A framework for comparing crop and pasture rotations in north-western NSW

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Summary. The importance of rotations to the short-term economic viability and long-term sustainability of north-western NSW is well recognised. Rather than a shortage of information on rotations, farmers and their advisers are faced with information dazzle. This paper reports an extension program on rotations that attempts to deal with this abundance of information in a way that emphasises the requirements of the end user. The program started as the production of a manual that would predict the optimum rotation for a given situation but evolved to a much smaller decision framework that enables comparisons between rotations. The criteria for evaluating a rotation are presented and the use of paper-based and computerised support data, such as the output from the PERFECT model are discussed in terms of farmer decision making.

Introduction

Two major issues causing north-western NSW agriculture to look back and plan ahead are declining terms of trade which threatens short-term economic survival, and degradation of the resource base which threatens long-term sustainability of the region. Rotations are recognised by farmers and their advisers as addressing both issues. Even with increasing inputs of herbicides and fertilisers, it is difficult to maintain yields in a monoculture system, much less profitability. By contrast, sound rotation management enables cost-effective weed and disease control, improved soil nitrogen status and the ability to use soil moisture when it is available. The more chronic problems of soil erosion, soil fertility decline, dryland salinity and pesticide use also relate directly to crop/pasture rotations and fallow management. It is through the crop/ pasture rotations on individual paddocks that much of the ethic of care for the land is translated into practice.

NSW Agriculture and the Soil Conservation Service have run a number of large programs which relate to rotation management in north-western NSW. The Conservation Farming Program and Operation Quality Wheat have involved both agribusiness and government agencies successfully targeting specific areas such as nitrogen fertility, and better fallow management with a reduction in aggressive tillage and stubble burning. Despite a certain level of success, extension in the region has been criticised for focusing on output, with problems being dealt with as they occur rather than taking a whole systems view that focuses on prevention (7). The Conservation Farming Program has been described as having been 'pushed as technical fix to the problem of soil erosion' with an over dependence on chemicals and a neglect of fertility decline and dryland salinity problems (1).

Just as the complexity of the rotation farming system presents a technical challenge to extension, it also challenges extension methods. Traditionally, the role of the extension officer has been to transfer technology between researcher and farmer. The task is one of removing any constrictions in the pipeline between the two groups and increasing the flow by adding a little economic analysis, well written literature or computer software (5). This model can be characterised *as* knowledge being created by research, transferred by extension and used by farmers (4). While this model may be appropriate for a new cultivar of wheat or a new herbicide, it is inadequate for farming systems as the knowledge generated on research stations is only a small component of the total pool of knowledge. An alternative model is that the generation of knowledge is a normal aspect of coping with the environment and not a special function of research (4). Under this model, researchers, farmers and extension workers are co-learners and the task of the extension officer is to facilitate the communication between the diverse pools of knowledge (5), be they farmer observations or precise trial results.

Another challenge facing extension programs is the rapid development in computer technology. This needs to be managed in a way which ensures adequate attention is given to the information needs of the user rather than the technology driven enthusiasm of the developer.

There are models which are relevant to rotations in north-western NSW such as PERFECT (Productivity Erosion and Runoff Functions to Evaluate Conservation Techniques) which use long term weather records to simulate the plant-soil-water-management dynamics in a cropping system (2). It is likely that other models relevant to the farming systems in north-western NSW will be developed over the next few years.

The challenge of crop and pasture rotations for extension is to use appropriate methods of extension and adult education which enable farmers to manage an increasingly complex farming system. Past experience suggests that this requires an appreciation of the vital role that the end user has in solving the problem.

Methods

An objective of the 1990 advisory program of NSW Agriculture was to produce a manual on rotations in North-western NSW that would indicate an optimum rotation strategy for a given situation. In hindsight, this approach fitted the extension model of knowledge being generated by the government agency and then transferred to farmers.

Preliminary findings from survey work on wheat grower attitudes in the region by the University of Western Sydney, suggested that this approach would not fit the way farmers approached major decisions (Kelleher, pers. comm., 1990). Rather than prediction of an optimum rotation, farmers preferred a comparison of the different options they had in mind. This assertion was supported by a survey in 1985 which found most farmers in the region planned a rotation but the weather ruined their plans (3) and a more recent survey in 1990 which reported 90% of farmers were using rotations as a management tool (6). Rather than a shortage of information or lack of awareness of rotations, growers and their advisers are confronted with information dazzle. There is too much information, usually aimed at one component of the system such as declining soil nitrogen or control of wild oats at the expense of other factors.

After interviewing a range of farmers, government and private extension workers and researchers, the objective was changed to the production of a decision support framework on rotation management which enabled a systematic evaluation of rotations and suggested the strengths and weaknesses of each. The changes were manifest in a much smaller end product which prompted the critical questions rather than provided all the answers. Further, they enabled a comparison of a range of strategies rather than predicted the ideal strategy and treated the farmer or adviser as a provider of knowledge on the problem rather than only a recipient. The emphasis of the package was decision support rather than prescriptive advice.

Although not computer-based, the framework is designed to use output from computer models where appropriate. Two areas where computers were considered the most appropriate technology were a simple cash flow spreadsheet and the use of historical weather records to compare cropping strategies through the PERFECT model.

Results and discussion

The synthesis of interviews with farmers, extension officers, agribusiness and researchers are shown in Table 1. Under this schema, a paddock sequence can be evaluated on three levels: (i) economic/farm management criteria which cover the short term economic and management programs of the farmer; (ii) agronomic criteria which evaluate how well the cycles of water and nitrogen are used and weed and disease cycles broken, and (iii) sustainability criteria which evaluate the paddock sequence in terms of degradation of the water and soil resources.

Table 1. Three groups of criteria for comparing rotations, based on interviews with farmers, agribusiness, extension workers and researchers.

Economic/farm management	Agronomic	Sustainability
· Gross margin (5yr) period · Cash flow (5yr) period · Additional capital required · Variability in returns due to seasons · Variability in returns due to markets · Flexibility of the paddock sequence, ability to respond to market and seasonal changes	· Water use efficiency of the paddock sequence · Weed management - grass and broadleaf · Disease cycles broken - cereal and broadleaf · Ability to manage pests · Dependence on residual herbicides that reduce flexibility · Effect on levels of VAM[1] · Allelopathic effects · Matching of N supply to crop demand	· Erosion risk of the paddock sequence due to lack of stubble cover · Erosion risk due to a full profile of moisture · Contribution of fallow moisture to groundwater · Soil nitrogen maintenance · Soil carbon maintenance · Acidification rate of the paddock sequence · Effect on soil structure · Build up of resistance to herbicides/insecticides

[1] Vesicular-arbuscular mycorrhiza

Using the criteria in Table 1, the standard rotation at Gunnedah NSW (wheat-long fallowsorghum-long fallow-wheat) would be shown in farm management terms to be convenient and planned with high annual gross margins but a poor cash flow over the whole rotation. From an agronomic perspective, this paddock sequence enables excellent weed and disease control and ensures that the soil profile is always full of water and nitrogen at planting but on sustainability grounds the long fallow is prone to erosion and deep drainage and with continuous cereal cropping, the nitrogen status will steadily decline.

The PERFECT model was run for the standard and an alternative rotation (wheat-long fallowsorghum-chickpea-wheat) using 80 years of Gunnedah weather data. Annual means for water runoff transpiration, evaporation, drainage, erosion are presented in Table 2 with the gross margin generated by a cash flow spreadsheet. In discussions with growers, both the averages and probabilities based on weather data are presented.

Table 2. A comparison of two paddock sequences at Gunnedah NSW.

Rotation	Runoff mm/yr	Transpiration mm/yr	Evaporation mm/yr	Drainage mm/yr	Erosion t/ha/yr	5 yr GM $/ha
Standard	38	136	358	13	17	1,500
Alternative	29	167	347	5	11	2,050

In designing the framework it was decided not to reproduce or add to the large amount of data applicable to rotations but rather to use the prompts in table 1 as a schema or framework for this data to be used. It can be argued that it is only when data is useful to the recipient and fits a schema that it becomes information (4). This approach of a checklist or framework with support information meets an important requirement of adult learning; that the user of information drives the system, not the provider.

The series of prompts are best handled with a group of farmers such as a Landcare group, the answers to the prompts will be a mix of research data, computer modelling and the rules of thumb which farmers and extension officers are so proficient at using. The output from PERFECT in the form of annual averages and probabilities appears to be especially useful in quantifying general observations and raising the level of discussion amongst growers and extension officers. This may be because one working lifetime is too short to experience the range of seasons in the summer dominant rainfall zone, or simply that computers like other decision aids have a place in farmer decision making on rotations providing they support farmer experience rather than threaten to replace it.

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