X_7 = Price of tractor (in real terms) :- The prices of various make of tractor were averaged out and then were deflated using price index for manufactured products to remove the effect of inflationary trend in the series

X_8 = Demand of tractors in previous year

Estimation of Future Demand

Future demand for tractors in Haryana state was estimated by log-linear analysis technique for the period of 20 years (*i.e.,* 2010-11 to 2029-30). Demand for tractors was taken as dependent variable and other factors contributing to demand of tractors were considered as independent variables (as mentioned above in production function model).

Method of Computing Contribution of Individual Explanatory Variables in the Total Explained Variation

The contribution of individual explanatory variables in the total explained variation was computed as follows:

1. The estimated partial regression coefficient (b_j) for each explanatory variable was converted into the standard partial regression coefficient (B_j) by the formula:

$$B_j = \frac{B_j S_j}{S_y}$$

Where,

j = 1,2,3,……K (K refers to the number of explanatory variables)

B_j = Standard partial regression coefficient of j^{th} variable

b_j = Estimated regression coefficient of j^{th} explanatory variable

S_j = Standard deviation of j^{th} variable, and

S_y = Standard deviation of dependent variable

2. Standard partial regression coefficients of j^{th} explanatory variable was multiplied by the correlation coefficient between the dependent variable (y) and the j^{th} explanatory variable, *i.e.*, $B_j r_{yj}$ and then summed up. Symbolically:

$$R^2 = \sum_{j=1}^{k} B_j r_{yj}$$

3. The ratio $B_j r_{yj} / R^2$ was interpreted as the relative contribution of j^{th} explanatory variable in explaining the variation in the dependent variable.

3.3.4 Problems faced by farmers in the purchase and use of tractors

Technical, infrastructural and economic & financial problems faced by the farmers in the purchase and use of tractors were studied under three broad categories.

1. Technical Problems

Technical problems mean impediments or restraints pertaining to lack of know-how or skill required for operating and functioning of tractor use.

2. Infrastructural Problems

These have been defined as impediment or restraints pertaining to organization in use and operating tractor.

3. Economic and Financial Problems

These mean the restraints pertaining to finance and profitable operation of tractor.

The interview schedule was specially prepared to find out the problems. The problems expressed by the respondents were categorized as primary, secondary and tertiary on the basis of number of respondents facing particular problem.

CHAPTER-IV

RESULTS

The present study entitled, "An economic analysis of tractorisation in Sirsa district of Haryana" was carried out with the objectives: to examine the magnitude and utilization pattern of tractors, to work out economics of tractorisation, to study the factors affecting demand of tractors and to identify the problems faced by farmers in the purchase and use of tractors. The results thus obtained are presented below.

4.1. Magnitude and Utilization Pattern of Tractorisation

4.1.1. Trends in tractorisation in Haryana

The number of tractors in the Haryana State at different positions of time has been shown in Table 4.1.

Table 4.1: Number of Tractors in Haryana (1966-67 to 2009-10)

Year	Number of Tractors*	Percentage increase or decrease over previous quinquennium
1966-67	4,803	---
1970-71	12,312	156.33
1975-76	25,451	106.72
1980-81	52,689	107.02
1985-86	83,120	57.75
1990-91	1,30,246	56.69
1995-96	1,62,030	24.40
2000-01	2,09,613	29.37
2005-06	2,46,914	17.79
2006-07	2,53,929	---
2007-08	2,60,987	---
2008-09	2,64,973	---
2009-10	2,59,030	4.67
Compound Growth Rate: 9.78 per cent (1966-67 to 2009-10) and 4.95 per cent (1980-81 to 2009-10)		

*Source: Different issues of Statistical Abstract of Haryana

It may be observed from the table that there has been a consistent increase in the number of tractors in Haryana during the last four decades. The number of tractors in Haryana in 1966-67 were 4,803 and rose to 2,59,030 during 2009-10. The rate of increase in tractor population was spectacular during 1970-71. It was about 156.33 per cent over 1966-67. This means that the need of tractors was actually felt after the introduction of high yielding varieties. The numbers of tractors in 2009-10 were more than three times to the number of tractors in 1985-86. The replacement demand for old tractors during this period gave another dimension to the total demand for tractors.

The compound growth rate of number of tractors in Haryana was estimated to be 9.78 per cent for the period from 1966-67 to 2009-10 and 4.95 per cent during the period 1980-81 to 2009-10.

4.1.2. District-wise tractor population

The district-wise distribution of tractors for the year 2009-10 has been presented in table 4.2.

Table 4.2: District wise distribution of tractors with their density in Haryana (2009-10)

District	Number of tractors	Tractor density (No. of tractors per 1000 ha of gross cropped area)
Ambala	8,410 (3.24)	40.82
Panchkula	10,941 (4.22)	232.78
Yamunanagar	11,974 (4.62)	55.95
Kurukshetra	13,805 (5.33)	50.38
Kaithal	12,162 (4.69)	31.58
Karnal	18,423 (7.11)	46.64
Panipat	2,129 (0.82)	11.14
Sonipat	16,339 (6.30)	54.28
Rohtak	12,413 (4.79)	52.82
Jhajjar	16,079 (6.20)	67.55
Faridabad	3,733 (1.44)	54.10
Palwal	14,318 (5.52)	75.35
Gurgaon	5,190 (2.00)	45.52
Mewat	4,363 (1.68)	25.36
Rewari	8,459 (3.26)	42.93
Mahendergarh	5,581 (2.15)	22.05
Bhiwani	21,194 (8.18)	27.92
Jind	13,679 (5.28)	29.10
Hisar	20,773 (8.02)	32.05
Fatehabad	15,955 (6.16)	37.62
Sirsa	23,110 (8.92)	32.18
State	**2,59,030 (100)**	**39.85**

Figures in the parenthesis represent percentage of total

During 2009-10 Sirsa district had the maximum number of tractors (23,110) followed by Bhiwani (21,194) and Hisar (20,773) while minimum number of tractors were in Panipat (2,129) followed by Faridabad (3733) and Mewat (4363). It was found that the tractor population in different districts was quite skewed and varied between 11.14 and 232.78 per thousand hectares of gross cropped area. The data further indicated that Panchkula (232.78), Palwal (75.35) and Jhajjar (67.55) districts had the highest concentration of tractors per thousand hectares of gross cropped area. The districts with low tractor density were Panipat (11.14), Hisar (50.73) and Mahendergarh (22.05).

4.1.3. Tractor Density in Haryana

Tractor density was estimated as number of tractors per thousand hectares of total cropped area in Haryana for the last two decades *i.e.,* 1990-91 to 2009-10 (Table 4.3).

Table 4.3: Trends in tractor density in Haryana (1990-91 to 2009-10)

Year	Tractor density (per 1000 ha of total cropped area)
1990-91	22.01

1991-92	23.94
1992-93	23.73
1993-94	25.67
1994-95	25.72
1995-96	26.90
1996-97	28.49
1997-98	29.42
1998-99	31.33
1999-00	31.86
2000-01	33.14
2001-02	34.42
2002-03	36.10
2003-04	36.23
2004-05	37.33
2005-06	37.93
2006-07	39.53
2007-08	40.41
2008-09	40.76
2009-10	39.85

Table 4.3 indicates that tractor density in Haryana increased over the last two decades. It was 22.01 tractors per thousand hectares of total cropped area in 1990-91 and increased to 33.14 by 2000-01 and 40.76 tractors per thousand hectares of total cropped area by 2008-09 in Haryana, but it slightly decreased to 39.85 tractors per thousand hectares of total cropped area in 2009-10 as compared to 2008-09. It has been observed that the tractor density in Haryana state turned out to be almost double during the last two decades.

4.1.4 Trends in tractor population in Sirsa district

Tractor density was estimated as number of tractors per thousand hectares of total cropped area in Sirsa district (Table 4.4). Table revealed that the total number of tractors in Sirsa district has increased over the period of time from 4,824 during 1980-81 to 23,110 by 2009-10. Table further indicates that tractor density in Sirsa has increased over the last three decades. It

was 9.31 tractors per thousand hectares of total cropped area in 1980-81 and increased to 32.18 tractors per thousand hectares of total cropped area by 2009-10.

Compound annual growth rate of number of tractors in Sirsa district was estimated to be 2.90 per cent for the period 1980-81 to 2009-10.

Table 4.4: Trends in tractor population/density in Sirsa district

Year	No. of tractors*	Tractor density (per 1000 ha of cropped area)
1980-81	4,824	9.31
1985-86	11,640	22.47
1990-91	12,230	22.44
1995-96	10,771	17.34
2000-01	16,867	25.17
2005-06	23,472	33.67
2009-10	23,110	32.18
Compound Annual Growth Rate: 2.90 per cent (1980-81 to 2009-10)		

*Source: Various issues of Statistical Abstract of Haryana

4.1.5 Availability of tractor power in Haryana

Availability of tractor power in Haryana has been presented in table 4.5. The total number of tractors in Haryana has shown a rapid increase since the inception of the State. The numbers of tractors in Haryana were 4.80 thousand during 1966 which increased to 260.98 during 2008. As a consequence, there has also been increase in the availability of tractor energy in the state from 120 thousand HP during 1966 to 6524.67 thousand HP during 2008.

Share of tractor power to the total draught power availability has also shown a significant increase over the last four decades. The availability of tractor power has increased from 16.90 per to total draught power to 73.29 per cent during 2008.

Figure 1: Trends in Tractor Density (number of tractors per 1000 ha of cropped area) in Haryana State From 1990-91 to 2009-10

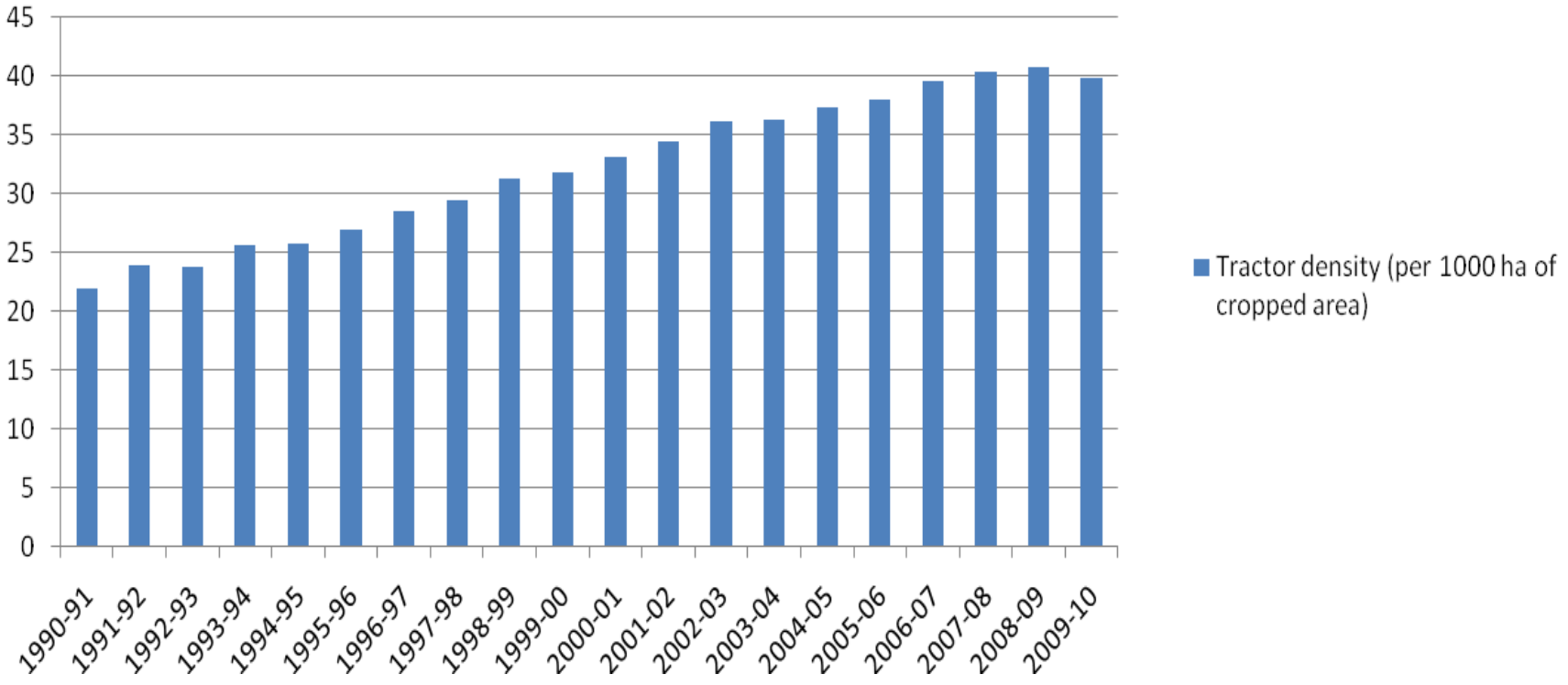


Table 4.5: Availability of tractor power in Haryana

Year	Number of tractors (in thousand)	Percent share of tractor power to the total draught power availability
1966	4.80 (120.07)	16.90
1972	12.31 (307.80)	21.37
1977	25.45 (636.27)	29.48
1982	58.43 (1460.87)	43.81
1988	102.78 (2569.50)	50.48
1992	133.41 (3335.45)	49.75
1997	173.00 (4325.00)	55.77
2003	231.56 (5789.20)	65.47
2008	260.98 (6524.67)	73.29

Figures in parenthesis are the tractor power in thousand HP (One tractor = 25 HP)

4.1.6. Utilization pattern of farm tractors

Utilization pattern of farm tractor in different operations for own work and for hired out operations is shown in Table 4.6.

The average annual use of tractors was found 784.41 hours, out of which for 321.90 hours (41.04 per cent) the tractors were used for own work and for 462.51 hours (58.96 per cent) the tractors were used for hired out operations. For own farm operations tractors were used for 73.12 hours for tillage, 48.93 hours for threshing, 64.87 hours for sowing, 10.30 hours for puddling, 12.18 hours for leveling, 26.25 hours for transportation, 6.93 hours for irrigation, 58.68 hours for interculture and 20.62 hours for non-agricultural operations. For hired out operations tractors were used for 110.05 hours for tillage, 85.30 hours for threshing, 77.80 hours for sowing, 21.55 hours for puddling, 13.12 hours for leveling, 62.80 hours for transportation, 59.05 hours for interculture and 32.80 hours for non-agricultural operations. Overall use of tractors was 183.18 hours for tillage, 134.23 hours for threshing, 142.68 hours for sowing, 31.86 hours for puddling, 25.30 hours for leveling, 89.05 hours for transportation, 6.93 hours for irrigation, 117.73 hours for interculture and 53.43 hours for non-agricultural operations.

The table further shows that for own work maximum use of tractors were found in tillage operations (9.32 per cent) followed by sowing (8.27 per cent) and interculture (7.48 per cent) whereas minimum use was found for irrigation (0.88 per cent) followed by puddling (1.31 per cent) and leveling (1.55 per cent). For hired out work also the maximum use of tractors was

found in tillage operations (14.03 per cent) followed by threshing (10.87 per cent) and sowing (9.92 per cent) but minimum use was for levelling operations (1.67 per cent) followed by puddling (2.75 per cent) and non-agricultural operations (4.18 per cent). Its use for irrigation was found nil for hired out work.

Tillage was observed as the major agricultural operation in which maximum use of tractors was found both for own work and hired out work (23.35 per cent), whereas minimum use both for own work and hired out work was found for irrigation (0.88 per cent).

Table 4.6: Annual utilization of tractor in different operations for own work and hiring out

S. No.	Operations	For own work (hrs.)	Hired out (hrs.)	Total annual use (hrs.)
1.	Tillage	73.12	110.05	183.18
		(9.32)	(14.03)	(23.35)
2.	Threshing	48.93	85.30	134.23
		(6.24)	(10.87)	(17.11)
3.	Sowing	64.87	77.80	142.68
		(8.27)	(9.92)	(18.18)
4.	Puddling	10.30	21.55	31.86
		(1.31)	(2.75)	(4.06)
5.	Levelling	12.18	13.12	25.30
		(1.55)	(1.67)	(3.22)
6.	Transportation	26.25	62.80	89.05
		(3.35)	(8.01)	(11.35)
7.	Irrigation	6.93	---	6.93
		(0.88)		(0.88)
8.	Interculture	58.68	59.05	117.73
		(7.48)	(7.53)	(15.01)
9.	Non-agricultural operations	20.62	32.80	53.43
		(2.63)	(4.18)	(6.81)
	Total	321.90	462.51	784.41
		(41.04)	(58.96)	(100)

Figures in parenthesis represent percentage of the total

4.2. Economics of Tractorisation

In this part, an attempt has been made to present the economics of tractorisation. This has been achieved by detailed study of the investment incurred in fixed cost and variable cost of tractors as well as the returns from the tractors. The economic viability of tractor was tested with

Figure 2: Trends in Tractor Density (number of tractors per 1000 ha of cropped area) in Sirsa Distrct of Haryana From 1980-81 to 2009-10

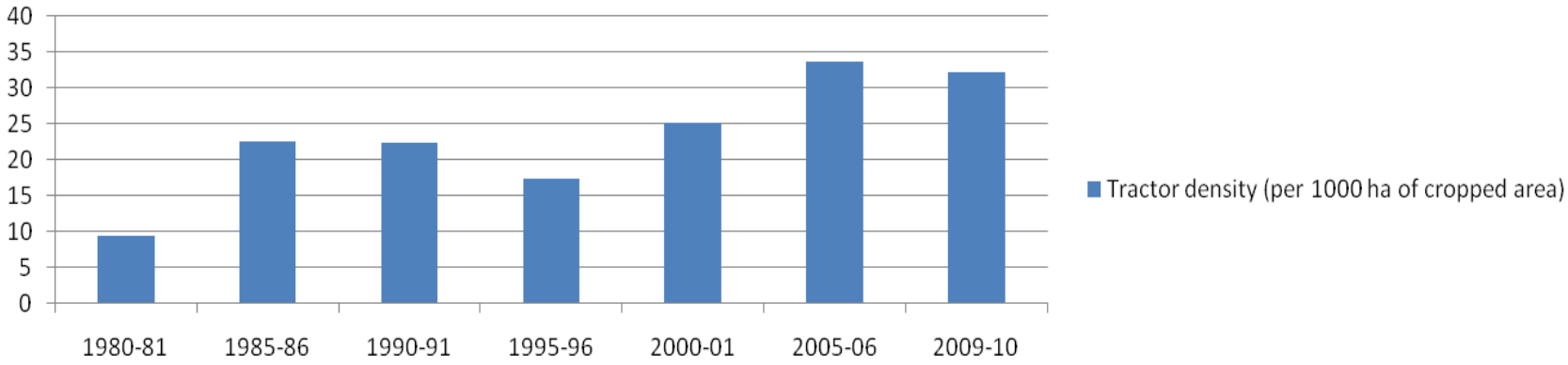


Figure 3: Availability of Tractor Power in Haryana (percent share of tractor power to the total draught power available)

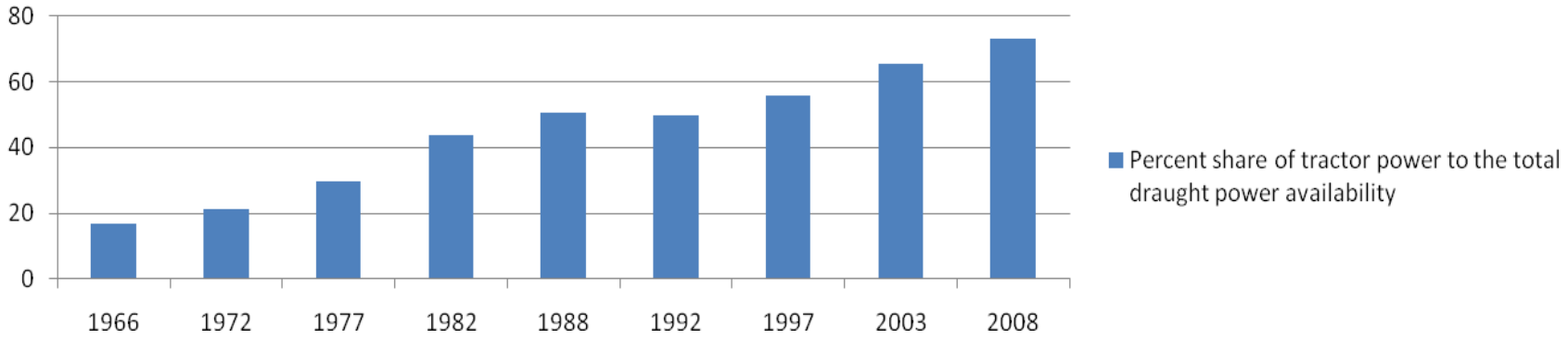
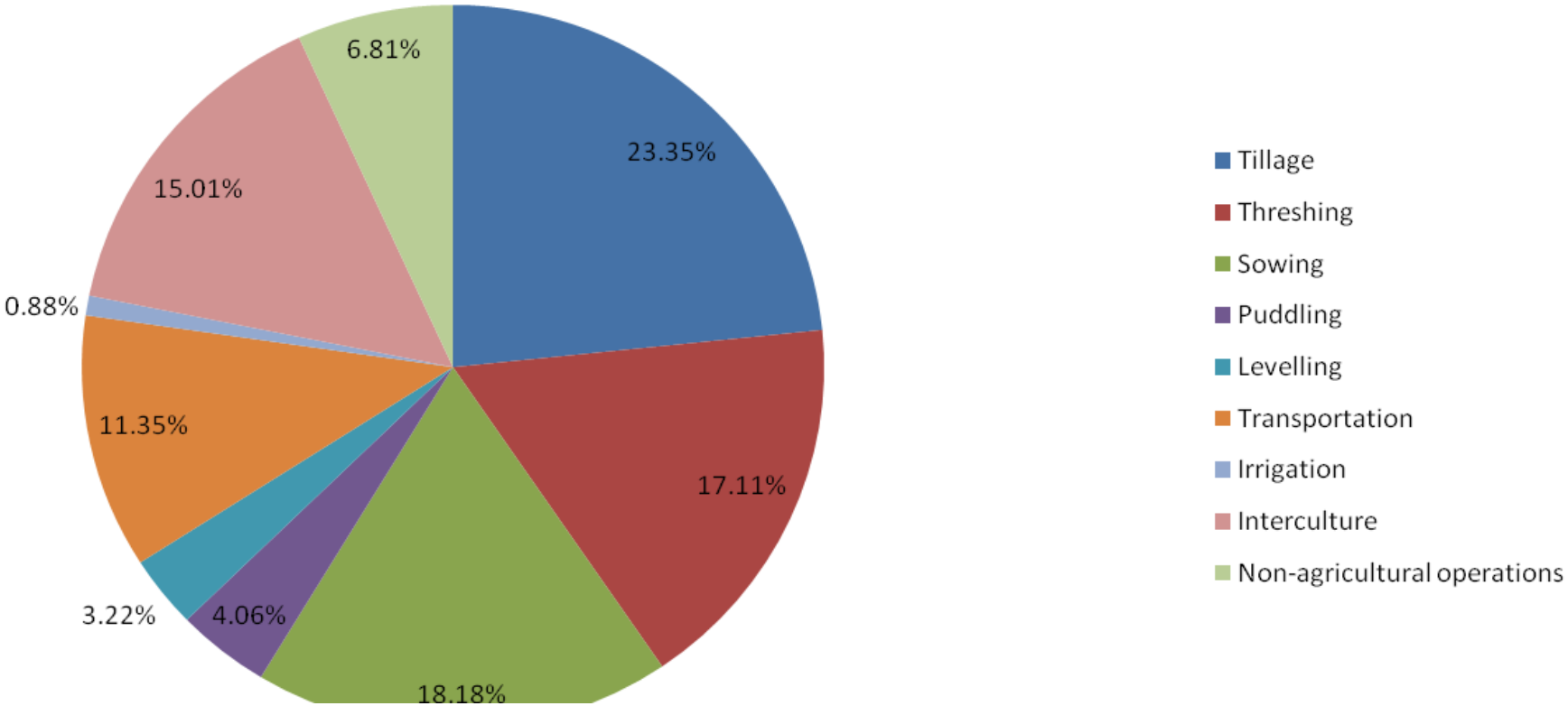


Figure 4: Total Annual Utilisation of Tractor for Various Operations



the help of the economic evaluation criterion viz., benefit cost ratio, net present worth, internal rate of return, modified internal rate of return, payback period and sensitivity analysis.

This part has been divided into following three sections:

4.2.1 Cost structure of tractor use

4.2.2 Return structure of tractor use

4.2.3 Economic evaluation of tractor.

4.2.1. Cost structure of tractor use

This part discusses cost structure of tractor as variable cost, fixed cost and total cost.

Cost in general, is a measure of what must be given up in order to obtain something whether by way of purchase, exchange or production. In short run, there are some costs which do not vary as output increases and vice-versa, at the same time, there are others which show this type of behaviour. The former is called the fixed cost and the later one the variable cost. The costs associated with fixed factors of production are fixed costs and those one associated with variable factors of production are the variable costs.

Average variable cost

The table 4.7 revealed that out of average total cost of ` 209795.33 per tractor per year, the average variable cost was ` 121519.50 per tractor per year. The cost of diesel oil in tractor was estimated as high as ` 62918.88 per tractor per year (29.99 per cent of total cost) followed by cost of driver/mechanic ` 38760.00 per tractor per year (18.47 per cent). The repair and maintenance cost was ` 11795 per tractor per year (5.62 per cent). The engine oil, gear oil and grease cost estimated to be ` 4450.20 per tractor per year (2.12 per cent), ` 2450.15 per tractor per year (1.16 per cent) and ` 1145.25 per tractor per year (0.54 per cent). The variable cost of tractor was calculated to be ` 154.91 per hour.

Average fixed cost

The table 4.7 further revealed that out of total cost of ` 209795.33 per tractor per year, the average fixed cost was ` 88275.83 per tractor per year. The interest on investment in the tractor estimated to be as high as ` 59400.00 per tractor per year (28.31 per cent) followed by cost of depreciation on investment ` 26333.33 (12.55 per cent). The insurance and taxes accounted for ` 2542 per tractor per year (1.21 per cent of total cost). The fixed cost of tractor was calculated to be ` 112.53 per hour.

Average Total Cost

The total cost was calculated to be ` 209795.33 per tractor per year, of which variable cost accounted for ` 121519.50 per tractor per year (57.92 per cent) and fixed cost accounted for ` 88275.83 per tractor per year (42.07 per cent of total cost). The total cost of tractor per hour was estimated to be ` 267.45.

Table 4.7: Cost Per Tractor Per Year

S. No.	Particulars	Cost (`/tractor)	Percentage of total cost
A. Variable Cost			
1.	Diesel oil	62918.88	29.99
2.	Engine oil	4450.20	2.12
3.	Gear oil	2450.15	1.16
4.	Grease	1145.25	0.54
5.	Driver/mechanic	38760.00	18.47
6.	Repair and maintenance	11795.00	5.62
Total variable cost		121519.50	57.92
B. Fixed Cost			
1.	Interest on investment	59400.00	28.31
2.	Insurance and taxes	2542.50	1.21
3.	Depreciation of the tractor	26333.33	12.55
Total fixed cost		88275.83	42.07
C. Total Cost (A+B)		209795.33	100

4.2.2. Return Structure of Tractor Use

This part discusses operation wise total returns from use of tractor as owner (agricultural operations and non-agricultural operations) and hired out operations (agricultural operations and non-agricultural operations). Agricultural operations included tillage, threshing, transportation of farm produce, irrigations and intercultural plant protection and other. Non-agricultural operations included material loading and human transportation.

Average Return From Owned Operations

Table 4.8 revealed that out of average total returns of ` 397791.79 per tractor per year, the average returns from owned operations were ` 149646.42 per tractor per year. Returns from

owned agricultural operations were estimated to be as high as ` 143457.80 per tractor per year (36.06 per cent of total returns) followed by returns of non-agricultural operations ` 6188.62 (1.55 per cent of total returns).

Average Returns from Hired Out Operations

Table 4.8 further revealed that out of total returns of ` 397791.79 per tractor per year, the average returns from hired out operations were estimated to be ` 248145.37 per tractor per year. The returns from hired out agricultural operations were estimated to be as high as ` 238303.50 per tractor per year (59.90 per cent of total returns) followed by returns of non-agricultural operations ` 9841.87 (2.47 per cent of total returns).

Average Total Returns

On the whole, the average total returns were calculated to be ` 397791.79 per tractor per year, of which average returns from owned operations accounted for ` 149646.42 (37.61 per cent of total returns) and average returns from hired out operations accounted for ` 248145.37 (62.38 per cent of total returns).

Table 4.8: Returns Per Tractor Per Year

S. No.	Particulars	Returns (`/tractor)	Percentage of total returns
A. Returns from owned operations			
1.	Agricultural operations	143457.80	36.06
2.	Non-agricultural operations	6188.62	1.55
	Total returns from owned operations	149646.42	37.61
B. Returns from hired out operations			
1.	Agricultural operations	238303.50	59.90
2.	Non-agricultural operations	9841.87	2.47
	Total returns from hired out operations	248145.37	62.38
	Total returns (A+B)	397791.79	100

4.2.3. Economic Evaluation of Tractor

The economic viability tests are designed to aid the decision maker in deciding whether or not the economic benefits that accrue from an investment are sufficient or not. The investment

analysis in tractor will help in testing the economic viability of the investment made for purchase of tractor and its maintenance there on.

In order to assess the capital productivity, the costs and returns were discounted. Several techniques can be successfully employed to evaluate the economic viability of any project since no single technique can always serve the purpose. Though many methods are available, the important methods viz., benefit-cost ratio, net present worth, internal rate of return, payback period and sensitivity analysis are important one and widely employed by researchers. The benefit cost ratio, net present worth, internal rate of returns and payback period are presented in table 4.9.

Benefit-Cost Ratio (BCR)

Benefit-cost ratio is used to measure the profitability of a project. Benefit cost ratio is the ratio of the present value of benefit stream to the present value of the cost stream of the project. For an economically viable project benefit cost ratio should be more than unity.

In the present study, benefit cost ratio was employed for measuring the economic viability of committed investment on tractor. The costs and returns were discounted. From the table 4.9, it is observed that the benefit cost ratio for the investment on tractor was 1.89. The benefit cost ratio was more than unity which reveals that investment committed on tractor was economically viable.

Net Present Worth (NPW)

Another criterion for project appraisal is net present worth of the project. Net present worth is calculated by subtracting the sum of discounted cost from sum of discounted benefits. It is expected that for an economically viable project the net present worth is positive. The NPW furnishes information not only on the relationship of the cost and returns that is the rate between two but it gives the quantity of net returns discounted at given rate of interest. Thus, it helps in understanding the quantum of net returns and sufficiency of project for the requirement of the family.

Net present worth at 12 per cent rate of discount has been presented in table 4.9. The present worth for discounted returns was ` 2709305.98 and present worth for discounted cost was ` 1428887.56 giving net present worth of ` 1280418.42. This indicates that investment committed on tractor was economically viable.

Internal Rate of Return (IRR)

It is the rate of discounting which makes the present value of the net returns (*i.e.* NPW) zero. It is the earning power of investment. The decision rule is that accept the project, if the yield from the investment of IRR is higher than or equal to minimum desired level (prevailing rate of interest) of yield from investment otherwise reject the project.

Internal rate of return was calculated to be 37.03 per cent which was more than prevailing rate of interest. So, this indicates that the investment on tractor is economically viable.

Pay Back Period (PBP)

It measures the length of time required to cover the initial outlay. It was calculated by sum of undiscounted returns from initial investment until the difference of these two became zero.

From the table 4.9, it has been observed that the payback period was 4 years.

Table 4.9: Investment Analysis of Tractors for the Period 2009-10

S. No.	Parameters of evaluation technique	@ 12 per cent finance
1.	Discounted Cost (`)	1428887.56
2.	Discounted Returns (`)	2709305.98
3.	Benefit: Cost Ratio (BCR)	1.89
4.	Net Present Worth (`)	1280418.42
5.	Internal Rate of Return (IRR)	37.03
6.	Pay Back Period (PBP)	4 years

Sensitivity Analysis

As the general price level changes continuously, along with it, the price of all inputs used in and outputs produced from any project also changes. These changes in prices and inputs and outputs affect the viability of a project. To study the impact of price change over the viability of the project, the sensitivity analysis technique was employed.

The table 4.10 and 4.11 shows the sensitivity analysis done by raising total cost and total returns by 5 per cent and 10 per cent. It was observed that total returns were higher than total cost for all the ten years, for which sensitivity analysis was done. This shows that even after 5 per cent and 10 per cent increase in the cost of project it remains viable. On increase in the cost

by 5 and 10 per cent, it was observed that for all the 10 years of project life, net returns were positive for all these years which indicate viability of the investment.

Table 4.10: Cost and Returns of Tractor at 5 Per cent Upward Variation in Total Cost and Total Returns (`)

Particulars	Years									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total Cost (TC)	187317.25	167247.55	149328.20	133328.70	119043.50	106288.80	94900.75	84732.82	75654.30	67548.48
Total Return (TR)	355171.24	317117.20	283140.30	252803.90	225717.70	201533.70	179940.80	160661.40	143447.70	128078.30
Total Cost after 5per cent increase (TC_1)	196683.12	175609.93	156794.60	139995.20	124995.70	111603.30	99645.79	88969.46	79437.01	70925.91
Total Returns after 5per cent increase (TR_1)	372929.80	332973.00	297297.40	265444.10	237003.60	211610.40	188937.80	168694.50	150620.10	134482.20
TR-TC_1	158488.12	141507.20	126345.80	112808.70	100722.10	89930.42	80295.01	71691.98	64010.69	57152.40
TR_1-TC	185612.54	165725.50	147969.20	132115.30	117960.10	105321.50	94037.09	83961.69	74965.79	66933.74
TR_1-TC_1	176246.68	157363.10	140502.80	125448.90	112008.00	100007.10	89292.05	79725.05	71183.08	63556.32

Table 4.11: Cost and Returns of Tractor at 10 Per cent Upward Variation in Total Cost and Total Returns (`)

Particulars	Years									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total Cost (TC)	187317.25	167247.55	149328.20	133328.70	119043.50	106288.80	94900.75	84732.82	75654.30	67548.48
Total Return (TR)	355171.24	317117.20	283140.30	252803.90	225717.70	201533.70	179940.80	160661.40	143447.70	128078.30
Total Cost after 10per cent increase (TC_1)	206048.98	183972.31	164261.02	146661.57	130947.85	116917.68	104390.83	93206.10	83219.73	74303.33
Total Returns after 10per cent increase (TR_1)	390688.36	348828.92	311454.33	278084.29	248289.47	221687.07	197934.88	176727.54	157792.47	140886.13
$TR-TC_1$	149122.27	133144.90	118879.28	106142.33	94769.85	84616.02	75549.98	67455.30	60227.97	53774.97
TR_1-TC	203371.11	181581.37	162126.13	144755.59	129245.97	115398.27	103034.13	91994.72	82138.17	73337.65
TR_1-TC_1	184639.39	164856.62	147193.31	131422.72	117341.62	104769.39	93544.06	83521.44	74572.74	66582.80

4.3 Factors Affecting Demand of Tractors

4.3.1 Identification of the factors affecting demand of tractors

In the present study, an attempt has been made to identify the factors that affect the demand of tractors in Haryana state. The factors affecting demand of tractors in Haryana were examined through multiple regression analysis carried out for the period 1990-91 to 2009-10. Log-linear form of the functions was followed for this purpose.

The information regarding relative impact of different factors on demand of tractors at regional level is helpful in reorienting the programmes and priorities of agricultural development at regional level. The demand of tractors, in general, depends on a variety of factors. However, all the factors cannot be taken into account due to a variety of reasons like non-availability of data, multicolinearity among the explanatory variables, problems in their quantification, their insignificant contribution in the total variation etc. To overcome these problems only a few but important variables are taken into consideration, in the present study, based on theoretical ground. The following variables were selected to study their impact on demand of tractors: (a) Total cropped area, (b) Gross irrigated area, (c) Area under high yielding varieties, (d) Cropping intensity, (e) Cropping pattern, (f) Weighted average price (Wheat, Cotton and Mustard), (g) Price of tractor and (h) Demand of tractors in previous year. An attempt has been made to estimate the impact of the selected variables on demand of tractors in Haryana.

For estimating the regression coefficients of multiple regressions function log-linear form of relationship was fitted to the data using Ordinary Least Square technique. Time series data for 20 years period, *i.e.*, 1990-91 to 2009-10 were considered. For estimating the regression coefficients of log-linear equation OLS regression were run by taking demand (log of demand) as dependent variable and log of eight explanatory variables as specified earlier in the text as independent variables. The regression results revealed that out of eight explanatory variables only four variables *i.e.*, gross irrigated area, area under high yielding varieties, cropping intensity and price of tractor in log-linear function were estimated to be significant with high R^2 and F-values. Therefore, to assess the extent of multicolinearity among the explanatory variables, zero order correlation coefficient matrices were estimated. The correlation matrices were then compared with the respective multiple correlation coefficients to find out the existence or otherwise less than respective multiple correlation coefficient of multicollinearity among the explanatory variables. Since the zero order correlation coefficients, it was taken to mean that there was no multicolinearity. But this decision was taken with grain of salt, because in model

involving more than two explanatory variables, the simple or zero order correlation does not provide an infallible guide to the presence of multicolinearity.

4.3.2 Regression Results of Log-Linear Relationship

The log-linear regression results finally obtained on the basis of step down method are presented in Table 4.12.

The zero order coefficients of correlation between the pairs of log of independent variables retained were found to be less than coefficients of multiple determinations and thus the multicolinearity among the dependent variables was absent or not important to be considered.

Table 4.12: Estimated Log-Linear Production Function for demand of tractors in Haryana (1990-91 to 2009-10)

S. No.	Parameters	Linear production function Reg. Coeff. (S.E.)
1.	Intercept	-0.128
2.	1. Gross irrigated area (X'_1)	0.536**
		(0.107)
3.	2. Area under HYV (X'_2)	0.816*
		(0.903)
4.	3. Cropping intensity (X'_3)	0.782*
		(0.213)
5.	4. Price of tractor (X'_4)	-0.069*
		(0.218)
6.	5. Coefficient of determination (R^2)	0.914
7.	6. 'F' – value for R	0.636
8.	7. Gross irrigated area elasticity of number of tractors demanded	0.536
9.	Area under high yielding varieties elasticity of number of tractors demanded	0.816
10.	Cropping intensity elasticity of number of tractors demanded	0.782
11.	Price of tractor elasticity of number of tractors demanded	-0.069
12.	per cent contribution of explanatory variable	62.60

	(X'_1)	
13.	per cent contribution of explanatory variable (X'_2)	8.29
14.	per cent contribution of explanatory variable (X'_3)	21.40
15.	per cent contribution of explanatory variable (X'_4)	-1.55

*Significant at 5 per cent level **Significant at 1 per cent level

The regression results revealed that the coefficient of gross irrigated area was significant (0.536) at 1 per cent of level of significance. The coefficients of area under high yielding varieties (0.816), cropping intensity (0.782) and price of tractor (-0.069) were significant at 5 per cent level of significance. These four jointly accounted for 90.74 per cent variation in the tractor demand in the state. As regard their contribution to the total variation, gross irrigated area contributed 62.60 per cent, area under high yielding varieties contributed 8.29, cropping intensity contributed 21.40 per cent and price of tractor contributed -1.55 per cent to the total variation. The calculated F-value was noted to be 0.636 with (8, 19) degree of freedom. This meant that explanatory variables included in the model were significant explanatory factors of the variation in demand of tractors.

The coefficients of elasticity of demand of tractors with respect to gross irrigated area, area under high yielding varieties, cropping intensity and price of tractors were 0.536, 0.816, 0.782 and -0.069, respectively. All of these indicated inelastic demand. From the above discussion it may be inferred that demand of tractors was mainly affected by gross irrigated area which indirectly had given the profitability of tractors. The other variable which contributed positively to the demand of tractors significantly was cropping intensity. The area under high yielding varieties and price of tractor contributed negatively in the demand of tractors.

4.3.3 Estimation of the future demand of tractors in Haryana state

Future demand of tractors in Haryana for period 2010-11 to 2029-30 has been presented in table 4.13. The future demand of tractors in Haryana state was estimated using log linear method for the period from 2010-11 to 2029-30 where tractor demand was taken as dependent variable and factors found responsible for tractor demand were used as independent variable. The total number of tractors in Haryana were estimated to be 5,17,424 for the year 2029-30.

4.4. Problems in the Purchase and Use of Tractors

An attempt has been made to examine the problems faced by the farmers in the purchase and use of tractors. Response of the farmers was tested on 25 problematic points on the basis of number of farmers facing that particular problem. All the problems were divided in to three categories as primary, secondary and tertiary. Problems which were faced by more than 60 per cent of the farmers were considered as primary problems and are required to be solved immediately. Secondary problems were faced by 21 to 60 per cent of the farmers. These problems are also required to be solved immediately. Lastly there were tertiary problems which were faced by 0-20 per cent of the sample farmers.

In the other categorization the problems responsible were divided in three categories viz., (a) technical, (b) infrastructural and (c) economic and financial.

Table 4.13: Future demand of tractors in Haryana for the period 2010-11 to 2029-30

Year	Number of tractors
2010-11	272699
2011-12	284437
2012-13	290903
2013-14	304638
2014-15	319723
2015-16	328596
2016-17	338828
2017-18	346346
2018-19	359180
2019-20	371955
2020-21	384846
2021-22	403148
2022-23	416889
2023-24	433441
2024-25	448093
2025-26	466783
2026-27	477671
2027-28	491262

2028-29	503122
2029-30	517424

4.4.1. Farmers Facing Technical Problems

The table 4.14 shows 9 technical problems reported by the farmers in use of tractor. Technical problems are the lack of know-how or skill required for operating functioning of tractor use. The table 17 revealed that among 9 technical problems there were two primary problems. The primary problems were: lack of essential matching implements/machineries and their use (71.25 per cent farmers) and operator/user should be capable of doing minor repairs (61.25 per cent farmers). There were 6 technical problems which were secondary in response. These were knowledge of various grade of oil to be used in the tractor during various services (53.75 per cent), non availability of tractor mechanic in village (51.25 per cent), technical know-how of the tractor (46.25 per cent), knowledge of repair and maintenance schedule of tractor (38.75 per cent), knowledge of safety precaution and road's signals/rules (36.25 per cent) and knowledge of using essential tool kit (35.00 per cent). The table 17 reveals that there was one tertiary problem faced by farmers in the use of tractor which was operator should get at least one week training at dealer's shop (18.75 per cent).

Table 4.14: Farmers facing technical problems in the use of tractors

S. No.	Problems	Frequency	Percentage	Category
1.	Technical know-how of the tractor	37	46.25	II
2.	Operator should get at least one week training at dealer's shop	15	18.75	III
3.	Knowledge of repair and maintenance schedule of tractor	31	38.75	II
4.	Knowledge of safety precaution and road's signals/rules	29	36.25	II
5.	Knowledge of various grade of oil to be used in the tractor during various services	43	53.75	II
6.	Knowledge of using essential tool kit	28	35.00	II
7.	Operator/user should be capable of doing minor repairs	49	61.25	I
8.	Non availability of tractor mechanic in	41	51.25	II

	village			
9.	Knowledge of essential matching implements/ machineries and their uses	57	71.25	I

4.4.2. FARMERS FACING INFRASTRUCTURAL PROBLEMS

Infrastructural problems have been defined as problems pertaining to organization in use and operating tractor. The table 4.15 revealed 7 infrastructural problems and one of these was primary, which was small land holding faced by 67.50 per cent of the farmers. The secondary problems were service station located at far distance (58.75 per cent), market distance is too long (40.00 per cent), second hand tractors are not available easily (30.00 per cent), Government does not provide proper guidance to the farmers for use of tractor (27.50 per cent) and parts needed for tractor are not available timely in market (23.75 per cent). Beside this, there was one tertiary problem faced by the farmers which was difficulties in purchase of original parts of tractor from local market as reported by 18.75 per cent of the farmers.

Table 4.15: Farmers facing infrastructural problems in the use of tractors

S. No.	Problems	Frequency	Percentage	Category
1.	Government does not provide proper guidance to the farmers for use of tractor	22	27.50	II
2.	Difficulties in purchase of original parts of tractor from local market	15	18.75	III
3.	Parts needed for tractor are not available timely in market	19	23.75	II
4.	Market distance is too long	32	40.00	II
5.	Service station located at far distance	47	58.75	II
6.	Small land holdings	54	67.50	I
7.	Second hand tractors are not available easily	24	30.00	II

4.4.3. FARMERS FACING ECONOMIC AND FINANCIAL PROBLEMS

These problems related to the finance and profitable operations were found to be nine in number. The table 4.16 revealed two primary problems and seven secondary problems. The primary problems were cost of new tractor is high (83.75 per cent) and tractor is used for only few days in a year (66.25 per cent). The secondary problems were cost of operating the tractor is very high (57.50 per cent), competition among tractor owners for hiring out the tractor (52.50 per cent), expenditure on servicing and parts of tractor is high (43.75 per cent), lack of availability of loan from bank or Government agencies (42.50 per cent), lack of subsidies on tractor (40.00 per cent), bank interest rate is high (28.75 per cent) and farmers are not aware about the profitability of tractor (26.25 per cent).

Table 4.16: Farmers facing economic and financial problems in the purchase and use of tractors

S. No.	Problems	Frequency	Percentage	Category
1.	Cost of new tractor is high	67	83.75	I
2.	Expenditure on servicing and parts of tractor is high	35	43.75	II
3.	Bank interest rate is high	23	28.75	II
4.	Lack of availability of loan from bank or Government agencies	34	42.50	II
5.	Tractor is used for only few days in a year	53	66.25	I
6.	Lack of subsidies on tractor	32	40.00	II
7.	Farmers are not aware about the	21	26.25	II

	profitability of tractor			
8.	Cost of operating the tractor is very high	46	57.50	II
9.	Competition among tractor owners for hiring out the tractor	42	52.50	II

CHAPTER-V

DISCUSSION

The present study, "An economic analysis of tractorisation in Sirsa district of Haryana" was carried out with the objectives: to examine the magnitude and utilization pattern of tractors, to work out economics of tractorisation, to study the factors affecting demand of tractors and to identify the problems faced by farmers in the purchase and use of tractors. Results obtained during the course of present investigation are discussed in this chapter under the following headings:

5.1. Magnitude and Utilization Pattern of Tractorisation

5.1.1. Trends in tractorisation in Haryana

In the present study, consistent increase in the number of tractors in Haryana has been observed during the last four decades. The number of tractors in Haryana at the time of its inception in 1966-67 were 4,803 and rose to 2,59,030 during 2009-10. The compound growth rate of number of tractors in Haryana was found 9.78 per cent for the period from 1966-67 to 2009-10 and 4.95 per cent during the period 1980-81 to 2009-10. Similar trends were reported in their studies by Pandey *et al.,* (1998) in Haryana, Singh and Singh (1993) and Chatha and Grewal (1991) in Punjab, observing an increase in the number of tractors over previous years.

5.1.2. District-wise tractor population

During 2009-10 Sirsa district had the maximum number of tractors (23,110) followed by Bhiwani (21,194) and Hisar (20,773) while minimum numbers of tractors were in Panipat (2,129) followed by Faridabad (3733) and Mewat (4363). In terms of density Panchkula (232.78), Palwal (75.35) and Jhajjar (67.55) districts had the highest concentration of tractors per thousand hectares of gross cropped area. The districts with low tractor density were Panipat (11.14), Hisar (50.73) and Mahendergarh (22.05). Similarly, Chatha and Grewal (1991) in their study observed the distribution of tractors in different districts of Punjab.

5.1.3. Tractor Density in Haryana

In the present study, it was observed that tractor density in Haryana increased over the last two decades. It was 22.01 tractors per thousand hectares of total cropped area in 1990-91 and increased to 39.85 tractors per thousand hectares of total cropped area by 2009-10 in Haryana. This indicates that the tractor density in Haryana state turned out to be almost double in last two decades. Similarly, Chattha and Grewal (1991) also observed an increase in tractor density in Punjab over a period of time.

5.1.4. Trends in tractor population in Sirsa district

Total number of tractors and tractors per thousand hectares of total cropped area in Sirsa district too has increased over the period of time. The total number of tractors in Sirsa district increased from 4,824 during 1980-81 to 23,110 by 2009-10. The tractor density in Sirsa has also increased over the last two decades. It was 9.31 tractors per thousand hectares of total cropped area in 1980-81 and increased to 32.18 tractors per thousand hectares of total cropped area by 2009-10. The compound growth rate of number of tractors in Sirsa district was 2.90 per cent per annum for the period 1980-81 to 2009-10.

5.1.5 Availability of tractor power in Haryana

In present study it has been observed that the total number of tractors in Haryana has shown a rapid increase since the inception of the State. The numbers of tractors in Haryana were 4.80 thousand during 1966 which increased to 260.98 thousand during 2008. As a consequence, there has also been an increase in the availability of tractor energy in the state from 120 thousand HP during 1966 to 6524.67 thousand HP during 2008. Share of tractor power to the total draught power availability has also shown a significant increase over the last four decades. The availability of tractor power has increased from 16.90 per cent to total draught power to 73.79 per cent during 2008. Pandey *et al.,* (1998) also observed similar trends in availability of tractor power in Haryana and found that there was significant increase in number of tractors and in tractor power availability in Haryana.

5.1.6. Utilization pattern of farm tractors

The average annual use of tractors was found 784.41 hours, out of which for 321.90 hours (41.04 per cent) the tractors were used for own work and for 462.51 hours (58.96 per cent) the tractor was used for hired out operations. For own work maximum use of tractors were found in tillage operations (9.32 per cent) followed by sowing (8.27 per cent) and interculture (7.48 per cent) whereas minimum use was found for irrigation (0.88 per cent) followed by puddling (1.31 per cent) and leveling (1.55 per cent). For hired out work also the maximum use of tractors was found in tillage operations (14.03 per cent) followed by threshing (10.87 per cent) and sowing (9.92 per cent) but minimum use was for levelling operations (1.67 per cent) followed by puddling (2.75 per cent) and non-agricultural operations (4.18 per cent). Tillage was observed as the major agricultural operation in which maximum use of tractors was found both for own work and hired out work (23.35 per cent), whereas minimum use both for own work and hired out work was found for irrigation (0.88 per cent). Similar studies to observe the utilization pattern of tractors were carried out by Suman (2004), Singh *et al.,* (1992), Yadav (1994), Duggal and Malhi (1999) and Shrivastava and Nilatkar (2005) in different states.

5.2. Economics of Tractorisation

In the present study, average total cost per tractor per year was estimated to be ` 209795.33 per tractor per year, out of which variable cost accounted for ` 121519.50 per tractor per year (57.92 per cent) and fixed cost accounted for ` 88275.83 per tractor per year (42.07 per cent of total cost). The total cost of tractor per hour was estimated to be ` 267.45. 397791.79 per tractor per year, of which average returns from owned operations accounted for ` 149646.42

(37.61 per cent of total returns) and average returns from hired out operations accounted for ` 248145.37 (62.38 per cent of total returns). Benefit cost ratio was found 1.89, the net present worth was estimated to be ` 1280418.42, internal rate of return was found 37.03 per cent and payback period was calculated to be of 4 years. All these economic evaluation methods showed that investment in tractor is economically viable. Sensitivity analysis also indicated that investment in tractor is economically viable. The sensitivity analysis done by raising total cost and total returns by 5 per cent and 10 per cent showed that total returns were higher than total cost for 10 years of the project life even after increase in the cost. This shows that even after increase in cost of project it remains viable since all the calculated values for net returns were positive even after increase of 5 per cent and 10 per cent in the total cost. Similarly, studies on economics of tractorisation were carried out by Singh and Dhawan (1994), AERC (1970 & 1971), NCAER (1974 & 1980) and Singh and Jindal (1993).

5.3. Factors Affecting Demand of Tractors

In the present study, time series data for 20 years period, *i.e.*, 1990-91 to 2009-10 were considered. For estimating the regression coefficients of log-linear equation OLS regression were run by taking demand (log of demand) as dependent variable and log of eight explanatory variables as specified earlier in the text as independent variables. The regression results revealed that out of eight explanatory variables only four variables *i.e.*, gross irrigated area, area under high yielding varieties, cropping intensity and price of tractor in log-linear function were estimated to be significant with high R^2 and F-values. Therefore, to assess the extent of multicolinearity among the explanatory variables, zero order correlation coefficient matrices were estimated. The correlation matrices were then compared with the respective multiple correlation coefficients to find out the existence or otherwise less than respective multiple correlation coefficient of multicollinearity among the explanatory variables. Since the zero order correlation coefficients, it was taken to mean that there was no multicolinearity. Coefficient of gross irrigated area was significant (0.536) at 1 per cent of level of significance. The coefficients of area under high yielding varieties (0.816), cropping intensity (0.782) and price of tractor (-0.069) were significant at 5 per cent level of significance. These four factors/variables jointly accounted for 90.74 per cent variation in the tractor demand in the state. As regard their contribution to the total variation, gross irrigated area contributed 62.60 per cent, area under high yielding varieties contributed 8.29 per cent, cropping intensity contributed 21.40 per cent and price of tractor contributed -1.55 per cent to the total variation. Earlier studies carried out by

Kumar *et al.,* (1995) in Punjab and Gajja *et al.,* (1985) in Western Rajasthan found almost similar factors affecting demand of tractors.

In the present study, future demand for tractors in Haryana for the next 20 years (2010-11 to 2029-30) was estimated using log-linear analysis technique where tractor demand was taken as dependent variable and factors found responsible for tractor demand by step down method were used as independent variables. The total number of tractors in Haryana were estimated to be 5,17,424 for the year 2029-30. Similarly, Grover and Sharma (2000) in their study 'Demand for tractors in India", projected the demand for tractors in India for the period 1997-98 to 2024-25.

5.4. Problems in the Purchase and Use of Tractors

In the present study, majority of respondents (71.25 per cent) mentioned that low knowledge/ lack of essential matching implements/machineries and their use was the primary technical problem in the use of tractor. Operator/user should be capable of doing minor repairs as reported by 61.25 per cent farmers, was another major technical problem faced by the tractor owner farmers in the use of tractor. The small land holding faced by 67.50 per cent of the farmers was found major infrastructural problem among the tractor owner farmers. Among economic and financial problems two problems were identified as major which were cost of new tractor is high as mentioned by 83.75 per cent of the farmers and tractor is used for only few days in a year as reported by 66.25 per cent of the farmers. Similar problems in use of tractors were identified by Suman (2004), Maggu (1982) and Pandey *et al.,* (2002) in their studies conducted in different regions of the country.

CHAPTER-VI

SUMMARY AND CONCLUSIONS

Farm tractorisation plays an important role in developing as well as developed countries, both in economic as well as social spheres, for increasing incomes and raising standard of life particularly of the rural masses. The current density of tractors in Haryana is 40 tractors per 1000 hectares of gross cropped area, therefore, the potential market for tractor in Haryana is tremendous. The use of tractor has increased considerably in Indian agriculture over the last five decades. The total number of tractors in the State of Haryana were 4,803 at the time of inception (1966-67) and the figure rose to 2,59,030 in 2009-10. The figure for Sirsa district was 23,110 during the year 2009-10.

Almost all the studies being conducted by researchers in the field of agriculture were targeted towards raising incomes and consumption of society as a whole in general and farmers in particular and our study also falls in the same line with similar broader objectives. To fulfill the said objectives of raising income and living standard of the farmers, it is important to increase the efficiency of farming business. Further, there are two ways to increase the efficiency of a business. One is through increase the scale of business and other is through increasing the use of advance technology or both. To achieve the main goal of the study "The increase in the efficiency through technological improvement", the present study entitled, "An economic analysis of tractorisation in Sirsa district of Haryana" was carried out with the following specific objectives:

1. To examine the magnitude and utilization pattern of tractors.
2. To work out economics of tractorisation.
3. To study the factors affecting demand of tractors and
4. To identify the problems faced by farmers in the purchase and use of tractors.

To fulfill these specific objectives of the study a scientific methodology was adopted. Sirsa district of Haryana state was selected purposively as it has the highest number of tractors amongst all the districts in the state. Four villages, namely Choutala and Asakhera from Dabwali tehsil and Randhawa and Arniawali from Sirsa tehsil were selected randomly. From each selected village 20 tractor owner farmers were selected randomly to form a sample of 80 farmers for the study.

Both primary and secondary data were used. Primary data were collected through personal interviews from tractor owner farmers. Secondary data were collected from Directorate of Economics and Statistics, Directorate of Agriculture Haryana, and various issues of Statistical Abstract of Haryana, etc.

Simple tabular analysis was carried out for studying the magnitude and utilization pattern for tractors. Beside this tractor density and compound growth rates were worked out.

The average cost and returns of the tractors were arrived at by simple averages of the year wise costs and returns of tractors taken from the sample farmers. The economic viability of investment in tractor was evaluated by applying various investment appraisal techniques like benefit cost ratio, net present worth, internal rate of returns, modified rate of returns, payback period and sensitivity analysis.

The factors affecting demand of tractors in the state were identified based on time series secondary data. The study was confined to a period of 20 years, *i.e.,* from 1990-91 to 2009-10. The important explanatory variables affecting demand of tractor in Haryana were estimated with the help of log-linear production function. Problems faced by farmers in the purchase and use of tractors were studied under three sub heads viz., technical, infrastructural and economic and financial problems. On the basis of intensity of the problems they were categorized into three types, *i.e.,* primary, secondary and tertiary problems. The salient findings of the present study are summarized below:

1. There has been a consistent increase in the number of tractors in Haryana during the last four decades. The number of tractors in Haryana at the time of its inception in 1966-67 were 4,803 and this rose to 2,59,030 during the year 2009-10.
2. The compound annual growth rate of number of tractors in Haryana was estimated to be 9.78 per cent for the period from 1966-67 to 2009-10 and 4.95 per cent during the period 1980-81 to 2009-10.
3. During 2009-10, Sirsa district had the maximum number of tractors (23,110) followed by Bhiwani (21,194) and Hisar (20,773) while minimum number of tractors were in Panipat (2,129) followed by Faridabad (3733) and Mewat (4363) districts.
4. The tractor population in different districts was quite skewed and varied between 11.14 and 232.78 per thousand hectares of gross cropped area. The data further indicated that in terms of tractor density Panchkula (232.78), Palwal (75.35) and Jhajjar (67.55) districts had the highest concentration of tractors per thousand hectares of gross cropped

area. The districts with low tractor density were Panipat (11.14), Mahendergarh (22.05), Mewat (25.36) and Bhiwani (27.92).

5. Tractor density in Haryana increased over the last two decades. It was 22.01 tractors per thousand hectares of total cropped area in 1990-91 and increased to 39.85 tractors per thousand hectares of total cropped area by 2009-10 in Haryana. It has been observed that the tractor density in Haryana state turned out to be almost double during the last two decades.
6. Tractor population in Sirsa district increased over the period of time from 4,824 during 1980-81 to 23,110 by 2009-10 and tractor density per thousand hectares of total cropped area increased over the last three decades from 9.31 in 1980-81 to 32.18 in 2009-10.
7. Compound annual growth rate of number of tractors in Sirsa district was estimated to be 2.90 per cent for the period 1980-81 to 2009-10.
8. The average annual use of tractors was found 784.41 hours, out of which for 321.90 hours (41.04 per cent) the tractors were used for own work and for 462.51 hours (58.96 per cent) the tractor was used for hired out operations.
9. Tillage was observed as the major agricultural operation in which maximum use of tractors was found both for own work and hired out work (23.35 per cent), whereas minimum use both for own work and hired out work was found for irrigation (0.88 per cent).
10. Average total cost per tractor per year was estimated to be ` 209795.33, of which variable cost accounted for ` 121519.50 per tractor per year (57.92 per cent) and fixed cost accounted for ` 88275.83 per tractor per year (42.07 per cent of total cost). The total cost of tractor per hour was estimated to be ` 267.45.
11. Average total returns per tractor per year were calculated to be ` 397791.79, of which average returns from owned operations accounted for ` 149646.42 (37.61 per cent of total returns) and average returns from hired out operations accounted for ` 248145.37 (62.38 per cent of total returns).
12. During economic evaluation of tractor investment, benefit : cost ratio was found 1.89, the net present worth was estimated to be ` 1280418.42, internal rate of return was found 37.03 per cent and payback period was calculated to be of 4 years. All these economic evaluation methods showed that investment in tractor is economically viable. Sensitivity analysis also indicated that investment in tractor is economically viable.

13. The coefficient of gross irrigated area was significant (0.536) at 1 per cent level of significance. The coefficients of area under high yielding varieties (-0.816), cropping intensity (0.782) and price of tractor (-0.069) were significant at 5 per cent level of significance. These four variables/factors jointly accounted for 90.74 per cent variation in the tractor demand in the state.
14. Gross irrigated area contributed 62.60 per cent, area under high yielding varieties contributed 8.29 per cent, cropping intensity contributed 21.40 per cent and price of tractor contributed -1.55 per cent to the total variation.
15. The total number of tractors in Haryana were estimated to be 5,17,424 for the year 2029-30.
16. Lack of essential matching implements/machineries and their use (71.25 per cent farmers) and operator/user should be capable of doing minor repairs (61.25 per cent farmers) were the major technical problems faced by the tractor owner farmers in use of tractors.
17. Small land holding faced by 67.50 per cent of the farmers was found major infrastructural problem among the tractor owner farmers.
18. Among economic and financial problems two problems were found major which were cost of new tractor is high as reported by 83.75 per cent farmers and tractor is used for only few days in a year which was reported by 66.25 per cent of the farmers.

Suggestions:

1. Per hour cost of tractor use can be reduced by increasing the annual use of tractors. Tractor use can be increased by intensive cropping.
2. Tractor investment is economically viable, so it should be encouraged.
3. The major problems faced by the farmers in the purchase and use of tractors should be removed by the required extension activity.
4. High initial cost should be subsidized to reduce the higher interest cost and increase the possibility of entrance of small farmers in the business and increase the possibility of marketing of services of tractor.
5. Low employment of machinery should be improved through initiative by the government in the creation of new and productive jobs using machinery.
6. The poor knowledge of tractor implements and minor repairs etc. should be removed by providing better extension services/activities.

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Appendix I

Simple Correlation Coefficients Between Different Variables For Demand of Tractors

(Linear Production Function)

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Y
Total cropped area (X_1)	1.000	0.496*	0.617**	0.642**	-0.375NS	0.434NS	0.573**	0.166NS	0.231NS
Gross irrigated area (X_2)		1.000	0.940**	0.701**	-0.586**	0.926**	0.974**	0.459NS	0.304NS
Area under HYV (X_3)			1.000	0.814**	-0.571**	0.841**	0.961**	0.466NS	0.318NS
Cropping intensity (X_4)				1.000	-0.565**	0.566**	0.756**	0.323NS	0.362NS
Cropping pattern (X_5)					1.000	-0.603**	-0.686**	-0.130NS	-0.125NS
Weighted average price (X_6)						1.000	0.917**	0.243NS	0.183NS
Price of tractor (X_7)							1.000	0.403NS	0.269NS
Demand of tractors in previous year (X_8)								1.000	-0.103NS
No. of tractors demanded (Y)									1.000

*Significant at 5 per cent level

**Significant at 1 per cent level

NS – Non-significant

Appendix II

Year	Total cropped area (lakh ha)	Gross irrigated area (lakh ha)	Area under HYV (lakh ha)	Cropping intensity	Cropping pattern	Weighted average price (Rs.)	Price of tractor	Demand of tractors in previous year	No. of tractors demanded
1990-91	68.97	40.74	26.73	123	113	448	65,000	8337	13109
1991-92	56.51	42.53	27.23	115	117	465	72,450	13109	18355
1992-93	59.17	42.37	27.34	121	116	530	80,700	18355	4921
1993-94	55.71	43.4	25.98	116	105	752	90,750	4921	8821
1994-95	58.54	44.73	26.73	122	117	644	99,245	8821	14266
1995-96	58.18	45.15	26.83	98	116	813	1,05,700	14266	6224
1996-97	59.86	45.92	27.99	112	115	1213	1,22,000	6224	10533
1997-98	60.22	46.73	27.02	111	116	1088	1,48,000	10533	12877
1998-99	60.72	47.85	28.23	112	115	856	1,62,000	12877	9560
1999-00	61.28	48.67	29.84	117	115	1132	1,80,500	9560	15075
2000-01	60.98	49.84	32.04	127	114	1136	1,96,800	15075	13022
2001-02	62.54	51.25	33.81	124	118	1129	2,11,500	13022	20121
2002-03	63.25	51.84	34.75	127	118	1115	2,35,000	20121	11745

2003-04	62.53	52.45	33.71	130	120	1228	2,48,000	11745	12862
2004-05	61.59	53.43	32.62	128	100	1436	2,69,500	12862	14628
2005-06	63.91	54.34	35.04	132	100	1258	2,98,400	14628	24595
2006-07	64.23	55.34	35.2	133	100	1404	3,12,000	24595	9975
2007-08	65.09	53.43	36.25	134	100	1456	3,34,000	9975	13457
2008-09	64.23	54.34	36.8	132	100	1520	3,50,000	13457	13809
2009-10	64.58	55.34	37.44	132	100	1542	3,75,800	13809	10448

ABSTRACT

Title of Thesis	:	An economic analysis of tractorisation in Sirsa district of Haryana.
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Admission No.	:	2009A04M
Title of degree	:	Master of Science
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Year of award of degree	:	2011
Major Subject	:	Agricultural Economics
Total No. of Pages in the Thesis	:	50+v
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The present study was carried out in Dabwali and Sirsa tehsils of Sirsa district of Haryana with the objectives of examining the magnitude and utilization pattern of tractors, testing economic viability of tractor, studying factors affecting demand of tractors in Haryana and identification of problems in the purchase and use of tractors. From each selected tehsil two villages (Choutala and Asakhera from Dabwali and Randhawa and Arniawali from Sirsa tehsil) were selected randomly and further 20 tractor owner farmers from each village were selected to comprise a sample size of 80 tractor owner farmers. A consistent increase in the number of tractors has been observed in Haryana state. Panchkula (232.78) had maximum number of tractors per 1000 hectares of cultivated land. The average annual use of tractors was found 784.41 hours, out of which for 321.90 hours (41.04 per cent) the tractors were used for own work and for 462.51 hours (58.96 per cent) the tractor was used for hired out operations. Tillage was the major agricultural operation in respect of use of tractor. Total cost of tractor was ` 209795.33 per tractor per year, of which variable cost accounted for ` 121519.50 per tractor per year (57.92 per cent) and fixed cost accounted for ` 88275.83 per tractor per year (42.07 per cent of total cost). The total cost of tractor per hour was estimated to be ` 267.45. Total returns from the tractor use were ` 397791.79 per tractor per year, of which average returns from owned operations accounted for ` 149646.42 (37.61 per cent of total returns) and average returns from hired out operations accounted for ` 248145.37 (62.38 per cent of total returns). Benefit cost ratio for tractor investment was 1.89, net present worth was ` 1280418.42, internal rate of return was 37.03 per cent and payback period was 4 years which indicate viability of investment in tractor. Sensitivity analysis by raising total cost and total returns by 5 per cent and 10 per cent showed that even after increase in cost, investment in tractor remains viable. Out of eight explanatory variables, gross irrigated area, area under high yielding varieties, cropping intensity and price of tractor were found significant and affected the demand of tractors. These factors contributed for 90.74 per cent variation in tractor demand. The total number of tractors in Haryana were estimated to be 5,17,424 for the year 2029-30. There were two financial (lack of essential matching implements/machineries and their use and operator/user should be capable of doing minor repairs), one infrastructural (small land holding) and two economic and financial problems (cost of new tractor is high and tractor is used for only few days in a year) which were the major problems faced by the farmers in the purchase and use of tractor.

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