A pattern for power distribution based on tractor demand in Iran

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ABSTRACT

This study was aimed to propose a pattern for tractor distribution in Iran. A pattern was suggested based on previous tractor demands in all provinces. Results showed that Iran agriculture needs at least 33462 tractors with nominal average power of 53 kW annually. These tractors cost approximately 435.006 million dollars. Tractors' supply should be continued with the previous increasing rate up to the point that farmers demand is fulfilled and replacement of depreciated machines are taken place without any delay.

Keywords: Mechanization, Iran, Tractor distribution, Mechanization level

1. INTRODUCTION

During this century, the substitution of horses and work animals with horse-power has been an impressive phenomenon in the world. This phenomenon, acting together with chemistry and genetics, has not only considerably increased the productivity of farm labor but has also increased, in a hitherto in conceivable way, cultivated land and agricultural production. Machines have also lowered the drudgery of farmers which so often characterized their existence (Biondi *et al.*, 1998).

Today, tractor is one of the most important power sources in agriculture. Effect of tractor power on agriculture is considerable (Singh, 2006). The use of modern technology during recent decades resulted in rapid growth of farm production. Tractors and farm machinery are important examples of this modern technology (Xinan *et al*., 2005 and Singh, 2000). The quality of inputs of mechanization and consequently, land and labor productivity with or without mechanization may differ considerably (Gifford and Rijk, 1980., Singh, 1997 and Singh and Chandra, 2002). Mechanization technologies keep changing with industrial growth of the country and also with socio-economic advancement of the farmer. Whereas declining interest in agriculture of the landowners and non-availability of the agricultural labor for field operations may be one of the major socio-economic issues in highly industrialized nations, increasing land and labor productivity with dignity are the mechanization requirements of the developing countries. Mechanization technology is, therefore, location-specific and dynamic (Gifford & Rijk, 1980).

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

An autoregressive integrated moving average (ARIMA) univariate model was used to predict the previous tractor demand in Turkey. The ARIMA model was determined as (2, 2, 2) in order to predict tractor demand by using logarithmic transformation. The trend of the tractor stock was calculated by using coefficients of the model for 2004–2015. According to the model result, the demand varied between 13,000 to 15,000 tractors per year, with an accumulated stock of 1.183 million by 2015 (Unakıtan and Akdemir, 2007).

In spite of the paramount importance of machinery in agriculture, government policies in recent years have led to improper machine supplies to Iran agriculture. The quantities of machine supplies not only overlooked the mechanization programs but also needed replacement machines were not provided adequately. The imposed situation has led to decline the mechanization level to the extent that farmers have to use depreciated and obsolete machines in their agricultural operations (Amjadi and Chizari, 2006).

Ratio of mechanized operations to the total operations is shown by equation (1):

$$MD = \frac{S_m}{S_t} \tag{1}$$

where MD is Degree of Mechanization, S_m is the area under mechanized operations (ha) and S_t is total area under cultivation (ha).

Degrees of Mechanization of main agricultural crops for 1995 are presented in Table 1. According to this table, mechanization degrees are very low except in energy intensive operations such as tillage. The result implies that the number of tractors distributed in Iran agriculture wasn't sufficient to cover the whole cultivated area. The low mechanization degrees due to shortage of tractors are still a major problem as addressed by Amjadi and Chizari (2006).

Table 1. Degree of mechanization in some Iran agricultural crops (Anonym., 1995).

Crop	Tillage				Plant	Cultivate		Harvest	
	Plough	Disc	Fertilizer spreading	leveling		Spraying		Combine harvester	Mover
						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	3.8	76.6	1.5	-
Rainfed cotton	99.9	100	66	1.84	53	3.8	76.6	1.5	-
Sugar beet	99.9	90.9	34.4	37.6	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	-	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	-	-

This study was carried out to determine the minimum number of tractors needed to fulfill agricultural operations based on previous tractor demand in Iran.

2. MATERIALS AND METHODS

Iran is subdivided into 29 provinces as shown in fig. 1. Information of tractors distributed in Iran was attained from Institute of Agricultural Machinery Extension. Also, the statistics for total cultivation area in each province, for the period from 1986 to 2006, was attained from Ministry of Jihad-e-Agriculture of Iran (Anonym., 2006). Since Razavi Khorasan, North Khorasan and West Khorasan have recently been endorsed by the government to be provinces, data of these provinces were lumped into Khorasan. Also, due to incomplete data, Qazvin, Ardabil and Yazd provinces were omitted from the survey. Number of tractors supplied in Iran agriculture from 1970 to 2006 was taken into consideration because the useful life of tractors in Iran is estimated about 13 years based on Ministry of Jihad-e-Agriculture of Iran reports (Anonym., 1995).

Total annual available power for all provinces was calculated using equation (2):

$$P = 0.75 \times \sum_{n=1}^{r} (p_i \times n_i) \quad (2)$$

where P is the total power of tractors available in each year (kW), 0.75 is the coefficient for converting the nominal power to useful power (Almasi *et al*., 2005), P_i is the nominal power of i_{th} model of tractor and r is the number of total models of tractors distributed in each year.

Figure 1. The map of Iran provinces.

Mechanization Level was calculated by equation (3):

$$ML = \frac{P_a}{S_t} \quad (3)$$

where ML is Mechanization Level ($kW.ha^{-1}$), P_a is the total available power of tractors (with 13 years useful life) in each year (kW) and S_t is total cultivated area (ha).

Graph of mechanization level (ML) from 1986 to 2006 in Iran is presented in fig. 2. According to this figure the mechanization level in Iran agriculture is increased from 1986 to 1989. This index was reached to its maximum level in 1989. Then, it decreased and reached to its minimum level in 2006. The descending trend is observed in all Iran provinces. This is mostly due to weak management in sufficient power distribution, economic sanctions, shortage of machinery production and overlooking timeliness in agricultural operations in Iran. Number of distributed tractors in 1989 (where ML is maximum), justifies the minimum number of needed tractors for agricultural operation. After this year (due to mentioned reasons), farmers' need for tractor was not answered. In the other words, tractor demand by farmers indicates the number of required tractors in all provinces. If the supply of tractors were continued after 1989 with the previous trend, mechanization level would increase in parallel. Thus, to meet the present requirements, the mechanization level in all provinces should reach its maximum level once more.

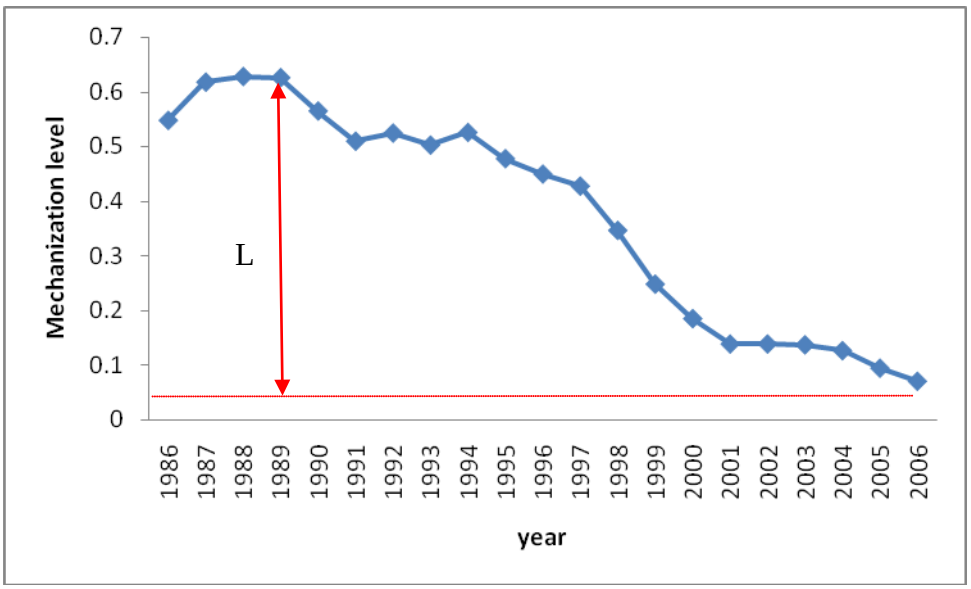

Figure 2. Graph of Mechanization Level (ML) from 1986 to 2006 in Iran.

The total power needed to achieve this mechanization level is calculated from equations 4-6:

$$L = ML_{max} - ML_{2006} \quad (4)$$

$$P_n = L \times S \quad (5)$$

$$P_g = \frac{P_n}{0.75} \quad (6)$$

where L is the difference between maximum mechanization level and mechanization level in 2006 ($kW.ha^{-1}$), ML_{max} is the maximum mechanization level of each province, P_n is the net power needed in each province, S is total cultivated area in each province in 2006 (last year of study) and P_g is the gross power (accumulated nominal power of tractors) needed in each province.

The total number of tractors are needed in each province is calculated by equation 7.

$$N = \frac{P_g}{53} \quad (7)$$

where N is the number of tractors needed for each province and 53 is the average nominal power of tractors in Iran. This number is selected, because the most prevalent tractors in Iran are those equivalent to MF285 with nominal power of 53 kW (Anonym., 2009, http://www.itm.co.ir/).

3. RESULTS AND DISCUSSION

Quantities of L, total cultivated area, P_n, P_g and N in all provinces are presented in Table 2. According to Table 2, at least 33462 tractors with 53 kW nominal power are necessary for all provinces, annually. Total cost for this supply amounts to 435.006 million dollars with exchange rate of 9874 Rls for each dollar (Anonym., 2009, http://www.cbi.ir) /. Also the number of tractors needed for each province based on previous demand of tractors is shown in Table 2. According to this table maximum number of tractors should be distributed in Hormozgan, Tehran, Kerman, Bushehr, Mazandaran, Kohgiluyeh and Boyer-Ahmad and Kordestan provinces.

Table2. The quantities of L, S_t, P_n, P_g and N in all provinces.

Province	L ($kW.ha^{-1}$)	S_t (ha)	P_n (kW)	P_g (kW)	N
Hormozgan	2.33	990700	2308514	3078019	58076
Tehran	2.654	632578	1678579	2238105	42228
Kerman	1.276	769773	982008	1309344	24705
Bushehr	0.523	1323445	691626	922168	17399
Mazandaran	0.819	686122	561784	749045	14133

Kohgiluyeh	0.726	654672	475256	633675	11956
Kordestan	0.620	687492	426537	568716	10730
Kermanshah	0.525	642198	337040	449386	8479
Khuzestan	0.408	766913	312889	417185	7871
Hamadan	0.675	402345	271558	362077	6832
Markazi	0.341	891068	303695	404927	7640
W.Azarbaijan	1.000	162883	162905	217207	4098
Fars	0.456	339159	156010	208013	3925
Lorestan	0.530	249178	132054	176072	3322
Sistan	0.364	338487	123299	164399	3102
Chaharmahal	0.247	493362	121764	162352	3063
Esfahan	1.145	106761	122233	162978	3075
Gilan	0.590	206242	121632	162176	3060
E.Azarbaijan	0.602	162517	97814	130418	2461
Ilam	0.513	153048	78502	104670	1975
Khorasan	0.360	200983	72323	96431	1819
Zanjan	0.302	211909	63909	85211	1608
Golestan	0.790	60932	48152	64202	1211
Semnan	0.259	114112	29514	39352	742
total	-	-	-	-	33462

The amount of required power is not sufficient for potential agricultural operations in Iran and just indicates the minimum power needed in all provinces. Tractors' supply should be continued with the previous increasing rate up to the point that farmers demand is fulfilled and replacement of depreciated machines are taken place without any delay.

The mechanization level of Iran with the calculated tractor supply will reach 0.86 $kW.ha^{-1}$. Mechanization level of some countries is presented in Table 3. The most importance factor affecting the mechanization level is the average area of farms (Almasi *et al.*, 2005). As the farm size increases, the mechanization level can decrease in parallel. According to Almasi *et al.* (2005), the area of approximately 72 percent of all farms in Iran is less than 5 hectares. The average area of farms in Iran is higher than that of Japan and is lower than that of USA. By considering the mechanization level of countries such as Japan and USA, with small farms and large farms, respectively, mechanization level in Iran may fall between 1.07 to 7.46 $kW.ha^{-1}$ (Table 3). Even with huge supply of tractors, as calculated before, mechanization level in Iran will still be under 1 $kW.ha^{-1}$ (0.86 $kW.ha^{-1}$).

Table 3. Mechanization level in some countries (Almasi *et al*., 2005).

Country	ML ($kW.ha^{-1}$)
USA	1.074627
Netherland	7.089552
Japan	7.462687
China	0.410448
India	0.074627
Pakistan	0.119403
Turkey	0.597015

4. CONCLUSIONS

To flourish agriculture in Iran, sufficient power distribution is necessary. A pattern was needed to suitably distribute power in the country. It was found that the least demand for tractors was in 1989 in which the most distributed number of tractors was happened. Based on this year's demand for tractors in all provinces the today's need was estimated. Results indicated that Iran agriculture is in need of at least 33462 tractors annually, with average nominal power of 53 kW. These tractors cost approximately 435.006 million dollars. Tractors' supply should be continued with the previous increasing rate up to the point that farmers demand is fulfilled and replacement of depreciated machines are taken place without any delay.

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