Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 69 (2014) 23214-23219

ISSN: 2229-712X

Compatibility of Iran Tractor Manufacturing Company's (ITM Co.) Tractors with Locally Designed and Constructed tillage and planting equipment From the Farmers' Point of view

R.Fellegari[1], H.R.Ghassemzadeh[1], H.Navid[1] and M.Moghadam[2]
[1]Department of Agricultural Machinery Engineering, University of Tabriz, Iran.
[2]Department of Agronomy, University of Tabriz, Iran.

ARTICLE INFO

Article history:
Received: 30 July 2013;
Received in revised form:
29 March 2014;
Accepted: 14 April 2014;

Keywords
Compatibility,
Mechanization,
Planting Equipment,
Tillage equipment,
Tractor.

ABSTRACT

Compatibility of implements with tractors has direct impact on quality of work (planting and tillage). To determine the degree of compatibility, data were collected from 310 tractor users throughout Kurdistan, West Azerbaijan, East Azerbaijan, Kermanshah and Hamadan provinces in Iran by random sampling method using Cochran's formula. Each questionnaire sheet had six check boxes indicating different levels of satisfaction (excellent, very good, good, moderate, weak and very weak) with the values of 6, 5, 4, 3, 2 and 1, respectively. Cronbach's alpha coefficient of 0.67 obtained for the questionnaires. The results showed that the slope of land had significantly negative effect on compatibility of tractors with the equipment. Also tillage and planting equipment were less compatible with MF240 tractor. MF285 tractor was incompatible with all the equipment used. On the other hand, MF399, because of its high traction capacity, observed to be the most compatible with equipment. Results also showed that the farmers' education had direct impact on compatibility between tractor and implements. Providing the farmers with more knowledge about the compatibility factors, draft and implement adjustments through CDs and manuals as well as short training courses may help to overcome tractor-implement incompatibility problems.

Introduction

High efficiency in agricultural production systems is one of the basic factors in sustainable and developmental agriculture. Farm tractor is a key component of Mechanized Farming system [1]. Experts have been conducting extensive research since late 18th to increase tractor's efficiency and safety [2]. MF 285 tractor, manufactured by ITM Co. in Tabriz, Iran, is the most preferred power source by Iranian farmers [3]. MF 285 sales also hit the top among other makes [4]. On the other hand, MF 240 due to it is good performance and lower price, and MF 399 due to it's high traction capacity are used by Iranian farmers. Therefore, ITM Co. has the largest share in Iranian farm power market. Undoubtedly, tillage is the most costly and energy consuming operation in mechanized agriculture [5]. On the other hand, to have high quality planting operation, good matching of tractor and planter is required [6]. So appropriate choosing and using of a tractor consistent with tillage and planting equipments, is one of the most important issues in Iranian farm mechanization policy [7]. Two criteria must be considered in choosing compatible tractor and implement:

a) Power requirements of equipment with regards to depth of work, speed of operation, working width of equipment and soil conditions,

b) Ability of a tractor to produce a required pull and drawbar power, considering the stability of a tractor, weight distribution, ballast, land conditions and tractor type [8; 9; 10; 11; 12 ; 13].

Much research on how to choose equipment and tractors has been carried out. Sahu and Raheman [14] conducted a study in India. They used Visual Basic software to provide a model that can be used in matching tractor and conventional as well as special equipment with regard to draft, traction, tire, and different soil and working conditions. Mehta [15] proposed a model, using a Visual Basic program, to choose compatible tractor and equipment. This model had a capability of predicting critical working width for timely operation. In another effort, Sharma and Pandey [16] used Algebraic equations in order to choose the best tire index for Indian 2WD tractors tires to be able to work in sandy, clay and loamy soils based on weight to power ratio and optimum weight transfer required for producing the highest possible pull. In another work, Parish [17] compared the performance of common disc to that of rotating disc. The results showed that rotating discs move the soil more easily and efficiently and concluded that a PTO powered discs-tractor combination is a better choice in cultivating heavy soils. In Iran, there are numerous companies producing tillage and planting equipments. Price, availability of after-sale services, farmers' levels of satisfaction, governmental support, financial aids to buy tractors and compatibility with farmers' demands, all have undeniable role on farmers decision to buy a particular tractor. Therefore, having interview with farmers on a variety of working conditions of farm tractors and implements can help to identify the factors that lead to incompatibility between tillage and/or planting equipments and tractors. Incompatibility between Equipment and tractors has adverse effects on agricultural operations and directly affect performance [19]. On the other hand, more energy consumption could also be expected [20,21].

The aim of this study was to determine the degree of compatibility of Iran Tractor Manufacturing Company's (ITM Co.) tractors with locally designed and constructed tillage and planting equipment From the Farmers' Point of view.

Tele:
E-mail addresses: R.fellegari@gmail.com

Materials and Methods

Compatibility of tractors and equipment Study was done According to need of farmers, manufacturers and sales agents. Farmer as a customer and user has relation with the tractor and equipment and compatibility of these two important factors, convenience, produce more and consume more energy efficient, and total benefit was questioned.The study was performed in the provinces (Kurdistan, East Azerbaijan, West Azerbaijan, Hamadan, and Kermanshah). The university professors, agricultural machinery experts, farmers, ITM Co., implements Reseller implements manufacturers were questioned about the surveys that to be coherent better prepared. Questionnaires were evaluated with different level of classification including (excellent, good, moderate, weak and very weak) with the values of 6, 5, 4, 3, 2 and 1respectively.

Questionnaire Structure

Questionnaire was designed that at the first step, the farmer should determine the type of his own tractor. At the next questions, compatibility of tillage equipment with the tractor, compatibility tillage equipment that requires PTO with tractors, compatibility of tillage and planting equipment with tractors regarding connection to tractor and compatibility of tillage equipment with tractor regarding traction was questioned. The sampling method for farmers with random manner was done in the form of Cochrane formula [22]. For calculating the number of samples in random sampling method, Cochrane proposed the following formula:

$$n = \frac{Z^2 S^2}{d^2} \qquad (1)$$

In which n the sample size, Z^2 acceptable coefficient for %5 of confidence level, S^2 variance estimation of questions in population studied and d is the degree of precision. Finally, for Kurdistan 70 and for the provinces of Hamedan, Kermanshah and West Azarbaijan 60 samples was selected. For East Azarbaijan province because of shortage of statistical population just 40 samples was selected. Information collection was done according to the type of land (located in the plains or slope lands). Because of Kurdistan have more slope lands than the other provinces, 45 percent of question respondents were stand on sloping lands. In other provinces, 30 percent of the samples were selected from slope lands. For more suitable analysis, sampling units were classified in provincial groups, type of land, type of tractor and schooling level. Reliability is one of the technical characteristics of measuring tools that dealing with the measuring tools on the same terms to what extent the results obtained is the same. Reliability was evaluated by Cronbach's alpha formula and using SPSS software. Cronbach's alpha coefficient of questionnaire was obtained equals to 0.77. Before data analysis, the normality of data and errors and uniformity of variance test was done. Characteristics had abnormal distribution and the variance was heterogeneous. According to this fact that data conversion was not too effective, so for comparing, the mean non-parametric Dunn was applied [23]. In this method, for calculating $S_{\bar{x}}$ equation 2 was used:

$$S_{\bar{x}} = \sqrt{\frac{N(N+1)}{12} \quad (\frac{1}{R_a} + \quad \frac{1}{R_b})} \qquad (2)$$

In which N is the number of total samples and R is the number of treatments. Other features of compare mean have not difference with parametric method. $S_{\bar{x}}$ multiplying Dunn table number ($q_{a,k}$) and the rank mean difference in two treatments are compared with the critical value. It should be mentioned that based on the principles of non-parametric mean comparison, the degree of freedom for extraction the table number Dunn, is considered infinitely.

Results and discussion

The results of tillage equipment compatibility, in terms of farmers are presented in Tables 1, 2, 3 and 4.

According to the results, in incompatibility problem in slope lands is severe. Therefore, designing equipment of tillage for slope and flat lands and including comfortable settings in order to minimizing inconsistencies slope areas that affected by incorrect settings is essential. Designing the appropriate moldboard, especially for MF240 is necessary. This matter is because of Compatibility level in the MF240 tractor is less than moderate. Also, due to the lack of a special moldboard for MF240 tractor, farmers were plowing by eliminating one of the Miner moldboard of MF285 tractors. MF285 tractor has higher mean than moderate and we can achieve more consistent level by education mode settings. Also for MF285 tractor, due to lack of combined equipment tillage-planting system, designing and manufacturing of this equipment is recommended. MF399 tractor due to high power and traction, from viewpoint of users had the most consistent level. Looking at education grouping results indicated that by increasing education and knowledge of the adjustment process had significant effect on compatibility. The investigation of Dee Jepsen [24] showed that the trained tractor driver makes the operation with better quality. The results of compatibility of device that require PTO are presented in the tables 5, 6, 7 and 8. According to the tables, type of land had no significant effect on compatibility. This result could be because of the three-point hitch, tractor traction and wheel slip factor that had low effect on the correct performance of equipment that require to PTO. because of MF399 tractor had two types of PTO (1000 and 540 rpm) from users point view was more compatible with equipment and had significant difference with the MF285 and 240 tractors. Farmers with more than high school education, due to learning more about how to connect rotary moldboard and settings (setting cover) had a higher mean. Also, Users demonstrated problems such as weakness of device safety in the joint point and device vulnerability in the lands have pebbles. Parish et al. [17] stated that the rotating disk due to no need to traction is more compatible than conventional discs. Also, According to Users view, tillage and planting equipment that take power from PTO had more compatibility. On the other hand, if combination equipment takes power from the PTO are more compatible. Adjustment process for tillage and planting equipment is one of main factors in compatibility. So, the next step for settings is simply connect and separation of equipment was questioned. Tables 9, 10, 11 and 12 are related to tillage implements. Results show that users were not familiar with accurate adjustments of tractor and equipment. Although by increasing the mean education level mean increased, but mean differences was not significant. This result indicated that the educated farmer had no knowledge from the equipment settings especially for moldboard. Ignorance about how to use from setting of levers draft and position control, causing numerous inconsistencies has been in tillage equipment. For Agricultural Machinery of Iran, lack of training is fully felt. To solve this problem, three principles including tractor manufactures, implements and promotes Division Ministry of Agriculture by taking advantage of the knowledge of Agricultural engineers Machinery be taught tractors and equipment adjustments to farmers.

Table 1 - Results in the provincial Category

province	samples	mean	variance	Rank mean
Kurdistan	70	3.18	1.11	123.81
Hamadan	60	3.58	0.82	153.03
Kermanshah	60	3.56	0.98	159.68
West Azerbaijan	60	3.53	0.80	149.40
West Azerbaijan	40	3.42	0.87	142.02
total	290	3.40	-	-

province	samples	mean	variance	Rank mean
Kurdistan	70	3.07	1.02	122.22
Hamadan	60	3.36	0.71	138.67
Kermanshah	60	3.73	0.74	172.35
West Azerbaijan	60	3.51	0.73	153.02
West Azerbaijan	40	3.40	0.55	133.28
total	290	3.40	-	-

	samples	mean	variance	Rank mean
flat	222	3.44	0.81	160.39
Slope	88	3.27	0.75	132.90
Total	310	3.30	-	-

Type of tractor	samples	mean	variance	Rank mean
MF240	43	3.30	0.55	135.80
MF285	222	3.28	0.69	133.87
MF399	45	4.05	1.09	222.13
Total	310	3.39	-	-

Type of tractor	samples	mean	variance	Rank mean
MF240	43	2.60	0.82	88.48
MF285	222	3.37	0.68	154.04
MF399	45	3.31	1.20	226.76
Total	310	3.40	-	

Type of tractor	samples	mean	variance	Rank mean
MF240	43	3.30	0.55	135.80
MF285	222	3.28	0.69	133.87
MF399	45	4.05	1.09	222.13
Total	310	3.39	-	-

Level graduations	samples	mean	variance	Rank mean
Illiterate	137	3.35	0.94	151.14
Level 1	156	3.36	0.96	152.93
Level 2	17	4.11	0.84	214.29
Total	310	3.40	-	-

Level graduations	samples	mean	variance	Rank mean
Illiterate	137	3.37	0.89	151.20
Level 1	156	3.39	0.74	156.87
Level 2	17	3.65	0.62	179.32
Total	310	3.39	-	-

province	samples	mean	variance	Rank mean
Kurdistan	70	3.36	0.72	150.74
Hamadan	60	3.42	0.49	156.78
Kermanshah	60	3.46	0.56	160.81
West Azerbaijan	60	3.22	0.48	135.36
West Azerbaijan	40	3.00	0.36	111.54
total	290	3.29	-	-

province	samples	mean	variance	Rank mean
Kurdistan	70	3.13	0.95	150.77
Hamadan	60	3.18	0.63	154.55
Kermanshah	60	3.33	0.56	167.77
West Azerbaijan	60	2.95	0.48	132.30
West Azerbaijan	40	2.73	0.41	120.10
total	290	3.08	-	-

	samples	mean	variance	Rank mean
flat	222	3.40	0.51	167.18
Slope	88	3.01	0.56	126.03
Total	310	3.29	-	-

	samples	mean	variance	Rank mean
flat	222	3.17	0.65	164.56
Slope	88	2.82	0.58	132.65
Total	310	3.07	-	-

Type of tractor	samples	mean	variance	Rank mean
MF240	43	3.09	0.61	134.29
MF285	222	3.30	0.53	157.80
MF399	45	3.40	0.61	164.44
Total	310	3.29	-	-

Type of tractor	samples	mean	variance	Rank mean
MF240	43	3.02	0.50	151.55
MF285	222	3.08	0.70	156.37
MF399	45	3.07	0.61	154.98
Total	310	3.07	-	-

Level graduations	samples	mean	variance	Rank mean
Illiterate	137	3.23	0.53	149.18
Level 1	156	3.31	0.58	157.98
Level 2	17	3.60	0.51	183.71
Total	310	3.29	-	-

Level graduations	samples	mean	variance	Rank mean
Illiterate	137	3.05	0.75	152.53
Level 1	156	3.05	0.59	154.10
Level 2	17	3.41	0.38	194.56
Total	310	3.07	-	-

province	samples	mean	variance	Rank mean
Kurdistan	70	3.33	0.72	138.55
Hamadan	60	3.38	0.68	142.42
Kermanshah	60	3.70	0.75	172.83
West Azerbaijan	60	3.31	1.06	134.01
West Azerbaijan	40	3.37	0.70	138.51
total	290	3.42	-	-

Type of tractor	samples	mean	variance	Rank mean
MF240	43	3.16	0.43	130.77
MF285	222	3.31	0.70	147.14
MF399	45	4.13	0.84	220.37
Total	310	3.41	-	-

Level graduations	samples	mean	variance	Rank mean
Illiterate	137	3.41	0.77	153.78
Level 1	156	3.37	0.72	152.52
Level 2	17	3.41	1.02	188.62
Total	310	3.29	-	-

Another mention point is that taking advantage of the video media i.e. CD, training way connects equipment to farmers because of the illiterate farmer is not deprived. Preparing suitable manual for tractors and equipment, with utilizing experts knowledge of agricultural machinery and university professors that written simply , exquisite shapes and images to use, can be beneficial. On the other hand the use of automatic mechanisms and online settings where the user is fewer roles can help to improve the consistency significantly. As Scarlett [21] for more consistency, proposed the installation of electronic systems on tillage equipment, planting and the tractor that automatically adjusts to the depth. The operator can minimize the conflicts by applying the electronic system. Results have shown that embedded systems will make better quality of operation.

Tables 13, 14, 15 and 16 are related to the equipment implanted. The results show that the mean lower replies and farmer's knowledge about the correct settings and how fitting planting equipment was little. Cereal planting equipment had the most shares among the respondents ranked questions. On the other hand, for the slope lands, the problem of settings were more severe and differences were significant with flat land. The mean among the educated farmers was somewhat higher. Weak repair and maintenance of planting equipment, was caused incompatibility with tractors, such as problems connecting arms and loppy. Lack of knowledge of Users about amount the appropriate amount of air tire for operations and lack of air pumps of tractor to adjusting air was caused some incompatibility. Users due to ignorance did not use the marker and separated that from planting device. Also, between the types of tractors, significant differences were not observed. Draft is the most important factor for compatibility of tractors and tillage equipment. Selecting a vehicle compatible with tractor is primarily depends on the tractor draft. By looking at the results of tables 17, 18, 19 and 20, we can find that compatibility problem terms of draft in slope lands more severe than the flat lands .Also due to the ability of MF399 tractor draft and high compatibility with tillage equipment, in general was more consistent and the differences of that with MF240 and MF285 tractors was significant. It is noteworthy that MF399tractor in combination equipment also had better performance. By increasing user awareness about draft factors (speed operation, soil moisture, slip, soil index, ballast to tractor, select the appropriate blade plow, maintenance and repair equipment and consistent choice of draft for tractors) in terms of draft, had dramatic impact on tractors compatibility.

Acknowledgment

The authors are thankful from the professors Agricultural Machinery Engineering Department of Tabriz University for providing possibilities in doing this project. The authors are grateful from the manager of Agriculture organization of Kurdistan, West Azerbaijan, East Azerbaijan, Hamadan, Kermanshah provinces that support information to farmers and type tractors in the mentioned regions.

References

[1] Ranjbar, A. Ghassemzade, HR. Davodi, SH. Power and tractor engine. University of Tabriz press. 2002; pp 10-50.

[2] Goering, C E. A century of tractors development: 1907-2007. Transaction of the ASAEB. 2008; (51): 379-383.

[3] Anonymous, Agricultural Statistics. Office Statistics and Information Technology Ministry of Agriculture. 2007; (3): 100-150.

[4] Anonymous, Iran Tractor Co. websites. http://www.itm.co.ir.

[5] Bowers, C G J. Southeastern tillage energy data and recommended reporting. Transactions of the ASAE. 1985; (28): 731–737.

[6] Gebresenbet, G. Jonsson, H. Performances of seed drill coulters in relation to speed, depth and rake angles. J. Agr Eng Res. 1992; (52): 121-145.

[7] Witney, B. Choosing and using farm machines. Longman scientific technical, 1988; 123-150.

[8] Morris, N L. Miller, P C H. Orson, J H. Froud-Williams, R J. The adoption of non-inversion tillage systems in the United Kingdom and the agronomic impact on soil, crops and the environment—A review. J. Soil & Tillage Res. 2010; (108): 1-15.

[9] Upadhyaya, S K. Williams, T H. Kemble, L J N E. Collins Energy requirement for chiseling in coastal plain soils. Transactions of the ASAE. 1984; (27): 1643-1649.

[10] Harrigan, T M. Rotz, C A. Draft of major tillage and seeding equipment. ASAE Paper, 1994; 94-153.

[11] Grisso, R D. Yasin, M. Kocher, M F. Tillage implement forces operating in silty clay loam. Transactions of the ASAE. 1996; (39): 1977-1982.

[12] Gould Lund, R D. Hill, J. Matching tractors and implements-the economic way. http://www.agekon.com/Machsem/Webroom1.

[13] Grisso, R D. Perumpral, J V. Zoz, F M. Spreadsheet for matching tractors and drawn implements Transations of the ASAE. 2006; (23): 259-265.

[14] Sahu, R K. Raheman, H. A decision support system on matching and field performance prediction of tractor-implement system. Comput Electron Agr. 2008; (60): 76–86.

[15] Mehta, C R. Singh, K. Selvan, M M. A decision support system for selection of tractor–implement system used on Indian farms. J.Terramechanics. 2011; (48): 53-73.

[16] Sharma, A K. Pandey, K P. Traction data analysis in reference to a unique zero condition. J. Terramechanics. 1998; (35) 179-188.

[17] Sharma, A K. Pandey, K P. Matching tyre size to weight, speed and power available for maximising pulling ability of agricultural tractors. J. Terramechanics. 2001; (38) 89-97.

[18] Parish, P N. Vilas, M S. Tanya, N. Peeyush, S. Performance of Free Rolling and Powered Tillage Discs. Soil & Tillage Res. 2010; (109): 87-93.

[19] Harries, G O. Ambler, B. Automatic ploughing: A tractor guidance system using opto-electronic remote sensing techniques and a microprocessor based controller. J. agric Eng Res. 1981; (26): 33-53.

[20] Serrano, J M. Pec-a, J O. Silva, J M D. Pinheiro, A. Carvalho, M. Tractor energy requirements in disc harrow systems. Biosystems eng. 2007; (98): 286 – 296.

[21] Scarlett, A J. Integrated control of agricultural tractors and implements: a review of potential opportunities relating to cultivation and crop establishment machinery. Comput Electron Agr. 2001; (30): 167–191.

[22] Serrano, J M. Peca, J O. Silva, J R. Ma´rquez, L. The effect of liquid ballast and tire inflation pressure on tractor performance. Biosystems eng. 2009; (102): 51 – 62.

[23] Cochran, W G. Sampling techniques, Third edition. John Wiley & Sons: New York. 1977.

[24] Anonymou. Non-parametric multiple comparison tests. http://www.faculty.sfasu.edu/cobledean/biostatistics/lecture6/MultipleComparisonTests.pdf.

[25] Dee Jepsen, S. Assessment of the U.S department of labor's tractor and machinery certification program: a nation perspective. Doctor thesis. The Ohio State University. 2006.

Appendix Tables of Dunn test in probability level 0.05

Table 1. Minimal significant difference between provinces based on the Dunn test level 0.05

	Kurdistan	Hamadan	Kermanshah	West Azerbaijan
Hamadan	38.06			
Kermanshah	38.06	39.49		
West Azerbaijan	38.06	39.49	39.49	
East Azerbaijan	42.83	44.16	44.16	44.16

Table 2. Minimal significant difference between types of land based on the Dunn test level 0.05

	SLOPE	
FLAT	29.12	

Table 3. Minimal significant difference between types of tractor based on the Dunn test level 0.05

	MF240	MF285
MF285	35.52	
M399	49.31	37.80

Table 3. Minimal significant difference between levels of graduations based on the Dunn test level 0.05

	Illiterate	Level 1
Level 1	27.07	
Level2	59.36	59.06