RESEARCH ARTICLE :

A quantitative analysis of demand for tractors in India

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SUMMARY : India is an agricultural country. Higher productivity and greater output are the two major contributions in farm mechanization of any country. Tractors form an integral part of farm mechanization and have a crucial role to play in increasing agricultural productivity. The secondary data required for the study during the period 1974-75 to 2011-12 was collected mainly from Statistical Abstract of Punjab and Statistical Abstract of India. The study was carried out by employing tabulation with the compound growth rates and regression analysis for determining the factors responsible for increasing demand of tractors in the country. The analysis of annual compound growth rate of tractors in India showed that the growth rate was 12.55 per cent during Period I (1974-75 to1994-95) and it declined to 6.24 per cent in Period II (1995-96 to 2010-11). The regression analysis indicated that in the initial period (during 1974-75 to 1994-95) and overall period (1974-75 to 2010-11) of tractorisation, area under high yielding variety and gross irrigated area were significant factors determining the demand for tractors in the country. But, of late, during (1995-96 to 2010-11) social factors involved in owning tractor came out to be important variable.

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BACKGROUND AND OBJECTIVES

The recent structural changes in economic environment, liberalization policy and the signing of general agreement on tariff and trade has laid down new challenges in which, India has to compete in the international trade including agricultural trade. The basic requirement of this competition is to reduce the unit cost of production, and improve quality of agricultural produce so as to meet the international standards. The cost of production can be reduced only if the cost of every single factor contributing towards the total cost is minimized and resource productivity maximized. Also, various decisions regarding long term investments such as land, building and farm machines are taken with utmost care. Therefore, the agricultural strategies need to be based on the time-tested principles of business management and entrepreneurship so that agriculture can be made a profitable venture. There has been a progressive shift from draft animal power

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(DAP) to mechanical power in Indian Agriculture because DAP and manual labour were not sufficient to cope with the work load of intensive agriculture. The use of mechanical power is becoming indispensable for making an optimal use of other resources and in-time completion of various farm operations under intensive agriculture. Hence, the tractorisation which is the basis of farm mechanisation became very crucial for the further development of agriculture, as the time saved in completing different farm operations well in time, gives the crop more time to mature, affords the farmer to be more flexible in farm planning and facilities multiple and relay cropping etc.

Still tractorisation has been a controversial issue with regard to its impact on production, productivity, human employment and more importantly regarding the economic rationale of investment in farm machinery. A brief review of literature on the issue highlighted that some studies concluded that tractorisation has displaced human labour and created unemployment. The share of agricultural workers continuously declined since 1981 and expected to be only 5.09 per cent by 2011-12 and that of draught animal power from 27.23 per cent to 6.37 per cent in 2011-12. The increase in power has been mainly through introduction of tractors, whose contribution has increased from 7.5 per cent in 1971 to 51.08 per cent in 2011-12 (Kulkarni, 2011). While other showed that tractorisation shifted cropping pattern in favour of more intensive crops and therefore, created additional employment. As a study conducted on tractorised and non-tractorised farms in nine States of India revealed that tractor-owning farms had a higher cropping intensity of 137.5 per cent as compared to 131.8 per cent in the case of those without a tractor and thereby creating additional employment opportunities (NCAER, 1974).

The tractor penetration level in India has been very slow and not remained uniform throughout the country. The northern region especially Uttar Pradesh, Punjab, Rajasthan, Madhya Pradesh, Haryana and Gujarat is now almost saturated in terms of tractor uses, while the southern region is still under penetrated (Jain, 2006).Although the controversy of tractorisation, its form and extent, stands unresolved, yet there has been consistent increase in the demand for tractors in the country. The number of tractors increased from 0.1 million in 1971 to 2.7 million in 2004 and increased to 5.3 million in 2011-12 (GOP, 2014).

Therefore, it becomes pertinent to examine the factors responsible for this consistent increase in the number of tractors in the country. The present study has, therefore been designed to find out the factors responsible for enhancing tractorisation along with estimating the future demand for tractors in the country.

The specific objectives of the study are:
– To assess the compound growth rate of tractors in leading agricultural states of India; and
– To identify the various factors influencing the demand for tractors in India

RESOURCES AND METHODS

The present investigation has been entirely carried out using secondary data on different variables such as number of tractors, cultivated area, total cropped area, irrigated area, cropping pattern, area under high yielding varieties, and prices of major agricultural crops such as paddy, wheat and cotton were obtained from various issues of Statistical Abstract of India, Statistical Abstract of Punjab and Economic Surveys etc. The data on prices of tractors were taken from various dealers, Ludhiana.

Time series data on number of tractors in leading agricultural states of India for the period of 1974-75 to 2010-11 were collected and the growth trends were worked out. For three time periods *viz.*, Period I (1974-75 to 1994-95) which is characterised by high rate of growth in agriculture mainly due to technological revolution that occurred during mid-sixties and spread during this period, whereas II period (1995-96 to 2010-11) is characterised by moderate rate of growth in agriculture and overall period (1974-75 to 2010-11).

The variation in the demand for tractors is caused by a number of factors. To investigate the factors determining the demand for tractors in India, multiple regression analysis was carried out. Both linear and log linear type functions were tried but finally, log linear function was retained as results obtained from this function were better in terms of level of significance etc. The regression equations were fitted for three time periods so as to examine the changing significance of different variables over time. The general form of the demand model (log linear) is:

$$\text{Log } Y = a + b_1 \text{Log } x_1 + b_2 \text{Log } x_2 + b_3 \text{Log } x_3 + ... + b_n \text{Log } x_n + u$$

where
Y = Number of tractors demanded
a = Constant term

u = Error term

$b_1, b_2, b_3....b_n$ = Elasticities of different explanatory variables.

$x_1, x_2, x_3...x_n$ = Explanatory variables

The explanatory variables tried in the form of various combinations in the different demand models were:

D_T : Demand for tractors in current year

D_{t-1} : Demand for tractors in previous year

CA   : Cultivated area

TCA : Total cropped area

NAS : Net area sown

GIA : Gross irrigated area

NIA : Net irrigated area

HYV : Area under high yielding varieties

CI   : Cropping intensity

CP   : Cropping pattern

WAP : Weighted average price

RPAP: Real price of agricultural products

RPT : Real price of tractor

Some of the variables have been explained below

Demand for tractors in previous year (D_{t-1}):

Demand for tractors in previous year (which covers in a way the effect of social status and demonstration involved in purchasing a tractor). This variable has been included amongst the explanatory variables with the hypothesis that the number of tractors purchased in a particular village/locality in current year may have positive impact on the demand for tractors in the succeeding year, by way of tempting other neighbours/relatives to purchase a tractor too. Lagged demand for tractors was considered one of the relevant variables in the demand function as it covers in a way the effect of social status and demonstration involved in purchasing a tractor.

Weighted average price (WAP) :

Weighted average price of major crops, i.e. wheat, paddy and cotton was calculated as:

$$\text{Weighted average price} = \frac{P_W \times Prod. < P_P \times Prod. < (P_{DC} \times Prod. < P_{AC/BC} \times Prod.)}{Total\ Prod. (W < P < C)}$$

where $P_W, P_P, P_{DC,} P_{AC/BC}$ referred to prices of wheat, paddy, Desi cotton and American cotton/Bt cotton respectively.

Real prices of agricultural products (RPAP) :

The weighted average price thus calculated, was deflated using price index of agricultural products to remove the effect of inflationary trend in the series.

Real price of tractor (RPT) :

The prices of model of tractor i.e. Massy Ferguson were collected and it was deflated using price index for manufactured products to remove the effect of inflationary trend in the series.

OBSERVATIONS AND ANALYSIS

The results have been discussed under the following 2 heads:

(i) Growth rate of tractors in major agriculturally advanced states of India and

(ii) Determinants of demand for tractors in India

Section : I :

Growth of tractors :

The compound growth rates of tractors in leading agricultural states of India have been presented in Table 1. The tractors in the country increased at a rate of 12.55 per cent per annum during the period I (1974-75 to 1994-95) but the rate of growth declined to 6.24 per cent during the period II (1995-96 to 2010-11). The overall annual rate of growth was observed to be 9.72 per cent.

State–wise analysis showed that during Period I *i.e.* 1974-75 to 1994-95, the maximum growth rate of 19.52 per cent was recorded for Madhya Pradesh followed by Haryana (17.08 %), Rajasthan (14.37 %) and Uttar Pradesh (13.49 %). While the lowest growth rate was observed for Tamil Nadu (3.55%). During the period II (1994-95 to 2010-11), Karnataka attained the maximum growth rate of 11.1 per cent followed by Maharashtra (8.13%). Kerala showed a negative rate of growth of -0.37 per cent. When the overall picture of two periods was analysed, it indicated that Madhya Pradesh recorded the highest rate of growth *i.e.* 13.63 per cent and the minimum rate of growth was again observed in Kerala (3.65 %). The rate of growth during the period 1995-96 to 2010-11, compared to earlier period of 1974-75 to1994-95 was lower in almost all the states with an exception of Karnataka and Tamil Nadu where it increased from 10.47 and 2.93 per cent in period I to 11.13 and 9.35 in period II (1995-96 to 2010-11), respectively.

Few points clearly emerge from the preceding

discussion. Firstly, the growth of tractors, in general, was higher during the period I (1974-75 to 1994-95) as compared to period II (1995-96 to 2010-11). This impressive rise in the rate of growth of tractors during the Period I could be credited to the Green revolution which started in mid-sixties but spread during this period. Thus it was the impact of Green revolution and new technology that contributed significantly and positively towards the demand for tractors during these years (1974-75 to 1994-95). Secondly, in period II (1994-95 to 2010-11) it can be seen that growth has been relatively high in states where tractor penetration was low initially *viz.,* states like Tamil Nadu and Karnataka. The more heavily mechanised regions particularly Punjab, Haryana, and Uttar Pradesh, overtime the pace of tractorisation in these states had slowed down significantly reason being that the number of tractors have almost reached a saturation level from both economic as well as operational point of view. A study conducted by Bhattathiri (2013) indicated that Kerala has exhibited decreased and negative growth rate overtime, mainly citing the reason of declining trend in the paddy cultivation due to escalating cost of rice production, hike in diesel prices etc.

Section : II :
Determinants of demand for tractors :

An attempt has been made in this section to investigate the different factors affecting the demand for tractors overtime. Various regression equations using different combinations of explanatory variables were tried for all the three periods, separately and one each (best fit in terms of level of significance of explanatory variables, co-efficient of multiple determination and signs of the variables) and Mallow cp was selected for discussion. The same have been demonstrated in Table 1.

Period I (1974-75 to 1994-95) :

It may be seen from the equation of period I that the co-efficient of multiple determination (R^2) came out to be 0.99 which indicated that 99 per cent of the total variation in the demand for tractor was explained by the independent variables included in the model.

The co-efficient of area under high yielding variety seeds (HVY) was found to be 1.39 being significant at 5 per cent probability level, indicated that 1 per cent increase in area under high yielding variety would raise demand of tractors by 1.39 per cent.

The regression co-efficient of demand for tractors with respect to gross irrigated area came out to be 2.35 and it was found statistically significant at 1 per cent probability level. It revealed that increase in gross irrigated area in the country had positive impact on the tractor demand *i.e.* 1 per cent increase in the gross irrigated area would result in 2.35 per cent increase in demand for tractors in the country.

Table 1: Compound growth rates of tractors in different states of India (%)			
States	Period I (1974-75 – 1994-95)	Period II (1995-96 – 2010-11)	Overall (1974-75 – 2010-11)
Gujarat	12.66*** (0.73)	6.74 *** (0.23)	10.09*** (0.33)
Haryana	17.08*** (0.78)	6.30*** (0.43)	11.62*** (0.53)
Maharashtra	12.14*** (0.60)	8.13*** (0.37)	10.30*** (0.26)
Punjab	10.85*** (0.65)	1.90*** (0.17)	6.26*** (0.44)
Rajasthan	14.37*** (0.92)	6.89*** (0.22)	12.02*** (0.41)
Uttar Pradesh	13.49*** (1.0.3)	6.57** (3.29)	9.36*** (0.76)
Andhra Pradesh	11.06*** (0.49)	6.89*** (0.22)	9.51*** (0.55)
Karnataka	10.90*** (0.45)	11.13*** (2.87)	9.70*** (0.26)
Kerala	5.06*** (1.45)	-0.37[NS] (1.82)	3.65*** (0.60)
Madhya Pradesh	19.52*** (1.36)	7.61*** (1.37)	13.63*** (0.71)
Tamil Nadu	3.55*** (0.89)	6.45** (2.34)	10.35*** (0.82)
Other States	9.30*** (2.26)	9.35*** (1.91)	10.70*** (0.81)
India	12.55*** (0.42)	6.24*** (0.14)	9.72*** (0.29)

Statistical Abstract of India
Note: ** and *** indicate significance of values at P=0.05 and 0.01, respectively   NS=Non-significant
Figures in parentheses are standard errors

Period II (1995-96 to 2010-11) :

A glance on the equation of period II revealed that demand for tractors in the previous year (D_{T-1}) and real price of tractor were significant variables which influenced the demand for tractors in India during Period II. The co-efficient of multiple determination (R^2) showed that all the independent variables included collectively explained about 99 per cent of variation in the demand for tractors.

It may be observed that the co-efficient of lagged demand was 0.74 and it was found significant at 1 per cent level. It implied that with 1 per cent increase in the demand for tractors in the current year would increase 0.74 per cent increase in demand for tractors in the succeeding year. The regression co-efficient of real price of tractor was found to be -0.63 per cent being statistically significant at 5 per cent of probability level which indicated that 1 per cent increase in real price of tractor would result in 0.63 per cent decline in demand for tractors.

Importance of variables overtime :

A comprehensive view of above mentioned regression equation for Period I and Period II clearly expounded the changing significance of different factors determining the demand for tractors overtime. The only variable real price of tractor which found to be significantly influencing the demand in both the Periods I and II. To sum up the foregoing discussion, it could be inferred that gross irrigated area and the area under high yielding variety were the significant factors that determined the tractor demand in Period I. So, it may be

inferred that with the technology transformation *i.e.* spurt in the area under high yielding varieties of paddy and wheat and due to up rise of irrigated area during this period (1974-75 to 1994-95), the tractors were adopted at a faster pace irrespective of high price of tractors.

During the period II, lagged demand showed the significant and positive association with tractor demand. The real price of tractor emerged out significant and showed negative association with tractor demand. The total cropped area came out as non-significant in this period. The elasticity of lagged demand was found to be 0.74 in Period II. So, it may be inferred that with the demonstration effect there was tremendous increase in demand during II period.

Period III (1974-75 to 2010-11) :

Equation of Period III in the Table 2 brought out that gross irrigated area and area under high yielding variety had been responsible for increased demand for tractors in India. But, the real price of tractor showed significant and negative association with the demand for tractors.

The co-efficient of area under high yielding variety seeds (1.63) was found to be statistically significant at 1 per cent probability level. This implied that with 1 per cent increase in the area under high yielding variety, the demand for tractors would increase by 1.63 per cent.

The elasticity co-efficient of gross irrigated area was found to be 1.73, significant at 1 per cent level of probability. It revealed that with 1 per cent increase in gross irrigated area; demand for tractors would increase by 1.73 per cent. Thus, it revealed that gross irrigated

Table 2 : Results of regression equations developed for tractors affecting demand for factors in India

Period	Intercept	D_{t-1}	TCA	GIA	HYV	CP	RPAP	RPT	R^2	Mallow cp
1974-75 to	-8.08	-	-	2.35[***]	1.39[**]	2.03[NS]	-0.21[NS]	-	0.990[***]	5.0
1994-95				(0.72)	(0.53)	(2.03)	(0.36)			
1995-96 to	3.2	0.74[***]	0.073[NS]	-	-	0.72[NS]	0.16[NS]	-0.63**	0.992[***]	6.0
2010-11		(0.08)	(0.47)			(0.59)	(0.25)	(0.28)		
1974-75 to	-7.1	-	-	1.73[***]	1.63[***]	-	-0.41[NS]	-0.32**	0.993[***]	5.0
2010-11				(0.47)	(0.28)		(0.21)	(0.16)		

Note: *, ** and *** indicate significance of values at P=0.10, 0.05 and 0.01, respectively
Figures in parentheses are standard error of associated coefficients
D_{t-1} : Demand for tractors in previous year
TCA : Total cropped area
GIA : Gross irrigated area
HYV : Area under high yielding varieties
CP : Cropping pattern
RPAP : Real price of agricultural products (weighted)
RPT : Real price of tractor

area was important variable which largely influenced the demand for tractors in India during this period.

The regression co-efficient of real price of tractor (-0.32) showed significance at 5 per cent level of probability. It revealed that with 1 per cent increase in real price of tractor; the demand for tractors would decrease by about 0.32 per cent.

So, an important conclusion that emerged out of this analysis is that in the initial stage of tractorisation (during 1974-75 to 1994-95) area under high yielding variety seeds and gross irrigated area were only significant factors determining the demand for tractors in the country. However, the role of other variables was not apparent. But, of late, during (1995-96 to 2010-11) social factors involved in owning tractor came out to be important variable. So farmers are purchasing tractor widely not only of their farming necessities but also because tractor has become a status symbol for the farming community.

Conclusion :

The study revealed that the tractors in India increased at the rate of 12.55 per cent per annum in period I (1974-75 to 1994-95), but the growth rate declined to 6.24 per cent in period II (1994-95 to 2010-11). The state–wise analysis showed that during Period I the maximum growth rate of 19.52 per cent was recorded for Madhya Pradesh but during period II, Karnataka attained the maximum growth rate of 11.1 per cent. The analysis to investigate the different factors affecting the demand for tractors overtime brought out that in the initial stage of tractorisation (during 1974-75 to 1994-95) area under high yielding variety seeds and gross irrigated

area were only significant factors determining the demand for tractors in the country. But, of late, during (1995-96 to 2010-11) social factors involved in owning tractor came out to be important variable. So, farmers are purchasing tractor widely not only of their farming necessities but also because tractor has become a status symbol for the farming community. This particular analysis would guide the government to make the right choice and know which particular factor to be given more importance in order to improve tractorisation on the farms thereby increase the production and yields.

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