INTEGRATING PASTURES WITH CROPS FOR SUSTAINED PRODUCTIVITY

David Coventry
Rutherglen Research Institute
Department of Agriculture and Rural Affairs
Rutherglen, Victoria.

Many farming systems in southern Australia include the rotational use of self regenerating annual pasture legumes with crop production. This ley-farming system, which started in the 1930's, is now well established with sub. clover widely grown on the neutral to acidic soils and barrel medic, and other medics, on the more alkaline and drier soils. Traditionally the make up of the rotation is 5-8 years pasture followed by 2-3 years crop. However, in the last decade, with the use of grain legume crops, there has been a swing towards more cropping and fields may be under crop for 5 to 8 years continuously. Some farms have switched completely to all-crop regimes but most (>95%) still return their fields to pasture.

The advantages of the ley-farming system are well documented and this system is often considered an ideal sustainable farming system. The pasture legumes provide sufficient soil nitrogen to support up to 3 subsequent cereal crops, with net increments of from 40 to 100kg N/ha annum. The pasture also improves the structure of the soil and acts as a break for crop diseases and pests. Finally, ley-farming offers the farmer the diversity of both crop and livestock enterprises. Whilst these are still important for a sustainable farming system, problems associated with pasture productivity and land degradation are de-stabilizing this ley-farming system.

Given the dynamic nature of farming, where changes in biological, environmental, sociological and economic demands are continuous, it is probably illogical to expect that a farming system will be sustainable for more than a decade or two at the most. Examination of the history of Australian wheat yields, which closely reflect the farming systems of the time, illustrate this point well. The introduction of new varieties, fertilizer applications, fertility and disease considerations each resulted from a requirement for change. Consequently, the development of our farming systems is an evolutionary process. We know well that we are still involved in this process and must continually refine and occasionally redirect our farming systems. Factors which are presently contributing to changes in the ley-farming system include economic and market considerations and soil degradation.

Economic factors.

For the past decade or more farmers have had to operate in a downward trend in their trading position. Consequently there has been pressure on farmers to both increase output and also to achieve cost economies in their operations. Prior to 1984/85 higher returns were possible from cropping, and, with

technological change in labour saving/capital using operations favouring crop production rather than livestock, the adoption of new tecnhology has been more in the cropping industries. Thus we have seen a tightening of the rotation with more cropping. One consequence of the economic situation was that farmers often neglected the re-establishment and management of pastures on the mixed farm. With poorer pastures often resulting from this neglect, and associated reductions in animal production and N inputs, the confidence of many farmers in the pasture phase of the rotation has been undermined. Clearly this is an area where a major extension effort is required.

Pasture Management

Pasture Re-establishment

With cropping rotations being extended, a new approach is needed to ensure the re-establishment of productive pastures after a cropping period. The two main options are i) to re-seed paddocks with relatively high rates of both legumes and grasses at the end of the cropping period, or ii) to adopt the cropping practices to ensure better pasture survival, particularly of legumes.

Cropping fields should be re-seeded with at least 5-10 kg/ha of sub. clover or medic, plus a companion grass, after cropping. Re-introduction of the relevant *Rhizobium* strain is usually necessary. Paddocks not treated this way after a long period of cropping are virtually bare in year one and then become overrun with weed species. Fields re-seeded with pastures alone can become productive in either year one or two, whilst those sown with a cover crop usually take longer to reach satisfactory densities. If undersowing is carried out then the seeding rate of the cover crop should be reduced dramatically. Also some crops, such as triticale, are more suitable as cover crops.

An alternative to re-seeding pastures is to manipulate existing pasture through the cropping phase, for example, a pasture-wheat-pasture-wheat rotation. A technique used to achieve this is to spray an existing pasture with paraquat/diquat to eradicate grassy and broadleaved weeds (which will only suppress the sub.clover), then establish the cereal using direct drilling. Subsequent herbicide usage in the crop is restricted to materials tolerated by the legume. The following season the pasture legume readily regenerates, particularly if the cereal stubble is burnt. An annual grass may be direct-drilled into the sward to improve winter production, but the overall effect is to alternate between a fully productive crop followed by a fully productive pasture.

Species and varieties

The two key factors to be considered when selecting pasture legumes are persistence and productivity. With the ley-farming system, the strong complementary link between the crop and

pasture phase must be recognized and it is essential that nodulated legumes persist in reasonable numbers.

In the higher rainfall areas of the cropping belt (>400mm average annual rainfall), the use of mixtures of pasture legumes is often a sensible strategy. In this way the high persistence of sub.clover varieties such as Daliak and Nungarin can be combined with the better production of Seaton Park, Woogenellup or Trikkala.

The improvement of annual grasses adapted to the cropping areas has so far received little attention. Annual ryegrass increase winter feed production and also is integral in improving soil structure. Although the ryegrass will have to be controlled in subsequent crops, it is still worthwhile sowing ryegrass in pasture mixes in many areas.

Fertilizers

With the decline in pasture topdressing in recent years, many farmers now rely on the residual carryover effect of phosphate fertilization during cropping for the pastures. Often pasture seed is sown with no additional fertilizer and on some soils this can be a contributing factor to poor initial establishment of pastures.

The use of concentrated phosphate fertilizer rather than superphosphate may eventually affect the sulphur nutrition of pastures.

Another nutrient problem that is now identified on the acid soils in the cropping regions is the deficiency of molybdenum (discussed later).

Pests and diseases

Breaking up of pasture for cropping is generally highly effective in controlling major pasture pests eg. cockchafers. However these and other pests may carryover, possibly more often where minimum tillage methods are used, and cause damage to subsequent crops.

Red-legged earthmite can contribute to poor pasture establishment. On cropping farms there is often a high proportion of pasture being sown, and it is this that is particularly prone to attack by earthmite.

Weeds

There are several weed species becoming more prevalent in the mixed farming areas of southern Australia and these include brome grass (*Bromus sp.*) docks (*Rumex sp.*) rat's tail fescue (*Vulpia bromoides*) and Patersons Curse (*Echium plantagineum*).

The ley-farming system does allow more scope for weed management, although for the cheaper control of problem species an integrated approach utilizing grazing, cultivation and chemicals will probably have to be devised. Spray topping techniques also have a role both for the pasture phase and also for the control of grass weeds in the final year of pasture.

Soil degradation

Soil acidity

The areas in southern Australia in which excessive soil acidity is affecting crop/sub.clover farming system is quite substantial, with more than 10 million ha affected. The soils in most of this area have become progressively more acid with time. There is ample evidence from long-term experiments and surveys to implicate the farming system itself in the acidification of the soil ie. a system based on annual species incorporating pasture legumes. In other words, one of the main factors in the success of this farming system - the input of N into the soil by symbiotic fixation - is also responsible in the long-term for de-stabilizing the system.

Much research has recently been carried out with lime to overcome excessive acidity. Results from crops and pastures have been variable according to soil type, soil pH and cultivars grown but frequently substantial yield increases have been obtained. For example, in the Rutherglen region in north-east Victoria, DM production increases of 30% with sub. clover and grain yield increases of 60-70% with wheat are obtained when the soil is limed.

The factors associated with the acidity which are affecting plant growth are aluminium and manganese toxicity and molybdenum deficiency. In sub.clover pastures, especially those in rotation with crops, lowered soil pH is strongly associated with a decline in the populations of *Rhizobium trifolii*, and when sub.clover is re-establishing after cropping (without clover seed inoculation) the nodulation of the clover is poor. The poor nodulation of clover, and reduced nitrogen fixation results in reduced productivity of the sub.clover. However, when the clover seed is inoculated (and this should be done irrespective of soil pH) and the plants nodulated in the re-establishment year, then this allows the build-up of sufficient *Rhizobia* populations to ensure nodulation in subsequent years. Liming the soil usually corrects molybdenum deficiency, although for some of the acid soils in north-east Victoria absolute deficiencies of molybdenum have been identified and growth responses with clover are obtained with molybdenum fertilizer even when the soil is limed.

Methods for correction of acidity problems will vary according to economic circumstances and also the extent of the lime response obtained. Liming the soil to remove toxic aluminium is frequently the optimum answer. Lime on the farm is expensive in

southern Australia but where large grain yield increases with crops are obtained, its use can be economic in the short term, even after year 1. The cropping farmer also has the advantage in that the lime can be incorporated during normal land preparation procedures. Where economic restraints preclude the broadcasting of lime, the productivity of the pasture can be improved on acid soils by seed inoculation (and lime pelleting) and the use of molybdenum fertilizer. Plant tolerance to soil acidity is also valuable particularly with crop selection.

Strategies to reduce the rate of acidification include more use of perennial species to reduce leaching losses of nitrate and other nutrients and consideration of the implications of product removal such as hay.

Soil compaction

Excessive cultivation during cropping and/or trampling by stock during the pasture phase of the rotation can form compacted layers in the soil. Compacted layers or hardpans restrict both the movement of roots and water and reduce both wheat and sub. clover growth. Disruption of the hardpan by deep ripping increases wheat yield by about 20% in north-east Victoria.

Minimum tillage

Minimum tillage methods allow the establishment of crops or pastures without the harmful effects on soil structure caused by repeated cultivation. With less breakdown of soil structure, and the inclusion of grain legumes in the rotation, it is feasible to intensify crop production and reduce the total pasture area. Although this modification of the rotation reduces the grazing area, animals are still required to control plant growth prior to spraying or the pre-sowing cultivation. In effect, this means that the 'ideal' system will remain one where the crop and livestock enterprises are integrated within whole-farm management.

Conclusions

1. The sustainability of a ley-farming system is dependent on the recognition of and the ability to respond to changing demands.

2. Any change in this system must be biologically sound as well as acknowledging and responding to market demands.

3. The use of self-regenerating annual pasture legumes will continue to have an assured place in southern Australian farming systems.