Grass pea and green manure effects in the Great Hungarian Plain.

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Background

Developing an appropriate crop rotation scheme is one of the most challenging tasks for sustainable agriculture. Farmers should develop a rotation plan with both the needs of the farm and the needs of the sustainable system in mind. Crop rotation should provide effective weed control by (i) alternating between crops, (ii) including plants adapted to mechanical weed control, or with (iii) allelopathic properties, including (iv) leguminous crops and (v) crops with fibrous root systems to improve soil structure. Crop rotation should also provide an effective insect and disease control [(3)].

Studies have shown that cultivated fallow and monocropping destroy soil structure and increase soil compaction [(1)]. By growing green manure crops, farmers increase water infiltration and retention of nutrients and thereby improve the ability of soil to sustain the plants in drought conditions and reduce both wind and water erosion [(4)]. Legume crops play an important role in the regenerative soil conserving strategy. Root and green manure crops add organic matter to the soil, assist in dissolving insoluble nutrients, bring up nutrients from the subsoil and improve the water holding capacity of the soil [(6)]. The crop rotation system should improve soil condition by including deep rooted plants and plants with a fibrous root system to improve the stability of soil aggregates [(5)].

Grasspea

The beneficial effect of grasspea on the yield of subsequent crops has been known since ancient times. There is also evidence suggesting that an improved soil structure increases biological activity in the soil and enables plants to utilise soil moisture and nutrients more effectively. Nutrients and trace elements may also be assured or enhanced through the inclusion of certain crops into the rotation [(7)]. The present research is aimed to validate a new model for an integrated system of sustainable production, which takes advantage of biological diversity available and helps to safeguard it from erosion. This programme will promote a self-sustainable system where the cultivation of leguminous crops becomes advantageous for local farmers because of soil conservation effects and increased market possibilities for healthy products [(2)].

Grasspea can be grown successfully in the arid area of the Great Hungarian Plain. This fact gives grasspea a distinct advantage since other legume crops usually fail on low fertility soils, as compacted soil or low moisture inhibit the growth of the root system. Grasspea is commonly thought to be best adapted to arid regions and to be tolerant of salt accumulation in solonetz soil. It has also been widely reported that they require limited amount of water or fertilisers, but these views are not entirely correct. Low productivity is not necessary for grasspea and high yields can only be achieved with productive soil conditions. Growing grasspea on the other hand can reduce potential for soil compaction and increase soil fertility.

A research project carried out during the late 1970's investigated the suitability of spring-sown grasspea for arable agriculture. Although the crop germinated and performed well early in the season, it suffered from uneven maturity and was not ready for harvest until late July. In these circumstances yields were unreliable and seed quality was poor.

Selection within ecotypes and, more recently, plant breeding have led to substantial improvements not only in seed yield but also in stability of yield. A strong and positive correlation between seed yield and biomass production has persisted throughout domestication, whilst harvest index, the ratio of seed to biomass, has remained relatively stable. Seed qualities such as seed size, nutritional quality, protein concentration and the frequency of disease-damaged seeds have been modified by selection for seed yield. Likewise, straw quality in terms of nutritional value as feed, and those characters that promote the persistence of large residue fragments on the soil surface (e.g. leaf retention until harvest, vegetative vigour, large stem diameter and the distribution of lignified fibres throughout the stem) have also been influenced by selection for seed yield. Ongoing selection for seed yield seems likely to continue to have economically significant consequences in terms of these diverse quality characteristics (Table 1).

The use of ecotypes, which are well adapted to their environment, maximises effective crop duration, resource capture and thereby dry matter accumulation and ultimately biomass and seed yield. The development of cultivars which are phenologically well-adapted to their environment, able to avoid late-season drought through timely flowering and maturity, or cold-tolerant and disease resistant cultivars which are suitable for autumn sowing, are therefore likely to contribute substantially to future yield improvements. Seed losses of grasspea at harvest can be substantial, especially when harvesting is mechanised and so selection for resistance to lodging, is necessary to further improve and stabilise yield.

Table 1: Agronomic characteristics of grasspea varieties

	Varieties				
	Karcagi fehérvirágú	**Kinalskaja**	**Sl-105**	**Sl-106**	**Sl-107**
Plant height (cm)	156	143	141	145	143
Number of pods/plant	21.5	22.0	21.2	21.5	21.3
Number of grain/ plant	45.1	43.5	43.5	45.8	42.2
Grain weight/plant (g)	9.27	9.22	8.99	9.57	8.87
Number of grain/ pods	2.10	1.90	2.05	2.13	1.99
Grain weight/pod (g)	0.39	0.40	0.42	0.44	0.44
1000 grain weight (g)	205.6	211.9	206.7	208.9	210.3
Grain yield (t/ha)	3.37	3.51	3.09	4.08	3.68

Soil productivity is an important concern for farmers. Growing a legume crop to be worked into the soil is an old agricultural practice that is increasing in popularity again. Grasspea, as a leguminous crop, also offers the potential advantages of crop rotation. They can be used to add organic matter, nitrogen, to conserve and recycle plant nutrients and protect the soil from erosion.

Grasspea is a remarkable and versatile crop, which can grow successfully in soil, with poor nitrogen status and in semi-arid conditions, and which provides both high-protein seed for food and straw for feed or soil conservation. In recent years consistent progress has been made in improving both the seed and biomass yields of the crop (Table 2). Prospects for further seed yield gains continue to improve largely as a result of rapidly improving knowledge of grasspea genetics and the availability of novel techniques, such as marker-assisted selection and gene transfer, which can assist in the selection of beneficial traits.

Table 2: Yield, composition and effect of grasspea green manure

	Plant growth stage			
	Flowering	**Pod production**	**Seed production**	**Waxen ripeness**
Average of grasspea varieties				
Green yield (t/ha)	7.78	35.70	40.40	24.11
Dry matter (%)	12.5	15.6	25.8	51.3
Dry matter yield (t/ha)	0.97	5.56	10.42	13.36
Protein content (%)	25.83	20.90	18.66	15.80
Protein yield (t/ha)	251.2	1163.9	1945.0	2111.8
Subsequent wheat yield (t/ha)	5.48	5.82	6.24	5.92
Subsequent wheat yield (%)*	121.8	129.3	138.7	131.6
Average of pea varieties				
Green yield (t/ha)	7.41	21.44	29.88	15.36
Dry matter (%)	12.0	13.5	19.7	45.0
Dry matter yield (t/ha)	0.89	2.89	5.88	6.91
Protein content (%)	21.81	24.18	17.08	14.35
Protein yield (kg/ha)	194	698	1006	992
Subsequent wheat yield (t/ha)	5.24	5.19	5.52	5.36
Subsequent wheat yield (%)*	116.4	115.3	122.7	119.1

*per cent of control, wheat after wheat biculture

In regions, where grasspea straw is valued for feed, or where crop residues are vital in restricting soil erosion, selection for biomass production is also a priority. Several studies have confirmed the existence of sufficient heritable genetic variation in straw yield to warrant direct selection. However, in regions where straw is less valuable than seed, it is important to ensure that straw yield is not increased at the expense of seed yield. Grasspea biomass has already increased considerably as an indirect result of selection for seed yield. When genotypes are phenologically well-suited to their production environments there is a strong and positive correlation between improved seed yield and biomass, whilst HI has remained more or less stable. Grasspea seed yield is dependent upon the rate of dry matter accumulation, particularly during preflowering growth. The correlation between seed yield and biomass therefore seems likely to continue for the foreseeable future.

Concluding statements

Grasspeas offer some potential advantages and new management options compared to other legumes. These include: (1) equal or higher yield potential under unfavourable soil and climatic conditions (Table 2), (2) better adaptation to conservation tillage systems, (3) it reduces soil compaction potential, (4) expand production area and providing an alternate rotation crop to producers. One of the aims of this joint programme of research is to identify suitable genotypes and safe production technologies for sowing of grasspea for various locations and altitudes throughout Europe.

Research conducted within functioning sustainable agriculture is essential to overcome some of the technical problems, which still need to be resolved and to improve further grasspea production.

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