Research Paper

Curriculum Design of and Rationale in *Managing Agroecosystems* — A Core Subject in the Sustainable-Agriculture Postgraduate Coursework Programme in Australia

Anantanarayanan Raman[1, 2]*, **Anthony McKenzie**[1], **Dennis Hodgkins**[1]

[1] *Charles Sturt University, Australia*

[2] *E H Graham Centre for Agricultural Innovation, Australia*

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In sustainable agricultural-management education, agricultural ecology enables the postgraduate learner to practice holistic and sustainable agriculture in real life. In recent decades agricultural education has evolved necessitating learners to demonstrate high levels of intellectual capabilities and logistical skills in the ecological management of agriculture. To meet such a need, we developed *Managing Agroecosystems* at the Orange campus of Charles Sturt University (CSU–O). In this paper we describe the design and rationale in teaching this subject, which sits within a coursework programme in sustainable agriculture. *Managing Agroecosystems* operates with other subjects that collectively represent and reinforce the *Triple Bottom Line* (TBL) concept of sustainable development. The Sustainable Agriculture Programme (SAP) at CSU–O has been constructed on the TBL concept. Curriculum of *Managing Agroecosystems* has been designed to empower the learner to (i) make sense of historical agricultural practice, (ii) apply that learning in issues of contemporary agricultural practice, (iii) recognize and validate those practices that favour sustainability, and (iv) determine those that have not. Teaching strategy of *Managing Agroecosystems* emphasizes self-directed learning by engaging the learner in a contemporary research challenge: the learner chooses an appropriate local problem and deals with it. To achieve alignment between learning activities and outcomes, we have designed *Managing Agroecosystems* facilitating learners to explore patterns of ecological processes in natural environments and apply that exploration in agricultural contexts. Learners are trained to hone their already acquired research skills by applying systems principles in the evaluation of diverse management options; they learn to infer impacts of systems principles in terms of performance, productivity, stability, social equity, economics, and sustainable management of natural resources. To achieve the most desirable outcomes such as free and motivated learning, self-directed learning reinforced in *Managing Agroecosystems* fosters capabilities to think, differentiate, and rationalize. Learners practice how to handle and solve unfamiliar problems in unfamiliar contexts. *Managing Agroecosystems*, seated at the intersection of ecology, agriculture, and management, has been developing employable and intellectually flexible graduates with the capability to develop new solutions to problems, as evidenced in learner feedback.

Keywords: *agricultural-management education, capability building, constructive alignment, ecological management, research skills.*

***Author for correspondence:** Charles Sturt University, PO Box 883, Orange, NSW 2800, Australia; e-mail: araman@csu.edu.au

The context

Practitioners of sustainable development achieve proficiency by applying new thinking to deal with problems and innovative approaches to solve them. Such thinking and approaches need to remain in congruence with the 'triple-bottom line' (TBL) concept (see Hamblin, 2001), which integrates the ecological, social and economic dimensions of sustainable development. To achieve the congruence, formal professional education in sustainable development has to draw from holism (Carley and Christie, 2000; Stables and Scott, 2002) and systemic thinking (Ikerd, 1993; Seiffert and Loch, 2004; Martin, 2008). In the specific context of sustainable agricultural-management education constructed on TBL concept, learning about ecologically managed agriculture provides the theoretical and practical basis for the postgraduate learner to be able to design sustainable agricultural systems and launch them effectively in their future professional lives. Consequently, in educational planning, empowerment of learners with greater levels of intellectual capabilities and practical skills in the ecological management of agriculture and their landscapes has gained ground. In such a context, in this paper, we describe and discuss the design and presentation of an agricultural-ecological management subject offered through distance mode under the title *Managing Agroecosystems*. This is one subject in a multi-subject postgraduate coursework programme in sustainable agriculture in Australia.

In this paper, we describe the educational approaches that reinforce a learning practice constructed on holism and systemic thinking. We demonstrate that the disciplinary strengths of agricultural ecology integrate with the techniques used by us in encouraging self-directed (Brockett and Hiemstra, 1991) and capability-based (Stephenson, 1998) learning. We also demonstrate that the practice followed in teaching *Managing Agroeosystems* is in accordance with Biggs's (1996) pedagogical principle of constructive alignment, which proposes a matching of learning objectives, teaching and assessment.

Sustainable-Agriculture Programme at Charles Sturt University

The sustainable-agriculture programme (incorporating an articulated postgraduate certificate, diploma, Masters) at the Orange campus of Charles Sturt University (CSU–O) has evolved in stages involving phased improvements in the overall structure and design, since its inception in the late 1990s. This section provides a summary of the overall context of the programme, outlining its conceptual underpinnings and development over time, thus delineating the specific context of *Managing Agroecosystems*.

Thoughts on starting the sustainable agriculture programme (SAP) (Eiseman et al., 1991) were influenced by the concept of sustainable development as indicated in the Brundtland Report (World Commission on Environment and Development, 1987), enriched further in the Australian policy documents, the *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee, Government of Australia, 1992) and the *Sustainable Agriculture Assessment Report of the Commonwealth Standing Committee on Agriculture and Resource Management* (1998). SAP acknowledges agriculture as a systematized human activity that involves the modification and management of terrestrial and aquatic ecosystems to service the needs of human society. Throughout this paper the term *agroecosystem* would mean either the land used for raising crops, pasture, and livestock, or water used for raising aquatic organisms, both set within the

larger landscape (also referred as *catchment* and *watershed*), which supports other plants and animals. The core principle of SAP is that sustainable-agricultural systems are to remain socially acceptable and economically viable, and also to enhance the natural-resource base and functional vibrancy of ecosystems.

The curricular aims of SAP were determined as follows:

That the graduates would be enabled to

- think creatively and critically about systems of agricultural production and land management so as to enhance levels of sustainability at a range of scales
- develop economically sound, socially viable and ecologically sustainable agricultural production systems
- strengthen their skills in effective communication, anticipative planning, sharp inquiry sense, and problem solving, hence to be leaders in sustainable agriculture
- understand scientifically sound and cost-effective pathways towards sustainable management in Australia, and apply that understanding through small-scale self-directed learning exploring contemporary issues of Australian agriculture and its sustainable management.

An additional, but key, curricular aim was self-development of graduates as thinking and empowered individuals, who would demonstrate the capacities to

- develop their personal philosophy of sustainable agriculture
- collaborate in learning and undertake cooperative research-based investigations with farmers and other stakeholders
- integrate ecologically-sustainable agricultural production systems with business management, self-management, and social behaviour
- apply their learning to real-world situations and issues
- adopt the habit of continuous learning after the completion of formal study.

In its original design made in the 1990s, SAP included (i) *Sustainable Agriculture: Issues & Viewpoints*, (ii) *Managing Agroecosystems*, (iii) *Research Methods*, and (iv) *Sustainable Agriculture Dissertation* as the core subjects. The electives were grouped under the streams (specific titles of subjects are indicated in italics in brackets) (i) Agricultural Systems (*Integrated Pest Management*, *Alternative Agriculture*), (ii) People (*Strategic Management in Agriculture*, *Managing Change*), (iii) Business (*Agricultural Risk Management*, *Foundations of Marketing*), and (iv) Natural Resources (*Sustainable Soil Management, Property and Catchment Planning*). In subsequent years, SAP underwent a series of professional reviews and modifications that reflected changes within the University as well as the in the global paradigms on agricultural sustainability (Sydorovych and Wossink, 2008). Despite multiple changes over the years, the TBL concept continues to direct SAP and offering of *Managing Agroecosystems* continues to occupy a central role.

In the following section we explain the curriculum design of *Managing Agroecosystems*. First, however, we present a brief description of logistical details of the programme.

Graduates with a bachelor's degree in agriculture, natural-resource management, environmental science, and biology usually form the bulk of the enrollees in the SAP. Rarely, however, applicants without a bachelor's degree, but with proven work experience in an agricultural enterprise, are admitted into the programme. Applicants of the latter category, before being offered admission, will be carefully verified for their academic capacity and aptitude to take on the rigour involved in a senior-level study pro-

gramme.

Learners completing certificate and diploma programmes generally end up as assistant managers and project officers in diverse agricultural and related enterprises, from privately owned crop and horticultural farms to state-administered agricultural departments and private agriculture-based industries. Learners completing the master programme usually get into middle—senior management level jobs either in academia or in government research departments and private agricultural research institutes.

Sustainable Agriculture Programme has been regularly reviewed since its inception, and most recently in 2009—2010. Past reviews have recommended the continuation of the programme with endorsement from employers of graduates. As a result the programme has remained essentially the same, but with minor changes and periodical updating of the contents. The 2009—2010 review sought inputs from current students, graduates, and representatives of agricultural-apex bodies and potential employers. Specific changes to the course curriculum were implemented following the review, the most vital of them being the addition of two new core subjects, covering aspects of resource — environmental economics and human ecology. Graduates and employers have provided evidences in writing for the success of graduates in contributing to sustainability in diverse fields of agricultural sector, both public and private. However there has been no 'before and after' assessment of learner competencies.

Managing Agroecosystems: Curriculum Design

The objectives of *Managing Agroecosystems* are to empower the learner to

- think, reflect, and learn useful messages from historical agricultural practice
- apply that learning to solve issues in contemporary agricultural practice
- recognize and validate those practices that have favoured sustainability over time and be able to identify those that have not.

Because the subject seeks empowering learners with a strong analytical ability, the curriculum has been so designed that the learners would demonstrate the capabilities to

- analyze ecological principles that drive agriculture and apply them meaningfully in relevant contexts
- evaluate sustainability within contexts of ecological disturbance and recovery
- discuss sustainable agriculture in the context of global food security
- critically assess the outcomes of research and development projects that involve sustainable farming practice
- develop eco-friendly agricultural system models to preserve agricultural and ecological resources and gauge the soundness of such models
- display management skills in generating sustainable, eco-friendly technologies in crop ecosystems, through a small-scale research activity.

Managing Agroecosystems is a 1-semester offering to all learners enrolled in SAP irrespective of the stream the learner chooses to specialize. Because a sound knowledge of basic ecological theory is not a prerequisite for enrolment in the SAP, the design of *Managing Agroecosystems* has been made recognizing keeping that element. *Managing Agroecosystems* is offered through three modules: (i) Ecological principles relevant to agriculture, (ii) Ecological processes in agroecosystems: concept of sustainability in agriculture, and (iii) Efficient management of sustainability: towards eco-friendly agricultural

systems, and is spread over a 16-week functional semester. These three modules provide the framework for the three assessment tasks (assignments) outlined in subsequent sections.

Teaching strategy of *Managing Agroecosystems* emphasizes self-directed learning, which is facilitated by a printed study guide. This study guide includes an outline structure of the semester-long learning programme, details of the recommended study topics, copies of essential readings, and a supplementary list of suggested additional readings, which will include a selection of recent research articles and selected chapters from most-recent books. In learning *Managing Agroecosystems*, learners use the resources identified in the study guide, the subject's website as well as personal observations, and media-based experiences. Learners discuss with the subject coordinator and their peers online. Learners are strongly encouraged to interact with professionals in related fields (e.g., extension officers, scientists, social scientists employed in departments of agriculture and other government departments). Out of these stimuli the learners negotiate the depth and breadth of their engagement in their assessment tasks.

Dedicated research-based assignments reinforcing self-directed learning

The design of the assignment tasks is such that it necessitates demonstration of the learner's self-directed study by completing a small-scale, hands-on research task on a contemporary real-life issue that would involve field work. From where do learners get the theoretical knowledge and skills training that are required for conducting the research project? As a general rule Australian undergraduate programmes include training in qualitative and quantitative research methods, conducting a small-scale research project, and writing a professionally acceptable report. For example, the 6-semester long undergraduate programme, *Bachelor of Ecological Agricultural Systems* offered in CSU–O includes the subjects *Research Methods & Statistics* (Semester 5) and *Research Project* (Semester 6), each one of one semester duration, each one providing training in research theory and practice. The study guide supplied to learners in advance includes guidelines, which facilitate learners in selecting a project that will enable them to achieve the objective of self-directed learning.

The following paragraphs explain the mechanics of the assessment.

The major assignment task requires the learners to complete a research-based learning contract*, which is weighted at 70% of the total. For reasons of convenience, this major assignment task is divided into Assignment 1 (the learning contract proposal; final assessment value 0%) and Assignment 3 (the executed research-study report) (final assessment value 70%). (A learning contract is an agreement between an individual student or group and the subject coordinator on aspects of what will be assessed.) Learners submit assignments 1 and 3, one after the other in a specified timeframe, which are reviewed and assessed independent of one another. In the time between submitting Assignments 1 and 3, learners submit Assign-

* A learning contract is a learning-design element that allows the learners to channel their learning according to their needs and interests. A learner submits a proposal explaining a mini-research task (the project) following the guidelines and the project is approved, either with or without negotiation, by the teacher responsible. The project culminates in the submission of a major assessable work. A learning contract will normally specify the criteria against which it may be assessed. Because projects can vary in focus, assessment criteria tend to be general rather than specific.

ment 2 (final assessment value 30%), which requires providing a detailed analytical response to an identified theme by providing an ecological discourse, and thus demonstrating their versatility in general ecological theory and practice.

Assignment 1

To meet the requirements of Assignment 1, learners submit a 700–800 word proposal, in three weeks of commencement of classes, identifying a topic — worthy of researching and achievable within the semester timeframe — that would broadly fall within the context of *Managing Agroecosystems*, considering the following:

- an issue that can be remedied by agroecological methods relevant to the region/locality of the learner
- an evaluation of the historical context of the issue
- a justification why the chosen issue is contemporary and needs resolution
- an experiment/field trial (so that it can be completed in approximately 14 weeks, within a functional-semester timeframe of 16 weeks) that will achieve a convincing resolution anticipated outcomes and management strategies.

In the submitted assignment, learners are urged to provide the following details in a professional-report format following a standard style (e.g., *Cambridge Manual for Scientific Style and Format*, The Council of Science Editors 2006) conforming to the word limits stipulated: (i) a tentative title, (ii) a brief statement of the issue to be investigated (the *Research Problem*) (100 words), (iii) justification for the choice of the research problem and which learning objectives of the subject will be met through this investigation (100 words), (iv) the mechanism and strategies that will be adopted by the learner to achieve the identified learning objectives (200 words), (v) a brief description of the methods to be used in the investigation (200 words), (vi) mechanism of demonstration of achievement of learning (150 words), (vii) a time chart earmarking the action plan, and (vii) list of references matching those cited in the text.

The submitted assignment would be assessed as either 'satisfactory' or 'unsatisfactory'. Irrespective of the status achieved a detailed, word-processed feedback would be provided to the learner within 2–3 days of assignment submission. The feedback would include critical references to (1) the technical soundness of the choice of the issue to be investigated, its relevance to *Managing Agroecosystems*, its relevance to local agricultural — natural-resource management context, and its usefulness and pertinence to related national and global contexts, (2) description of the measurement tactics (learners can opt to follow either a quantitative or a qualitative approach; if they decide to do an experimental trial using a quantitative approach, then they would explain the sampling strategies, adequacy of sample sizes for testing, statistical testing tools to be used, and achievability of the research task within the functional semester frame; on the other hand, if they decide to do a sociological study using a qualitative approach, then they would explain the sampling strategies, details of survey questions, population size, and the way the generated data would be processed and interpreted).

A learner achieving an unsatisfactory level would be encouraged to revise the submitted assignment and resubmit in the following three weeks and the earlier described process of assessment is repeated.

Assignment 2

Learners would present a discourse (not exceeding 5000 words and including a profession-

ally presented bibliography) by responding to one of the themes identified (A–D) below:

A. "Energy can neither be cycled nor reused – matter can". Critically evaluate this assertion and its significance in the function of a natural ecosystem and in an agro ecosystem.
B. "Much of the world's forests have been cut down for timber or to open up land for agriculture." Discuss the consequences for the communities that live in rivers and the human communities that live on the floodplains.
C. Taking an environmental pest that has been introduced into your region; evaluate various consequences to the natural environment of your region.
D. A.G. Tansley, the ecologist of the early 20th century, when asked what he meant by nature conservation, defined it as maintaining the world in the state he knew as a child. From your perspective, as we are in the 21st century, how would you define and explain the aims and scope of conservation biology?

In discussing the selected topic, the learner is expected to demonstrate the use of the study material and the list of references cited therein and the learner's independent search for relevant new information.

The assessment criteria include a comprehensive review of pertinent literature, demonstration of the learner's ability to analyze relevant ecological principles and concepts, and, synthesis of ecological knowledge in the management processes.

Assignment 3

Based on the review of and feedback on Assignment 1, learners conduct their experimental study, submit a written report, in high professional quality, before the end of the semester.

The items to be included are

- A cover page with the title, learner details, and a 150–200 word abstract, which will include brief details on the proposed investigation by identifying the purpose of the investigation, research question (or the hypothesis), results obtained, and a concluding statement outlining whether the research question has been alluded to in positive or in the negative.
- An introduction (of 600–750 words), which will state the issue investigated, justification as to why that issue was critical to the locality (or region), and concluding with the specific research questions that have been addressed. In the context of addressing the justification as to why the chosen issue was critical, the learner is expected to comprehensively review pertinent literature in a succinct manner.
- A section on materials and methods used (500–600 words) will follow the introduction. The learner will also include a brief note on the methods employed to analyze the collected data. The learner at this stage could follow a quantitative approach involving empirical sampling procedures and analyze his/her data statistically, with a reliable sample size. Alternatively, the learner could choose to follow a qualitative approach identifying the nature of stakeholders who may have a stake in the identified issue for the investigation and considering their opinions through a structured questionnaire.
- A section of results (800–1000 words).
- A section on discussion incorporating an analysis of the results obtained in the context of ecological knowledge and agricultural management processes (1000–1500 words).

Elements of originality and creativity would be considered favourably, while assessing the report. Table 1 provides a representative list of titles of research assignments that were successfully completed in 2009. These titles

Table 1. Research assignments successfully completed in *Managing Agroecosystems* in 2009*

1. *Trial of two non-chemical management measures for red-legged earth mite (RLEM): sustainable options for managing RLEM in pasture in south-western Victoria* by Mark Lee [A quantitative study of biological control of an arthropod pest infesting pastures].
2. *The relationship between tree and leaf characteristics with soil acidity in eucalyptus woodlots* by James Donnelly [A quantitatively correlated measurement of the implications of one non-preferred soil feature on tree performance].
3. *Shelterbelts and their influence on soil moisture* by Barbara Chenoweth [A quantitative measurement of enhanced biological diversity in agroecosystems *via* agroforestry and its impact on one preferred soil feature].
4. *Influence of native grass hedgerows and borders on radish yield and soil pH* by Christopher Radcliffe [A quantitative measurement of enhanced biological diversity in a selected vegetable crop ecosystem and its impact on one preferred soil feature].
5. *Vegetative matter content in soil and its effect on moisture retention in a semi-arid environment* by Blaise Flanagan [A quantitative measurement of soil organic matter and its relevance in soil-water retention in dry soils].
6. *The impacts of development in the metro-Atlanta region of Georgia: the role of sustainable agricultural practices and implications for food production and security* by Simon Underhill [A qualitative study of perceptions of sustainable agricultural practice and production systems among the residents in a suburban environment].
7. *The role of farmers' markets in the community: an evaluation of farmers' markets and their contribution towards a sustainable food supply system* by Fiona Wyborn [A qualitative study on the relevance and usefulness of supply chains and direct marketing of locally produced fresh food products by small-scale farmers].

Titles (italicized) listed here are representative. The learners, Mark Lee, James Donnelly, Christopher Radcliffe, Blaise Flanagan, Simon Underhill, Fiona Wyborn, gave permission in writing to publish their research assignment titles. Nature of the study has been briefly explained in square brackets after each title.

indicate the context, breadth, and depth of the field-based multi-disciplinary research undertaken by this group of learners.

Learner Feedback

Approximately 120 distance-education learners from Australia, two from the US, one from Argentina, and one from UK, have completed *Managing Agroecosystems* as of 2009 and as part of their enrolment in SAP. Learner experience and their enthusiasm about this subject are reflected in the following samples of feedback (names withheld) obtained over several years of offering of this subject.

> "The subject was highly useful and enabled me to think differently in managing the properties I own"; "studying *Managing agroecosystems* was a unique experience that enabled me to link ecological knowledge with commercial agriculture"; "investigating a conventionally managed farm for several decades and providing an ecologically sound management plan was an exciting learning experience"; "I am profoundly equipped with rational thinking and research approach to tackle agricultural issues

and scientifically sound ecological management"; "*Managing agroecosystems* is a special subject that provided useful training in dealing with real-life issues and has enabled me to think intensively and act extensively"; "the research experience was fantastic".

Constructive Alignment of and Capability Building in *Managing Agroecosystems*

Constructive alignment, a highly useful concept in higher-education pedagogy, emphasizes that learners be empowered in a manner that they can construct new meanings from what they do to achieve best learning outcomes, whereas the teachers would be able to align the activities intended for learning with the outcomes expected at the conclusion of learning (Biggs and Collis, 1982; Biggs, 1996). The premise of constructive alignment is that the curriculum should be so designed that the learning activities and assessment tasks remain positively lined up with the intended learning outcomes, establishing contiguity and consistency. In keeping with these dictates of the principle of constructive-alignment, *Managing Agroecosystems* has been developed to enable learners to build further on their understanding of natural ecosystems and how that understanding can be applied to make the conventionally managed agricultural systems function at a greater degree of integrity. The subject has been so designed that learners explore the biotic and abiotic relationships in natural environments and apply this understanding in the context of agricultural-landscape management. In achieving constructive alignment between learning activities and assessment tasks, the subject ensures the development of skills in applying 'systems' principles in the evaluation of diverse management options and to demonstrate them in the research assignment by drawing worthwhile conclusions and meaningful connections in the context of their likely impacts in terms of productivity, stability, social equity, economics, and natural-resource management.

Capability-based education is well represented in the literature and practice of university education (Stephenson and Yorke, 1998). The capability approach seeks to equip learners to take full responsibility for their educational and personal development and in doing so, it provides the most appropriate learning environments for learners to achieve their goals (Raman, 1998). Capability is gaining justified confidence in one's ability to act appropriately, communicate effectively, collaborate with others and learn from others' experiences from familiar and unfamiliar circumstances (The Royal Society for the Encouragement of Arts, Manufactures, and Commerce, 1980). Learning to handle complex situations in unfamiliar contexts and manage them effectively is the focal point in the capability approach to education (Stephenson, 1998). The capability approach promotes the habits of reflection and self directed learning and more importantly, the seven 'rural management capabilities'** espoused at CSU–O are considered vital for a well-rounded rural manager with a commitment to sustainability. Upon graduation our former learners express unique integrations of these qualities in their practice.

In keeping with the principles of capability-based approach *Managing Agroecosystems* has been designed to facilitate learning with motivation. The semester-long research task has

** Rural management capabilities: (i) critical and creative thinking, (ii) communication, (iii) leadership and teamwork, (iv) ethical, social, and professional understandings, (v) management skills, (vi) personal and intellectual autonomy, and (vii) information literacy.

played, and continues to play, a vital role in the assessment design. As learners develop and execute their response to the research-based tasks, they learn to apply ecological theory in specific real-life contexts of Australian agricultural management. Assignments 1 and 3 require the learners to demonstrate their understanding of the most vital elements of ecological literacy, viz., interdependence, flexibility, and diversity (Capra, 1996; Cochrane *et al.*, 2007) and their ability to make reasonable and convincing meanings by relating them to the specific context of their research task. While executing their research-based assignments, they demonstrate their capability to think beyond the immediate time and into the future. *Managing Agroecosystems*, thus, encourages reflective learning through engagement with one contemporary real-life issue that requires intelligent management of an agricultural issue with appropriate ecological concepts. This subject provides a platform for equipping learners with the abilities not only to think, differentiate, and rationalize, but also to handle and solve unfamiliar problems in unfamiliar contexts by determining the problems and ways to resolve them. By constructing a programme at the intersection of the disciplines, viz., ecology, agriculture, and management, *Managing Agroecosystems* has enabled the development of empowered graduates, who, over these years, have proved employable and endowed with various functional efficiencies.

Conclusion

Our Earth is experiencing human-induced environmental pressures of unprecedented intensity. Agriculture in its diverse forms is a significant contributor to that trend. In a small yet significant way the teaching of *Managing Agroecosystems w*ithin the context of sustainable development has the potential to play a pivotal role to lay an alternative, viable future.

We have sought to demonstrate how one subject, *Managing Agroecosystems*, goes to the heart of the problem – knowing how to restrict ecological decline in agricultural contexts and how to extend ecological frameworks to better manage agriculture for a sustainable Earth. The capability development philosophy underpinning the SAP has created an educational design, evident in *Managing Agroecosystems*, in which learners, as either current or future managers of agricultural ecosystems, develop not only the capacity to find more appropriate approaches to agricultural land use, but also develop understanding of the human factors involved in bringing about micro- and macro-scale changes.

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