

Intercropping cereals and grain legumes: a farmers perspective

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Abstract –Intercropping cereals and grain legumes show potential for organic agriculture in many ways. However, the use of land equivalent ratio (LER) as a measure for calculating the cropping advantage of intercrops over sole crops is too simple: neglecting weed suppression, yield reliability, grain quality, and minimum profitable yield, which are all relevant factors from a farmer's perspective. Only when the crop selection for the mixtures is carefully done, and crops are grown on the right soil in the right rotation, can intercropping be made to profit.¹

INTRODUCTION

In recent years much research has been done on intercropping cereals and grain legumes, mainly in Denmark. The main focus of this research was on comparing sole grain legumes with intercropping grain legumes and cereals. The comparison was made using land equivalent ratio (LER) (De Wit and Van der Berg, 1965) and weed suppression as the main indicators (Hauggaard-Nielsen 2001^a, 2001^b and Jensen 2005).

LER, however, is a poor measure for farmers to indicate a cropping advantage. A LER higher than 1 only shows that if a farmer has one piece of land available and he wants to grow those amounts of cereals and grain legumes as produced in the crop mixture, he would have been better of doing that as an intercrop. But farmers have the ability to choose between different pieces of land and grow those crops that are most suited for those parcels. Any shortage can be bought from other farms that can produce these products more economically. So for farmers an intercrop becomes interesting when the net returns of that crop are better than those of one of the sole crops.

Next to economics, weed suppression, reliability of yield and grain quality are other important indicators for farmers.

To provide the farmers with the necessary tools to make crop decisions on their own farm we started on-farm field trials in 2002. We started by concentrated on the most familiar intercrop: pea-barley. Over the course of the years we incorporated other intercrops as well: faba bean-wheat (2004), lupin-barley and lupin-wheat (2005). In this article an overview of the results of these experiments are presented. All were on-farm experiments in three-fold.

WEED SUPPRESSION

Grain legumes are known to be weak suppressors of weeds. This is caused by a slow early development of the plants and lodging (pea) or loss of leaves (faba beans) in the ripening phase of the crop. For Dutch organic farmers this poor weed suppression is the main reason for not growing grain legumes at all. Adding a cereal to the grain legume highly improves the weed suppression abilities of the crop. However, compared to a sole cereal crop, weed suppression is at best comparable, but often less in an intercrop (Hauggaard-Nielsen 2001^a, Jensen 2005). As the cereal is the main weed suppressor in the intercrop, cereals should be sown at sufficient levels (see table 1).

| Intercrop | | Sand | | Light Clay | |
|-----------|-----|-------|-----------|------------|-----------|
| Barley | Pea | Yield | Weedseeds | Yield | Weedseeds |
| kg/ha | | t/ha | kg/ha | t/ha | kg/ha |
| 5 | 200 | 1,8 | 408 | 5,9 | 38 |
| 20 | 190 | 2,5 | 372 | 6,2 | 26 |
| 40 | 180 | 3,1 | 230 | 6,4 | 25 |

Table 1 Grain yields and weed seed yield in three barley-pea intercrop mixtures sown in different ratios in 2003

RELIABILITY OF YIELD

Reliability or stability of yield over the years is an important factor for a farmer. Like weed suppression, intercrops tend to have a higher yield reliability than sole grain legumes. However, for certain intercrop mixtures the yield reliability is still too low to convince farmers. Especially pea-barley mixtures are highly variable in yield due to possible damage by pigeons directly after sowing and during ripening. During the growing season the peas can be affected by lice and draught and in the ripening crop, a large part of the harvest can be lost due to lodging and bad weather (see table 2).

| | | 2002 | 2003 | 2004 | | 2005 |
|-----------------|------------|--------------|--------------|--------------------------|-------------------------|---------------------------|
| | | | | before rain ¹ | after rain ¹ | |
| Pea-Barley | Sand | | 3,2 (37%) | 3,7 (13%) | | 1,8 ² (49%) |
| | Light clay | 5,4 (22%) | 6,4 (53%) | 5,7 (20%) | 2,4 (10%) | 2,7 ³ (15%) |
| Faba bean-Wheat | Sand | | | | 4,3 (74%) | 5,7 (57%) |
| | Light clay | | | | 4,2 (56%) | 6,4 (47%) |

¹ Part of pea-barley mixtures is harvested before and part after heavy rains at the end of august 2004

² Low yields due to lodging and rain ³ Pigeon damage during emergence

Table 2 Average grain yield (t/ha) and grain legume content (%) in intercrop mixtures in 2002-2005

Also a wrong choice of cereals and grain legumes causes a great risk of loss of yield and reduction in

grain quality. Combining an early ripening crop like barley or pea, with a late ripening crop like wheat or faba bean does increase the risk considerably as the early crop can loose its grains while waiting for the late crop to ripen. But even when two crops theoretically match, an extra uncertainty is introduced compared to sole cropping. Even a slight delay in harvest of a cereal crop due to the fact that the grain legume hasn't fully ripened, can cause a drop in grain quality due to bad weather. So intercropping cereals with grain legumes does not automatically give an improvement of yield reliability. This can only be reached by carefully choosing the right crops and varieties for the mixtures. Of the different intercrops, an early ripening faba bean with a late ripening wheat seem to give the highest yield reliability as both crops are hardly prone to lodging and grain loss (see table 2).

GRAIN QUALITY EFFECTS

Although weed suppression and yield stability can be important advantages of intercrops over sole grain legumes, the advantage of intercrops over cereal crops is not yet obvious. But there is one aspect that greatly favours intercrops over sole cereal cropping: the effect of intercropping on the protein content. In both experiments with pea-barley and faba bean-wheat we found a considerable heightening of the protein content in the cereal grains when intercropped with a grain legume (table 3).

| | 2004 | 2005 |
|-----------------|-------|-------|
| Wheat-sole crop | 11,2% | 10,2% |
| Wheat-intercrop | 13,0% | 12,5% |

Table 3 Average protein content (%) in wheat grown as a sole crop or intercropped with faba beans

The heightening of the protein level of roughly 2% is not much from a feed value point of view, but large and possibly decisive for a distinction between animal feed and baking wheat. Obtaining the same protein levels in sole wheat crops has been proven to be very difficult.

ECONOMICS

The production cost of cereals and grain legumes or their crop mixtures is roughly the same.

| Yield t/ha | Production cost | |
|---------------|-----------------|---------|
| | €600/ha | €300/ha |
| 3,0 | 0,42 | 0,32 |
| 4,0 | 0,31 | 0,24 |
| 5,0 | 0,25 | 0,19 |
| 6,0 | 0,21 | 0,16 |
| 7,0 | 0,18 | 0,13 |

Table 4 Average production costs of cereals and grain legumes including labour, machines and land rent of €600/ha or €300/ha

Generally, production levels need to be quite high to make these crops economically viable (see table 4). For livestock farmers that want to grow part of their concentrate feed themselves, the production cost has to compete with market prices. Organic feed cereals are €0,18-0,19/kg purchase and feed grain legumes €0,24-0,25/kg. The necessary yields

for cereals should be 7 t/ha on expensive, often productive soils and 5-5,5 t/ha on cheaper soils. As the price of grain legumes is higher than that of a cereal, yields of sole grain legumes and crop mixtures can be lower to be profitable (1 resp. 0,5 t/ha on expensive soils and 2 resp. 1 ton/ha on cheap soils).

For an arable farmer, crop mixtures have to compete with baking wheat. As the price of baking wheat (€0,21-0,25/kg) is higher than feed cereals, the yields need to be roughly the same as sole cereals to be equally profitable. However, intercropping wheat with grain legumes has the advantage of securing baking quality for the wheat without using a lot of manure. As manure is becoming increasingly expensive, intercropping seems to be a good organic solution.

CONCLUSIONS

The LER has proven to be a poor measure for farmers to indicate a cropping advantage of intercrops over sole cropping. Comparing net returns, weed suppression abilities and yield reliability of the different crops appear to be much more useful. As sole grain legumes are highly weed susceptible and have a low yield reliability, Dutch farmers are reluctant to cultivate these crops themselves. As a result, farmers do not compare intercrops with sole grain legumes, but with sole cereal crops.

Of the different intercrops, pea-barley mixtures are still considered to be too risky to cultivate (low yield reliability). Faba bean-wheat mixtures seem to be the most reliable and economically viable option.

Still, dairy farmers will generally favour the production of cereals over intercrops as these crops can benefit more from the high soil fertility caused by the preceding perennial grass clover swards. The biggest benefit of intercrops can be expected in arable rotations, where the percentage of nitrogen fixing legumes is lower and where the heightening of the protein level in the cereals can be made to profit in the production of baking wheat.

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