# POTENTIAL OF A NOVEL WHITE CLOVER/CEREAL BI-CROPPING SYSTEM FOR WHOLE CROP FORAGE PRODUCTION

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**ABSTRACT**

A novel low input system for growing cereals, so far mainly winter wheat (*Triticum aestivum L*), in close association with white clover (*Trifolium repens L*), is being developed currently, co-operatively by five research stations in northern Europe. An established sward of pure white clover is defoliated in the autumn and winter wheat drilled into it using a rotary type direct drill. After silage or grain harvest of the cereal/clover mixture the clover regrowth may add to the productivity of the system until defoliation and drilling-in of the next cereal crop takes place. With the system described dry matter yields of 7.5 - 13.0 tonnes per ha have been achieved at the soft dough stage of wheat development. Chemical quality parameters were not improved compared with conventionally grown wheat. The white clover/cereal bi-cropping system offers significantly reduced costs relating to tillage, fertilizer nitrogen and other agrochemicals. The perennial clover understorey also probably reduces soil erosion and leaching of nutrients and adds to the overall biodiversity of arable land.

**KEYWORDS**

Cereals, winter wheat, white clover, bi-cropping, direct drilling, arable silage.

**INTRODUCTION**

A new system for growing cereals in a white clover understorey was pioneered by Williams and Hayes (1991) and Jones (1992), growing spring cereals, and Jones and Clements (1993), growing winter wheat. The cereal crop is sown into an established sward of pure white clover using a rotary type direct drill and the two species grow and develop in close association. The system has several desirable features addressing resource economy and environmental sustainability. Since the cereal component benefits from nitrogen (N) fixed by the clover, amounts of fertilizer N applied can be reduced substantially. Further a well established clover understorey competes strongly with emerging weeds thus reducing the need for herbicides. Also, problems with aphids and fungal diseases may be less severe compared with conventional wheat production (Jones and Clements, 1993; Deadman et al., 1995). The reduction in tillage and the fact that the clover sward can be used for successive cereal crops has important environmental and ecological implications, including reduced risks of leaching and soil erosion.

The white clover/cereal bi-cropping system is currently being further developed for the production of winter wheat for grain as well as for silage. This paper summarises some of our experiences with the system and reports on yields and crop quality so far achieved for the clover/wheat whole crop compared with conventional wheat.

**MATERIALS AND METHODS**

Swards of medium leaf-size white clover, cv Donna, were established at the five locations represented by the authors. The clover was sown in spring of 1993 at Long Ashton and in spring of 1994 at the four other sites. Seeding rates were 9-12 kg/ha. Soil pH and levels of P and K were corrected according to soil type and analyses to ensure good conditions for clover growth. In September/October the clover was defoliated by machine or by sheep grazing, and winter wheat, cv. Hereward, was direct drilled in using a Hunter Rotary Strip Seeder (Hunters of Chester, Ltd., Tarporley, Cheshire, UK). The machine produces 8 cm wide slots centered 23 cm apart. Seeding rates of wheat varied from 300 to 450 kernels/$m^2$ between the five experimental sites. The clover/wheat bi-crops generally received 40-50 kg N/ha of chemical fertilizer in early spring except at Long Ashton where no N-fertilizer was applied. Pure wheat crops were grown in a conventional (ploughed) seed bed receiving 140-220 kg N per ha and agrochemicals according to local recommendations. At Foulum and Long Ashton sowing of the conventional crops was done with the Strip Seeder while conventional drills were used at the other sites. Yields were determined at the soft dough stage of wheat using a Haldrup harvester. Samples for botanical and chemical composition were obtained by quadrat sampling.

**RESULTS AND DISCUSSION**

Wheat seeds rotaseeded into white clover generally emerged satisfactorily producing plant densities (not shown) comparable to those of the conventional seed beds. Occasionally, problems with profuse clover growth in autumn were encountered, but in no case did the wheat fail to establish. Tillering of the wheat, however, (not shown) generally seems restricted when rotaseeded into clover compared to seeding into a conventional seed bed. It is unresolved at present whether this reduction in tillering is due to a more shallow seeding or is a result of competition from the white clover.

Whole crops of white clover/wheat yielded 7.5 - 13.0 tonnes of dry matter per ha, which was mostly considerably less than conventional wheat (Table 1). The low yield at North Wyke was caused by severe infestation of grass weeds, mainly *Poa* species. Generally grass weeds have been identified as a major problem which if not controlled may worsen greatly during succeeding bi-cropping cycles. Conventional wheat yielded 12.3 - 22.0 tonnes of silage dry matter per ha. Yields of bi-cropped white clover/winter wheat thus made up approximately 60-100 % of conventional yields when grass weeds were not severe. The relatively low conventional yield at Foulum was probably restricted by an insufficient tiller density as a result of the wide row distance of the Strip Seeder combined with dry conditions.

Hopes that inclusion of clover would improve whole crop quality so far have been largely disappointed. Crop compositions at Foulum (Table 2) illustrate the overall experience that neither N content or acid detergent fibre have been favourably affected by the new system. The lowering effect of clover on the dry matter concentration may however improve compressability and hence aerobic stability of the whole crop silage.

The work has demonstrated that winter wheat can be rotaseeded into a white clover sward and develop to produce acceptable yields of whole crop with greatly reduced costs. There is scope for further

improvement of the system, especially by improving the drilling technique, by optimizing competition between clover and wheat, and by developing procedures for control of grass weeds.

**ACKNOWLEDGEMENTS**
The work on bi-cropping is funded by the EU-commision (AIR 93-0392) and by national grants.

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**Table 1**
Dry matter yields (tonnes/ha) of whole crop white clover/winter wheat and conventional wheat at five north European locations.

| | North Wyke UK | Foulum DK | Long Ashton UK | Carlow IE | Dublin IE |
|---|---|---|---|---|---|
| W. clover/w. wheat (A) | 7.5 | 12.4 | 10.7 | 13.0 | 9.5 |
| Conventional w. wheat (B) | 16.4 | 12.3 | 17.1 | 22.90 | 16.3 |
| A x 100/B (%) | 46 | 101 | 63 | 59 | 58 |
| LSD (P = 0.05) | Unrepl. | 1.4 | 2.2 | 2.6 | Unrepl. |

**Table 2**
Composition of whole crops of white clover/winter wheat and conventional winter wheat at Foulum

| | | % of DM | | |
|---|---|---|---|---|
| | DM, % | Clover | N | ADF |
| W. clover/w. wheat | 43.9 | 18.0 | 1.29 | 26.6 |
| Conventional w. wheat | 53.5 | - | 1.39 | 26.3 |
| LSD (P = 0.05) | 5.1 | - | n.s. | n.s. |