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Selection of Suitable Tillage Pattern for Fuel Economy

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Abstract

A study was conducted to determine the suitable tillage pattern based on fuel economy and to minimize the tillage cost in sandy loam soil. Circuitous, straight alternation and overlapping alternation or traditional tillage pattern were performed by two wheel tractor tillage system. Fuel consumption, width, depth of cut and physical properties of soil were measured at different land for different patterns. Field parameters namely fuel consumption, depth of tillage and soil properties including soil moisture content, particle density, bulk density and soil texture were studied in this research. The highest fuel consumption was found (21.11 Lha^{-1}) for circuitous pattern with depth of tillage 8 cm. Difference in fuel consumption and tillage depth between traditional and straight alternation pattern was not found. Lowest tilling time (6.67hrha^{-1}) was observed in traditional tillage pattern, whereas circuitous pattern required highest time for tillage (9.26 hrha^{-1}). Traditional tillage pattern was found most fuel economical tillage pattern for sandy loam soil.

Keywords: Tillage pattern, Fuel economy, Circuitous pattern, Straight alternation pattern, Traditional pattern.

Introduction

Agriculture is an important sector and contributes almost 20% of the total gross domestic product (GDP) in the national economy of Bangladesh. Again, crop sub sector contributes nearly 75% of the agricultural GDP and about 11% of the total GDP in Bangladesh[1].

The net arable and sown area are gradually decreasing since 1980 because of rapid urbanization and industrialization and causing food scarcity for the increased population in Bangladesh. Besides, 220 ha of farming lands are being occupied by non-agricultural sector per day[2]. More than 60% land of Bangladesh is being used under agricultural purposes against only 12% for the world. It is quite impossible to expand the field horizontally. According to the data of BBS[3], cultivated and operated area per capita are available 0.05 ha and 0.07 ha respectively. Therefore, it is urgent to increase the productivity of land, cropping intensity and cultivate high yielding variety, improve cropping pattern with cost effective technology by agricultural mechanization.

Agricultural mechanization includes the use of agricultural tools and machineries in an effective and efficient way to reduce the production cost with leading higher yields[4]. Among various agronomic practices tillage is most important for improving the soil quality physically, chemically and biologically that would ultimately result in higher seed germination, seedling emergence, maximum plant growth and increased crop yield[5]. It has been reported that improper cropping system with tillage practices are major causes behind the low production of various crops in Bangladesh. Suitable tillage results in the optimum growth of crops and higher yield by developing soil structure of a seedbed[6]. However, the growth of plants and total production largely depend on different tillage practices.

Two wheel tractor is firstly introduced for tilling operation in Bangladesh, but nowadays, it is being used in irrigation, paddy threshing, milling rice, transportation, and so on. Low labor cost, less maintenance cost, desired depth of tilling with better quality of soil structure resulted from power tiller tilling operation ultimately bearing on soil fertility and crop productivity. According to Quayum *et al.*[7], the total number of power tiller in Bangladesh was 2,36,048 in economic year of 2006. But in economic year of 2011, total number of power tiller and tractors are recorded in Bangladesh almost 3,50,000 and 40,000 respectively[8].

According to Hunt[9], substantive improvements can be made in the field efficiency by analyzing and changing the model for planning and field operations that depend on the area and shape of the field. As a developing country, Bangladeshi farmers need to apply appropriate tillage pattern for saving fuel and reducing the cost of tillage in different soil condition all over the country. Therefore, the study is needed to find out suitable tillage pattern for fuel consumption, to know the soil properties, time required for different tillage pattern during tillage operation and the suitable land area for tillage practice. The main objective of the research work is to find a suitable tillage pattern for crop production and fuel economy.

Materials and Methods

Land selection: Land was selected for application of different

tillage pattern to increase the efficiency of fuel. The selected land was dry and grassy. The density of grass so much scattered and the height of the grass was approximately 9 cm.

Tillage pattern selection: Three different patterns such as Straight alternation tillage pattern, Circuitous tillage pattern and overlapping alternation or mechanically operated traditional tillage pattern were chosen to perform the tillage operation. The operation was performed approximately at the same speed that was determined by measuring the time and distance travelled by the two wheel tractor.

Experimental design: For the operation of tillage an area of 90×15 m^2 was selected from a cultivable land at HSTU, Dinajpur. Total area was sub-divided into three plot 30×15 m^2 each.

Parameter studied: For tilling of each plot the tilling time was recorded by the stopwatch. A graduated measuring scale made to penetrate tilled soil was used to measure ploughing depths. The depths of tilled soil was measured for thirty (30) times at different points along the ploughed field and then averaged to the soil depth of each tillage operation.

Fuel consumption was determined in liters per hour (L hr^{-1}). The fuel tank of the power tiller was filled up to it's full before starting the tilling operation in the test plot. The quantity of fuel required to fill the tank fully after tilling the plot was measured to determine the quantity of fuel consumed for measurement of fuel consumption of the test plot[10].

The soil samples were collected randomly (before tilling operation) from the different experimental plot. Soil physical properties including soil moisture, particle density, bulk density, soil texture were determined in the soil science laboratory of HSTU, Dinajpur according to Foth[11].

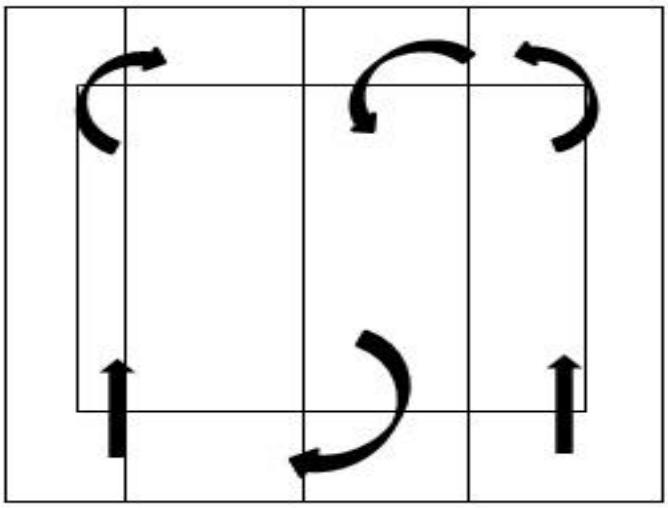

Figure-1
Straight alternation tillage pattern

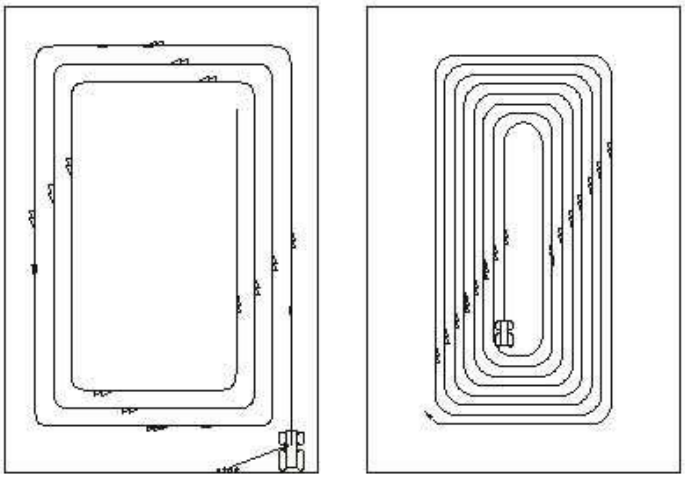

Figure-2
Circuitous tillage pattern

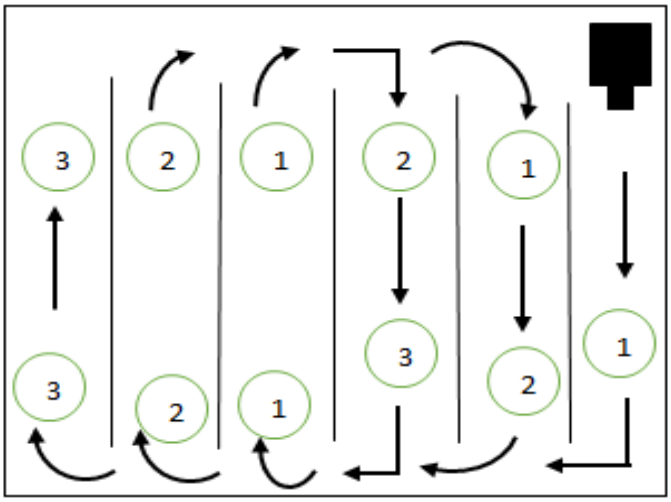

Figure-3
Overlapping alternation or mechanically operated traditional tillage pattern

Results and Discussion

Soil analysis: The results of the soil analysis carried out on the research farmland for three plot of land are shown in Table-1. The soil was found to be mainly sandy-loam, has higher water retention ability with average moisture content of 15.22% by wet basis, average particle density 2.21 gcm^{-3}, andaverage bulk density 1.53 gcm^{-3}.

Table-1 shows that the moisture content was higher in plot-2 than plot-1 and plot-3. On the other hand, particle density was higher in plot-2 compared to plot-1and 3. Bulk density was higher in plot-2 than others. The percent sand was higher in plot-1, whereas rest of two plots contained same amount of sand. However, the percent silt and clay were found to be lower in plot-1 among three soil samples.

Fuel consumption of two wheel tractor for three tillage patterns: Fuel consumption by power tiller during tilling operation was measured for three different plots with three different tillage patterns namely, circuitous, overlapping alternation or traditional and straight alternation. Results for fuel consumption with tillage depth and time requirement for tilling 0.045 ha of sandy loam land with three different tillage patterns are presented in Table-2.

Results of fuel consumption indicated that highest amount of fuel (21.11 L) was required for tilling 1 ha of land with circuitous pattern. However, lowest fuel consumption (17.78 L) was required for both traditional and straight alternation tillage pattern to till 1 ha of sandy loam land. Possible reasons of higher fuel consumption and time requirement with circuitous tillage pattern may be due to more turns and higher tilling depth in pattern.

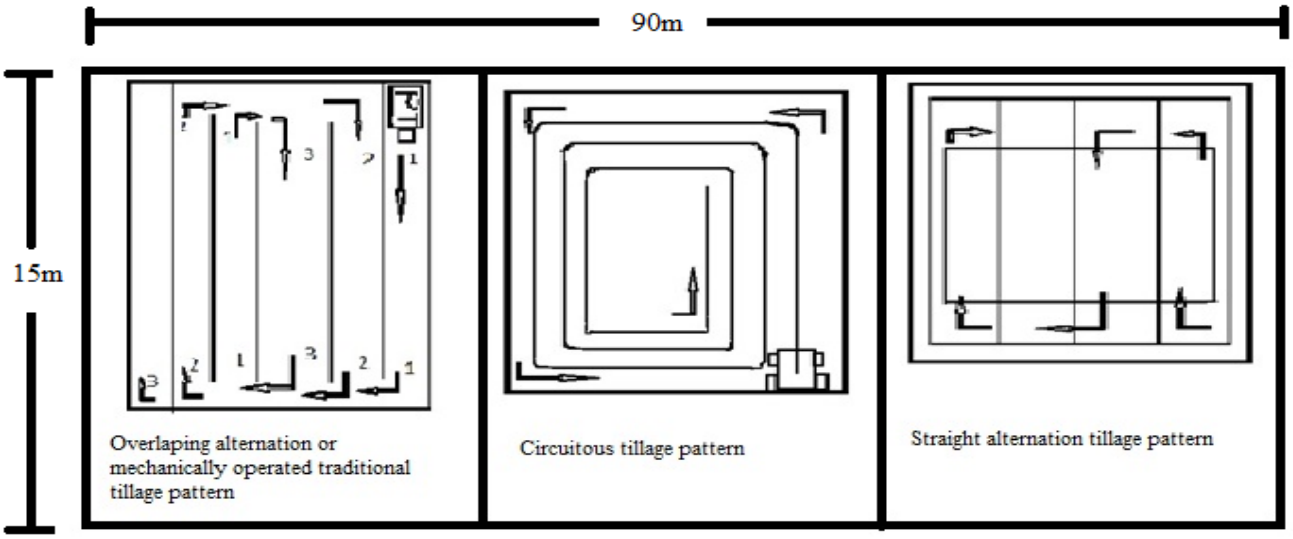

Figure-4
Design of experiment of land

Table-1
Soil analysis test on research farm

Soil Properties	Plot-1	Plot-2	Plot -3	Average
% Sand	65.6	55.6	55.6	58.93
% Silt	17.6	25.6	25.6	22.93
% Clay	16.8	18.8	18.8	18.13
Soil type	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
Moisture content (%)	14.95	15.5	15.2	15.22
Particle density (g/cm^3)	2.22	2.24	2.17	2.21
Bulk density (g/cm^3)	1.5	1.58	1.5	1.53

Table-2
Fuel consumption, tillage depth, time requirement analysis

Properties	Circuitous pattern	Traditional pattern	Straight Alternation pattern
Fuel consumption (L)	0.95	0.8	0.8
Tillage depth (cm)	8	7	7
Time required (min)	25	18	22

Conclusion

This experiment indicates that fuel consumption and tilling time could be minimized by the application of suitable tillage pattern during tillage operation. Traditional tillage pattern requires less fuel and time for tillage operation compared to circuitous and straight alternation pattern that would reduce the production cost. Although the tillage depth was found lower for traditional pattern than other two tillage patterns. As most of the farming lands are small and fragmented in Bangladesh, therefore traditional tillage pattern is most fuel economic for tillage operation.

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