Mech. Engg.Res. Bull.
Vol.13 (1990) pp 1-6

Tractor Selection for Tillage Operation under Bangladesh Conditions

Md. Saleque Uddin*
Md. Nurul Islam*

ABSTRACT

Fourteen tractors have so far been tested in the Department of Farm Power and Machinery to determine their different field performance parameters. But the present study deals with only the area tilled per unit energy and fuel consumption per unit of tilled area of presently available tractors such as FORD-390,MF-135, MF-240,MF-375 and Belarus YuMZ-6AM to find out the best suited one for tillage operation. The tractors were selected on the basis of two criteria: maximum area tilled per unit energy and minimum fuel consumption per ha. According to the criteria of selection, Tractor MF-240 was found most suitable among the presently available tractors because its tilled area ($A= 12x10^{-3}$ ha/kWh) was the maximum and fuel consumption per unit of tilled area ($G_t = 11.17$ lit/ha) was minimum. It the above mentioned criteria be considered as the main criteria of tractors selection as desired by the farmers/buyers, then the results of the present study will be helpful to them prior to the purchase of tractor.

INTRODUCTION

Import of tractors in Bangladesh (the then East Pakistan) was started at the end of 1950 to supplement the draft power shortage in agriculture. Statistics of Bangladesh shows that 2,000 tractors were imported in 1970. To enhance farm mechanization a committee suggested to introduce about 30,000 tractors [Pakistan Govt. (1970)] by the end of 1985. A list of tractors as imported by the Government and Non-Government Organizations of Bangladesh were tested by the Bureau of Research, Testing and Consultation of Machinery and their power sources in co-operation with the Department of Farm Power and Machinery of Bangladesh Agricultural University,Maymensingh is shown in Appendix I. There are also prevailing tractors such as FORD-1600, INTERNATIONAL-276 and 434, INTERNATIONAL: B-275 and B-440, Chinese tractor DURBAR-150 and 250 in Bangladesh, which were not tested in the Department of Farm Power and Machinery but using by the different organizations. The department was responsible for different types of test and making reports for their suitability and operating conditions. But uptill now there prevails no comparative statement and recommendation upon the best suited tractor for tillage operation. Therefore, the authors of the present study have undertaken an initiative to prepare a comparative statement with a view to select a suitable size tractor depending upon the criteria of maximum area tilled per unit energy and minimum fuel consumption per ha during tillage operation. The objectives of the study were as follows:

1. To study the actual area tilled per unit energy of different types of tractor.
2. To study the fuel consumption of tractors per ha during tillage operation.
3. To compare the field performance parameters (area tilled per unit energy and fuel consumption per ha) of tractors for tillage operation.
4. To recommend the best suited tractor for tillage operation under Bangladesh conditions.

CRITERIA OF TRACTOR SELECTION

Different scientists of the world have developed some criteria for the selection of tractor and tillage machinery. Some of the suggested criteria for the selection of tractor for tillage operation were maximum area tilled per unit energy and minimum operative cost per ha [Jangiev (1980)]. The criteria were as follows:

$$A = ws/N_e = ws/\xi N_H \quad \text{..... max.} \quad (1)$$

$$C = (A_c e + B_c)/e_f \quad \text{..... min.} \quad (2)$$

where A = area tilled per unit energy, ha/kWh
w = width of tillage implement,m
s = actual working speed of tractor, km/h
N_H, N_e = nominal and axle (input) power of tractor, kW
C = operating cost per ha
A_c = combined cost components (purchase price, depreciation, fuel and oil cost, repair and maintenance cost, shelter and driver cost ect.) of tractor per ha
B_c = combined cost components (purchase price, depreciation , repair, and maintenance cost and shelter, etc.) of tillage machinery per hour
ξ = coefficient of nominal power use of tractor (ξ=0.9), decimal

* Department of Farm Power and Machiery, Bangladesh Agricultural University, Mymensingh.

e_f = effective field capacity of tractor, ha/h

For tractor utilization in tillage operation all other cost components (purchase price, depreciation, repair and maintenance cost, shelter and driver cost etc.) except fuel may be considered to remain constant. Therefore fuel consumption may be taken as the most important variable cost component, which particularly influence the operating cost of tractor per ha and must be kept minimum (2) to reduce the operating cost, which can be represented by the following equation:

$$G_t = GT + G_i T_e + G_e T_e \ldots\ldots \text{ min. } (3)$$

where

G_t - fuel consumption per unit of tilled area, lit/ha

G, G_i, G_e - fuel consumption of tractor when at work, at turning and at the stoppage in the field respectively, lit/h

T, T_i, T_e - time spent by the tractor at work, at turning and at the stoppage in the field respectively, h/ha

MATERIALS AND METHODS

Field tests of tractors were carried out in Bangladesh Agricultural University Farm both in dry and wet soil conditions. The soil of the test plots were belonged to sandy, sandy loam, clay and clay loam type. The length of test runs were limited to 50m. The implements used for different tillage operations were mainly mould-board plough, disk plough, disk harrow and rotary tiller or rotavator. The moisture content of soil during dry land preparation was 25-50 percent (d.b.). But the puddling operations were accomplished under 10-30 cm standing water. The depth of ploughing and harrowing in dry soil condition were 16-24 cm and 6-12 cm respectively but in puddling operation the depth of tilling varied from 15-20 cm. the experiments were repeated three times in each gear speed.

The field capacity is the rate of tractor performance in tierms of area tilled per unit time. Here the effective field capacity was calculated on the basis of actual area tilled and total time spend. The effective field capacity of tractor [Cornelio et al (1986)] was calculated by the following formula:

$$e_f = A'/t \qquad (4)$$

where, e_f - effective field capacity of tractor, ha/h

A' - actual area tilled, ha

t - time spend, h

The area tilled per unit energy (1) was calculated by the following formula:

$$A = A'/N_e = A'/\xi N_H \qquad (5)$$

Very simple method was used to record the fuel consumption of the tractors. Before starting field operation the fuel tank was completely filled up with diesel fuel. Then after tilling the desired area of the plot, the fuel tank was refilled again by using a fuel measuring glass tube. thus the amount of fuel consumed by the tractors for tilling the particular area of plot was determined. The fuel requirement per ha (3) was calculated by the following formula:

$$G_t = 10^{-4} G'/(BL) \qquad (6)$$

where

G' - fuel requirement for the tilled area, lit

G_t - fuel consumption per unit tilled area, lit/ha

L - length of tilled area, m

B - width of tilled area, m

The required total time for tilling the particular area of plot and loss of time were recorded by a stop watch. The actual working time of tractors was calculated by deducting the loss time from the total time required for the particular area.

Depending upon the field performance data and the criteria of maximum area tilled per unit energy and minimum fuel consumption per ha the selection of tractor for tillage operation was accomplished.

RESULTS AND DISCUSSION

Bangladesh has no tractor industry and she is importing tractors from Japan, U.K., U.S.A., U.S.S.R., China, Italy, India and many other countries of the world. Therefore, prior to purchase/selection it is urgently needed to find out and analyse the field performance parameters of the presently imported tractors of different makes and models. Fig.1 shows the comparative analysis of area tilled per unit energy and fuel consumption per ha of presently used tractors for tillage operation. The old models of tractor are not included in the analysis except MF-135 and the new models of tractors. These were farm tractors: FORD-3910, MF-135, MF-240,

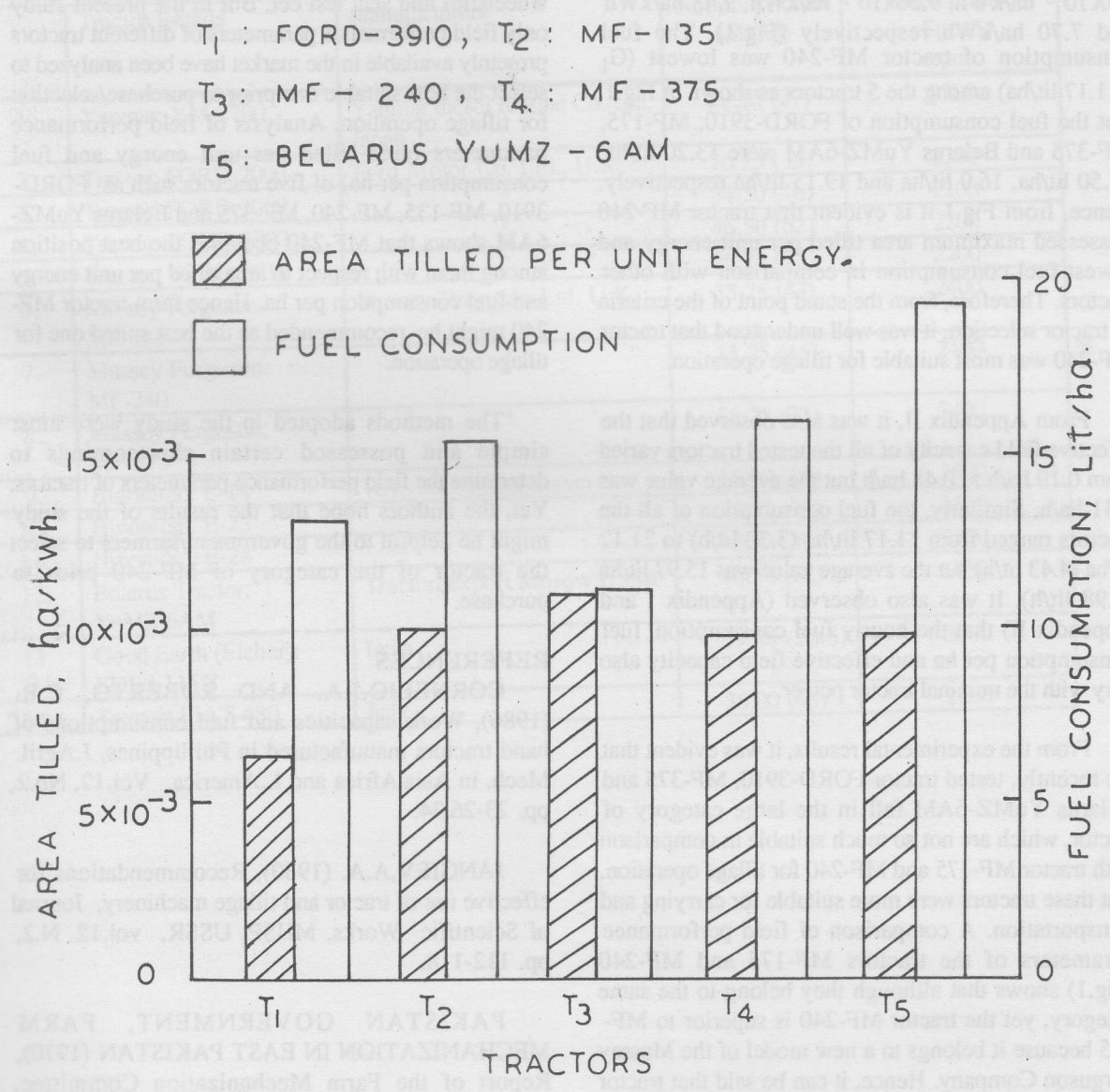

FIG. 1 GRAPH SHOWING THE COMPARATIVE FIELD PERFORMANCE PARAMETERS OF PRESENTLY IMPORTED/USED TRACTORS IN BANGLADESH.

MF-375 and Belarus YuMZ-6AM. The area tilled per unit energy of MF-240 was highest (A = $12X10^{-3}$ ha/kWh) in comparison with all the presently available tractors. But MF-135, Belarus YuMZ-6AM, MF-375, FORD-3910 possessed tilled area per unit energy $10X10^{-3}$ ha/kWh, $9.56x10^{-3}$ ha/kWh, 9.48 ha/kWh and 7.70 ha/kWh respectively (Fig.1). The fuel consumption of tractor MF-240 was lowest (G_t =11.17 lit/ha) among the 5 tractors as shown in Fig.1. But the fuel consumption of FORD-3910, MF-175, MF-375 and Belarus YuMZ-6AM were 13.20 lit/ha, 15.50 lit/ha, 16.0 lit/ha and 19.15 lit/ha respectively. Hence, from Fig.1 it is evident that tractor MF-240 possessed maximum area tilled per unit energy and lowest fuel consumption in comparison with other tractors. Therefore, from the stand point of the criteria of tractor selection, it was well understood that tractor MF-240 was most suitable for tillage operation.

From Appendix II, it was also observed that the effective field capacity of all the tested tractors varied from 0.19 ha/h to 0.48 ha/h but the average value was 0.31 ha/h. Similarly, the fuel consumption of all the tractors ranged from 11.17 lit/ha (3.30 lit/h) to 21.12 lit/ha (4.43 lit/h) but the average value was 15.97 lit/ha (4.98 lit/h). It was also observed (Appendix I and Appendix II) that the hourly fuel consumption, fuel consumption per ha and effective field capacity also vary with the nominal tractor power.

From the experimental results, it was evident that the recently, tested tractor FORD-3910, MF-375 and Belarus YuMZ-6AM fall in the large category of tractor, which are not so much suitable in comparison with tractor MF-175 and MF-240 for tillage operation. But these tractors were more suitable for carrying and transportation. A comparison of field performance parameters of the tractors MF-175 and MF-240 (Fig.1) shows that although they belong to the same category, yet the tractor MF-240 is superior to MF-175 because it belongs to a new model of the Massey Ferguson Company. Hence, it can be said that tractor MF-240 is more suitable for tillage operation that the large type/size and also than that of the same type and category of tractor MF-135.

CONCLUSIONS

Fourteen tractors have been tested in the Department of Farm Power and Machinery to determine the field performance parameters : area tilled per unit energy, hourly fuel consumption and fuel consumption per unit of tilled area, kinematic parameters (circumference of turning circle, radius of turning and speed of turning) drawbar and lugging ability tests (drawbar pull, drawbar power and wheelslip) and seal test ect. But in the present study only field performance parameters of different tractors presetnly available in the market have been analyzed to select the best suitable one prior to purchase/selection for tillage operation. Analysis of field performance parameters (area tilled per unit energy and fuel consumption per ha) of five tractors such as FORD-3910, MF-135, MF-240, MF-375 and Belarus YuMZ-6AM shows that MF-240 occupies the best position among them with respect to area tilled per unit energy and fuel consumption per ha. Hence farm tractor MF-240 might be recommended as the best suited one for tillage operation.

The methods adopted in the study were most simple and possessed certain shortcomings to determine the field performance parameters of tractors. Yet, the authors hope that the results of the study might be helpful to the government/farmers to select the tractor of the category of MF-240 prior to purchase.

REFERENCES

CORNELIO,J.A. AND ROBERTO, C.B. (1986), Work capacities and fuel consumptions of hand tractors manufactured in Phillippines, J.Agril. Mech. in Asia,Africa and L.America, Vol.12, No.2, pp. 23-26,34.

JANGIEV,A.A. (1980), Recommendations for effective use of tractor and tillage machinery. Journal of Scientific Works, MIISP, USSR, vol.12, N.2, pp. 112-118.

PAKISTAN GOVERNMENT, FARM MECHANIZATION IN EAST PAKISTAN (1970), Report of the Farm Mechanization Committee. Rawalpindi: Ministry of Agriculture and Works, Pakistan.

Appendix I

A list of Tractors tested in the Department of Farm Power and Machinery.

	Tractor Brands	Manufacturers	Nominal Power kW(hp)	Rated Engine Speed rpm
1.	Yanmar: YM-2700	Yanmar diesel Engine Co. Ltd. Japan	20.25 (27)	2700
2.	Tractor: FORD-2000	Ford Motor Co. Ltd., U.K.	26.25 (35)	2200
3.	Tractor: FORD-3000	"	34.50 (46)	2200
4.	Tractor: FORD-4000	"	46.50 (62)	2200
5.	Tractor: FORD-3910	"	56.25 (75)	2200
6.	Massey Ferguson MF-135	Massey Ferguson Ltd. U.K.	35.25 (47)	2400
7.	Massey Furguson: MF-240	"	33.75 (45)	2400
8.	Massey Ferguson: MF-375	"	56.25 (75)	2400
9.	Hinomoto: E-18	Toyosha Co.Ltd. Japan	15.00 (20)	2500
10.	Hinomoto: E-23	"	18.75 (25)	2500
11.	Hinomoto: E-28	"	22.50 (30)	2500
12.	Belarus Tractor: YuMZ-6AM	Tractoroexport Mosow,USSR	46.50 (62)	1750
13.	Good Earth (Eicher): EDI-d-115/8	India	19.88 (26.5)	2000
14.	Tractor: FIAT-480	Italy	36.00 (48)	2200

APPENDIX II

Field performance parameters of different farm tractors tested in the Department of Farm Power and Machinery

	Tractor Brands	Effective field capacity	Fuel consumptions	
		ha/h	lit/ha	lit/h
1.	Yanmar: YM-2700	0.27	20.12	5.43
2.	Tractor: FORD-2000	0.21	21.12	4.43
3.	Tractor: FORD-3000	0.26	16.89	4.39
4.	Tractor: FORD-4000	0.37	13.49	4.99
5.	Tractor: FORD-3910	0.39	13.20	5.15
6.	Massey Ferguson: MF-135	0.34	15.50	5.27
7.	Masey Ferguson: MF-240	0.36	11.17	4.02
8.	Massey Ferguson: MF-375	0.48	16.00	7.68
9.	Hinomoto: E-18	0.19	13.28	2.52
10.	Hinomoto: E-23	0.20	14.98	3.00
11.	Hinomoto: E-28	0.33	14.47	4.78
12.	Belarus: YuMZ-6AM	0.40	19.15	7.66
13.	Good Earth: (Eicher) EDI-d-115/8	0.25	17.00	4.25
14.	Tractor: FIAT-480	0.35	17.20	6.02