

Grass/legumes associations in crop rotations

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Summary

The objective is to quantify the potential of meadows and more especially of grass/legumes associations as head of crop rotation, instead of maize silage. Different legumes are studied in association with grass: lucerne and clover. The annual productions of each crop have been recorded. Benefits provided by the meadows for soil structure (in relation to the roots system of the legumes) and therefore for growth of the following crops will be especially studied. In addition, the impact of legumes on nitrogen fertilisation and nitrogen balance for the next crops (N fixation, soil residues) will be evaluated.



Background

Crop-livestock systems are looking for new head of rotation since the traditional one has been limited due to quota limitation (sugar beet) or to their negative environmental impact (maize). Therefore, this study aims to illustrate the interest of legumes rich meadows as rotation head in comparison to a classical head of rotation (maize) and to maize mono-cropping. Indeed such meadows would help to control weeds, to maintain a good soil structure, to support pollinator activity and to supply nitrogen to the rotation. Furthermore, they also improve mixed farm fodder nitrogen autonomy in comparison to sugar beet crop, an issue of which farmers are more and more aware.

Crop rotations and annual production

Table 1 presents annual productions of each crop. Three cropping systems are tested: 1) maize mono-cropping; 2) maize followed by two cereals; 3) meadows for three years. The management of maize and cereals crops follows usual rule (fertilisation, ...). The nitrogen fertilisation of meadows is limited (according to the cropping year 0 to 1 application of 27 kg N/ha for grass-legumes association; 1 to 3 applications for grass).

		Cocksfoot														
Cocksfoot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Cocksfoot
	CS3	CS1	CS2	CS3	CS3	CS3	CS3	CS2	CS1	CS3	CS3	CS3	CS3	CS1	CS2	
	Cocksfoot	Maize mono-crop	Crop rotation	Cocksfoot + lucerne	Cocksfoot + clovers	Cocksfoot	Cocksfoot + lucerne	Crop rotation	Maize mono-crop	Cocksfoot + clovers	Cocksfoot + lucerne	Cocksfoot	Cocksfoot + clovers	Maize mono-crop	Crop rotation	

Cropping system 1: average maize production is normal but tends to decrease, probably in relation with climatic conditions of the cropping year.

Cropping system 2: similar production for maize mono-crop or maize in crop rotation the first year, spelt grain production appears normal but barley grain production is low due to a very dry spring.

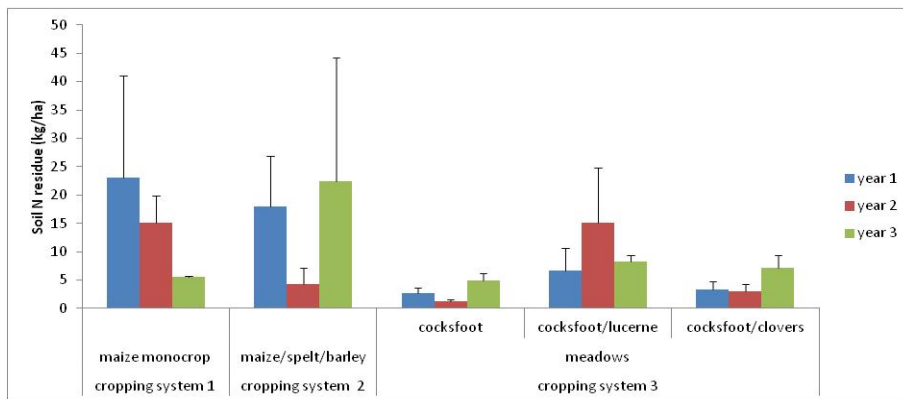
Cropping system 3: legumes associations are more productive than grass crop. The first year (meadows sown in spring), meadow productions are 2 to 3 times lower.

Table 1. Annual crop productions (ton of Dry Matter/ha)

		Year 1	Year 2	Year 3
Cropping system 1	Maize mono-cropping	22,0	19,6	19,4
Cropping system 2	Maize	21,4	/	/
	Spelt grain/straw	/	6 / 3,2	/
	Barley grain/straw	/	/	6,7 / 1,9
Cropping system 3	Meadows : nb of cuts	3	4	3
	Cocksfoot + lucerne	5,6	16,6	14,6
	Cocksfoot + clover	5,3	14,3	13,7
	Cocksfoot	3,1 (2 cuts)	8,0	8,1

Legumes, nitrogen fixation and soil nitrogen residues

Legumes are able to fix atmospheric nitrogen which is then available for the plant association. The nitrogen fixation is here estimated by difference (N exported by crop – N from fertilizer – N from soil).

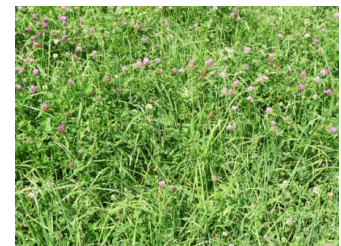


In cocksfoot/lucerne crop, nitrogen fixation by legumes is estimated to 117 kg/ha the sowing year and to 410 kg/ha the second year. Nitrogen fixation by legumes reached 105 kg/ha and 296 kg/ha in cocksfoot/clovers crop. Nitrogen soil residues (0-30 cm) are lower than 15 kg/ha under

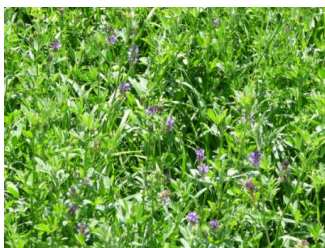
meadows. On average, soil nitrogen residues are lower than 25 kg/ha for all cropping systems.

Lucerne or clover or other legumes, recommendations

Red clover (*Trifolium pratense*) is frequently sown with Italian ray grass for temporary pasture. In pure cropping, diploid variety is sown at 15-20 kg seed/ha and tetraploid variety is sown at 20-25 kg/ha. In association with grass, the red clover is sown at 8 kg/ha with 20 kg of grass seed. The nutritive value of the association, mainly in term of protein concentration, is good as is its frost resistance. Its main disadvantage is its wilt difficulty and its short persistence (2-3 years).



Lucerne (*Medicago sativa*) is a perennial plant (persistence: 3-4 years) mainly sown alone (15-20 kg seed/ha) for hay or silage. It can be associated with cocksfoot at the seeding rate of 12 kg cocksfoot for 15 kg lucerne. According to the cropping area (north or south of Europe), the choice of the botanical type (Flemish type for the North or Mediterranean type for the South) is important for the growing success. Likewise, for a good development of the crop, it is better to inoculate lucerne seeds with rhizobia (nitrogen fixing bacteria) before sowing. Lucerne is sensitive to water excess and soil acidity. As for clover, the main disadvantage is leaves loss during wilting.



Birdsfoot trefoil (*Lotus corniculatus*) is a perennial plant used for grazing or mowing. Birdsfoot trefoil doesn't like rich soils and intensive management (high cutting frequency, high nitrogen fertilisation). The recommended seeding rate is 15 kg/ha in association with 10 kg of grass such as timothy, tall fescue or ray grass. The annual production is low compared to lucerne or red clover association. Birdsfoot trefoil contains tannins which are known to protect protein from ruminal degradation. So, this legume leads to less bloat risk than lucerne or red clover.

