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MEDIUM SIZE TRACTOR FOR WHEAT CULTIVATION

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The results of field experiments demonstrated a poor performance of a power tiller for wheat crop. Bullocks and a small size tractor of 12 H.P. being uncomfortable, slower, ineffective and outlier were considered inappropriate. A medium size tractor of about 50 H.P. was suggested for wheat cultivation as a suitable mode of power because of its favourable effects on soil strength, seedling emergence and cost of operation.

INTRODUCTION

A diversified opinion on the use of small tractors for general use in our agriculture continues to exist. Often the use of small or large tractors is advocated entirely on the basis of economic considerations with utter disregard to their technical performance. This situation has caused many setbacks during the past, in addition to developing apprehensions among the country farmers with regard to the merits of different modes of power in our agriculture. The present study was, accordingly, undertaken to experimentally compare the effects of various modes of farm power on soil-crop parameters.

MATERIALS AND METHODS

The following power units (treatments) with their associated tillage implements were used with a view to assess their effects on the quality of seedbed preparation, seedling emergence, etc;

1. Bullocks with 'Munna' (an indigenous) plow
2. Chinese power tiller (Dong Feng, 12 H.P.) with rotavator
3. Chinese power tiller (Dong Feng, 12 H.P.) with double plow
4. Holder AM-2 (German, 12 H.P.)- a small tractor with rotavator
5. Massey Ferguson (MF-135, 47 H.P.) - a medium size tractor with disk harrow

All the above treatments with three replicates for each were completely randomized. Each implement was used twice in a plot of 58 x 46 square meters. Plowing depth, soil density and soil penetration resistance were measured after seedbed preparation. Shear strength of soil was measured at three levels of normal stress with Cohran shear graph. The regression analysis was employed to calculate cohesion, angle of internal friction of soil with a view to develop an equationfor the shear strength of soil. Wheat was seeded with a calibrated grain drill. The force required by a seedling to emerge under each treatment was calculated. The emergence rates were recorded by counting the number of seedlings per 1.5 meter in a row after the first irrigation. The analysis of variance was used for the analysis of the data.

RESULTS AND DISCUSSION

The effects of different modes of power on various soil-crop parameters have been discussed below:

a) *Plowing Depth*: Deep plowing provides additional soil depth with plant nutrients, particularly the moisture during drought periods. The plowing depths that were easily attained under various treatments have been given in Table 1. The depth of plowing remained generally limited in case of both the types of rotavators.

Table 1. *Soil tool properties*

Treatment	Plowing depth* (cm)	Penetration* resistance (N/cm^2)
1. Bullocks with 'Munna,	12.2, 12.7, 11.4	1.5, 1.0, 1.2
2. Power tiller with rotavator (12 H.P.)	5.8, 6.1, 6.1	3.4, 3.6, 3.5
3. Power tiller with double plow (12 H.P.)	10.0, 11.0, 12.0	1.6, 0.5, 0.8
4. Holder with (12 H.P.) rotavator	8.4, 8.1, 6.8	0.5, 0.6, 0.5
5. Massey Ferguson tractor with disk harrow (47 H.P.)	12.2, 11.4, 13.2	0.5, 0.7, 0.7

* Each value is the mean of three readings.

b) *Penetration Resistance:* Measurements on soil penetration resistance from different treatments (Table 1) tested statistically significant, indicating a different quality of soil tilth with each implement. Plots prepared with power tiller operated rotavator showed maximum resistance to penetrometer. Tillage operations with bullocks also remained relatively ineffective in reducing the the strength of soil. Both the Massey Ferguson (a medium size tractor) with disk harrow and Holder (a small tractor) with rotavator had favourable effects on decreasing the resistance of soil.

c) *Shear Strength of soil:* The following equations were developed from the regression analysis of the data on shear strength of soil measured against three levels of normal stress:

S = 65.76 + 0.242N - Bullocks with 'Munna,
S = 46.6 + 0.249N - Power tiller with rotavator
S = 95.2 + 0.159N - Power tiller with double plow
S = 66.5 + 0.240N - Holder with rotavator
S = 40.85 + 0.267N - Massey Ferguson with disk harrow, where,
S = Shear strength of soil (N/cm_2)
N = Normal stress (N/cm^2)

The above equations suggest that the power tiller operated plow did a poor job in reducing soil shear strength, perhaps for the reason that the double plow is a primary implement and causes more inversion than pulverization. Power tiller operated rotavator appears to be a better tool, but its shallow plowing depth disqualifies it. The operations with a medium size tractor in seedbed preparation were found appropriate with regard to the reduction of soil strength.

d) *Emergence:* The plots prepared by a power tiller resulted in poor emergence (Table 2). Seedbed preparation with bullocks and Holder (a small tractor) had favourable effects on germination. Nevertheless, they could not compete with disk harrow operated by a medium size tractor.

The best performance of disk harrow operated by a medium size tractor may be associated with a reasonable plowing depth, better pulverization, reduced soil penetration resistance as well as soil shear strength and above all a

Table 2, *Emergence*

	Treatment	Emergence/1.5 meter/row			Average
1.	Bullocks with 'Munna'	41	42	35	39.3
2.	Power tiller with rotavator	38	39	42	34.7
3.	Power tiller with double plow	34	84	43	37.0
4.	Holder with rotavator	40	43	44	42.3
5.	Massey Ferguson with disk harrow	44	45	45	44.7

slight soil compaction underneath the disks.

e) *Emergence Force:* Force required by a seedling to emerge known as emergence force of seedlings is an indicator of the quality of soil tilth. The force required by a young seedling to break through the soil surface may be calculated from the formula developed by Sheikh (1972).

$F = UD(2cl \tan(45° \pm \varnothing) + wl \cdot \tan^2(45 + \varnothing)$ where,

F = force exerted by the seedling (gm)

U = Coefficient of friction between the seedling and soil 0.25 (assumed)

D = Mean dia of the seedling (cm) = 0.1524

L = Depth of planting (cm) = 5.08

C = Soil cohesion $(gm/cm)^2$

$\varnothing$ = Angle of internal friction of soil (degrees)

W = Wet soil density $(gm/cm)^2$

The values of W, C, $\varnothing$ and F for different tillage treatments are as below:

	Treatment	W $(gm/cm)^3$	C $(gm/cm)^2$	$\varnothing$ (degrees)	F Emergence
1.	Bullock with 'Munna'	2.84	65.76	13.60	38.5
2.	Power tiller with rotavator	3.02	48.60	13.98	23.1
3.	Power tiller with double plow	2.86	95.20	9.03	43.2
4.	Holder with rotavator	2.87	66.50	13.49	33.0
5.	Massey Ferguson with disk harrow	2.87	40.85	14.95	20.7

The force required by a wheat seedling to emerge was the least in case of disk harrow plots prepared by a medium size tractor again establishing its superiority among the treatments. The value of the force is unexpectedly low for the plots prepared by the rotavator of the power tiller. This may be associated with the reduced cohesion near the soil surface in the said treatment. Excepting power tiller's rotavator, cultivation with bullocks and a small tractor were next to disk harrow (used with a medium size tractor) as regards emergence force. Double plow of power tiller is a primary implement and thus fails to provide a good seedbed. The above comparisons indicate that a medium size tractor seems to be a better set of equipment under the given soil and crop conditions. It may also be noted that the use of bullocks and a small tractor carry better prospects than the power tiller in the light of above experiments.

CONCLUSIONS

1. The power tiller with its implements was poor in performance for seedbed preparation of wheat fields.
2. The use of bullocks and a small tractor carry better prospects than power tillers for at least the wheat belt of Pakistan. The inability of bullock and a small tractor in carrying out operations like deep plowing/chiseling, and precision levelling, further suggest the use of a medium size tractor.
3. Use of a medium tractor of about 50 H.P. overides all the modes of power considered in this study.

REFERENCE

Sheikh, Ghulam Sarwar. 1972. The mechanics of soil cutting equipment and emergence of seedling. Ph. D. Thesis, Iowa State University, Ames, Iowa, U.S.A.