RESEARCH PAPER

Measurement of indexes agricultural mechanization in agriculture and horticulture crops in Fars Province

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Abstract

Fars province due to favorable conditions for agriculture is one of the most important areas of crop production in Iran. This research for agricultural mechanization status by identifying and measuring important indicators of the level and capacity of mechanization of farming and gardening in Fars province.Data for this study were collected through interviews and completion of 684 questionnaires and ministry of Agriculture Statistics. For all tractors and combines useful life of 13 years was considered. The conversion factor is computation according to the following useful life of 13 years for an average of 0.75 per unit and after useful life of 13 years for devices worn-out at 0.5 was considered significant. In this study it was all tractors of the 22531 device is active, the number 10476 (46.5 percent) are in the range of useful life. Total numbers of combines is 2089, that 1160 units (55.5 percent) are in the range of useful life. In other words, the fleet of combines is younger than tractors fleet. The results showed that is capacity of the level of mechanization, regardless of orchards 1711.3 (hp-hr/ha) and taking 50% of gardens 1410.7 (hp-hr/ha), and the level of agricultural mechanization 1.89 (hp/ha) and 50% in terms of level gardens1.46 (hp/ha). Agricultural mechanization level in Fars province (1.89 (hp/ha)) was higher than the national average (1.5(hp/ha).

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Introduction

Agricultural mechanization is considered as a basic factor in agricultural development. Development and application of mechanization in the field of agriculture can lead to enhancement of production level by using scientific and experimental awareness of experts and correct method of using machines. According to key role of mechanization as an essential factor and main stimulus of agricultural development in responding to various needs of producers needs in one hand and consumers in the other hand (both in national and international levels) and also regarding main concern of Fars province, i.e. "labor", the necessity of this study to determine and recognize different aspects of developments in agricultural mechanization in Fars province and consideration of social and technical issues of mechanization application in agronomical and horticultural crops of Fars province will be highlighted in addition to using different potentials of this field along with achieving country's macro development. About one million and one hundred thousand hectare of Fars province's total area is cultivable which about 65% of it is related to agronomical crops and 35% of it, is advocated to horticultural products. Moreover, 73.8% of field is related to irrigate agriculture and 26.2% is advocated to rainfall crops.

This province has second rank by having 8.39% of agricultural fields and has third rank by producing 13% of horticultural and agronomical crops among other provinces of country. It should be mentioned that Fars has second rank in production of citrus and first rank in production of rainfall horticultural crops such as pomegranate, Figs, almond and grapes.

Total horticultural and agronomical crops of this province are more than 14 ton in which agronomical crops' amounts is about 11.5 million ton and horticultural crops' amount is more than 2.5 ton. This shows good existed potential from climate and water source's aspects which indicates the importance of mechanization in this field.

Presence of different varieties of modern and advanced agricultural machines for doing different functions in farms increases production potential. In this province, total numbers of tractors are 22518 machines and total numbers of harvest combine are 2089 machines. These amounts make Fars province as one of the pole of combine and lead Fars to associate in harvest of 19 provinces.

Having more than 200 modern machines makes Fars as a valuable province in reduction of waste amount during harvest and help in reduction of harvest's time. Clarke (2000) considered strategies of mechanization development and existed rules per private and state sections.

He compared portions of industry and agricultural sections in development flow, and mentioned that agricultural growth in development procedure is the main factor for supporting growth in industrial sections. Entrance of mechanization in agriculture is one of the supportive factors which lead to growths and improvements in production of agricultural crops.

Dong *et al*, (2005) evaluated the effect of technology on agricultural production in China. To do so, a value function was considered in the format of Cobb-Douglas for agricultural productions in which production factors were labor force, chemical fertilizer, and machines. According to achieved results, it was determined that during selected period 45% of production growth rooted in mechanical and technological inputs (chemical fertilizer and machines).

The proportions of other factors such as labor force and irrigation ratios were 18.3 and 9.8% in order. In addition, 26.3% of agricultural growth is attributed to growth of efficacy of total production factors. Amjadi and Chizari (2006) believed that despite of the importance of machinery technology in agriculture, government policies in past years led to unsuitable offer of machines to agriculture section.

Not only the amount of provided machines can't lead to achieve mechanization programs in this section, but also can't respond to the amount of machines' amortization. This situation leads to reduction of mechanization coefficient and makes farmers to use rusty machines.

Toro and Hansson (2004) analyzed functions of farm's machine by daily situation of soil by simulating discrete event and compared its results with simpler method. Their study showed that the cost of labor and delayed costs in machinery functions will reduce by increasing the number of machines. So using huge machines can lead to reduction of costs.

The aims of this study are listed as below:
- Calculation of area and capacity of agricultural mechanization in under-cultivated area both horticultural and agronomical.
- Considering existed status of agricultural potentials in Fars province (tractors and combines).

Method

In mechanization science 2 main indexes exist which are used for analyzing and evaluating condition of area in micro and macro levels. These indexes include mechanization level and capacity. Mechanization capacity is an index which is result of agricultural quality and quantity and is equal to the amount of consumed energy per unit of area. Mechanization level indicates the ratio of total tensional powers by under cultivated area. These 2 indexes are useful in analysis of existed situation of mechanization in regional, province and national levels.

These indexes are valuable criteria for decision making and determine development's structure. The following equation is used for calculating mechanization level.

$$MA = \frac{Thp \times CF}{A} \quad (1)$$

In this equation:
MA = mechanization level (hpha^{-1})
T hp = Total existed tensional powers (hp)

CF = Convey coefficient
A = Total under cultivated area in under studied zone (ha)

To gather needed data, 684 questionnaires were completed by interview and using data of Jahad of agriculture organization. To do the first phase, after defining the number of tractors and trailers and combines which are active in the province, the tensional power of them was determined. In this study, useful life for all instruments was considered as 13 years.

Convey coefficient for each instrument was considered 0.75 on average for useful instruments, yet for waste instrument it was considered as 0.5.

To calculate under cultivated area, questionnaires help us. The numerical amount of these parameters varied extremely because of climate conditions, demand amount, the effect of cost enhancement specifically fuel and fertilizers, water crisis even policies of markets. Eventually the under cultivated area for this study was achieved by sum of total under cultivation area in horticultural fields.

To consider mechanization capacity below equation was used:

$$MC = \frac{TE \times CF}{A} \quad (2)$$

MC = mechanization capacity (hp – hr/ha^{-1})
TE = Total consumed energy (hp – hr)
CF = Convey coefficient
A = Total under cultivated area in under studied zone (ha^{-1})

It should be mentioned that, to calculate consumed energy nominal power of each tractor or combine multiplied by average hours of their annual usage and finally they were summed after application of convey coefficient.

Results and discussion

According to definition of mechanization level which is an important factor in macro and micro policy and decision making in the field of province agriculture, this faction was considered in different cities of province. First, mechanization level was calculated for

each city in 3 statuses by considering half of province's gardens and without it and by considering power of existed tractors without considering combine powers. The results are shown in table 1. Mechanization level was measured about 1.89 (hp/ha⁻¹). According to Jahad of agriculture's statistics in 2005, this amount was less than 1 hp/ha⁻¹ and now it has a noticeable growth. Mechanization level is more than country's average (1.5 hp/ha⁻¹). This shows hard attempts of participants who are successful in their commitments. Regarding research's findings, the most level of mechanization level is related to Mehr town with 3.41 (hp/ha⁻¹) and the lowest amount is related to Rostam town with 0.48 hp/ha⁻¹.

Table 1. Calculation of the level of mechanization in the areas of Fars province.

City	Level of mechanization (hpha⁻¹)		
	Regardless of the gardens	With 50% of the gardens	Without the power of combine
Abadeh	1.66	1.46	1.49
Arsenjan	1.83	0.8	1.13
stahban	1.97	1.78	1.79
Eglid	1.92	0.99	1.17
Bovanat	1.95	1.7	1.86
Pasargad	1.94	1.66	1.69
Jahrom	1.46	0.97	1.42
Khorambid	0.98	0.64	0.97
Khonj	1.95	1.72	1.9
Darab	0.66	0.61	0.65
Rostam	0.37	0.36	0.53
Zarindasht	1.74	1.71	1.78
Sepidan	1.17	1.02	1.29
Sarvestan	2.34	1.94	2.24
Shiraz	3.28	2.71	2.9
Farashband	1.75	1.24	1.87
Fasa	1.55	1.32	1.34
Firozabad	0.97	0.71	0.89
Ghir	1.5	0.96	1.07
Kazeron	3.21	2.13	3.2
Lar	1.97	1.65	1.71
Lamerd	2.96	2.66	2.83
Marvdasht	2.98	2.76	2.16
Mamasani	1.45	0.89	1.39
Mehr	3.92	3.1	3.45
Niriz	1.63	0.65	1.57
Fars province	1.89	1.46	1.65
Extent of the variation	2.85	2.44	2.83
Standard deviation	0.75	0.7	0.71

This shows that tractor and power production factors aren't speared homogeneously across the province. By considering calculated numbers it is indicated that the most important reason for inhomogeneous distribution in some zones, is decomposition of large cities to smaller towns.

High level of mechanization level in some areas such as Shiraz and Marvdasht is predictable, because these areas are considered as agricultural poles of province. More parts of their lands are under cultivation and most of the farmers welcomed the up-to-data science and tended to use new technologies. New and heavy tractors are used mostly in these cities. In the other

hand, these cities are near to related banks and organization.

High level of mechanization in some southern zones shows financial powers of farmers that finance in this section. This is rooted in their good earnings from countries around the Persian Gulf.

Analysis of mechanization technical status in Fars province

To do analysis of Fars mechanization technical status, machine analysis should be done. 2 main sources are tractors and combines which should be considered and evaluated. At first province's tractors should be considered from number, model, brand, useful lifetime, usage hours, nominal power and the amount consumed fuel aspects.

Table 2. Status of tractors working in Fars province.

Type	Model	Useful life	Not helpful life	Total	Operation (hr yr^{-1})	Rated power (hp)	Fuel consumption	
							Lit hr^{-1}	Lit ha^{-1}
John Deere	4955	18	0	18	1000	200	19	10
John Deere	4560	15	0	15	1000	165	17	9
John Deere	3140	112	1058	1170	1000	110	16	16
John Deere	2040	15	1737	1752	800	75	10	15
Ferguson	6290	39	6	45	1000	135	15	10
Ferguson	399	1538	65	1603	1000	110	16	16
Ferguson	285	7877	2025	9902	800	75	11	15
Romania	650	52	6673	6725	800	65	11	16
Valtra	T170	37	0	37	1000	170	17	11
Valtra	8400	183	0	183	1000	145	16	11
NewHolland	TM 155	220	0	220	1000	155	17	9
Case	5150	37	0	37	1000	145	15	11
Volvo	-	1	70	71	800	75	11	15
ITM	-	90	189	279	800	75	11	15
Fiat	-	120	10	130	800	45	8	19
Cobato	-	0	15	15	800	35	7	20
Goldoni	942	3	8	11	800	42	8	19
Goldoni	938	55	30	85	800	38	7	20
Goldoni	930	0	33	33	800	35	7	20
Goldoni	341	44	73	117	800	30	6	21
Rakhsh	-	0	28	28	800	85	11	15
Darvana	JM 254	5	35	40	800	20	6	25
Other	-	15	0	15	800	75	12	16
Total		10476	12055	22531	-	-	-	-

Table 3. Existing situation Combine in Fars Province.

Type	Model	Useful life	Not helpful life	Total	Operation (hryear^{-1})	Power (hp)	Capacity (hahr^{-1})	Losses (%)	Fuel	
									Lit ha^{-1}	Lit hr^{-1}
John Deere	1450	3	0	3	1300	203	1.2	1.5	14	17
John Deere	1165	37	0	0	1300	140	0.73	1.6	23	14
John Deere	1155	16	0	0	1300	100	0.65	1.6	17	11
John Deere	1055	45	0	0	1300	100	0.65	1.6	17	11
John Deere	955	824	891	1715	1300	100	0.65	2.35	17	11
Sahand	68	25	0	25	1300	100	0.65	1.7	17	11
Sempo	2065	1	0	1	1300	155	0.9	1.4	19	17
Class	68	0	8	8	1300	100	0.65	2.95	17	11
Class	76	0	8	8	1300	100	0.24	2.94	16	11
Class	310	19	0	19	1300	180	1.2	1.23	14	17
Class	Mega	1	0	1	1300	240	1.2	1.23	16	20
Class	510	1	0	1	1300	216	1.2	1.23	15	18
Glyner	F	0	22	22	1300	100	0.65	2.1	17	11
Yanmar	-	2	0	2	1300	40	0.24	2.5	25	6
Total		1160	929	2089	-	-	-	1.73	-	-

The results are shown in table 2. In this study total numbers of province's tractor is 22531 which 10476 (i.e. 45.5%) of them are used less than 13 years and 12055 (53.5%) of them are used more than 13 years, so their useful lifetime has been ended.

These machines work 18690400 h annually in average and consume 244252800 lit of fuels. The most observed brand is related to Massey Ferguson 285 with 9902 machines then Romani 650 with 6725 machines stands in second rank and third rank is related to John Deere 2040 brand with 1752 machines. New Holland 155 which is known as a modern and heavy machine with 220 machines has the most proportion among heavy machines.

Table 4. Capacity of mechanization in agriculture and horticulture situation in Fars province.

50% of the area gardens (hp-hrha⁻¹)	Excluding the area of gardens (hp-hrha⁻¹)
1410.7	1711.3

Another source of power in mechanization is related to engine combines. As Fars province has the first rank f wheat production is the country, from the aspect of combine's numbers Fars is considered an important province. Total numbers of province's combines are 2089 machines which they sometimes associate with other provinces' harvests.

1160 machines (55.5%) are used less than 13 years while 929 machines (44.5%) are used more than this. The situation of Fars combines is indicated in table 3.

Regarding study's findings, the average combines' wastes in Fars province is 1.73% which in comparison with country's waste amount (about 2.4%) it shows a good condition. Attempts for reduction of harvest's wastes are an important issue that experts always should bear in mind.
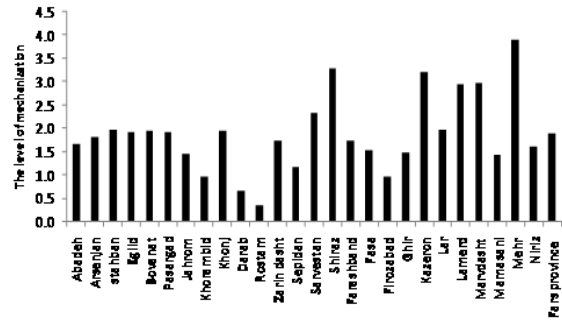

Fig. 1. The level of mechanization in the Fars province without gardens.

Regarding findings, combines worked about 271560h per year and 359400800 lit is the amount of their consumed fuel. From spear aspect, Shiraz and Marvdasht had great proportions, but there are some towns in which there isn't any combine. As Fars province has a good road condition combines can be transferred to other cities, so the problem of spear is covered through which. As a result, considering of existed combines' power in province in our calculations isn't reasonable.
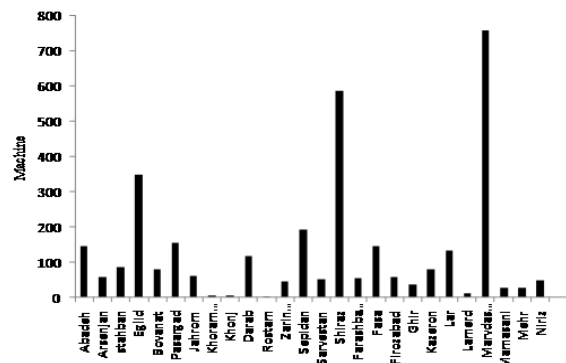

Fig. 2. Distribution of tractors over 100 hp in cities of Fars province.

Under cultivation areas in Fars province

According to study's achievements, under cultivation area in Fars province is 710327 (ha⁻¹) which is producing right now. From this amount, the production is about 16348 (kg/ha⁻¹) that entire the year; Fars will have 11613161 ton production. In this field the numbers of exploiter persons are 177593.

By considering total under cultivation area, each person has 4 ha. In fig. 6 the situation of under cultivation area in different cities are shown.
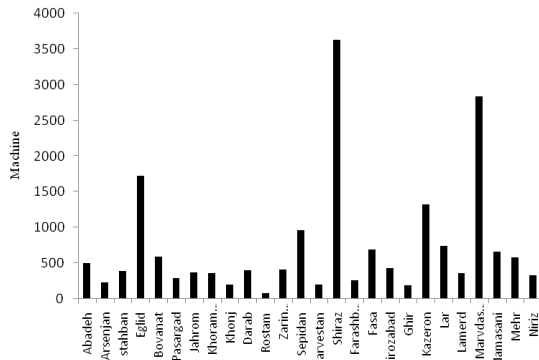
Fig. 3. Distribution of tractors between 65 to 100 hp in cities of Fars province.

First rank of cultivation is related to wheat both rainfed and irrigated which 5345698 ha equal to 48.7% of under cultivated area is advocated to wheat. At next stages barley with 86650ha^{-1} (12%), corn with 63956ha^{-1} (9%) alfalfa with 48354(ha^{-1}) (6.8%) and rice with 30677 ha^{-1} (4.3%) are placed in order.

In garden field, total under cultivated area is 374523 (ha^{-1}), which 7057 (kg/ha^{-1}) is total production in average. Among this the first rank is attributed to grapes with 72832 ha^{-1}, then citrus with 60238 ha^{-1} and almonds with 46800 ha^{-1} and Fig with 45584 (ha^{-1}) are stayed in next steps.
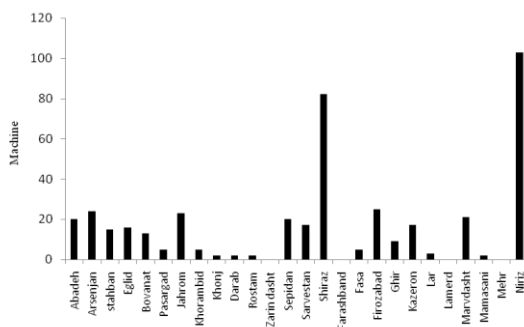

Fig. 4. Distribution of tractors with less than 65 hp in cities of Fars province.

According to surveys, Fars province is in the first rank of country in production of horticultural crops such as pomegranate, almonds, Fig and grapes and is in the second stage in production of citrus. If 50% of province gardens' area is considered in calculation of mechanization capacity, the amount of consumed annual energy per hectare will reach to 1410.7 (hp/ha^{-1}). This conclusion is shown in table 4.

Mechanization crisis, its obstacles and methods of removing them

Mechanization crisis and absence of motive force leads to low quality and out of date operations in agricultural field. So crop functions are faced to reduced level. The effects of lack of agricultural machines in production stage and the amount of waste crops show out of time operations. Case studies and statistics show that there are some farmers across the country that their average function per unit of area is two times more than country average function, and according to equal amount of production factors such as fertilizer, seeds ... its cause can be available motive force.

Unfortunately, despite of the importance of machines in agricultural field in economic explanation, horsepower index per hectare has been followed reduction rout till the end of 70^s.
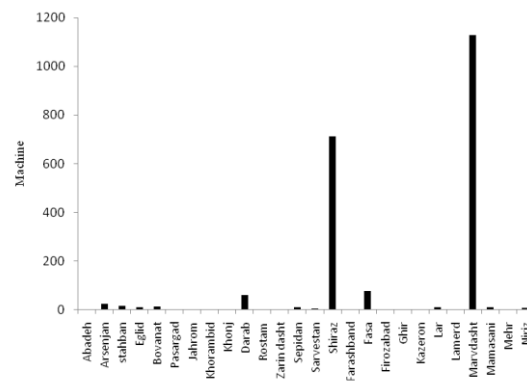

Fig. 5. Distribution of Combine cereal working in cities of Fars province.

Major role of mechanical energy in agricultural activities and side effects of reduction rout of motive force is transformed to mechanization crisis. The most important items are listed as follow:

- Problem in machines production and undefined machine's trustee

- Absence of defined standards in machine fields and necessity of technical committees' activation.

- Absence of sufficient industrial materials and varieties in their prices.

- Difficulties in achieving bank facilities and problematic rules in this path.

- Water crisis and doughtiness in recent years

- Existed international boycotts

- Serious threats in labor system and risks in achieved benefits in the field of agriculture

- Low amount of under cultivation area

- Problem in fixation, and after sale services and lack of suitable garage

- Absence of training programs

- Presence of different decision making centers and absence of harmony among them and absence of provided policies to quick up development procedures in mechanization field.

- According problem in relation with selection of machines

- Problems in absorbing experts

- Increasing rate of costs

Fars province gained fist, second and third ranks for what production, under cultivation area and production of agricultural products accordingly. It is considered as one of the country's machine poles from the number of combines and tractor aspect. Although the average of mechanization level is more than country's average, the spear in cities isn't suitable. Some decisions should be made for providing new machines.
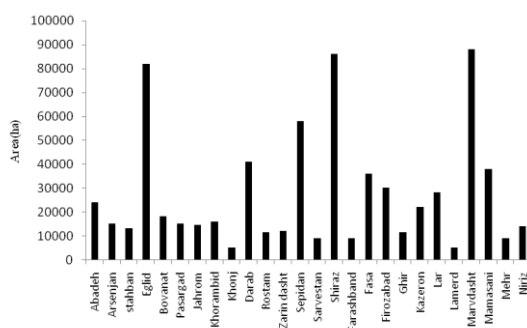

Fig. 6. The area of cultivated crops incities of Fars province.

According to international boycotts the way to achieve facilities should become easier to each to more favorable mechanization level.

Cultivation system should change in a way that the amount of consumed water decreases and protective cultivation system should be substituted.

In fact present study needs continues training from related organizations and effective steps toward

enhancing machine functions, decreasing the effect of water crisis and costs.

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