An introduction to the analysis of agricultural systems

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Abstract

The use of systems thinking to understand and manage problems and opportunities in agriculture has recently increased, but not all members of the agricultural research and advisory communities have been trained to use these approaches. This paper presents a straightforward step-by-step guide to analysing agricultural systems as taught to second year university students. A farm and an industry case study are used to illustrate the approach. A major objective of the degree course referred to in this paper is to sensitise students to the concept of a system and its use in understanding a farm and allied industry and to alert them to alternative ways of thinking about problems/opportunities. The process presented here has been developed to challenge the way students think about situations and equip them with a useful framework for future use. It is suggested that the process described here may be useful to agricultural professionals.

Additional key words: *rich picture, human activity system, soft systems, TOWS analysis*

Introduction

Agricultural enterprises such as farm systems and agribusinesses exist to fulfil the goals of people (Pearson and Ison, 1987). The purposes of agricultural systems are mainly economic and social. Nevertheless, many sub-systems, such as the pastoral livestock sub-system on a family farm, are technological. Therefore, agricultural managers are faced with analysing both hard and soft systems and their interface, whether they are managing a farm, a processing industry or some other agribusiness. Most scientists and agricultural students are familiar and comfortable with the reductionist approach and hard systems, but many are less familiar with the tools that enable systematic rigour to be applied to the ill-defined, complex and unstructured problem situations of soft systems (Checkland, 1981). Hard and soft systems thinking are described in Figure 1.

The use of systems thinking to understand and manage problems and opportunities in agriculture has increased in recent years, but not all members of the agricultural research and advisory communities have been trained to use these approaches. In agricultural degree programmes, tertiary education institutions have increased the emphasis on an holistic understanding of agricultural systems, and on learning to manage the manageable environment of farm systems at the macro and micro levels (Hodgson *et al.*, 1999; Rickert, 2001). It is no longer sufficient to educate agricultural professionals by focussing on the micro level of applying technology to improve farm productivity and profitability (Rickert, 2001). Similarly, research funding organisations have moved towards requiring scientists to demonstrate that they can co-operate in multi-disciplinary teams, that their research relates to the needs of a community of interest, and that it is in agreement with the economic, cultural and ethical views of society.

Students in the Agricultural Systems paper in the Bachelor of Applied Science program at Massey University are required to analyse hard system problems or opportunities, and soft system problem situations in two case studies. Typically, they analyse a farm system and a post-farm gate industry. This approach develops their understanding of the types of decisions faced by agricultural managers. The systems thinking taught in Agricultural Systems has evolved over time as the team teaching the material has sought to develop a straightforward, but rigorous introduction to the analysis of agricultural systems.

Hard System Thinking	Soft System Thinking
Clearly defined problem	Ill-defined, complex and unstructured problem situations
The system has a clearly defined purpose or goal	Problem situations involve people acting in purposeful ways
Components, and relationships between the components are clear and measurable	Components and relationships are unclear Problems are dependent on people involved in the situation
Solutions tend towards greater levels of efficiency/optimisation	People view problems and situations differently
Emphasis on the 'end' not the 'means'	Sharing views and discussion is likely to improve the problem situation
Tend not to be problems involving human activity	

Figure 1. Comparison of the key features of hard and soft systems thinking (adapted from Checkland, 1981.)

This paper presents a straightforward step-by-step guide to analysing agricultural systems as taught to second year university students that is also relevant to agricultural professionals with little formal training in the analysis of agricultural systems. The objective is to provide an introduction to the analysis of agricultural systems that will encourage wider use of both hard and soft systems methodologies.

Methodology and Case Studies

The key steps that are used to analyse agricultural systems are:

1. Gather information relevant to the client and the system being analysed (see Fig. 2).
2. Develop the rich picture.
3. Compile a list of defining factors.
4. Identify key tasks and issues relevant to the client.
5. Identify problems or opportunities.
6. Construct models to explore the selected problems or opportunities.
7. Formulate recommendations.

Rich picture

The objective of the rich picture is to elucidate the structure and processes in the information gathered. During this process, the first intimation of problems and opportunities begins to emerge. Figure 2 shows the typical components of the rich picture. These are usually analysed with standard farm management tools such as feed budgets and cash flow analysis. The components of the rich picture are then structured using methods such as diagrams, pictures, mind maps, grouping and ranking, or SWOT analysis to make clearer the activities and tasks within the system, and the issues that are of concern to the client and others involved in the situation (Fillery *et al.*, 1996). From

The Rich Picture

- Identification of the problem owners and decision makers and their long-term goals.
- Identification of other important decision makers.
- Farm family profile and the short and long term goals of its members.
- A description of the physical and socio-economic environments in which the farm business operates.
- A resource list, incorporating information about the family, with relevant attributes and industry standards.
- An estimate of seasonal and annual pasture production.
- A description of the stock classes and stocking rate, including stock reconciliation.
- Production calendar.
- Short-term targets for each enterprise and reasons for these targets.
- Financial position of the farm, including a quantitative list of the important inputs and outputs for the farm with costs and prices.
- Supporting data and information from journals, articles, agricultural statistics, etc that relate to the enterprises on the farm.

Figure 2. Components of a rich picture for a family owned pastoral livestock farm.

the rich picture clear statements on the purpose of the system can be developed. For example, the purpose of a family deer farm might be: 'To generate cash to pay off debt, and to support an enjoyable rural lifestyle and travel, by managing an efficient and productive finishing enterprise based on yearling red deer.'

Defining factors

The defining factors for the system set the boundaries and characteristics of what is considered to be an acceptable change for the client. The defining factors are the set of criteria that can be used to judge whether changes will be acceptable, feasible and desirable to the client. They need to take into account the purpose of the system, the goals and objectives of the client, and any other key issues that have been identified such as land use sustainability or animal welfare concerns. An example of defining factors for a client with a family owned deer farm are:

1. Not interested in sheep farming but will farm deer, cattle and crop.
2. Maintenance of cash flow through the year is important.

3. Main farming objective is to develop a deer-finishing unit.
4. Leisure time for hobbies is important.
5. Client has a flexible outlook and acquires new skills and technology readily.

The notion that possible solutions to hard system problems are constrained by the goals of people is often novel to students who tend to think that the most profitable solution is the right one.

Tasks and issues

Tasks and issues are two aspects of the problem situation worth considering to help challenge current thinking about the situation. The business or farm has tasks or activities that the people or business are there to perform, or there are tasks which need to be performed for the business or farm to continue to survive. For example, on a family deer farm the key tasks will include:

1. Animal husbandry.
2. Grazing management.
3. Selling and trading stock.
4. Communication with family, workers, advisors, salespeople, etc.
5. Accountancy: Bookkeeping, banking, payments, etc.
6. Decision-making: short term and strategic.

Issues are the topics or matters that are of concern, or that are the subjects of dispute. Issues are often not stated which leaves question marks hanging over the situation. These issues can include concerns about succession, products out of favour with consumers, whether the farm or parts of it should be sold to offset debt, whether the business should expand, and market stability or access. Examples of issues for a client with a family deer farm are:

1. Surplus pasture production due to mismatch of feed supply and animal demand.
2. Timely access to space at an abattoir.
3. Sensitivity of income to price of one market product (venison).
4. Succession: children's long-term interest in the farm not known.

Problems and opportunities

Case study 1

In 2000, the Agricultural Systems class analysed a family farm in lowland Manawatu with a yearling deer, finishing unit as the main enterprise. This farm system has been used in the examples above. The analysis of this farm system uncovered a number of problems and opportunities, two of which are detailed here. A hard system problem was the 800,000 kg DM surplus pasture in late spring and summer due to selling yearling deer during winter and spring when venison prices are usually at a premium. That is, the demand for pasture of this yearling deer finishing enterprise did not match the pasture supply on the farm. This surplus was suggested by the client's observations and confirmed by feed budgeting the deer enterprise. The problem of surplus summer pasture presented an opportunity to add another livestock enterprise to the farm system. Although the evaluation of the optimum livestock enterprise is a biological and economic problem, the choice of an additional enterprise was constrained by the criteria in the defining factors. The relevant defining factors were; the client's desire for regular cash flow for good debt management, antipathy towards sheep husbandry, and the ability to acquire new skills.

Potential options for using the surplus pasture were bull or steer finishing and dairy heifer grazing. Financial analysis showed that bulls were the most profitable livestock class, and feed budgeting with a sensitivity analysis of pasture growth rates showed 260 rising two year old bulls were needed to control the surplus pasture. Nevertheless, the purchase of 100 bulls was recommended to the client after considering the defining factors. Although it was useful to provide the client with the optimum technological solution so he could see what the potential opportunity was, it would have been unacceptable to recommend that he should make the change to 260 bulls.

Family succession was identified as a problem situation requiring soft system thinking. At the time of the initial analysis the family had spent little time sharing views or discussing this issue. The potential successor to the client was his son who worked part-time on the farm, but had made no long-term commitment to the farm. No other family member, other than the father and son, wanted to work on the farm, but the other family members needed to be involved in discussions on the future of the family farm (Fig. 3). Succes-

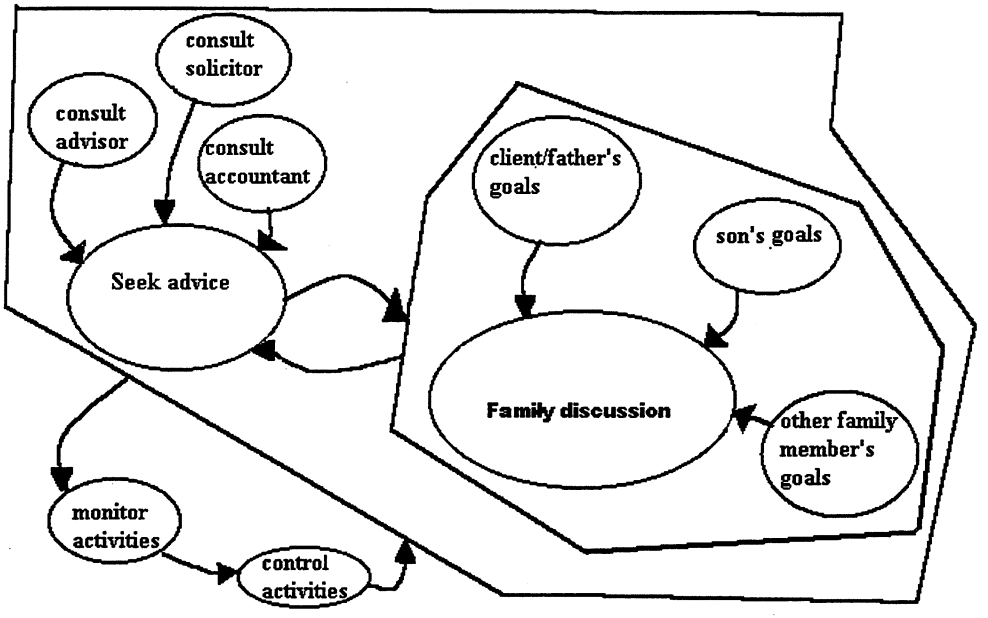

Figure 3. A human activity system model for purposeful discussion of succession planning by a family owning a deer farm.

sion is a complex and sensitive issue for many families to discuss so a human activity system model (Checkland, 1981) was developed to aid in the transformation from the family being unplanned for succession to the family being planned for succession. The human activity system model in Figure 3 was based on the worldview (Checkland, 1981) that the client would have greater certainty about the future options for the farm system if the issue of succession was discussed within the family and with outside advisors.

Case study 2

This case study was on the Large Herds Association, a dairy farmer's organisation concerned about the shortage of skilled labour in the dairy industry. The full analysis will not be presented here, but the strategies developed by the TOWS analysis (Porter, 1980) are presented in Figure 4. The TOWS analysis has been found to be an excellent starting point for the analysis of agribusiness companies and organisations by students in Agricultural Systems.

The TOWS analysis is an example of the soft system analytical techniques available that bring rigour to the development of corporate strategies from the rich picture information (objectives of organisation, geographic domain, structure and membership, products and services, financial position, goals and objectives of other stakeholders in the industry, competitors, social and political environment and so on). The key steps are to audit the strengths and weaknesses within the organisation and the opportunities and threats in the external environment, and then to use the matrix to brainstorm strategies that use the strengths and minimise the weaknesses of the organisation (Fig. 4). Strategies can then be selected and further developed using a human activity system model.

Internal Enviroment / External Environment	Strengths 1. Window to Dairying 2. Established organisation 3. Funds available	Weaknesses 1. Meet irregularly 2. No formal structure
Opportunities 1. Growing/progressive industry 2. Co-operative history	*Max O / Max S* Promote dairy careers Sponsor scholarships & training	*Max O / Min W* Create membership advantages
Threats 1. Lack of skilled employees 2. Poor working conditions	*Min T / Max S* Develop greater labour pool (Win to Dairying) Set minimum employer standards	*Min T / Min W* Develop a more formal structure in LHA

Figure 4. A TOWS matrix analysis of the potential opportunities available to the Large Herds Association.

Conclusions

The main advantages that students in Agricultural Systems (and by inference agricultural professionals unfamiliar with the systems approach) obtain from the introduction to the analysis of agricultural systems outlined are:

1. Systematic rigour in the analysis of agricultural systems,
2. awareness that the possible solutions to hard system problems are constrained by the goals of people, and
3. awareness of the range of soft system techniques and models that have been developed for organising information and improving problem situations.

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