The effect of tractor supply in Iran agriculture from a macro plan point of view

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Abstract: The aim of this study was to investigate the effect of the tractor supply on agricultural yield from a macro plan perspective. The required information was obtained from the Institute of Agricultural Machinery Extension and Ministry of Jihad-e-Agriculture of Iran. Regarding the number of tractors distributed, the maximum number of tractors distributed in Iran was 37 996 in 1983. The effect of this distribution pattern on the crops yields and planted area was investigated for a thirteen-year period from 1983 to 1996. The results showed that these tractors had significant effects on the crops yields and planted area. Also it was inferred that the power distribution in Iran agriculture with the current trend is not acceptable and no significant changes are expected from the current policy. It seems that the Iran agriculture market needs a shock like that in 1983, and that many tractors with different engine sizes should be supplied into the market in a short period of time.

Keywords: Iran; tractor supply; mechanisation

Tractors are known as most important power sources in agriculture and the effect of the tractor power on agriculture is significant (Singh 2006). The use of modern technology during recent decades resulted in a rapid growth of the farm production. Tractors and farm machinery are important examples of this modern technology (Xinan *et al*. 2005 and Singh R.B. 2000). The quality of inputs in mechanisation and land and labour productivity may differ considerably (Singh G. 1997, 2000; Singh & Chandra 2002). The mechanisation technologies keep changing with the industrial growth of the country and socio-economic advancement of the farmers. Whereas the declining interest of the landowners in agriculture and non-availability of the agricultural labour for field operations may be one of the major socio-economic issues in the highly industrialised nations, an increasing land and labour productivity with dignity are the mechanisation requirements of the developing countries. The mechanisation technology is, therefore, location-specific and dynamic (Gifford & Rijk 1980).

Giles (1975) reviewed the power availability in different countries and demonstrated that productivity was positively correlated with the potential unit farm power. The impact of tractorisation on the productivity of land (yield and cropping intensity) and economic growth (income and employment) were previously assessed (NCAER 1981). The trends in the European and Asian countries were, however, distinctly different. Binswanger (1982) defined the states of mechanisation by the growth of mechanically power operated farm equipment over traditional human and animal power operated equipment. Rijk (1989) reviewed the growth of mechanisation in different Asian countries and suggested a computer software (MECHMOD) for the formulation of strategy for the mechanisation policy based on the economy of using animate and mechanical powers for different field operations. Singh and De (1999) reviewed the methodologies adopted by several authors to express a mechanisation indicator. A major defect in quantifying the mechanisation indicator based on the ratio of mechanical tractive farm power to total farm power is that it does not bring to light the actual use scenario. Whilst the unit farm power could be considered as indicative of the potential power availability, it may not necessarily be fully utilised on the farms. This may depend upon the availability of diesel fuel and electricity and adequate workload. The majority of the farmers in the developing countries use tractors for the transport of agricultural and non-agricultural commodities.

In spite of the paramount importance of machinery in agriculture, the government policies in

Table 1. Degree of mechanisation in some Iran agricultural crops (Anonymous 1995)

Crop	Tillage				Plant	Cultivate			Harvest	
	plough	discing (harrowing)	fertiliser spreading	levelling		weeding	spraying		combine harvester	mower
							tractor	motor		
Irrigated wheat	96.2	82.6	44.8	28	56	–	19.4	–	67	9.5
Rainfed wheat	87.7	64.7	22.8	5.32	45	–	19.2	–	54.5	8.6
Irrigated barley	94.5	85.6	47.5	28.2	–	–	10.12	–	67	9.5
Rainfed barley	73.7	56.3	19.5	2.7	–	–	–	1.2	54.5	8.6
Rice	99	14.5	0.1	73.8	–	–	–	15.6	–	1.3
Irrigated cotton	99	95.8	67	18	53	4	3.8	76.6	1.5	–
Rainfed cotton	99.9	100	66	1.84	53	4	3.8	76.6	1.5	–
Sugar beet	99.9	90.9	34.4	37.6	46	46	–	35.5	62.7	–
Potato	94.8	67.2	21.6	8.8	–	–	–	29.8	–	–
Onion	96.7	76.5	5.2	12	–	–	–	10	–	–
Corn	90	74	5.2	12	–	–	–	10	–	–
Cereal	91	80	5	8	–	–	–	10	–	–
Oil seeds	97	98	60	10	50	40	–	15	45	–
Alfalfa	65	46	29	16	15	–	–	21.5	–	26
Apple	–	–	–	–	–	–	70	–	–	–
Citrus	–	–	–	–	–	–	70	–	–	–
Grape	–	–	–	–	–	–	45	–	–	–
Date	–	–	–	–	–	–	3	–	–	–
Almond	–	–	–	–	–	–	–	20	–	–
Olive	–	–	–	–	–	–	–	40	–	–
Pistachio	–	–	–	–	–	–	–	80	–	–

recent years have performed an improper machine supply to Iran agriculture. The numbers of machines supplied in recent years have not been in the right direction of the mechanisation programs and their goals. Besides, the depreciation of old machines has not been considered correctly and the quantity of machines provided seems to be insufficient for the replacement of old machines. The situation has led to a continuously declining mechanisation level, thus many farmers are forced to use depreciated and worn-out machines in agricultural operations (Amjadi & Chizari 2006).

The ratio of the mechanised operations to the total operations is called the Mechanisation Degree (*MD*) and is calculated as:

$$MD = \frac{S_m}{S_t} \quad (1)$$

where:

MD – mechanisation degree

S_m – area under the mechanised operations (ha)

S_t – total area under cultivation (ha)

The mechanization degrees of principle agricultural crops in 1995 are presented in Table 1. According to Table 1, except for the energy-intensive operations such as tillage, this index is very low. This indicates that the number of tractors distributed in Iran agriculture have not been sufficient for agricultural operations. According to Amjadi & Chizari (2006), the shortage of tractors is an on-going problem which has been intensified year after year. The aim of this study is to investigate the effect of the tractor supply on agricultural yield from a macro plan point of view.

MATERIALS AND METHODS

The information concerning the tractors distributed in Iran was obtained from the Institute of Agricultural Machinery Extension. It should be noted that the information provided from 1966–1994 is a complete and reliable data but the data collected later were dispersed and unreliable. It is believed that, due to the national and international economical problems (such as war and sanctions) imposed, no significant changes in the trend of the number of tractors supplied are expected.

A graph showing the numbers of tractors distributed in Iran from 1996–2000 is presented in Figure 1. The number of the tractors distributed in 1983 was 37 996 which was the highest ever. Also, the mechanisation degrees of the principle agricultural crops are presented in Table 1. According to Table 1, the mechanisation degree of horticultural operations is shown to be very low and the tractor application in horticultural operations is restricted to the spraying operations. Therefore, it can be assumed that almost all tractors distributed in Iran have been used in farm lands. Hence, the aim of this study is focused on the effect of tractors on the yields of farm crops.

The statistics dealing with the yields of different crops in different years was obtained from the Ministry of Jihad-e-Agriculture of Iran (Anonymous 2006). Agricultural crops reveal an extensive range of yields from lower than 10 t/ha for grains and cereals to more than 30 t/ha for sugar beet, tomato, and vegetable crops. Due to different cultivation

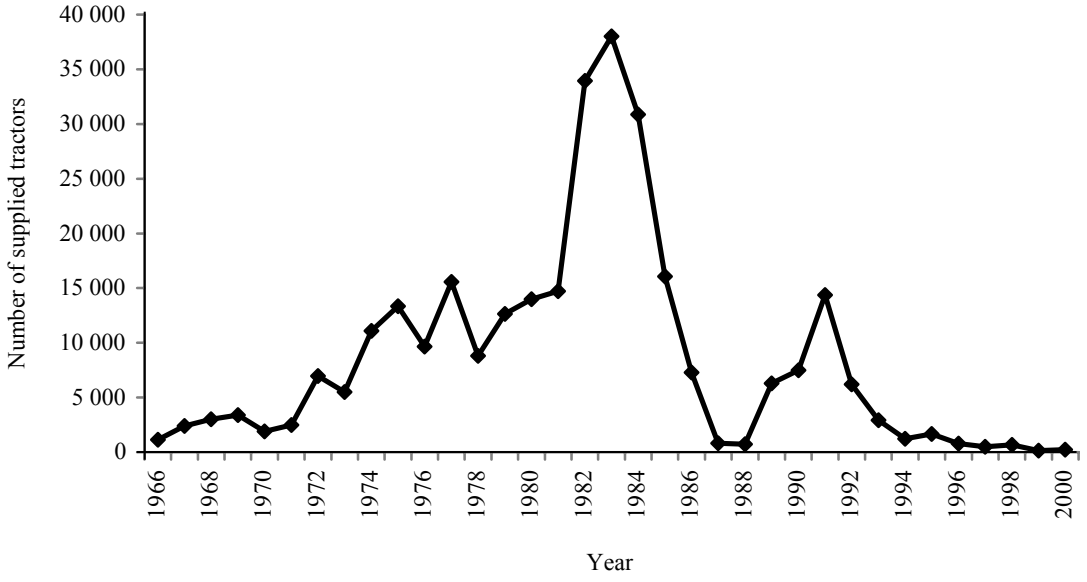

Figure 1. Graph of tractor numbers supplied to Iran agricultural sector (Anonymous 2001)

patterns in different years, the comparison between the crops yields should be carried out with a logical index. Therefore, the crops were divided into two categories, namely high yield crops such as sugar beet, potatoes, tomatoes, and low yield crops such as grains and cereals. Finally, the harmonic mean of yield was calculated by Eq. (2) (Meibodi & Rezaei 2007):

$$\overline{Y} = \frac{1}{\left(\frac{S_1}{Y_1}\right) + \left(\frac{S_2}{Y_2}\right)} \quad (2)$$

where:

$\overline{Y}$ – harmonic mean of yield of total agricultural crops (t/ha)

S_1 – percent of area planted under low yield crops (decimal)

S_2 – percent of area planted under high yield crops (decimal)

Y_1 – yield of low yield crops (t/ha)

Y_2 – yield of high yield crops (t/ha)

According to Figure 1, the maximum number of tractors distributed in Iran was 37 996 in 1983. The economical life of tractors in Iran is estimated to be 13 years (Anonymous 2001). The effect of this distribution pattern of tractors on the crops yield was investigated for a thirteen – year period from 1983 to 1996. The number of tractors supplied to Iran agriculture from 1970 to 2000 (4 years after the last year of study) was considered in calculations. Total power available in each year was calculated using Eq. (3):

$$P_i = 0.75 \times \sum_{n=1}^{r} (p_j \times n) \quad (3)$$

where:

P_i – total power of tractors available in i^{th} year (kW)

0.75 – coefficient for conversion of nominal power to useful power (Almasi *et al.* 2005)

p_j – nominal power of j^{th} model of tractor

n – number of each model

r – number of total models of tractors distributed in each year

The year 1983 is assumed to be the basic year because the number of tractors distributed in this year is significantly higher than in other years (Figure 1). The change between the yields total crops (harmonic mean of the total crops yield) in the years different from this year was calculated using Eq. (4):

$$\Delta\overline{Y} = \overline{Y}_i - \overline{Y}_0 \quad (4)$$

where:

$\Delta\overline{Y}$ – change between harmonic mean of the total crops yield in i^{th} year from that in 1983 (t/ha)

$\overline{Y}_i$ – harmonic mean of yield of crops in i^{th} year

$\overline{Y}_0$ – harmonic mean of crops yield in 1983

Also, the change between the areas under cultivation in the years different from the basic year was calculated using Eq. (5):

$$\Delta S = S_i - S_0 \quad (5)$$

where:

ΔS – change between the areas under cultivation in the i^{th} year and those in 1983 (ha)

S_i – represents the areas under planting in i^{th} year (ha)

S_0 – areas under planting in 1983 (ha)

The production per available power (Y_p) for both groups of crops in each year was calculated by Eq. (6). Also, the harmonic mean of production per available power ($\overline{Y}_p$) in each year was calculated by Eq. (7) and the changes between $\overline{Y}_p$ in years other than the basic year were calculated by Eq. (8):

$$Y_p = \frac{Y}{ML} \quad (6)$$

$$\overline{Y}_p = \frac{1}{\left(\frac{S_1}{Y_p}\right) + \left(\frac{S_2}{Y_{p2}}\right)} \quad (7)$$

$$\Delta\overline{Y}_p = \overline{Y}_{pi} - \overline{Y}_{p0} \quad (8)$$

where:

Y_p – production per available power (t/kW)

Y – yield of the crop (t/ha)

ML – mechanisation level (kW/ha)

$\overline{Y}_p$ – harmonic mean of production per available power (t/kW)

S_1 – percent of area planting under low yield crops (decimal)

S_2 – percent of area planting under high yield crops (decimal)

$\overline{Y}_{p1}$ – production per available power of low yield crops (t/kW)

$\overline{Y}_{p2}$ – production per available power of high yield crops (t/kW)

$\Delta\overline{Y}_p$ – change between the harmonic mean of production per available power in i^{th} year from the year 1983 (t/ha)

$\Delta\overline{Y}_{pi}$ – production per available power in i^{th} year

$\Delta\overline{Y}_{p0}$ – production per available power in 1983

ML in Eq. (6) was calculated from Eq. (9):

$$ML = \frac{P_a}{S_t} \quad (9)$$

where:

ML – Mechanization Level (kW/ha)

P_a – total available power of tractor in each year (kW)

S_t – total planted area (ha)

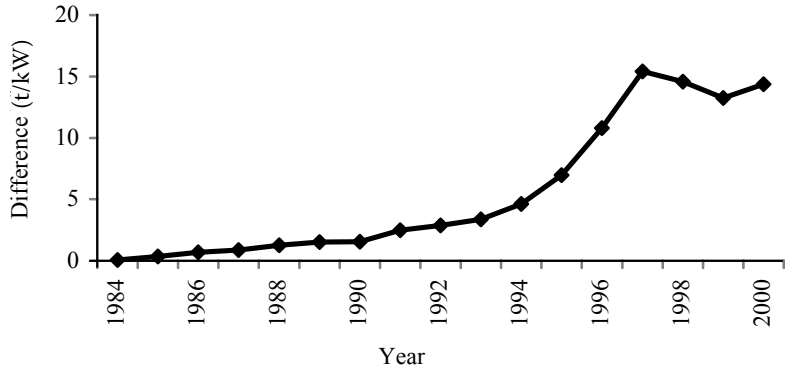

Figure 2. Graph of changes of crop production per available power ($\Delta \overline{Y}_p$)

RESULTS AND DISCUSSION

Production per available power

The graph of the changes of the crop production per available power ($\Delta \overline{Y}_p$) is presented in Figure 2. It is clear from the figure that the production per available power has increased through the period of study. In the starting years, this index was lower than in the ending years. Two reasons can account for this increase:

Decrease in available power: Because the tractors supplied in 1983 were still in use and had not been depreciated in the starting years. The effect of depreciation is clearly observable in the ending years.

Increase in crop production: This increase is due to the rise in the available power per hectare and mechanisation of agricultural operations.

Production changes

The graph of changes in the crops yield ($\Delta \overline{Y}$) from 1983 to 2000 is shown in Figure 3. Also, the trend shows an increase in the rate of the yield changes during the study period. Figure 3 shows that the rate of production increase in starting years (1983 to 1986) was lower than in the rest.

As it has been observed, the maximum yield of crops was obtained in 1993, the year in that almost all tractors distributed in 1983 were in the final years of their economical life. After 1993, some decrease in the crop yields was observed. One of the reasons for this abating is the depreciation of the tractors distributed and, as a result, a shortage of power required for the mechanised operations. Also, Figure 3 shows that the crop yield decreased in the ending years of the economical life of the tractors but was still higher than that in 1983 (the basic year). This could be due to the incorporation of other technological developments such as the use of modified seeds, new irrigation methods, and the use of fertilisers, pesticides, and herbicides, as well as agricultural promotion and education. However, with no doubt, a significant yield decrease due to the lack of available power is clearly observed.

Change of area under planting

The graph of the changes of the area under cultivation (ΔS) is presented in Figure 4. As shown in the figure, the effect of the available power on the amount of cultivated area is more pronounced than the effect of power quantity on the crops yield. The amount of area under cultivation increased to

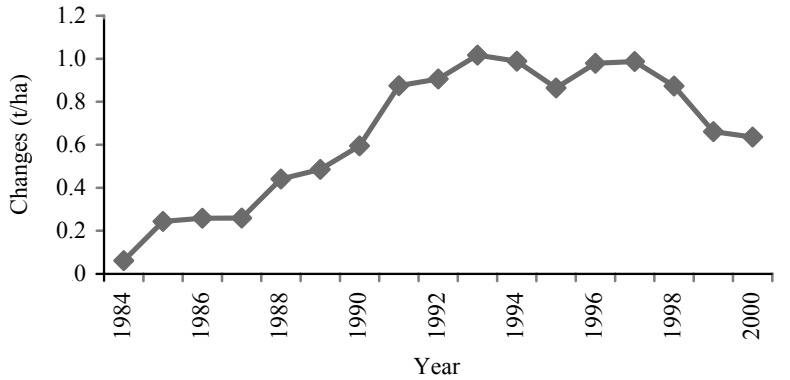

Figure 3. Graph of changes of crops yield ($\Delta \overline{Y}$)

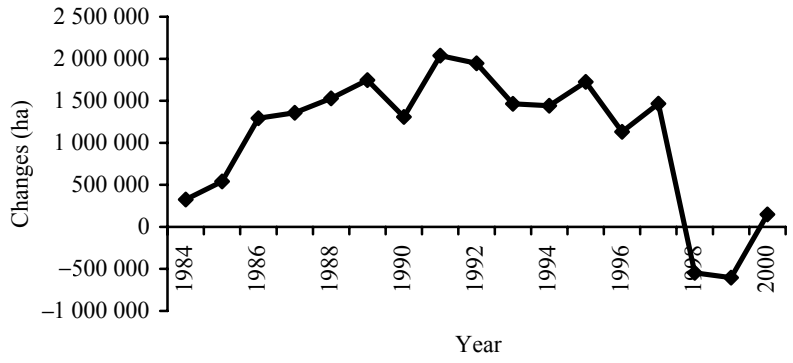

Figure 4. Graph of changes of area under cultivation (ΔS)

its maximum in 1991. The cultivated area in 1998 showed a significant decrease which was due to the fact that almost all tractors distributed in 1983 were depreciated with no replacement. In this year, the cultivated area was even smaller than that in 1983 which was a clear reason for the shortage of the available power.

CONCLUSION

As shown, the availability of sufficient power has a significant effect on both the crop yield and the area under cultivation. The power distribution in Iran agriculture with the current trend is not acceptable and no significant changes are expected from the current policy. It seems that the Iran agriculture market needs a shock like that in 1983, and that many tractors with different engine sizes should be supplied into the market in a short period of time. Also, the economical life of tractors should be considered for proper and continuous replacements to cope with the reality of depreciation which seems to be simply overlooked. It should be noted that this huge supply needs many fundamental issues such as financial and technical as well as educational programs to be taken care of to make use of the available power at its most.

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Abstrakt

Ghadiryanfar M., Keyhani A., Akram A., Rafiee S. (2009): **Vliv dodávky traktorů do iránského zemědělství z hlediska makrokoncepce**. Res. Agr. Eng., **55**: 121–127.

Cílem studie bylo posouzení vlivu dodávky traktorů na zemědělský výnos z hlediska makrokoncepce. Požadované informace byly získány od Ústavu pro rozvoj zemědělského strojírenství a od iránského Ministerstva Jihad-e-Agriculture. Maximální počet traktorů distribuovaných v Iránu byl v roce 1983 37 996. Vliv této dodávky na výtěžek plodin a na rozlohu osazované plochy byl sledován po dobu 13 let, v letech 1983 až 1996. Byl prokázán významný vliv dodávky traktorů jak na výtěžek plodin, tak na rozlohu osazované plochy. Současně bylo odvozeno, že rozdělení síly v iránském zemědělství není při současném trendu přijatelné, přičemž se při stávající politice neočekávají významné změny. Zdá se, že iránský zemědělský trh potřebuje stejný zlom, ke kterému došlo v roce 1983, a že by na trh měl být v krátkém čase dodán velký počet traktorů s různými velkostmi motorů.

Klíčová slova: Irán; dodávka traktorů; mechanizace

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