Potato mechanization in Iran

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Abstract

Some experiments were conducted to select a soil preparation method for potatoes. The energy input requirement of a high speed disk plough (Yule and Roddy 1994; Ghazavi 1997) was compared with that of a mouldboard plough and also the effects of each implement on the soil were investigated. Then, these implements were used in the preparation of a potato seedbed for final evaluation. The energy input was measured using a 3-point linkage dynamometer with on-board data acquisition system. Soil physical changes were measured including soil aggregate analysis, cone penetrometer resistance, bulk density, surface relief and soil moisture content before and after cultivation. The comparison of total energy requirements between the two tillage tools, showed a higher requirement for the mouldboard plough than for the high speed disk plough. The field experiments concluded that an overall improvement of about 40 % in output (ha/hr) could be obtained when using the improved disk plough compared with a conventional plough. The aggregate analysis of the cultivated layer revealed that the performance of the two machines were largely similar, and no significant differences were seen in potato production rates during two years of field experiments, indicating no disadvantage from using an alternative to the mouldboard plough.

Media summary

An improved high speed disk plough was found to have advantages over the usual mouldboard plough used for seedbed preparation for potatoes.

Keywords:

Soil preparation; potato; high speed plough; mechanization

Introduction

In world food production, the potato is the fourth most important crop after wheat, rice and maize. In 2001, the world production of potato has been estimated at about 307 million metric tons (Fennir 2002). Increasing populations and limited arable land have caused researchers to focus on increased mechanization of potato production (Rembeza 1993; Bentini 1992). Mechanization includes soil preparation, planting, protection, harvesting and also post harvest aspects that all impact on the technological aspects of production (Spiess 1994; Gupa et al. 1994; Ridder et al. 1993). In fact any improvement in mechanization will affect the quality and quantity of potato production (Betini 1992).

One of the most important goals in tillage is maintaining a high degree of aggregation in a soil because then roots can develop and penetrate better, and the maximum amount of water can be stored for plant needs. In addition, soil surface particles resist breakdown under rainfall better, preventing surface sealing and allowing maximum water intake, reducing erosion due to runoff, and reducing the breakdown of aggregates into fine particles which are transported by water. Also, aggregated soil particles provide improved resistance to compaction by wheels or tracks of tractors and field machines, and to the action of tillage machines (Richey 1961).

There is no standard tillage system used in the preparation of potato fields, but it is obvious that as few operations as possible would be better to save time and energy and to reduce excessive soil compaction. The wide range of soil types on which potatoes are grown and the variety of tillage implements available for soil preparation are two important factors in tillage management. The correct amount of crop residue must be incorporated into the soil to allow the planter to work without trouble. The amount of tillage required to do this will depend upon the soil type and the ability of the planter to operate properly in crop residues. Tillage should produce enough loose soil to allow the planter shoe to penetrate to the desired depth and to provide the hiller tools with enough loose soil to construct a proper hill over the seed.

The most common tillage procedure is to plough down the previous year's crop residue with a mouldboard plough in the fall or spring. Then a disk is used in the spring to break large soil clods. This is normally followed by a third operation with a spring tooth harrow that levels or smoothes the soil and can incorporate fertilizer (Skorupinska et al. 1991; Unger 1994).

Methods

Two series of experiments were carried out from 1995 to 2002 on the Nafferton Farm at the University of Newcastle in the UK, and at the Khatoon Abad Farm at the University of Islamic Azad (Khorasgan branch) in Iran. A schematic view of the energy measurement system is presented in Fig. 1.

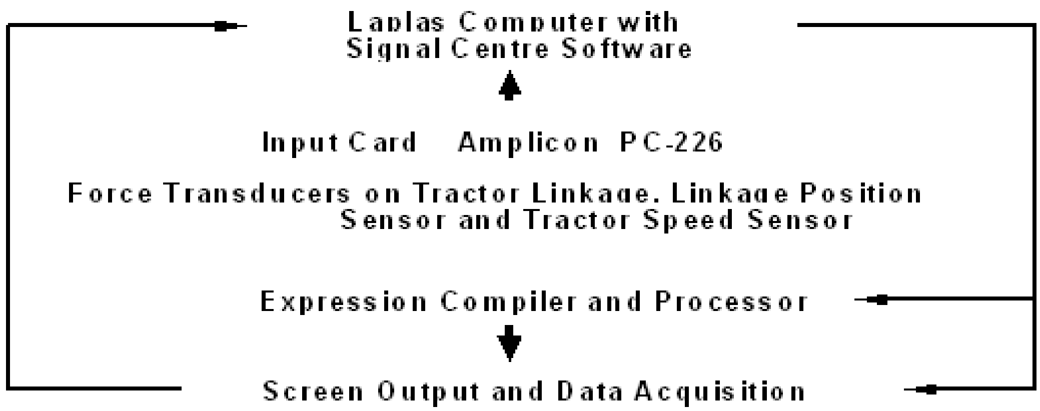

Fig. 1. Schematic of energy measurement system

The first series of experiments, using a fully randomized strip design with four replications of the three tillage treatments, were conducted on the Nafferton farm of the Newcastle University. The 12 plots in each experiment were 100 m in length and 4 m wide and the soil type was sandy clay loam. The high speed plough was designed by Yule et al. (1994) and it was completed by Ghazavi (1997) with some modifications. A conventional three furrow mouldboard plough with general purpose plough body design and a chisel plough with powered roller were used. The following tests were carried out in the plots.

Table1. Soil physical property measurements

Tests	Instruments
Soil moisture content	Core sampler
Dry bulk density	Core sampler
Cone-index	Bush penetrometer
Soil aggregate	Special core sampler

Soil roughness	Microrelief meter
Soil movement and mixing	Coloured markers

In a second series of experiments, the high speed disk plough, and mouldboard plough with chisel plough were both used. The plots were the same size as in the first series of experiments mentioned above. A randomized complete block design was used to compare the primary tillage machines' behaviour on potato growing, and the quality and quantity of potato products during two years of experiments in the Khatoon Abad Farm of Islamic Azad University and laboratory.

Results

In terms of the soil cone index, the mouldboard plough left the soil in the weakest condition, while the high speed disk plough achieved better consolidation. Cone index measurements were consistent with soil dry bulk density results, while the measurement of soil moisture content showed that the conventional mouldboard plough caused losses in moisture content due to soil inversion. The high speed disk plough behaviour was between those of the mouldboard plough and chisel plough because of partial soil inversion and the retention of some soil residue on the soil surface.

The analysis of variance was used on mean energy parameters of the experiments. The mean, minimum and maximum values of draft were lower for the high speed disk plough than for the mouldboard plough in all experiments.

Aggregate size distribution revealed broadly consistent results between machines.

The main advantage of using the mouldboard plough was its more complete soil inversion which allowed good burying of trash. The improved disk plough achieved good mixing with a relatively clear soil surface. Although the degree of soil inversion was less than with the mouldboard plough, and more plant residue was left on the soil surface, the high speed plough was able to reduce moisture loss in late summer/autumn conditions.

There were no significant differences in potato yield, pH, glucose, starch, moisture, vitamins and ash of potatoes between the mouldboard plough and improved disk plough treatments.

The high speed disk plough as an alternative implement gave good performance and would appear to offer a financial advantage to farmers, making it worthy of further development and testing.

References

Bentini-M (1992). The mechanization of potato cultivation. Maquinas-y-Tractores-Agricolas. 3, 60-62.

Cargill BF (1986). Engineering for potatoes. Michigan State University and ASAE. Copyright by the ASAE, St. Joseph, Michigan.

Fennir MA (2002). Respiratory response of healthy and diseased potatoes (Solanum tuberosum L.) under real and experimental storage conditions. Ph. D. thesis of Agricultural and Biosystems Engineering , Macdonald Campus of McGill University, Montreal, Canada.

Frede HG and Gath S (1995). Soil Surface Roughness as the Result of Aggregate Size Distribution 1. Report: Measuring and Evaluation Method. Z. Pflanzenernahr. Bodenk. 158, 31-35

Ghazavi MA (1997). Energy Inputs and Resulting soil physical conditions of primary tillage implements. Ph.D thesis, Newcastle University, Newcastle, England.

Gupta ML, Vatsa DK and Verma MK (1994). Development of power tiller-operated potato planter-cum-fertilizer applicator. Agricultural Mechanization in Asia, Africa and Latin America. 25(2), 26-28.

Rastovski A and van Es A (1981). Storage of potatoes. Post harvest behaviour, store design, storage practice, handling. Pudoc, Centre for Agricultural Publishing and Documentation Wageningen.

Rembeza J (1993). Effectiveness of mechanization of potato production in private farms. Roczniki Nauk Rolniczych. Seria C, Technika Rolnicza. 79(4), 85 90.

Ridder JK, Rops AHJ, Floot HWG, Geelen PM and Schouten TM (1993). Weed control in potatoes.Themaboekje Proefstation en Informatie en Kenniscentrum voor deAkkerbouw en de Groenteteelt in de Vollegrond. 15, 15-26.

Skorupinska A and Wasilewska B (1993). Polish potato bibliography 1991. Biuletyn Instytutu-Ziemniaka. 42, 123-146.

Unger PW (1994). Managing Agricultural Residues. Lewis Publishers, an imprint of CRC Press, US.

Yule IJ and Roddy TP (1994). High speed plowing: A practical reality. Proc. Int. Soil Tillage Res. Org., Soil tillage for crop production and protection of the environment. Aalborg, Denmark, ed. Jensen, H.E., Schjonning, P., Mikkelson, S.A., Madsen, K.B., 1295 -1300.