Pastures for prime wheat production

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Overview:

Producing nitrogen from legume based pasture gives feed as well as improving soil fertility. Nitrogen gains from pasture are thought to be more efficient than applying fertiliser, which is especially important when trying to produce prime hard wheat. This is a good example of the need to look at farming systems rather than cropping or pastures in isolation. Initial results suggest that wheat following pure legume stands achieves higher yields and Prime Hard status. Adding ryegrass to the pastures reduces yield (by 0.8t/ha) and protein levels (by 2.5%) in subsequent wheat crops.

Why grow pastures for prime wheat production?

In the low rainfall areas of central and southern NSW, the only bio-economically sustainable means of lifting the grain protein in wheat is to improve the nitrogen benefits gained from legume pastures in a phase farming system. Nitrogen fertiliser is rarely an economic source of nitrogen because of its low efficiency in producing high protein and because of the high degree of risk in this environment. In comparison, legume based pastures that fix nitrogen can provide both quality livestock feed and improved soil fertility for subsequent crops.

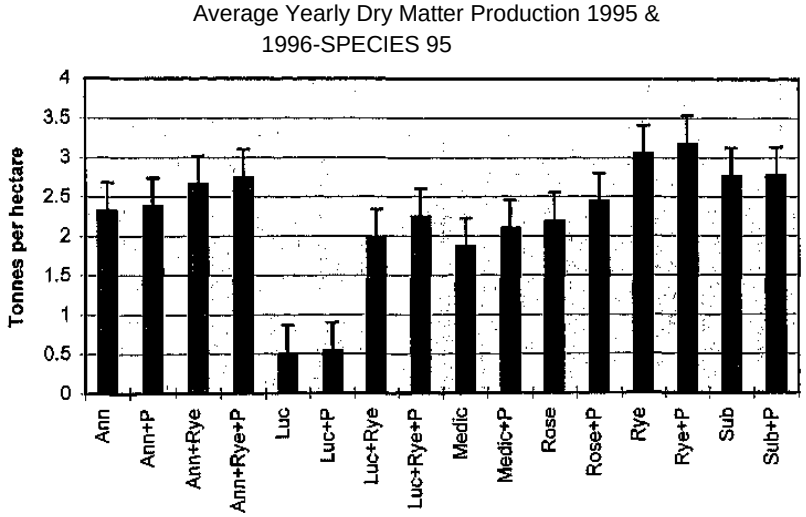
What do we need to know?

A solid understanding of how to best produce and manage this nitrogen supply in pasture and crop rotations in a low rainfall environment is lacking. The choice of pasture species, length of the pasture phase and management of the pastures, especially in terms of grazing and weed management, phosphorus nutrition and soil acidity, are all important variables that need to be understood in terms of their influence on the nitrogen cycle and productivity in this environment.

What has been found (preliminary findings)

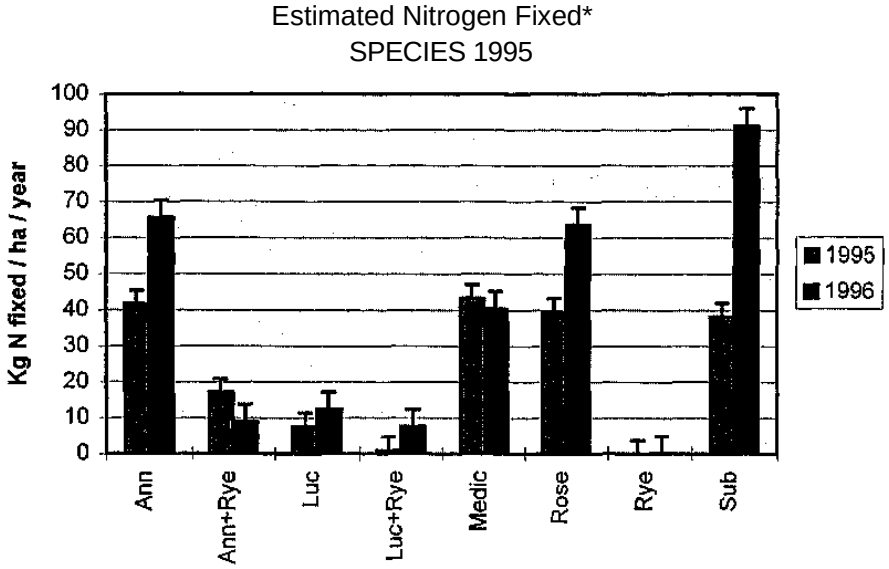
Dry matter production results from 1995 and 1996 suggest that there are no significant benefits from the addition of phosphorus fertiliser (@ 20kg/ha) on any of the pasture treatments. Pure stands of ryegrass produced the largest amount of dry matter followed closely by Subterranean clover and a mixture of annuals and ryegrass. The lucerne produced very little dry matter owing to its poor establishment. Of the annual legumes, the Subterranean clover has performed significantly better than the medic and the rose clover and mix of annuals lie in between (See Figure 1). This will probably change with the season; future results will confirm this.

Figure 1.



Nitrogen fixation estimates (obtained from the dry matter data) show that the potential differences in the amount fixed between the two years were often greater than those between treatments (see Figure 2). For example, in the establishment year (1995) all the annual legumes fixed similar amounts of nitrogen however in the following year there were large differences between the annual species. In 1996 the average amount of nitrogen fixed by Subterranean clover was 91kg/ha, rose clover 64 kg/ha and medics 40 kg/ha these differences are all highly significant, the mix of three annual species fixed ~66 kg/ha, similar to the rose clover. The effect of ryegrass in the annual mixture reduced the average nitrogen fixed to only ~9 kg/ha due to competition. Acidity (pH 4.6) in the top 10 cm of the experimental site appeared to be a potential problem affecting the pasture production. It is probably affecting the production of the medics which are more sensitive to pH. The lime trial results will resolve this. The lucerne treatments are utilising the deep water reserves while the annual legumes and ryegrass only exploited soil water above 70 cm.

Figure 2.



** Amount of N fixed is estimated from the legume dry matter using Peoples "rule-of-thumb" (25 kg N fixed for every tonne of legume dry matter produced). (NB: Error bars represent 2 standard errors.)*

In June 1997 the first experimental pasture trial was sown to wheat. Despite an extremely dry start, the wheat developed well and in November it was successfully harvested yielding above local farmer averages. The average yield over the plots was 1.9 t/ha (See Figure 3). The best yields came from the pure lucerne and annual mix treatments (2.2 t/ha). Whereas the yield following the pure ryegrass pasture was significantly lower than all other treatments (only 1.4 t/ha).

The amount of nitrate left in the soil varied significantly between pasture treatments. A good correlation (R2 = 0.69) was found between nitrate at 30 - 50 cm depth and final grain protein levels (See Figure 4). The lucerne and annual legume treatments consistently provided significantly more available nitrogen than treatments containing ryegrass between 10 and 70 cm. This was reflected in the protein levels of the harvested wheat which reached Prime Hard (>13.5%) only from these treatments. On average protein levels from pastures with a ryegrass component were reduced by 2.5%. (See Figure 5)

Figure 3.

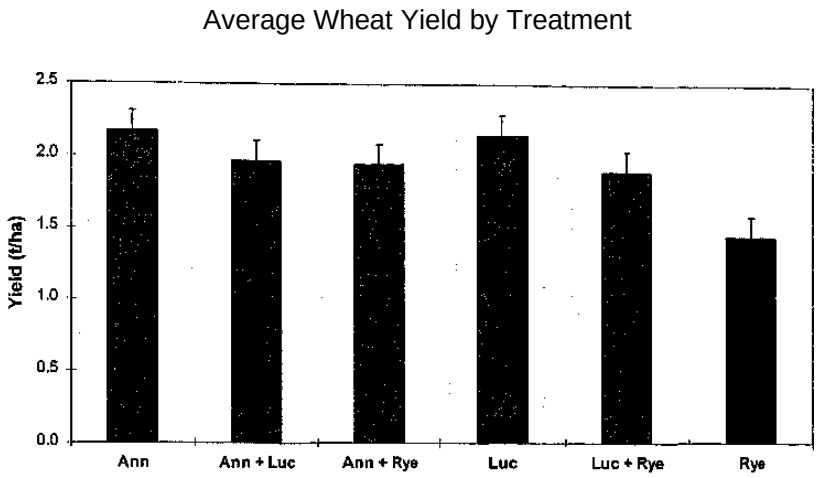


Figure 4.

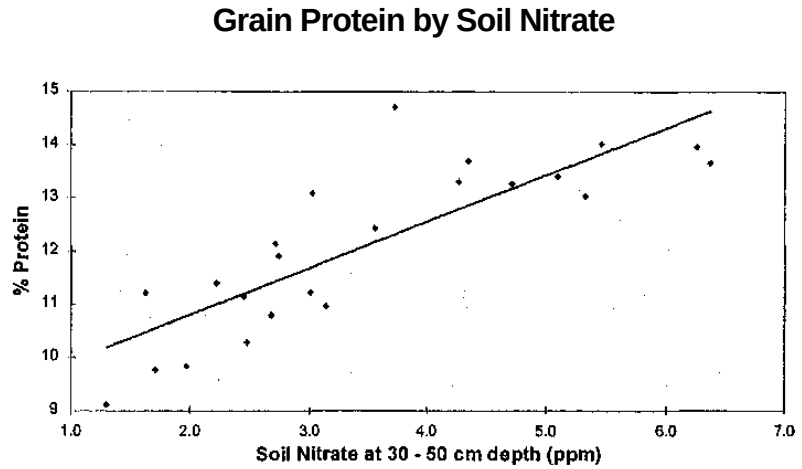
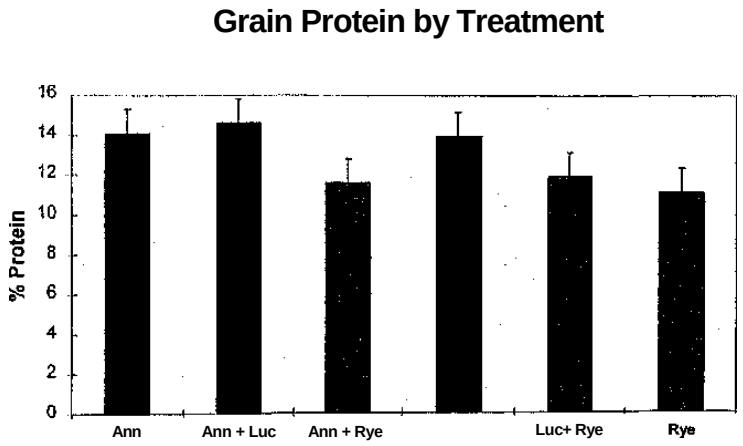


Figure 5.



Initial conclusions suggest that to achieve good yields and Prime Hard wheat, farmers need to establish pure stands of legume in the pasture phase. Lucerne, Subterranean clover and rose clover fix the most nitrogen. It also appears that a short pasture phase of only two seasons is able to achieve this Prime Hard status. Note that these conclusions are based on only one years results, these will need to be verified over several seasons before robust relationships can be established.

How have we been investigating this?

This GRDC funded pasture project commenced in 1995 with the aim of examining a range of pasture species and management options that could aid in the production of Prime Hard Wheat. The nitrogen fixation and cycling capabilities of each management option are being investigated as well as their effects on the quality of the soil resource. Most importantly, the effects of the pasture supplied nitrogen on wheat yield and quality are to be determined.

The experiments:

Several experimental trials have been sown on the research station to observe the effects that pasture species, length of the pasture phase and management have on the nitrogen cycle.

Two *SPECIES* trials were sown on the research station in 1995 and 1996. These experiments were designed to resolve if any species differences exist in production and/or nitrogen fixation. The treatments cover options of individual legume species in relatively pure stands (Lucerne, Subterranean clover, Rose clover and Medic) and mixtures of the three annual legumes (Annual mix) and a Lucerne/Annual mix. The effect of a grass component on legume production is included with Ryegrass, Ryegrass/Lucerne and Ryegrass/Annual mix treatments. A chemical fallow completes the treatments. Two phosphorus rates (0 and 20 kg/ha) were used and all treatments are replicated three times. These treatments will all be sown to wheat after four years of pasture.

While the amounts of nitrogen contributed annually can be resolved from *SPECIES* trials, it is limited to one pasture phase length (4 years). The optimum duration of phase length is the focus of the *PHASE* trial. Utilising phosphorus at sowing of 20 kg/ha, six treatments (primarily from *SPECIES)* and four phase length options with four replicates were sown in 1995. Treatments are Lucerne, Annual mix, Ryegrass, Ryegrass/Lucerne, Ryegrass/Annual mix and Lucerne/Annual mix. The first cropping phase commenced with fallow in September 1996 and was sown to wheat in June 1997 (Janz sown @ 45 kg/ha with double super @ 16kg/ha). It was harvested last year. The second cropping phase was sown in June this year.

Two pasture *lime* trials were sown in 1997 and 1998. These investigate the effect that soil acidity is having on both pasture productivity and its ability to fix nitrogen. It is believed that low soil pH may be responsible for poor productivity and low amounts of fixed nitrogen, these trials should resolve this and quantify how much soil acidity is affecting potential crop productivity. Treatments consist of relatively pure stands of Lucerne, Subterranean clover, Rose clover, Barrel Medic, Balansa clover and Ryegrass at four rates of lime (0.75, 1.5, 3 and 6 t/ha) replicated three times. These will be cropped to wheat after four years of pasture.

A lucerne *DENSITY* trial was sown this year to investigate the effects that different stands of lucerne have on nitrogen inputs, soil water usage, sustainability and ground cover. Pasture ground cover plays a key role in maintaining soil physical condition. Lucerne was sown at three rates (1,2 and 4 kg/ha) with and without annual companion species (annual legume mixture and volunteer grasses) replicated four times.

What we measured

These experiments are being monitored for pasture dry matter production and species composition including weeds. Legume plant material is collected to determine the amount of nitrogen being fixed. Soil samples are collected to measure soil fertility including mineral nitrogen (nitrate and ammonium) status and pH. Soil water use efficiency is monitored using a neutron probe in some trials. Properties measured from the wheat crop that is sown after each pasture phase include, dry matter production, harvest index, yield, grain size and protein. The pasture trials are grazed after each plant sampling period.

Who's responsible for all this?

This pasture project is an initiative of NSW Agriculture. Funds are provided by Australian farmers through the Grains Research and Development Corporation (GRDC). Gerard O'Connor managed the project up until his resignation in January 1997. Libby Roesner has taken over as Pasture Agronomist for the project since June 1997.

What's happening in the future?

The most important results from this work, being those obtained from the wheat stage of the system, will need to be collected for several more years in order to develop substantial findings. This project has been refunded by GRDC for a further 5 years which will enable this important work to be completed. Pasture monitoring will continue and subsequent wheat yields and quality will be assessed and monitored to determine the long term effects particularly of the different phase lengths.