AN INTEGRATED APPROACH TO LINK FARMING SYSTEMS RESEARCH, EXTENSION CO-LEARNING AND SIMULATION MODELLING

R.J. Martin[1], P.S. Cornish[2] and A.G. Verrell[3]

[1]NSW Agriculture, Locked Bag 21, Orange, NSW 2800
[2]University of Western Sydney, Richmond, NSW 2753
[3]NSW Agriculture, RMB 944, Tamworth, NSW 2340

Summary. The low-rainfall northern grain-belt is Australia's primary source of Prime Hard wheat. However, yields and protein levels are declining and conventional farming practices are seen as damaging soil structure and accelerating soil fertility decline. Because of the variable climate and fragile soils, extrapolation of research results from other areas may be inappropriate. The emphasis of extension services is also shifting from 1:1 advice to facilitation of self-directed groups. This new project will break with tradition by letting farmers set the research agenda and participate in the R, D & E process in four key modules: basic systems and process research; on-farm problem solving; self-directed farmer groups in collaboration with agribusiness; and simulation modelling support. This project will contribute to the debate about R, D & E methodology. Dissemination to a wider range of farmer groups will be through existing group networks and through innovative extension techniques. It is seen as a model or prototype for future farming systems R, D & E.

INTRODUCTION

The continuing decline in the terms of trade and competition from subsidised economies make it increasingly difficult for Australian farmers to remain internationally competitive. To add to these problems, the sustainability of many Australian farming systems is being questioned not only from within Australia but at an international level. Australian farming systems will be required to have production and management strategies that meet international targets with respect to greenhouse and carbon tax as well as monitoring indicators of sustainability for inclusion in national resource inventories. Future agricultural research needs will thus be defined on the basis of increased understanding of systems to take account of production efficiency, resource sustainability, as well as environmental and social impacts.

The focus on these issues is sharpest in "marginal" areas such as the low-rainfall (450-550 mm) northern grain belt west of the Newell and Leichhardt highways between Dubbo and Miles. Until now, profitability has been assured by premium prices for high protein wheat produced on soils with high initial fertility and by long-fallowing for water security and mineralisation of nitrogen. This exploitive system has damaged soil structure, accelerated soil fertility decline and resulted in declining grain yields and protein levels similar to those documented for areas to the east which have had a longer cropping history (1). Because of the variable climate and fragile soils, soil degradation and productivity decline is of major concern to farmers in the low-rainfall cropping belt.

Little farming systems research has been done in the region and there is a strong farmer demand to establish large-scale long-term crop rotation-soil management experiments. This comes at a time when the benefit-cost of this type of research is being questioned (2). The value of these experiments has also been questioned because there has been little involvement of farmers, agribusiness, and advisers beyond the planning stage. A narrow discipline-based focus on system components has also neglected the farm-level issues and socio-economic constraints that bear on farmers' decisions. As a result, many farmers have been unable to adapt results of major field experiments to their local conditions.

Innovation in farming systems R, D & E in Australia since the mid 1980s has focussed until recently on the central role of operations research using crop simulation models (3). Other recent workers have identified the need for systems experiments to complement these models (4, 5). At the same time there has been strong interest in Australia in farmer group activities as a means of integrating and extrapolating results of production research. The new program described here combines the elements of operations research, systems experiments, farmer-led problem solving research and co-learning group activities to help farmers adopt more sustainable cropping systems. Building on the definition of Remenyi and

Coxhead (6), we define FSR as "a multi-disciplinary approach to competitive agricultural economic development that sustains the resource base and continuously involves the farmer, agribusiness and adviser in the process of research".

The program will comprise four interactive modules (Fig 1). The on-farm development components will be backed up by process research and long-term experiments at 3 key sites in the region where the sustainability of a range of alternative crop/pasture rotational systems will be examined. Data collected from experiments and on-farm will be used in models to extrapolate findings elsewhere in the region and beyond. Collaborators in the new program are NSW Agriculture, Queensland Department of Primary Industry, the Agricultural Production Research Unit (APSRU) and the University of Western Sydney. The Grains Research & Development Corporation (GRDC) Northern Panel has allocated $3 million over five years to the program.

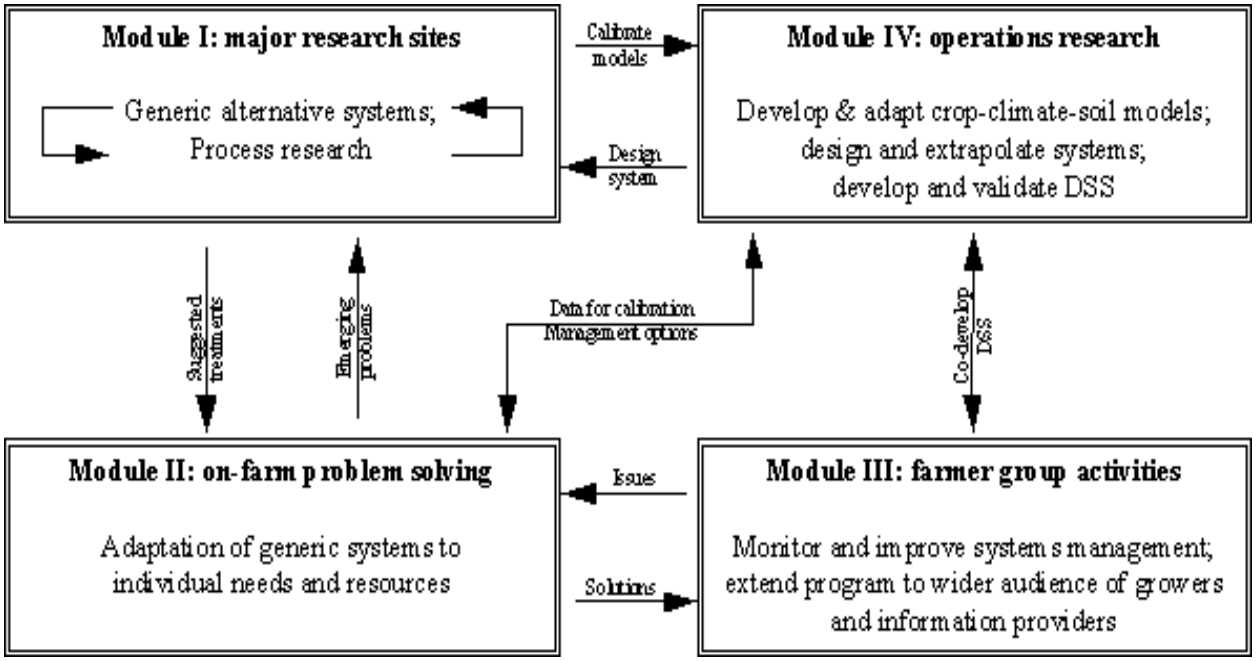

Figure 1. Framework for client-focussed R,D&E.

BASIC SYSTEMS AND PROCESS RESEARCH (MODULE I)

Core sites will: examine farming systems to define, measure and predict key long-term sustainability indicators; test operation of components in a systems context and provide indicators of sustainability. They will also identify issues for field or controlled environment process research, validate simulation models at the farm system level and deal with broad issues of long-term interest such as nutrient, water and soil management. Core sites will be located on major soil types where the cropping history has been such that soil fertility (organic carbon) has declined to 1/3 to 1/2 the original level (1). Treatments will be imposed to capture the widest possible range of exploitative and restorative systems as well as varying the level of inputs to give low and high risk scenarios. Systems that are representative of the range from exploitation to restoration include: cultivated long-fallow cereal production; no-tillage cereal production; no-tillage cereal-grain legume rotation; opportunity or response cropping of cereal, grain legume and summer crops; and permanent pasture. The level of risk is related to the timing and level of inputs; for example the amount and timing of bag nitrogen applied.

Decisions on crop sowing dates, varieties, fertiliser rates and length of cropping phase will be based on a set of rules agreed upon by the project team and the collaborating farmer group. Decision rules allow flexibility of experimental systems to respond to environmental and economic conditions, as farmers do,

and thus systems will respond differently and progressively diverge with time. Decision support systems developed from the project's modelling component will be used in the decision making process.

Data collection will be in accordance with the measurement of known sustainability indicators with respect to the impact of crop/crop and crop/pasture sequences on soil biological, chemical and physical processes. Core sites will provide data to enable extrapolation of findings to other locations within the region using crop-climate-soil models in Module IV (3).

ON-FARM RESEARCH AND PROBLEM-SOLVING (MODULE II)

On-farm research and problem-solving sites will be established and managed by growers and agribusiness. Project staff will provide the technical support with respect to technical aspects of crop, soil water and nitrogen monitoring. Facilitated meetings with these key groups will identify farmer priorities, resource management issues, environmental problems and development opportunities (7). A research agreement will be formalised between the project team and the farmer group, setting out agreed responsibilities and duties for both parties with respect to field operations and data collection. The grower groups will decide what system components need to be examined in their environment. The level of complexity of these sites will also be decided by the growers and may range from simple test strips to large scale un-replicated farming systems trials. On-farm research treatments will include conventional (benchmark) as well as a range of alternatives. Decision rules will be as for core sites. Data collection will be less intensive than for Module I but will also feed Module IV.

BUILDING NEW FARMER GROUPS WITH AGRIBUSINESS (MODULE III)

The elements of Module III are: (1) farmer monitoring of key indicators of farm system performance with respect to sustainability, crop production and financial management; (2) interpretation, evaluation and sharing of monitoring data in groups based on adult learning principles. This module will build a better information infrastructure by involving agribusiness and other information providers, develop best management practice monitoring protocols and build new farmer groups. Farmer and agribusiness groups will be facilitated to co-operatively discuss and draw out their problem issues as for Module II. Groups will access a range of workshops, according to their agenda/needs, this may include monitoring crop or system performance using their own soil, crop, pasture, farm business and socio-economic data using TOPCROP, SoilPak and other group decision support systems. A model for this process is also described for soil nitrogen decision making by Lawrence and others (these proceedings).

Farmers will access or develop the technology or information they require to implement change so their farms become more viable and sustainable. The expertise of project staff will be accessed by growers when they require it, thus allowing growers to set their own agenda. Project staff will facilitate learning activities using decision support tools so that groups can make better strategic and tactical decisions. New resource material will be developed to ensure consistent messages are delivered through state agencies and agribusiness. Information produced by or for the growers groups will be published and distributed to non-participating clients.

SIMULATION MODELLING SUPPORT (MODULE IV)

Models, when used in conjunction with long-term weather information, allow the use of data collected in just a few years in a variable environment to predict the performance of a range of farming systems options in the long term. Module IV will develop and adapt crop-climate-soil models to extrapolate findings from core sites and on-farm demonstrations to other locations within the region. Models will be used to analyse production and sustainability of alternative cropping systems, based on experimental and model outcomes, and provide information in forms that can guide system performance and tactical decisions. The role of simulation models in cropping systems research needs to be demonstrated to scientists and farmers before it can become a credible support tool. This involves the testing and demonstration of model performance using researcher and farmer based data sets. A negotiated minimum data set will be determined to ensure that experiments in Modules I and II are amenable to model testing and application.

Data collected in I and II will provide sufficient description of site and agronomic features to enable the models to predict actual systems performance (eg yield, soil water and nitrogen status etc).

Models of system components, using experimental and on-farm data will examine responses to tactical issues, and provide guidance on best bet management approaches in a highly variable climate. Where possible, models will be tested and validated at the farm level using systems experiments. A range of crop rotations will be analysed for their longer term performance, over much greater range of conditions and time periods than experimental conditions, thus providing improved understanding of consequences of rotations on production and resource maintenance. Model development and testing will utilise data sets outside those collected within this project, thus capturing maximum benefit from other previous and current crop research activities. Opportunity for training in model application will be available to members of the project team to allow them to develop in house skills to whatever level they choose. It must be recognised that high skill levels are only achieved through considerable time commitment.

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