THE EFFECT OF HARVEST TECHNIQUES ON YIELD, BOTANICAL COMPOSITION AND SOIL STRUCTURE IN AN ORGANIC CLOVER GRASS SWARD

M. Lund
Norwegian Centre for Ecological Agriculture, N-6690 Aure, Norway

ABSTRACT
The objectives of this study were to find out if lighter machines with less number of wheel-passes are favourable for harvesting grassland under wet conditions. A field trial on an ecological experimental farm in Norway was performed with two different mechanization systems. One was a conventional mechanization system with reduced ground pressure tractor driving a forage harvester and grass trailers, and one less wheeling system with reduced ground pressure where a two-wheel tractor with a mower was putting the grass in a swath and a self loading trailer was picking the swath up. The field work was carried out as normal farm practice. After two years of experimentation, results show that conventional machines have the largest influence on soil compaction. This is shown by increased penetrometer resistance, reduced infiltration rate and reduced volume of air filled pores. Regarding yield and botanical composition there are no clear tendencies.

KEYWORDS
Grass harvest machinery, soil compaction, mechanization, botanical composition, organic agriculture

INTRODUCTION
Harvesting of perennial grasslands requires a lot of driving with different vehicles. The traffic causes damage on plants and soil structure which reduces yield, particularly on wet soil (Douglas et al., 1993; Håkansson et al., 1990). In organically grown ley negative effects of traffic can be expected because of the following reasons; Red clover, which is necessary for nitrogen fixation, has shown to be more sensitive to mechanical damage compared to many grass species (Rasmussen and Møller, 1981), weed population increases when the clover-grass sward gets thinned out (Hansen, 1993) and utilization of nitrogen in perennial ryegrass can be decreased in a compacted soil (Douglas et al., 1993). All this is unfortunate in a low input system, like organic agriculture.

Many studies under Scandinavian conditions stress the importance of avoiding soil compaction and plant damage in ley (Hansen, 1993; Håkansson et al., 1990). However, they do not give any recommendations regarding type of mechanization. Thus, the objectives of this study were to find out if lighter machines and less number of wheel-passes are favourable for harvesting grassland under wet conditions as compared to a conventional mechanization system with reduced ground pressure.

MATERIAL AND METHODS
The experimental field was located in 1.2 ha in Tingvoll (62 55 N, 8 13 E) in western Norway 1994 to 1996. The soil is an imperfectly drained clay loam (USDA), but there are good conditions for surface run-off. The climate in the region is fairly cold and rainy with an average yearly temperature of 5.6° C and an average rain- and snowfall of 1160 mm.

In May 1994 the field was ploughed and seedbed tillage was made. The field was seeded with 61% timothy, 18% meadow fescue, 18% red clover and 3% white clover with oat as nurse crop. Seed rate was 34 kg ha^{-1} for clover-grass and 120 kg ha^{-1} for oats.

The treatments were the traffic while harvesting the clover-grass as normal farm practice. The crop was harvested two times yearly as silage. Two harvesting systems and one zero traffic treatment (ZT) were compared. In the conventional mechanization system with reduced ground pressure (CR) a tractor equipped with low pressure tires drew a forage harvester and grass trailers. The less wheeling system (LW) with reduced ground pressure was a two-wheel tractor with a mower, putting the grass in a swath, and a tractor equipped with low pressure tires, drawing a self loading trailer picking the swath up. Details of loads, tire pressure and working width of the machinery are given in Table 1. The wheel track area in CR treatment was about 140% of field area and in LW treatment about 40% for tractor and self loading wagon. All registrations were made in 12 spots in each treatment. At every harvest herbage dry matter yield was assessed by collecting one 1x0.5 m square cut with a hand-operated clippers fit with 50 mm high skids. The herbage was sorted before drying.

The pore space, water content, gas permeability, and soil density were determined in intact core samples (diameter 58 mm, height 38 mm) collected from 0.07-0.12 m depth, before first cut the first year and before every cut remaining years. Samples for aggregate analysis were taken before first cut the first year and before every cut remaining years. Penetrometer measurements were made before every cut except at second cut the second year in LW treatment. Infiltration rate was measured every autumn after second cut on every second registration spot. The diameter of the infiltration rings was 0.37 m.

RESULTS AND DISCUSSION
In the first year (1994) the soil was relatively wet when treatments were applied, about 40%, which is close to field capacity. In the second year (1995) at first cut soil moisture v/v was 30 to 35% when harvesting with LW system and 40% when harvesting with CR system. At second harvest soil moisture was 35 to 40%.

The results from the first two years show that CR treatment has the largest influence on soil structure. This is shown by increased penetrometer resistance, reduced infiltration rate and reduced volume of air filled pores. Regarding yield and botanical composition there are no clear tendencies. In second cut 1994 the highest yield was registered in ZT treatment, but as for total yield 1995 there were no significant differences obtained between treatments.

The results after two years of experiment do not indicate that a farmer with tractor and trailers of moderate size equipped with low pressure tyres should change to a less wheeling equipment. But CR treatment has slightly compacted the plough layer and further treatments may eventually increase soil structure damage.

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Table 1
Details of the machinery used in the experiment

Vehicle	Weight	Rear tyre pressure	Front tyre pressure	Working width
Less wheeling system (LW)				
Two wheel tractor (Bucher M-550)	350 kg	30 kPa (dual wheels)		1.80 m
LW-tractor (Fiat 45-66)	2650 kg	60 kPa	50 kPa	
Self loading wagon (Pöttinger Boss junior I-T)	1800 kg (empty) 3500 kg (full)	100 kPa		
Conventional mechanization system (CR)				
CR-tractor (Agriful 65)	3150 kg	50 kPa	50 kPa	
Forage harvester	600 kg			1.12 m
Trailer (Tim)	1150 kg (empty) 2900 kg (full)	120 kPa		
Trailer	1350 kg (empty) 2900 kg (full)	100 kPa		