Food Environment Education

Agricultural Education in Natural Resource Management

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Guardia della Selua "Guardian of the Forest"

Variously used as a watchtower in a castle wall in Roman times, as a monk's cell when the estate served as a monastery, and today as a Resident's studio of the Rockefeller's Bellagio Center, this inspiring aerie retains the above words in faded paint - appropriate to the subject of the text prepared in it.

The Author: Fulfilling a youthful dream to work in the tropics, Lindsay Falvey departed suburban Melbourne for Darwin with his new wife Jan, immediately upon completion of his first degree. Five productive years of adventure dulled when Cyclone Tracy blew away house, belongings and metaphorically, Lindsay, Jan and their first son Leslie, to Chiang Mai. Thailand provided renewed professional exotica until after five years, the family, now with the infant Christopher returned to Australia. A short stint as an academic cured Lindsay for the next 15 years which he spent building up an international professional consulting firm in agriculture and related fields to become, at one stage, the largest exporter of services from Australia. He joined the University of Melbourne in 1995 as Dean of the Faculty of Agriculture, Forestry and Horticulture to integrate six agricultural, horticultural and food colleges with existing university departments of agriculture and forestry to create what is certainly Australia's largest and probably most forward-looking faculty of agriculture and related activities. Professor Falvey maintains an active involvement internationally in agricultural education, research and development. He holds a Bachelor of Agricultural Science with Honors and a Master of Agricultural Science from La Trobe University, a Ph.D. from the University of Queensland, is a Fellow of the Australian Institute of Agricultural Science, and is the recipient of a number of awards. Professor Falvey has led tens of international missions, participated in more than 100 international teams, and been responsible for his organizations' projects in more than 60 countries. He is the author of more than 80 scientific and development papers and four books.

The Crawford Fund for International Agricultural Research: The Crawford Fund was established in July 1988, by the Australian Academy of Technological Sciences and Engineering. Its name commemorates the outstanding services of the late Sir John Crawford AC to international agricultural research. Its mandate is to:

- make more widely known the benefits that accrue to all countries from international agricultural research and development; and
- encourage greater support for, and participation in, international agricultural research and development by national and international agencies and organizations, and industrial, agricultural and scientific communities, throughout the world.

The Fund also manages a training scheme which provides short periods of hands-on, practical training for persons from developing countries who are engaged in agricultural research and development. The Crawford Fund is a non-government organization that depends on donations from the private sector and the community.

The Institute for International Development Ltd: The IID is a public company limited by guarantee and registered in Australia. It is chartered to provide international development services and to promote international cultural interaction. Included in its responsibilities is management of an International Development Fund which supports worthwhile activities consistent with the Institute's charter - contributing to publication of this book is one such activity.

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Acknowledgments

> *From the time of Pliny the Younger, the tranquillity of this hilltop has inspired works that have brought stimulation and delight in our search to understand nature and that part of nature that is ourselves. Enjoy them as you add to them.*
>
> From the Library of the Bellagio Study and Conference Center

This book owes its existence to the foresight of the Rockefeller Foundation and its uniquely supportive Bellagio Study and Conference Center. The honor accorded to me in being selected as a Resident at Bellagio for the month of May 1996, provided the preliminary motivation to collate and draft the text, and the time spent in my assigned study in the forest of the villa's grounds allowed the thoughts to be redrafted toward their final form. The staff of the Villa Serbelloni demonstrated an art form in managing scholars, stimulating interaction between a dozen persons from different academic fields, and making all feel worthy of the special surroundings so conducive to fellowship and reflection. I thank all concerned with the Rockefeller Foundation and the Bellagio Center.

Before others, I wish to thank my wife Jan for her support in this, yet another diversion from family life, and for her prints and sketches which make the book at least attractive enough for some to open.

I also thank sincerely the many persons who assisted in the conception and production of this book. Their ideas and inputs are clear to me even if they are not to others. However, I accept all responsibility for the mistakes and unpopular opinions expressed in the book. I especially wish to acknowledge Derek Tribe who initially suggested the Bellagio experience as one which a young and naive Dean of a huge amalgamated faculty would need in his second year if he was ever to do anything beyond administration. I thank Derek, together with John Dillon and Doug Forno for their encouragement of the concept of the book, and the Rural Industries Research and Development Corporation of Australia for travel support.

I gratefully acknowledge the generosity and support of my employer, The University of Melbourne in providing the necessary time away from my desk and for the encouragement to pursue the project.

To those who willingly agreed to read the draft book or its chapters, I gratefully acknowledge your comments - most of which have been accommodated. Especially I acknowledge the inputs of my colleagues; Barrie Bardsley, Alex Buchanan, John Cary, Adrian Egan, Leo Maglin, Glyn Rimmington, Derek Tribe, and Robert White. Thanks also to Mary Vatsaloo and Bernadette Matthews for word processing and organizational support.

JLF

Abbreviations and Acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
ARC	Australian Research Council
AusAID	Australian Agency for International Development
CES	Cooperative Extension Service
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Center for International Forestry Research
CIMMYT	Centro Internacional de Mejoramiento de Maiz Y Trigo
CIP	Centro Internacional de La Papa
DAAC	Danish Agricultural Advisory Center
DANIDA	Danish International Development Agency
DITAC	Department of Industry, Technology and Commerce , Australia
EDI	Economic Development Institute of the World Bank
FAO	Food and Agricultural Organization
IARC	International Agricultural Research Center
ICARDA	International Center for Agricultural Research in the Dry Areas
ICLARM	International Center for Living Aquatic Research Management
ICRAF	International Center for Research and in Agro-Forestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIMI	International Irrigation Management Institute
IITA	International Institute of Tropical Agriculture
ILO	International Labor Organization
ILRI	International Livestock Research Institute
IMF	International Monetary Fund
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ISNAR	International Service for National Agricultural Research
IT	Information Technology
LDCs	Less Developed Countries
LGCs	Land Grant Colleges
MDCs	More Developed Countries
NARI	National Agricultural Research Institutes
NARS	National Agricultural Research Systems
NASULGC	National Association of State Universities and Land Grant Colleges, USA
NBEET	National Board of Employment, Education and Training, Australia
NGO	Non- governmental Organization
NRC	National Research Council, USA
NZNHF	New Zealand Natural Heritage Foundation
OECD	Organization for Economic Development and Cooperation
TAC	Technical Advisory Committee (of the CGIAR)
T and V	Training and Visit system
UNCSD	United Nations Commission on Sustainable Development
UNCSTD	United Nations Conference on Science and Technology
UNDP	United National Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
VET	Vocational education and training

WARDA West Africa Rice Development Association
WFP World Food Program

Foreword

It was agriculture that enabled human beings to become producers rather than hunters and gatherers, and in doing so to settle into communities. From these earliest settlements have developed the elaborate and complex societies of today. During all these millennia, we have tended to take agriculture for granted. This is unfortunate, and unfair by all those - farm men and women in the fields, scientists in their laboratories, and policy makers in parliaments and elsewhere, for instance - who have contributed to the development of agriculture; an enterprise that is as significant as it is exciting.

The history of modern agriculture which has made possible the greatest leap in well-being that the human family has yet experienced, has seen the integration of research-based knowledge with traditional wisdom to bring about great improvements in agricultural varieties, farming techniques and management practices. The consequence of that "marriage" has been undreamed of increases of food productivity which served as the center of concentric circles of progress. Understanding that process and, more important, the substance that made - and can continue to make - that process work, is the task of agricultural education. The origins of agricultural education as we know it today, and the challenges that lie ahead of it, are the central themes of this marvelous little book by Dean Lindsay Falvey.

This is a very personal book. It is not just a scholarly recounting of events, an arid collection of theories, or a series of anecdotal episodes strung together. It bespeaks intense knowledge of the subject and material as well as personal experience in the field. Most of all, however, it presents agricultural education as a societal endeavor whose future development is of clear relevance to the progress of all people everywhere. It is presented with a rare combination of erudition and a warm sense of humanity.

The major challenge for the future, as he points out, is for agricultural education to explore and fully comprehend the complex interactions of science, people, and the environment; to strengthen its relevance by grappling with the scientific issues, both national and international, that affect the continued transformation of agriculture and the protection of the natural resources on which agriculture depends.

For all those like myself who believe that agriculture and agricultural research, more specifically, stand at the very heart of the future of humanity, it is important to be aware of the strength and the weaknesses of current agricultural education. It is only from that starting point that we can move towards ensuring that agricultural education remains relevant, interesting, and vibrant.

Dean Falvey makes a signal contribution to helping us acquire such understanding. He makes the material easily accessible in an engaging and "user friendly" style. He has organized his text in such a way that it can attract many classes of readers. He caters to the needs of browsers, dedicated readers who have not succumbed to the "sound bite syndrome", teachers who seek out resource material, students who want to be inspired, specialists who are interested only in information on a particular topic, or even those who do not wish to handle a book at all but want access to it in electronic form. For those who want their minds to soar, there is poetry as well.

This is truly a book for our times by an author whose knowledge and interests are not bound by time. From yesterday's experience he challenges us to create bright tomorrows. Dare we evade that challenge?

Ismail Serageldin

Chairman,
The Consultative Group on International Agricultural Research
Vice President for Environmentally Sustainable Development,
The World Bank

To the Reader

Dear Reader, as I recall the many additional thoughts which I originally wished to include in this book, and the many which probably should not have found there way in, I realize that if only a small number of persons think and act in the manners propounded, I will be satisfied. Such a subject can never be covered in one publication.

This book can be appreciated in a number of ways apart from reading from cover to cover. For those readers who wish to trace the main arguments, the text may be followed without reference to the Boxes. Others may choose to refer primarily to the Boxes which are mainly the work of others. Some may elect to simply scan the words and dally over the sketches, which pay tribute to the stimulating and productive airs of the Villa Serbelloni in Bellagio on Lake Como - where the publication was given form. Some may even prefer to simply read the poems which attempt to capture the essence of each Chapter. The publication is also accessible on the Internet at http://www.agfor.unimelb.edu.au/falveybk/

This book takes the apparent declining emphasis on agricultural education as an indicator of need for change. It suggests that the increasing separation of urban populations from food production has partly fueled interest in greater environmental care, and that agricultural education should embrace this public viewpoint in order to command respect and funding. The benefits which accrue from education are assumed on the basis of investigations in less developed countries which indicate that GDP growth is higher where education is emphasized even where significant policy distortions work against economic growth.

Agricultural education in both more and less developed countries is under pressure from apparent reduced demand and fiscal pressure. In less developed countries this may relate to the profile of students gaining access to universities - mainly from urban areas and privileged backgrounds, and to the polices of the countries which emphasize investment in new industries. In more developed countries this may relate to a continuing reduction in the numbers of persons engaged in modern agriculture with its high levels of automation and hence the partial loss of past political influence, and to public and student perceptions that agriculture is an mature industry that does not offer great potential growth for future career opportunities. Agriculture also suffers from an image of damaging the environment.

Criticisms of the environmental impact of modern food production have merit in many cases. However, there is a need for a wider public understanding of the compromises that necessarily must occur in order to produce sufficient food at current levels of knowledge. Projections of future food demand indicate that present technologies are insufficient to produce global food requirements. The challenges and opportunities for food production research and development contrasts with common perceptions.

The dual trends of concern for the environment and the need for increased food production provide a context for future agricultural education. Existing courses mainly take a balanced scientific approach - to this there would appear to be a need to include a greater input from the humanities including an understanding of environmental ethics. The imperative to produce food, as far as we know today, will continue to rely on continued intervention in the natural environment. In accepting the responsibility to manage the environment with care, agricultural education may need to see itself as a field of natural resource management - managing the natural resource base (soil, water, mined fertilizers and so on) to produce food while understanding the interactions with that resource base.

The opportunity to introduce change exists as a function of the near global shifts in the popularity of courses and funding. To introduce such changes, the field of agricultural extension - the dissemination of information to producers and others - can be seen as part of education as an extension of the classroom. Electronic technologies already allow this and may be introduced as much by fiscal imperatives as by visionary managers of education. Past trends of agricultural education in more developed countries being followed by less developed countries may be superseded by communication technologies allowing international access to high quality and relevant courses. Investment in this sector in less developed countries may do better to focus on these technologies than infrastructure and traditional approaches to education

The term *natural resource management* is used to emphasize that the majority of the world's terrestrial resources are managed by farmers, foresters and those in industries and services which support them. For the foreseeable future, the objectives of this management are to increase food and fiber production efficiency in a manner which is equitable for all producers including the poor, and which minimizes impact on the natural resource base.

Agricultural education faces the choice of becoming a variable output from science or skills oriented courses with less understanding of the interactions between science, people and the environment, or of shifting its own orientation to embrace public requirements and emerging technologies. Individual institutions and nations will determine their own response, if they indeed recognize the choice. The great agricultural education centers of the world next century will, more probably, be those which are able to offer their services within areas of specialization on an international basis, and which create a learning environment which encourages motivated students to understand agriculture as the management of risks within the environment - the management of natural resources.

The book begins with the significant impact of food production on the environment in Chapter 1 and, in Chapter 2 places that impact within the context of the absolute need to further increase food production while reducing poverty. In creating a new knowledge base, the need to increase environmental empathy and understanding in existing education is discussed in Chapter 3.

In order to discuss the current and future needs for agricultural and natural resource education in less developed countries, Chapter 4 considers university agricultural education while Chapter 5 introduces vocational agricultural education. The origins of agricultural education, its present delivery and possible future metamorphosis into the wider field of natural resource management education in more developed countries is then introduced in Chapter 6.

Chapter 7 then discusses the development agencies including the international agricultural research centers as a suitable focus for forming a closer association between research and education and between universities in more and less developed countries. The origin of agricultural extension as part of education is emphasized in Chapter 8 and rapidly developing electronic and other communication technologies in extension and education are considered in the context of change in the university learning environment in Chapter 9.

The final chapter amplifies the opportunity and responsibility which agricultural educators and their funders have in shaping a future for education which is more accessible, internationally interconnected, current, and oriented to balancing the issues of food production, environmental care and financial rewards.

I hope you enjoy the words, graphics and thoughts expressed in these ten chapters. The generosity of individuals and organizations has allowed the book to made available cheaply to some and free to others according to circumstances. I hope its value is higher than its price. The value of books in general was shown to me several years ago in Vietnam where a collaborating author of the Vietnamese translation advised the setting of our book price at the government breakfast allowance rate - the rationale being that any self-respecting intellectual would be prepared to forgo one breakfast for a book. But if this book was for sale, I would prefer the words of Cramer (1993) who, in his preface to his thoughtful discourse on life and science, quotes a colleague as saying ... *whoever has two pairs of pants should sell one pair and use the money to buy this book*.

Lindsay Falvey
Melbourne
September, 1996

Chapter 1

Natural Resources

Man has lost the capacity to foresee
and to forestall. He will end by
destroying the earth.

Albert Schweitzer

This Chapter introduces the impact of agriculture on natural resources in general terms. In identifying causes for concern, it highlights the need for knowledge of ecosystems and the impacts of agriculture to form part of agricultural education, and in so doing widen agricultural education to the field of natural resource management.

Concern

The natural environment in which humankind exists is not static. Examples of dynamic systems which have affected the earth with or without interference from humans include global warming and the greenhouse and *El Nino* effects. While humans have undoubtedly affected the natural environment, the inherently dynamic systems of the earth have hitherto had greater impact on our natural environment than has human action. However, we may now be at the stage of human actions influencing these hitherto wider natural variations. This is today's concern - for both rich and poor countries.

Natural resource management is the term utilized in this book to identify a range of terrestrially-based human practices instituted on the basis of experience. For land systems, the major intervention in natural resource management made by humankind is that of food production.

In seeking to feed itself, the human race has developed sophisticated production systems, commonly termed agriculture, the processes of which are based around modification of the immediate environment in order to increase food output. Environmental modification may be in terms of genetic manipulation of plants and animals through breeding to suit an environment, modification of the environment itself through such mechanisms as greenhouses, or persistent interventions through management techniques as simple as weeding. The increased sophistication of agriculture that has necessarily resulted from increased demand for food, has established an efficient research, education and extension system which effectively supports the industry in those countries in which there is concern for the environment, which have high needs for food production, or which earn high export incomes from agricultural produce. This places scientists involved with agricultural research, education and extension in responsible positions with respect to natural resource management. These scientists include the various branches of agricultural science such as agronomy, animal science, soil science, socio-economics and meteorology. The role of education is pivotal through its functions in; producing future responsible researchers in fields of natural resource management, educating practitioners in natural resource management - which includes agriculture, and providing information to the wider public about the essential compromises and balances in interactions between agriculture and the natural environment.

Natural resource management is a current concern. This is due in part to rapid global information exchange and the clear problems associated with human population pressures. Stable systems, such as paddy rice in Asia and elsewhere have been based on sophisticated management within current technology and levels of knowledge. The city civilizations which agriculture stimulated through its surpluses, have now separated us from a society-wide ethic of land management. Moreover, such separation has led to many urban-based persons being ignorant of the care taken by most informed primary producers when they are allowed to manage land resource themselves under conditions of fair trade. We have much to learn from the historical viewpoint which acknowledges farmers to be responsible custodians under most circumstances rather than seeing them as pillagers of natural resources.

Nevertheless, today we must face the dual realization that increased food production is essential and that current practices are potentially damaging to the environment.

What is the answer? One part of the answer is to realize that the issue will not be resolved unless an adequate food supply is guaranteed. It is not currently guaranteed because projections of future food security, such as those of the World Bank, assume continual yield increases. Such increases in the past have relied on high investment in agricultural research, and today's research funding is lower as a proportion of economic activity than during the periods used in such analyses. One reason for such a decline is the separation of investment decision-makers from the primary production base - the cities from the country-side. To increase research funding for resource management will require educating those engaged in production about new techniques and resource-safe practices, and of the rest of us in the practicalities of producing sufficient food from a smaller resource base. Smaller, that is, until a viable breakthrough in harnessing a production base other than soil occurs. The keys to the future of natural resource management may well be; improved general education and the reorientation of agricultural courses to a resource management context One consequence of improved understanding - *The Key for the Future* - should be increased investment in food production research.

The Key for the Future

The problem may be simplified to one of rising pressure on resources and increased awareness of the impact of that pressure. It is not one which has recently occurred nor is it one which has been commonly understood in rapidly expanding economies. The overriding need is for wider awareness of the issues in technical and scientific terms which reduce the emotion of some of the current popular discussions in developed countries and informed concerned persons in developing countries. Education through impartial and informed institutions and a wider mandate for current university courses, particularly agricultural science courses is likely to be a cost-effective and longer term benefit than many other project interventions. (Falvey, 1995b)

This chapter illustrates some of the changes in the natural resource base and the influence of agriculture. The underlying resource base for agriculture is considered in the forms of the land and soil, water, atmosphere and genetic resources.

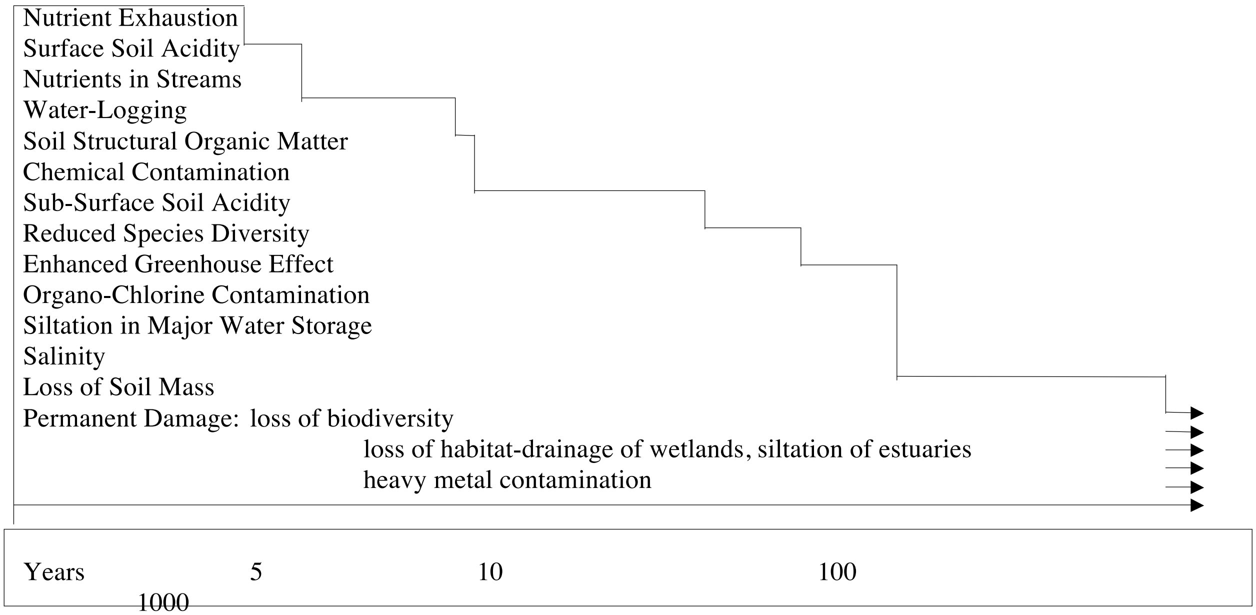
The Underlying Resources

Land and Soil

Consideration of land use necessarily focuses on modern agricultural practices. It has become popular to consider the relatively benign influence of earlier human civilizations on the soil resource as a function of low population density. However, such generalizations ignore the land degradation that has resulted from the actions of early civilizations. Exploitation of soils and related resources was a major factor in the demise of the Mayan civilization according to many analysts. Detailed analysis of the influence of humans on the degradation of soil and land resources, such as that of Carter and Dale (1974) imply not only ignorance, but unwillingness to introduce an ethic of care for the environment. Today, the emotional aspects of this movement are evident in the titles of publications about the extent of human negligence, for example *Rape of the Earth* (Jacks and Whyte, 1939). Pimental *et al* (1995) up-date such emotion, and while perhaps overstating some aspects, they highlight the need to better manage land and soil. They claim that soil erosion poses one of the world's major environmental threats, particularly to sustainable agriculture. It is claimed that in the last 40 years, approximately one-third of the world's arable land has been lost through erosion and continues to be lost at a rate of more than 10 million hectares per year.

Roberts (1995) presents the various types of soil degradation which can occur as a result of human actions and usefully places estimates on the periods of time necessary to restore soil to its initial capacity (Figure 1.1). Such analyses are inherently subjective and are mostly oriented to the use of soil as a substrate for agriculture. They also may include natural variations which humans may seek to influence to suit their own continued production requirements. Nevertheless, they serve to focus our attention on the knowledge base which is essential for any intervention in the natural resources of the earth.

Figure 1.1 - Restoration Periods for Various Forms of Land and Soil Degradation (after Roberts, 1995).



Traditionally, expansion of agriculture has been based on expansion of the cultivated area. It is now clear that such expansion of land for agriculture can no longer continue to be assumed in any predictions of future food production. Large global losses of land are not countered by minor *Creation of New Lands*, such as in Africa where increased human population appears to assist the opening of hitherto uninhabitable areas to livestock which are an integral part of subsistence African agriculture.

Land availability is indicated starkly in figures of the World Resources Institute (1995) which postulates that the year 2000 will bring a reduction of cropland per person in industrialized economies to 0.5 hectares compared with 0.25 hectares for centrally planned economies and 0.1 hectares for some developing countries. These trends are related to increasing demand for food production as a function of rising population and affluence, coupled with declining availability of land associated with soil degradation and the utilization of land for urban and industrial purposes.

Creation of New Lands

... the Tse Tse fly [is] *the major carrier of trypanosomiasis, a serious disease affecting both animals and people. In 1963, the FAO published a study of Tse Tse fly infestation in Africa in which it was estimated that some one million hectares of land in the central part of the Continent were affected. ... Although the Tse Tse fly primarily threatens cattle, it could inhibit the conversion of lands to crop production because much of African agriculture is built on an intimate relationship of animals to crops. ... The current view that Tse Tse fly infestation puts large areas of sub-Saharan Africa off-limits for crop and animal production needs modification. First, ... experience suggests that flies of this subgroup virtually disappear when* [human] *population exceeds 40 inhabitants per square km. Second, simple non-polluting technologies to control the fly are becoming available. ... Third, the combination of increased availability of trypanocidal pharmaceuticals and acquired resistance allow animals of trypano-sensitive breeds to survive in a Tse Tse environment. ... Fourth, increased attention to the development of trypano-tolerant breeds has increased the availability of genetically resistant animals for the highly infected areas.* (Crosson and Anderson ,1995)

New lands brought into agriculture are of marginal potential and, in some cases, fragile and subject to high risk; they require informed and sensitive management to avoid degradation. Fragile soils include those of steep areas, shallow and skeletal soils, or those with limited nutrients or moisture. Soils which are fertile, deep, relatively flat with a high natural organic matter content and are well-drained are considered to be the most resilient to mis-management (IFAP, 1991). Chemical and physical fertility interact to determine soil productivity thus highlighting management interventions such as cultivation, fertilizer and irrigation as means of maintaining aspects of natural resources.

Greater food production forces the poor to *Farm at the Margin*. This is of significant concern as our techniques for management of such natural resources are still evolving. Even where knowledge exists of appropriate management, the imperatives of population and poverty may subvert those of natural resource management.

Farm at the Margin

... the world's marginal croplands are almost invariably semi-arid or characterized by shallow soils or steep terrains. The original economic interpretation of marginal was land that yielded enough to cover costs, but it has been overtaken by an environmental emphasis on its ecological significance. Marginal lands are most at risk from degradation for two reasons: (i) they are physically prone to soil loss by water and wind erosion; (ii) their low and variable yield cannot justify investment in preventative measures to ensure soil stability. These constraints limit the sustainability of agriculture on marginal lands world-wide. (Roberts, 1995)

Chemical herbicides utilized in agriculture are of rising public concern which is already leading to the introduction of stricter controls. While their residues in food are a major issue, contamination of soil and water and the rate of chemical mobility are the primary natural resource impacts. Roberts (1995) presents National Research Council information (Table 1.1) which indicates that seven of ten commonly used chemicals presently critical to our food production systems can be expected to be found moving through soil and water.

Table 1.1 - Relative Mobility of Ten Herbicides
(after Roberts, 1995 and NRC, 1989)

Herbicides	**Description**
Atrazine	Mobile
Bromacil	Mobile

2,4-D	Less Mobile (heavy use)
Dalapon	Mobile
DCPA	Mobile
Dicamba	Mobile
Diuron	Mobile
MCPA	Less Mobile
Picloram	Mobile
2,4,5, -T	Less Mobile

Water

Fresh water, as with soil, is associated mainly with agriculture. Common thought associates agriculture and water through run-off leading to both erosion and chemical fertilizer contamination of waterways. Yet, it is the large scale utilization of water for irrigation which should command a major focus. Irrigation utilizes an estimated 3,300 cubic kilometers of water per year - approximately six times the requirements of industry and households. Within this huge volume of water used for agriculture, it is estimated that less than half actually reaches the crops for which it was destined due to large inefficiencies in management and design of irrigation schemes (Clarke, 1991).

The International Food Policy Research Institute (IFPRI, 1995) estimates that about 30 countries are presently *water stressed*. These countries have major difficulties in food production during drought years. Twenty of these countries are designated as *water scarce* - a situation in which annual renewable water resources do not meet requirements for socio-economic development and environmental quality. In IFPRI's assessment of the future of food production and its relation to natural resources, it is noted that in *water scarce* countries competition for water could become a source of conflict between sectors and countries. The need for increased management of this natural resource is highlighted in the Box - *Water - the Universal Solution?*

About one-third of arable land in Asia is irrigated. Developed countries in general contain some 50 percent of the world's irrigated land. In Pakistan, irrigation has expanded rapidly to cover some 77 percent of arable land; figures for Korea, China and Indonesia are 58, 46 and 34 percent respectively. With some exceptions (Lao-PDR, Malaysia, Myanmar and the Philippines), South and South East Asian countries irrigate at least 20 percent of their arable land. In the 1980s, there were an estimated 20,000 irrigation dams compared to some 400 in 1950 (Falvey *et al*, 1991). Further expansion of irrigation is increasingly difficult. It should be anticipated that future gains will be made in improved management and efficiency of existing systems rather than the construction of new large schemes. This is indicated by the mounting evidence of poor maintenance, sedimentation and low system and farm-use efficiency in many Asian irrigation systems. It is estimated that irrigation efficiency is as low as 20 to 25 percent in Java, the Philippines and Thailand. In Pakistan, some 50 percent of the command area of the huge Indus Basin canal system is water-logged or salinized while in India water-logging has led to the abandonment of some 10 million hectares of once productive cropland.

Water - the Universal Solution?

Development of new water resources has slowed since the late 1970s. New sources of water are increasingly expensive to exploit because of high construction costs for dams and reservoirs and concerns about environmental effects and displacement of people. Investment in irrigation projects has slowed, especially in Asia ... efficiency of water use in agriculture, industry, and urban areas is generally low. ... Between 0.3 and 1.5 million hectares of land are lost each year world-wide from water logging and salinization. ... Inappropriate policies, distorted incentives and massive subsidies provide water at little or no cost to rural and urban users, encouraging overuse and misuse of water. Water for irrigation, the largest use, is essentially unpriced. The overarching challenge between now and 2020 is to treat water as the scarce resource it is. (IFPRI, 1995)

Agriculture must accept its responsibility for improved water management consummate with its use as a scarce and problematic resource. In Asia, agriculture utilizes some 86 percent of total annual water withdrawal, while in North and Central America this represents some 49 percent, and in Europe some 38 percent. The main cereal crop of Asia, irrigated rice, has a high water requirement - some 5,000 liters to produce one kilogram of rice according to present production techniques. By way of comparison, wheat consumes less than 4,000 cubic meters of water per hectare compared to the requirement of rice of some 7,650. Water use by irrigated agriculture is one function in the water equation - distribution of rainfall across regions and between and within years are other parts.

The Green Revolution allowed food production to meet rising food demand against significant odds through the use of irrigation, high-yielding crop varieties, and chemical inputs. The environmental cost may be assessed in terms of the chemical load added to different parts of the environment and evidenced through stream eutrophication and groundwater contamination. The increased rate of run-off and associated erosion has also had its impact on coastal marine life. All of these factors should cause us to focus greater education and research efforts on water management. Refer to the Box - *When the Well Runs Dry*.

When The Well Runs Dry

... the world's fresh water well is beginning to show signs of exhaustion. Strictly speaking this couldn't happen ... [but] *human uses of the life sustaining fluid have increased enormously over time: between 1900 and 1990 total world-wide water withdrawals increased at twice the rate of the population increase while, compared to three centuries ago, water use rose more than 35 fold. Moreover, water can become scarce in particular areas or regions - and in recent years, with increasing frequency, it has.* (IRRI, 1995)

The impact of water mis-management in terms of water-logging and salination has already been introduced. Once these processes become evident they are difficult to reverse and require major investments, such as drainage facilities. For example, the left bank canal of the Tungabhadra Irrigation Project in India now has some 33,000 hectares of water-logged saline cropland with some 20,000 hectares being abandoned through lack of productivity.

Pumping of groundwater represents exploitation of a natural resource in a clearer form than that of mis-management of surface water. Underground storage is, for most intents, a finite resource. In India, Pakistan and Bangladesh, over-pumping has produced shortages of drinking water and pollution of aquifers when they are recharged from irrigation water contaminated with chemicals. The use of shallow wells provided cheap irrigation sources for rice and wheat rotation-based systems in the Indo-Gangetic Plain of India. Such pumping of groundwater also temporarily reduced the effects of rising water-tables and associated salination. Further tube wells were therefore developed until the situation has now been reached whereby rates of replenishment of groundwater are below rates of groundwater use. If we improve education about means of exploiting such resources, surely we must improve education about means of responsibly managing the natural resource at the same time.

According to IRRI (1995), the groundwater table in Punjab may be receding at around 20 cubic meters per year over two-thirds of the area of the State. The question is now whether rice should be the major cereal crop of the region given its high demands for water. On a wider scale the challenge is to modify food production systems and varieties to utilize water more efficiently. An International Rice Research Institute (IRRI, 1995) publication illustrates this point through the Box - *Slipping Between The Cracks*.

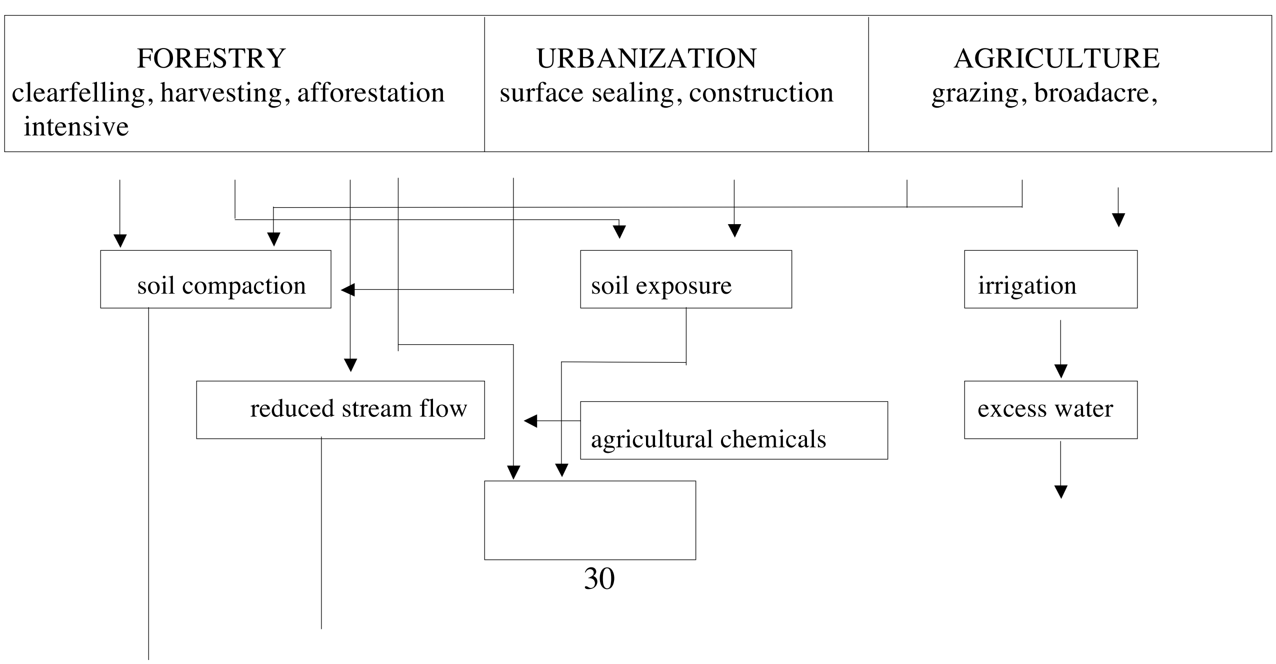
Slipping Between The Cracks

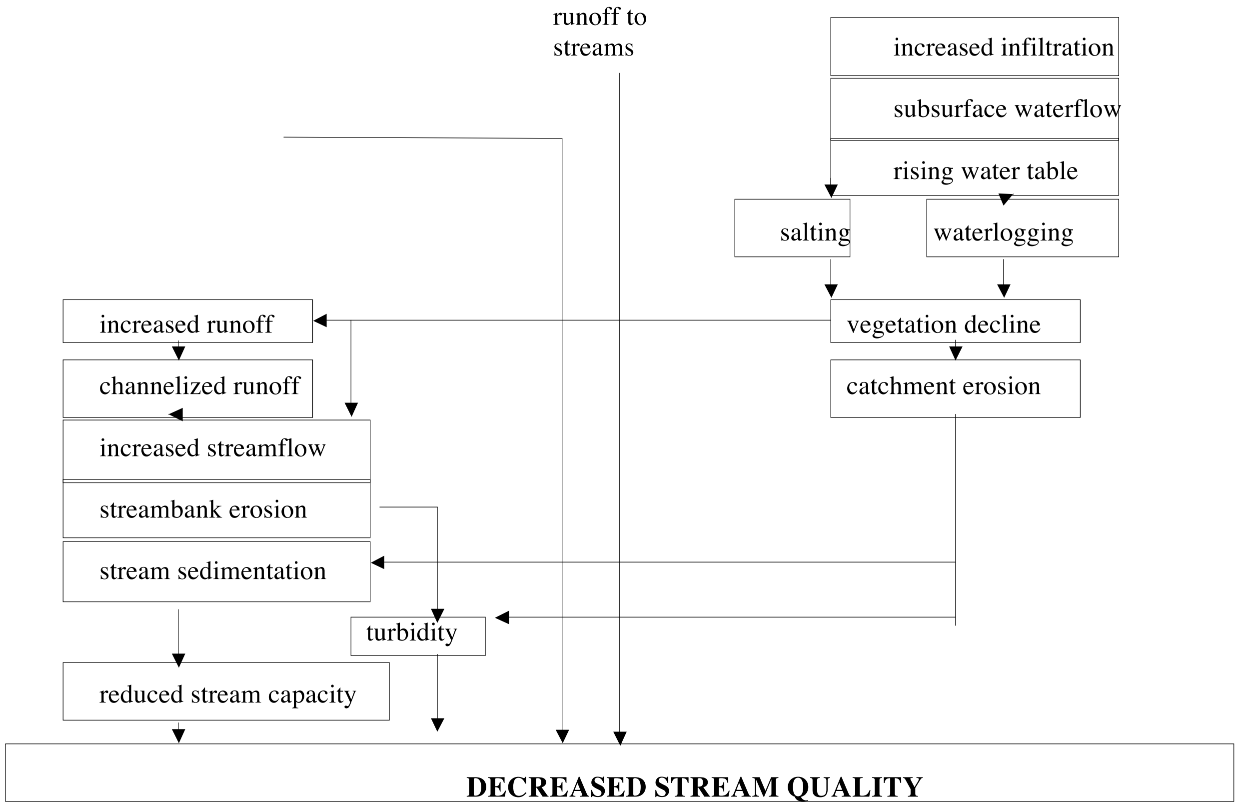
Most Asian farmers till a wet field rather than a dry one, because it facilitates transplanting of rice plants, helps level the land, plows under weeds and stubble and improves the soil conditions for plant growth. They first soak the land until the topsoil is saturated, shallow plow once or twice and then harrow once or twice. Plowing and harrowing are carried out with water standing in the field. Rice is usually grown in *clay soil, and alternate soaking and drying produces deep and wide cracks in it. In fields with permeable subsoil, up to 60 percent of the water applied for soaking flows through these cracks. About 30 percent of the flow recharges the water table below, while 70 percent is lost through lateral drainage. Experiments in the Philippines have shown that shallow surface tillage after harvesting of the previous rice crop can save about 200 mm water during land soaking and preparation. The tilled layer minimizes deep crack formation and surface soil particles block water flowing into the cracks.* (IRRI, 1995)

Traditional management of water for rice production is not simply a matter of carelessness and convenience. Flooded rice fields provide enhanced nutrient benefits to rice through floral interactions in that environment and suppress growth of weeds which would otherwise need to be controlled by chemical herbicides. The alternative of hand weeding becomes less acceptable as time passes.

The natural resource of water is largely utilized and managed with respect to its impact on food production. Other factors influencing water quality include forestry or deforestation, and urbanization. One critical measure of the success of water resource management is the quality of water in drainage streams as indicated in Figure 1.2.

Figure 1.2 Water Quality and Land Management
(after Castles, 1992)





Atmosphere

Impacts on atmospheric quality are commonly associated with high population and industrial activity. Impact of the major natural resource manager, agriculture, on the atmosphere is only peripherally recognized by many persons through occasional dust storms, pesticide-drift or offensive odors. Nevertheless, the impact of agriculture on the atmosphere through the production of potential greenhouse gases and pollutants and, the potential effects of changes in the atmosphere on agriculture and its subsequent environmental impact, are beginning to be recognized.

Volatile organic chemicals such as pesticides are suspected of being transported through the atmosphere (Atlas and Giam, 1988) and recent studies of the levels of herbicides in spring rainfall in Iowa (Nations and Hallberg, 1992) appear to confirm such movement. Atrazine, which showed the largest concentrations in rainfall in that Iowa example, could be related to chemical application times. Hatfield and Karlen (1993) note that it is not yet clear whether such organic chemicals are bound to small dust particles which escaped during cultivation of fields or whether they are associated with direct volatilization.

Perhaps the association between agriculture and the atmosphere which is most potentially emotive today is that of greenhouse gas emissions and their *effect*. Destruction of tropical rainforests for agricultural and livestock purposes, for example, is said to release large quantities of carbon monoxide and carbon dioxide which further amplifies the impact of deforestation on greenhouse gas emissions by enhancing atmospheric methane concentrations (Arrhenius and Waltz, 1990). However, they also note that the vast majority of greenhouse gases are produced in the highly industrialized areas of the world and that the impact of deforestation or reforestation should be kept in that perspective.

The concept of carbon sequestration through trees relies on keeping of wood in its original form and ideally, the growth of new trees in areas from which trees are harvested. Attempts to increase carbon sinks through agricultural techniques may be best focused, according to Arrhenius and Waltz (1990), on utilizing the inherent capacity of soils to store carbon through progressive increases in organic soil components. Recent research (Fisher *et al*, 1995) indicates that high root-density pastures and crops may also act as major carbon sinks. Such an approach removes one apparent element of competition for efficient use of productive lands.

The production of the second most important greenhouse gas, methane, is associated with agriculture through ruminant digestion and rice production. Gibbs and Lewis (1989) estimate that ruminant emissions could be reduced by 25 to 75 percent through modified feeding management and breeding approaches. While such reductions should be made where viable, the overall methane production of agriculture should be kept in context. It is estimated that the contribution of livestock to global methane production of about 15 percent is, according to the model commonly used, associated with about three percent of total global warming forecasts (Arrhenius and Waltz, 1990).

Regardless of the proportional contribution of agriculture to greenhouse gas emissions, the imperative of food production will require that agriculture adapt to any environmental changes associated with the Greenhouse Effect. Current reliance on a narrow gene pool in agriculture, a risk in itself (Rosenberg, 1987), also threatens biodiversity. Climate change could further reduce the availability of wild gene pools while necessitating modifications to the genetic make-up of major food crops. Such predictions imply a wider range of interactions between agriculture and the natural environment and require a responsible response to biodiversity initiatives by agricultural educators and researchers.

The relative importance of industrial and agricultural sources of greenhouse gases has been summarized in Falvey *et al* (1991). Estimates of the production of the two major greenhouse gases, carbon dioxide and methane, from various sources are increasing in accuracy, although the impact of these gases on environmental change remains a matter of speculation. Nevertheless, several countries, have accepted the responsibility to participate in a global program of the United Nations to monitor greenhouse gas levels and emissions. The possibility of future impacts supports responsible action today (Pittock, 1989).

Figure 1.3 Methane Emission and Uptakes in Australia (Castles, 1992)

Million tonnes per annum -10	-5	0	5
Biomass burning		--------------x	
Dryland	x-----------------		
Natural wetland		----x	
Kangaroos		x	
Termites			---------x
Domestic animals			------------
-x			
Landfills			--------x
Natural gas			---x
Mining		-----x	
Motor vehicles		---x	
Rice production		--x	

The impact on the atmosphere by agriculture is placed in context in Figure 1.3 which indicates that agriculture is not the villain it is sometimes portrayed to be. In terms of carbon dioxide, the major greenhouse gas, it is estimated that, for Australia at least, agriculture emits only about two percent of the total compared to emissions of around 20, 27 and 38 percent for the residential, transport and industrial sectors respectively (Castles, 1992).

The contribution of agriculture and other human activities to the Greenhouse Effect is popularly associated with global warming. It is important that we view such debate in a context history and cyclical variations in climate (see for example, the Box - *Long Range Weather)*.

Long Range Weather

While there is not unanimous support for Ponting's (1991) opinions, he has eloquently described climate changes in modern times ... *Since the end of the last Ice Age there have been alternating periods of warmer and colder weather in Europe. After a steady improvement from about 10,000 BC, which marked the end of the last Ice Age, the warmest period of all came in the 2,000 years after 5,000 BC when temperatures were between 1° and 2° C above 20th Century levels. Vegetation zones moved northwards and it is interesting that this period of climatic optimum coincided with the development and spread of agriculture across Europe. The general decline in temperatures then set in, reaching a low point between 900 to 300 BC, a time of very high rainfall too. An improvement was noticed by around 100 BC when vines spread further north, but petered out around 400 AD with a cool spell which lasted for around 400 years. Then a warm period that was shorter and less intense* [was followed by] *the "Little Ice Age" when temperatures were between 1° and 2° C lower than at present. ....* [Later in a] *warm period which lasted about 400 years before 1200, the tree line in central Europe was about 500 ft higher than today, vines grew in England as far north as Severn and farming was possible on Dartmoore as high as 1,300 ft. Large parts of the uplands of southern Scotland were arable and in 1280 the sheep farmers of Northumbrea* *were complaining about the continual encroachment of arable land on their upland pastures.*

A paper prepared for the National Association of State University and Land Grant Colleges by the Texas Center for Climate studies (Crowley and Nowlin, 1995) indicates three main types of climate variation of relevance. These are:

- **Inter-annual variations** in which climate varies between years and which is most commonly depicted to the public in terms of droughts, floods and severe winters. These variations are associated with changes in tropical sea surface temperatures as measured through the ENSO (*El Nino Southern Oscillation*) Index which is based on the atmospheric surface pressure difference between Tahiti and Darwin. Such information is proving increasingly useful and one input to agricultural planning in areas subject to variations in rainfall which appear to be related to the ENSO effect. Such inter-annual variations are also associated with volcanic activity and it is believed that the very cold spring of 1992 experienced in the north eastern USA was probably associated with the Mount Pinatubo eruption in the Philippines.
- **Decade-scale climate variations** such as appears to have occurred over eastern North America in 1958 and 1976. The shift was associated with the jet stream causing more north to south flow over North America which increased the frequency of very cold air outbreaks. Crowley and Nowlin (1995) state that *despite progress being made on understanding some aspects of decadal-scale variability, we are not yet at the stage where we can predict future shifts* ...
- **Greenhouse changes** will probably be the major factor responsible for climate change in the next few decades, largely as a result human activity. Various predictive models exist of which the most considered may be that of a jointly sponsored activity of the World Meteorological Organization and the United Nations Environment Program which produced the Inter-Governmental Panel for Climate Change Report. The report presents information according to categories of; consensus, very probable, probable and

uncertain. Consensus that warming increases of about 0.5° C during the twentieth century contrasted with uncertainty of the effect of greenhouse temperatures on global warming. Changes assessed as very probable included an increase in global precipitation, a reduction in northern hemisphere sea, ice and snow cover and a rise in global sea level. The over-riding conclusion from all such conjecture is that we require a greater understanding of these trends and their causes and effects.

Biodiversity

Biodiversity, the maintenance of a wide genetic pool in plants and animals, may be a casualty of modern agriculture. In its quest to continue to meet rising food demands, agriculture has focused its plant breeding on varieties which can produce the food outputs required. Srivastava *et al* (1995) note that the significant advances made in biotechnology research may imply that biodiversity is no longer as important as it once was. This view, which has been documented in Forbes magazine (Huber, 1992), leads to such conclusions as it is not necessary to preserve tropical rainforests or non-commercial species because genes can be created whenever they are needed for future plant breeding. This view is not correct insofar as it implies that current and expected short-term future knowledge of genetic material is sufficient to cover all foreseeable situations. It assumes an omniscient human society with the will to act responsibly on behalf of others - a brave assumption from any viewpoint!

The vast majority of genetic material utilized for food production now and for the foreseeable future traces its origins to wild varieties occurring naturally. However, we are relying on an increasingly narrow gene pool for our food supplies. Perhaps *One Pair of Genes is Not Enough*..

One Pair of Genes is Not Enough

World agriculture has now reached the stage where, out of the vast *number of plant species (300,000?), of which between 10,000 and 50,000 are said to be edible, and 5,000 of which are used as human food, only three species (rice, wheat and maize) supply almost 60 percent of the nutrients that humans derive from plants. ...* [Worse still] *the genetic variation within each of these species has been eroded through the selection programs of plant breeders. This means that if, for whatever reason, the climate or the environment change, or exotic pests or diseases invade a region, there is a danger that existing crops will not have retained sufficient genetic variability to enable them to adapt to the new circumstances.* (Tribe, 1994)

The International Plant Genetic Resources Institute has sounded a specific warning that traditional knowledge and genes may be lost forever (IPGRI, 1993). The World Bank has prepared a set of indicators to guide its project lending on means of assessing the impact of agricultural and forestry activities on biodiversity in the following summarized form (Srivastava *et al*, 1995).

Indicator	Cause	Proposed Mitigating Actions
Natural habitat loss	Encroachment by agricultural production systems	Intensify systems to increase productivity and income-generating options
Habitat fragmentation	Encroachment of agriculture in an uncoordinated manner	Minimize fragmentation (and interruption of gene flow and loss of certain species because remnant patches are too small to support them) by providing wildlife corridors along "bridges" of natural habitat
Species loss even when natural habitats are still intact	Air and/or water pollution; excessive sedimentation of water courses; excessive hunting, fishing, collecting or logging	Decrease dependence on agrochemicals by shifting to IPM; promote crop rotation, perennials, *green* label for environmentally-friendly production systems, management plans for harvesting wild plants and animals

Decline of biodiversity of crop species on-farm	New farming practices such as cereal monocropping, possibly propelled by fiscal incentives	Eliminate fiscal or regulatory measures promoting homogeneity; explore traditional, polyculture systems that can be rehabilitated while still raising yields
Decline in within-species biodiversity	Modern varieties and chemical protection, possibly propelled by fiscal incentives; adoption of intellectual property rights	Support yield research on traditional varieties, modern varieties with low chemical needs that may be replaced frequently (biodiversity over time), heterogeneous crop varieties, incentives, certification of traditional varieties

Forests

Forests engender much emotion with predictions that the world may soon lose its remaining natural forests. Yet Avery (1995) in his inimitable style contrasts such gloomy predictions with the statement of Sedjo (1983) that the world's industrial wood requirements for the next decade could be met from less than 200,000 million hectares of plantation forest which is about seven percent of current forest area. Nevertheless, forest has other benefits such as carbon sequestration, erosion and water runoff and biodiversity and as a natural habitat. From this perspective, deforestation of rainforests is particularly important due to the wide biological diversity supported in the ecosystem as noted by US Vice President, Al Gore (1992). The rate of clearing of forests is difficult to predict; Tribe (1994) notes that estimates differ by as much as 300 percent.

However, we do know that two motivators for deforestation, that of commercial exploitation in unpoliced areas and the need to expand food production, are associated with two overriding human factors, greed and poverty. Both may be addressed through development activities which lead to increased acceptance of responsibility for natural resource protection and management and the introduction of agricultural production techniques which allow increased productivity from existing agricultural areas. These factors are recognized in the strategy for collaborative forestry research presented by Center for

International Forestry Research (CIFOR, 1995) - refer to the Box - *Not See the Forest for the Trees*.

Not See the Forest for the Trees

The potential of forests to contribute to rural and urban welfare, economic growth, sustainable agricultural development and global environmental functions is vast. Yet it is constrained by accelerating deforestation and degradation of forest lands. About 15.4 million hectares of forests were converted to other uses or destroyed each year between 1980 and 1990 (0.8 percent per annum) and 4.6 million hectares of this was tropical rainforest (0.6 percent per annum). ... By 1990, 1756 million hectares of tropical forests remained; 52 percent in Latin America, 30 percent in Sub-Saharan in Africa and 18 percent in Asia Pacific. ... As pressures on land and competition for access to it have increased, inequities have developed in the distribution of the costs and benefits of forest use. These problems have occurred at the levels of forest communities, nations, regions and the entire world. They have affected the poor and the rich, foresters and farmers, individuals and corporations, local and distant users, and present and future generations. Societies traditionally have mechanisms to protect the diversity of forest users and the public goods value of forests. Some of these mechanisms have broken down under the onslaught of economic specialization and resource demand pressures. New resource management systems are emerging. The paradigm for the management of forests has shifted. (CIFOR, 1995)

Destruction of forests is likely to continue unless there are some significant breakthroughs in technical and policy areas relating to natural resource management and food production. The development of managed plantations for timber products can reduce pressure on natural forests and, indeed, appropriate management of natural forests can yield timber and other products on a sustainable basis. However, such approaches are most common in more developed countries (MDCs) where the imperatives of poverty are of a vastly lower order. We are at the beginning of a revolution in the cultivation of trees for specific purposes somewhat analogous to the domestication of crops and animals which led to agriculture millennia ago. Future supplies of timber and some non-timber products are likely to be generated from managed natural forests and domesticated sources and should be viewed as part of natural resource management in the same manner as agriculture.

Management of Natural Resources

While our attention focuses primarily on land-based systems, it is of interest to note that the fishing sector is also at crisis point. Estimates that more than 25 percent of world fish stocks are overexploited, that species loss is already occurring in freshwater and anadromous species, and the rising incidence of international disputes over fish-stock ownership, are indicators of this growing concern. Lack of coordination and mis-management of natural fish resources creates everyday international conflict in this area. There is an imperative to introduce management of existing natural stocks, protecting endangered species and fishing areas as well as those areas which have not yet been exploited. Aquaculture will continue to rise in importance from its current low level of significance; marine fish management continues to require international monitoring, the application of known and development of new scientific information is essential, and their remains an overriding need for consideration of the livelihoods of fishers to minimize their necessity to overfish.

The United Nations Commission on Sustainable Development (UNCSD, 1995) notes that a multidisciplinary approach to management of land resources is a process which:

- identifies human and environmental needs
- identifies the potential for change and improvement
- identifies and evaluates relevant physical, social, economic and policy factors
- develops a series of actions necessary to permit and facilitate change

This requires the addressing of the cross sectoral issues:

- creation of productive employment

- eradication of poverty
- responses to poverty, unsustainable consumption and production, population growth and changing demographic patterns
- security of land rights

The statement on *Poor Resource Management* suggests that it is inappropriate to treat management of natural resources from the perspective of the wishes and desires of the affluent in MDCs to the exclusion of the residents and food production needs of less developed countries (LDCs). Neither can we assume that the principles by which MDCs manage their own affairs have been accepted in LDCs. Also implied in this statement is the fact that much of the lifestyle of residents of MDCs is based on policies in LDCs decried as exploitive by residents in MDCs. The subject of natural resource management is all embracing and indicates the inter-connected nature of technical, environmental, economic and moral factors.

Poor Resource Management

Natural resource management research in Eastern and Central Africa is weak in three main areas: (i) monitoring and assessment of the land degradation process; (ii) the generation of technology to cope with land degradation phenomena; and (iii) the analysis of policies detrimental or conducive to the conservation of the natural resource base. The major constraints in the region for this sector include; the lack of national commitment, ... inappropriate cultivation practices and water management, water resource degradation, ... desertification and deforestation; land degradation, erosion and loss of soil fertility; degradation of rangelands, ... biological degradation (reduction of vegetation cover and soil content of humus and micro-organisms mostly in rangelands due to bush burning and the over-exploitation of vegetation cover); lack of a sufficient number of trained scientists due to the shortage of operating funds for research. (Weijenberg *et al*, 1995)

We must acknowledge difficulty in implementing natural resource management principles in those areas where we believe we have sufficient knowledge. However, in the vast majority of cases, our knowledge is inadequate and the most common outcomes from these debates must be identification of the need for an improved knowledge base. This has implications for knowledge generation through research, the imparting of knowledge to those who will utilize the information through education, and wider educational outreach activities through technology and other information transfer. The need for education continues to increase. Simply generating technical solutions, while essential at this stage and into the future, will not lead to major changes in human behavior unless educational levels and awareness of natural resource management principles are raised significantly.

As agriculture is the major source of impacts on terrestrial natural resources, education must include both an acknowledgment of this fact and a context in which such impacts can be minimized through sound management. This provides the context for agricultural education in the future. In order to better understand the compromises which must be accommodated and understood, it is necessary to understand the origins of agriculture and the overriding imperative for food production in the world today. The food production imperative is considered in the following Chapter.

The Tree of Life

Expelled by God from Eden,
Paradise purged of evil man,
Destructive, disobedient,
Man freed, not omniscient.

Through the eons knowledge grew,
was lost, regained and built anew,
But at best was partial only,
Seen in Paul’s mirror dimly.

The Tree of Knowledge

Humankind, so smart, forgetting too quickly,
Knowledge today becomes tomorrow’s folly,
One apple seed that made Adam so aware,
allows us to mine species, soil, water and air.

Management targeting requisite product,
Not just food, but greed, unconscionable conduct,
Focused not on balance or reduced impact,
Our knowledge lacks awareness of what we know not.

Sustain, nurture, foster, protect; bridge the rift!
These remaining seeds of poor Eve’s Pandoric gift,
can release, when does their dormant phase expire,
True management knowledge to which man must aspire.

Chapter 2

Food and Agriculture

how can we urge the preservation of animals,
how can we speak to those who live in villages and in slums
about keeping the oceans and rivers and the air clean,
when their own lives are contaminated at the source?
The environment cannot be improved in conditions of poverty,
nor can poverty be eradicated
without the use of science and technology.

Indira Ghandi

This Chapter introduces modern agriculture as the main form of terrestrial natural resource management. It discusses the need for increased levels of food production to meet rising population, the impacts of agriculture on the environment, and the need to include social sciences in education for natural resource management.

The Development of Modern Agriculture

Agriculture, defined as the practice or science of crop and animal production on organized land units, developed some 10,000 to 12,000 years ago and has formed an essential foundation of civilization. Humankind cannot survive in large numbers without productive agriculture.

Agriculture is most commonly based on changing a natural ecosystem to create a new habitat in which the plants and animals which produce food and other requirements for humans can thrive. The underpinning resources such as soil and water are managed on a basis which, according to the knowledge of the time, aims to maintain the long term productive capacity of the new environment. The history of humankind lists our attempts and failures in maintaining sustainable systems. As long ago as 6,000 BC, villages in central Jordan were being abandoned after approximately 1,000 years in response to soil erosion associated with deforestation and poorly managed land, declining crop yields, and the inability to continue to feed the community. Wooley's (1936) "Ur of the Chaldees" records ... *only to those who have seen the Mesopotamian desert will the evocation of the ancient world seem well neigh incredible. So complete is the contrast between past and present ... it is yet more difficult to realize, that the blank waste ever blossomed, bore fruit for the sustenance of a busy world. Why, if Ur was the empire's capital, if Sumar was once a vast granary, has the population dwindled to nothing, the very soil lost its virtue?*

Until relatively recently, humankind could move from one exhausted site to a new site. We can no longer do this. The overriding criterion in assessing agricultural technologies henceforth is the ability to continually produce the required output while maintaining the underpinning natural resource base intact (Wilken, 1991). We do not have, at present, the knowledge to allow a return to a system of minimal intervention with an existing natural environment. Our numbers are too great to contemplate this and indeed, our knowledge base is oriented to sustainability of production within the controlled environment, as distinct from the original natural environment which has largely disappeared. Hillel (1991) notes that the human species is the only one which seeks to change its environment on a large scale and to dominate other species in an ecosystem, sometimes crowding them to the point of extinction.

Agriculture had not been widely manageable until some 150 years ago although the use of manure and limestone on soils and the benefits of legumes were known in Roman agriculture. The application of science to agriculture based on the early works of Liebeg and Johnstone in the 1840s increased understanding of plant nutrition while the work on inheritance by Mendel in 1865 provided a basis for modern plant breeding (Hatfield and Karlen, 1993). This era has given rise to the research emphasis of scientific agriculture which today allows mass starvation to be averted.

Modern agriculture continues to affect the environment and humankind. Misinformed opinions, particularly in more developed countries (MDCs), assume that food production to meet global demands is possible from alternative systems. Unfortunately, our current knowledge does not allow such a luxurious consideration. Nevertheless, such concerns are useful in that they focus scientists and others on the need to understand the implications of technological interventions. This is especially so in today's funding environment for research which does not favor agriculture and emphasizes short term returns and quick solutions to immediate problems - in such circumstances it is easy to lose sight of the broader implications of natural resource management. Public concerns serve agricultural science well in focusing attention on the broader implications of essential environmental interventions.

Agricultural production systems in use today form a major part of environmental management in various ways. The major production systems can be classified as; intensive cropping, rainfed cropping, shifting agriculture, agroforestry, agropastoral, plantation and forest extraction.

Intensive Cropping Systems are often based on manual labor such as in traditional paddy rice and raised-bed agriculture, or on highly mechanized systems based on purchased inputs. Intensive agriculture is an essential component of habitat management because it limits requirements for new areas of land. It can however, lead to degradation of natural resources if not managed appropriately. Modern agriculture includes plant breeding, biotechnology and associated intellectual property rights, all of which are potentially able to adversely affect the natural resource base, particularly through declining biodiversity. High productivity is obtained in mechanized monoculture which in turn is dependent on chemicals which may inadvertently destroy desirable flora and fauna. Intensive cropping systems are suited to those environments where high yielding varieties, chemical inputs, fertile soils and irrigation can be guaranteed.

Rainfed Cropping Systems are based on annual plant species, and are commonly integrated with livestock production. Crop rotation is employed to manage soil fertility yet these areas are commonly fragile and increasing intensification can easily lead to degradation of the natural resource base.

Shifting Agriculture is a stable form of agriculture under low population density regimes. It is based on the clearing of forest or bush to prepare a cultivation plot and subsequently abandoning this to regrowth and eventual natural reforestation. Rising population density decreases the regrowth time available for forests and leads to this system becoming unsustainable, as it now is in most parts of the world. Some shifting agriculture has evolved into sophisticated agroforestry management systems while in others it continues to be practiced in response to poor land tenure policies.

Agroforestry involves cultivation of perennial and annual crops together in a sustainable manner and is increasingly practiced on degraded areas. The practice brings environmental benefits through soil protection and efficiency of utilization of water and soil nutrients. It also creates a wider diversity of environments for wildlife and other fauna. The practice is currently constrained by economic demands for single species production which facilitate economies of scale in harvesting and other tasks. Agroforestry would appear to be a field where tapping of local knowledge concerning the utility of native species could be mixed with scientific information to develop future farming systems.

Agropastoral Systems represent a variety of systems suited to resource poor or degraded areas and can impact severely on the natural resource base through overgrazing. In Latin America, deforestation to create grazing lands appears to be an inefficient mechanism for food production while also severely degrading the natural resource base. Traditional management systems such as the pre-socialist system of Mongolian herdsmen were able to preserve viability of grazing lands for centuries (Falvey and Leake, 1993). Today, integration of grazing livestock on small farms appears to be a more viable system in resource management terms while also providing alternative economic systems and by-products such as manure for application to crops. Reclaiming of degraded pasture lands through the introduction of new pasture species with associated management inputs can also stabilize degraded grazing lands. There is a clear need for more knowledge of traditional animal breeds, particularly those adapted to environments to which modern breeds are unsuited.

Plantation Systems are associated with such products as coffee, tea, palm oil, timber and rubber. These systems commonly are based on clearing of native forests. However, in some cases, perennial tree crops as used in plantation systems are also suitable for rehabilitation of degraded soils. Plantation forestry is oriented to the production of pulp or timber, and some cases fuel wood. Plantations are commonly monocultures and suffer similar problems to single-crop agriculture in being relatively inhospitable to fauna and other flora.

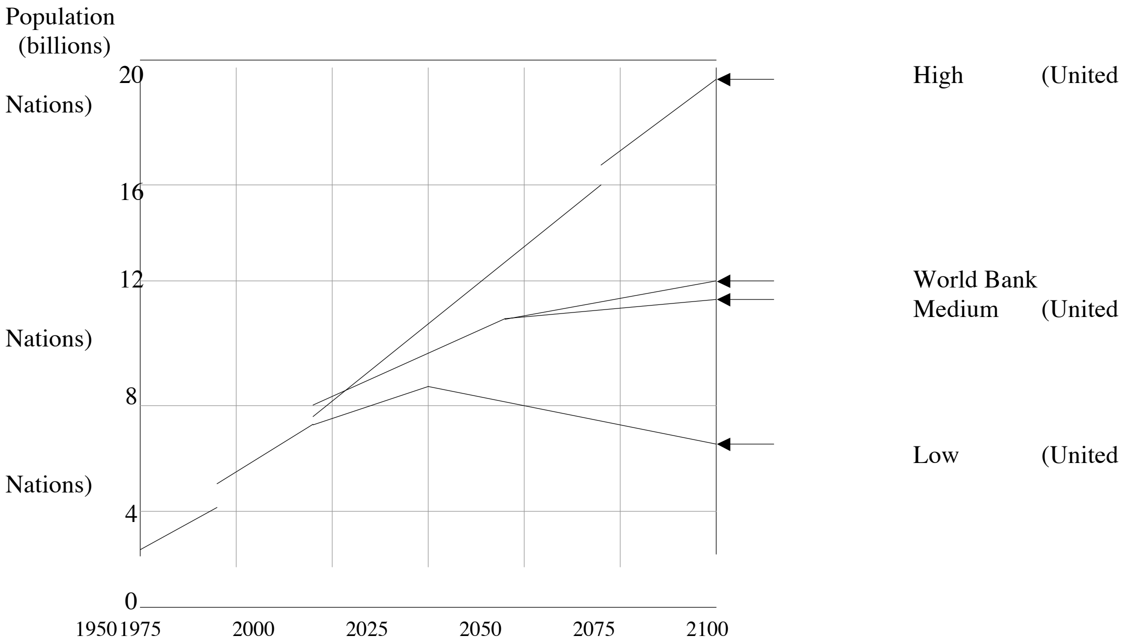
Forest Extraction continues as farmers seek new lands and timber prices encourage exploitation of remaining native forests. The trend of large scale forest destruction appears to have been reversed in MDCs with a reliance on plantation forestry, although extraction continues in less developed countries (LDCs). Extraction from forests can be sustainable on a managed basis as occurs in those cases where farmers abide by local rules governing rates of timber, animal and other product extraction from native forests. Nevertheless, communal ownership of such resources as forests may accelerate their demise in changing social circumstances. Such experience bears recalling when community managed forests are proposed in large scale development projects (Srivistava *et al*, 1995).

Natural resource management may be contrasted with agricultural or forest management or alternatively, agricultural and forests management may be seen as a major component of natural resource management. A viable future can only be based on the latter viewpoint which must acknowledge the dual imperatives of food production in a situation of rising food demand and of environmental responsibility. The next section introduces issues concerning population increase and food demand.

Population and Food

Population curves commonly show an exponential rise in human population providing the implication that population growth rate will continue to increase. Experience in controlled environments with other organisms indicates that living organisms may experience such an exponential growth in numbers up to a point of stability. Alternative population scenarios have been plotted by the international organizations of the World Bank and the United Nations (Figure 2.1) - they indicate wide variations introduced by differing assumptions about population growth rate and societal and individual behavior. While we may speculate about future population patterns, we know that, in the past, population rose slowly to approximately one billion in the early nineteenth century - Refer to the Box - *Populate and Perish?*

Figure 2.1 World Bank and United Nations Projections of World Population (billions)



The fact is that we cannot make firm predictions concerning population growth and, in many cases, are not even sure of the accuracy of current figures. Nevertheless, we do understand a number of relationships relevant to assumptions we might make in such predictions. For example, we know that after a short lag, rising levels of health and affluence lead to declining birth rates. Fertility rates in some LDCs have already reduced by 60 percent towards a stable population within one generation. Avery (1995) observes that births per poor woman have dropped from 6.1 in 1965 to a current level of 3.4 in low income countries and 3.0 in middle income countries. Stability of population growth is estimated to be at 2.1 births per woman and MDCs appear to have settled at around 1.7.

Populate and Perish?

Agriculture fed more people and human numbers doubled about every 1,000 years such that by 1,000 BC population reached about 50 million. A further doubling led to numbers reaching 200 million about 200 AD - the peak of the Han and Roman Empires. Decline of the empires and associated instability limited growth in population until about 1000 AD. Numbers then rose to about 350 million by 1200 AD and subsequently increased slowly to some 400 million - an apparent limit of food supply. Starvation and plague reduced numbers to an estimated 350 million in the 1300s and later rose to about 550 million by 1600 AD. Deteriorating climate then affected food production and population in 1700 AD was probably around 600 million. The most rapid growth to date occurred in the 1700s producing a total of 900 million by 1800 AD. Population probably first passed one billion mark around 1825 AD.

The scenario which shows population peaking at approximately eight billion around the year 2030 is considered to be the most likely because it is based on more extensive analysis than other predictions. Regardless of which scenario comes to pass, it is clear that population will continue to rise until the impact of declining birth rates is felt. This means that agriculture will be required to produce greater quantities of food say, twice as much as today.

In the recent past, we have faced the problem once. The late 1960s and early 1970s were oriented in many ways to feeding the world. During that period, global population reached some 3.7 billion, twice that of fifty years earlier. Population increase, limitations on the availability of new land to be brought into agricultural production, and natural disasters joined to present a picture of impending disaster. However, that disaster did not occur because the Green Revolution introduced known and new technologies which led to vast increases in production and enabled Asia in particular, to feed itself (Gutman, 1995). Wheat production increased by 70 percent and new varieties of rice had already covered 33 percent of rice areas before the end of the 1970s. Instances of maize yields quadrupling, for example in Kenya, and rice production doubling, for example in Columbia, all formed part of that Green Revolution. Such success had its price in the form of greater impacts on the natural environment, and in terms of complacency about the ability of agricultural scientists to continue to produce increasingly higher yields to feed growing populations. Even during this period there has been a tendency to overlook the 600 million or so people who continue to be undernourished.

By 1990 there were 1.5 billion more people being fed. Economic progress in South East and East Asia and elsewhere spawned an awareness of the need for sensible natural resource management. However, translation of this empathy into practice is not yet evident on a wide scale. An additional impact of the affluence in these countries has been an increase in demand for food per person and of food of particular kinds, often produced with lower resource use efficiencies. This increases further the total food production requirements of the globe.

The Green Revolution has provided valuable lessons. First, it has provided breathing space to prepare for the future. It has also taught us that famines are more likely to result from poor policies than natural disasters; that food production requires appropriate production resources and purchasing power among those who will buy agricultural produce; that agricultural development is the primary source of economic development in most low income countries, and that agricultural technologies must be managed within the wider context of natural resource management. As Gutman (1995) notes ... *the Green Revolution bought us time. With research and technological investments and better policies, it gave us tools to prevent world food crises. It showed us that agriculture is essential to feed people, alleviate poverty, and embark upon broad based economic growth.* Today, some commentators see a greater looming population crisis - *Malthusian Mayhem?*

The issue of population may be understood in the dramatic influence of humans on the environment. History may well view recent history as the first instance of a single species, in this case humans, reaching population levels which have a worldwide impact on the environment which supports them. Up until this time, humankind has been reproducing and living in an environment dominated by natural physical, chemical and biological systems. Now we are in a situation where these very systems are in effect regulated or affected by humankind. Thus the activities of each human are inextricably linked to those of every other human on the planet. The ascendancy of human activity to the same status as the great natural systems which have controlled the human environment to date requires a new philosophical approach to agriculture as a major component of natural resource management. Just as animal scientists have long managed rangeland and pasture resources in terms of sustainable carrying capacity, so we may use the same terminology of the human carrying capacity of the globe for a sustainable future (Malone, 1994).

Malthusian Mayhem*?*

Reverend Thomas Malthus was among the first to recognize that population tended to increase exponentially while food supply grew only arithmetically. If history proved Malthus wrong, as is commonly believed ... it did so only partially and only temporarily. Population has continued to rise exponentially, and it is true that the food supply has increased as well, much more than Malthus could have known. The reasons, however, had to do with the availability of land for agriculture and cheap energy. Green Revolutions work only with large inputs of fertilizers, pesticides, herbicides and machinery, all of which depend on a stable supply of low cost oil. US agriculture, for example uses about ten calories of fossil fuel energy to put one calorie on a plate. Farm energy costs are roughly 30 percent of the total energy used, and are rising. Conventional agriculture, dependent on chemical solutions for fertility and pest control, is requiring more to reach the same level of productivity. ... the intersection of these two curves suggests that the specter of famine raised by Malthus continues to stalk many nations of Africa and Asia. (Orr, 1992)

Future Food Demand

A future in terms of food production for the estimated world population in year 2020 has been presented by Pinstrup-Andersen (1995) through his vision of a world in which .... *every person has access to sufficient food to sustain a healthy and productive life, where malnutrition is absent, and where food originates from efficient, effective and low cost food systems that are compatible with sustainable use of natural resources*.

Analyses supporting the vision note that population growth is likely to be larger in urban than rural areas and that by the year 2015 the population of LDCs will be split evenly between rural and urban areas. Rapid urbanization, rising income and dietary changes will join with population growth to increase food demand continuously over the next 25 years with the projected increase in demand for cereals, meat, roots and tubers varying significantly between regions of the world. Resources which are sometimes assumed to be underexploited such as fisheries are shown to be at capacity or overexploited. Yet in this scenario real food prices are predicated to continue to fall, as they have for the past 20 years. World grain stocks have continued to decrease over the past decade and it is estimated that by mid-1996 grain stocks will represent only some 14 percent of annual world consumption. This is a lower proportion of total consumption than during the world food crisis of 1973.

In determining the productive capacity of the natural resource base, Pinstrup-Andersen (1995) notes that land degradation has been assumed to be irreversible in most analyses and such land has been treated as unproductive rather than of reduced productive capacity. Nevertheless, most of the increases in food production are expected to arise from yield increases which can only be generated through adequate investment in agricultural knowledge systems including education, research and extension. He proposes that LDCs allocate at least one percent of their Gross Agricultural Product to research with the intention of elevating this figure to two percent within five to ten years. The objective of such research would be to continue to reduce the unit cost of food production emulating the effect of the Green

Revolution which reduced the cost of producing a tonne of rice or wheat by about 30 percent.

Implementation of such a vision must be associated with improved governmental capacity in LDCs, improved education, reduced marketing costs and well focused international development assistance. Natural resource management in such a future would be based on such principles as improved water allocation and use efficiency, reversal of land degradation, reduction in the use of chemical pesticides, and rehabilitation and protection of marine fisheries. Investment in less favored agricultural areas including those considered fragile appears to be necessary and this requires a further increase in the knowledge base to sustainably manage such natural resources. The challenge to continue to equitably manage ourselves as a species calls for firm policies and hard decisions - it is time to *Act Now*.

Production and support systems for food also face future uncertainties. Speculation about the impact of possible climate change on agriculture has become a popular field. One scenario provides for reductions in growing periods and decreased water availability (Reilly *et al,* 1993) balanced against potential yield increases in mid to high latitudes associated with higher carbon-dioxide levels (Rosenzweig, 1995). Higher energy costs due to increased responsibility to reduce carbon-dioxide emitting fuels (Rosenberg, 1987) is likely to increase costs of agricultural production. Changes in rainfall are expected to increase costs of erosion and coastal inundation control (Earthwatch, 1992) and the need for continuing and rising investment in agricultural research and education will incur further costs (Oram, 1994).

Act Now

Our priority in the coming years must be on achieving the triple goal of alleviating poverty and food insecurity, increasing productivity and managing natural resources. ... if the global community does not get its act together soon, hunger and malnutrition and resulting illness will persist, natural resources will continue to be degraded, and conflicts over scarce resources such as water will become even more common. For most of humanity, the world will not be a pleasant place to live. Yet, it *does not have to be this way. With foresight and decisive action, we can create a better world for all people. We have the knowledge and the skills and we still have the necessary resources, including natural resources. Let us act now while we still have choices.* (Pinstrup-Andersen, 1995)

Even in the case of fish supply, Alverson and Larkin (1993) suggest that there is much more reason for concern about habitat degradation affecting marine life and fishing productivity than from overfishing. Our knowledge of fish stocks and the impacts of land degradation and overfeeding is grossly inadequate.

Population, poverty and increasing food demand represent the major forces at work on the natural resource base. Understanding these variables and the imperatives associated with them is essential to an understanding of natural resource management. As Nobel Laureate Norman Borlaug (CGIAR, 1995a) has indicated, the complexity of the task of producing sufficient quantities of desirable food represents a feat in environmental and economically sustainable development which has hitherto been uncontemplated. Associated with this task is one perhaps even more daunting - that of equitable food distribution. Once again the issues of poverty and lack of purchasing power become major factors in determining food distribution possibilities. The role of governments and the responses of individuals managing individual natural resources are all factors that will determine the future of natural resource management.

Land area is estimated to be expandable by around 0.9 percent per annum for the foreseeable future according to FAO (1981). However, Oram, (1995) disagrees with these estimates and notes that estimates vary so widely that they should be viewed with reserve - refer to the Box - *Land Demand*.

Similar levels of organic matter in the surface layer of tropical and temperate soils under sustained fallow or similar conditions hide the fact that the organic matter of tropical soils is concentrated in the top five to ten centimeters. In addition, the tropical soil organic matter oxidizes about four times more quickly than that of temperate soils. Sanchez (1991) nevertheless, believes that high input agriculture is technically sustainable in the tropics subject to appropriate management techniques being devised. Tropical soils are more susceptible to erosion than temperate zone soils (Stocking, 1984) although information on the effect that this has on productivity is scarce. The most detailed analyses conducted in the USA, for example those discussed by Crosson (1986), indicate expected losses in productivity of five to ten percent over a period of 100 years.

> ***Land Demand***
>
> *The likelihood of expanding the supply of agricultural land enough to accommodate at acceptable cost, a doubling in global demand for agricultural output and a 2.7 times increase in demand in the developing countries over the next 40 years is small to negligible. ... The implication is that the global supply of agricultural land will be inadequate to accommodate the prospective increase in global demand. Satisfying that demand at acceptable costs will require major, sustained increases in knowledge about agricultural production and how to manage its off-farm consequences. How to achieve the necessary knowledge increases is the critical question in achieving sustainable agricultural production.* (Crosson, 1991)

An attempt at mapping soil degradation in the world by Oldeman *et al* (1991) is useful although it does contain anomalous reference to moderately to severely degraded lands in the USA mid-west where crop yields have increased steadily over the past 40 years. Sombroek (1992) implies similar concerns over accuracy of the FAO (1992) Agroecological Zones approach. The relationship between soil degradation or land capability and agricultural productivity remains poorly understood. It is also difficult to separate emotive statements from factual information; while many see desert encroachment as continuous and accelerating, the World Bank (1992) notes that satellite imagery of the Sahelian zone of Sub-Saharan Africa indicates variations in vegetation cover of more than 200 kilometers between wet and dry years during the 1980s without any association to underlying trends.

Further exemplifying our ignorance is the observation of Crosson and Anderson (1992) that soil eroded from one landscape may remain elsewhere for several years or even centuries before washing into the ocean. The separation of human from otherwise natural effects has also proved difficult to understand.

The Agricultural Environment

The agricultural environment is characterized by; research which develops new technologies, periodic adjustments to production systems and their inputs, and the people engaged in these and other related practices.

Agricultural research and education has focused primarily on matching desired plants, animals and environments. Tribe and Peel (1989) identify three major aims of agricultural research as: (i) modification of the environment to increase availability of such resources as water, soil, nutrients or animal feed or by minimizing crop and animal losses by reducing the effects of weeds, predators and diseases; (ii) selecting genotypes of animals and plants suited to the environment through breeding or introduction of foreign species, and (iii) the application of improved management to improve the efficiency with which resources are utilized for agricultural productivity.

These principles have been elicited from the experience of developing agriculture in Australia noting large variations between the climates, soils, vegetation and ecological conditions in Australia and England, from whence many early farming systems were introduced. The approach of seeking to modify the natural environment and to orient species and management to the environment has been a mainstay of Australian agricultural research and education and is one of the reasons that such approaches to the development of new technology in new environments have proven transferable to other countries.

The principal components of the natural environment which support plants and animals - of soil, water, solar energy, biodiversity and climate - are influenced by such other factors as pollution. Intensive agricultural systems, including irrigation-based agriculture in LDCs and slash and burn techniques in areas where population density has risen beyond the ability of this system to sustain forest regrowth, provide an ever changing environment to which agriculture must adapt. And that change in the environment is in fact an output of the agricultural systems themselves. The more intensive the production system, the greater the potential to *Modify the Environment*.

No matter how we view the imperatives for improved natural resource management, the manager of the land is ultimately an individual such as a farmer. Farmers seek a reasonable financial return on their capital and labor in the first instance and therefore seek production techniques which minimize physical effort and personal time. They will, on average, prefer farming methods that minimize risk from markets and climatic variables and in personal terms will aim to maintain their properties in good condition to meet peer group expectations and to maintain the capital value of their resource. Such land managers tend to cherish their independence and freedom to work with minimum regulation. They choose to access information where they may. For these lasting reasons, the management of the natural resource cannot be readily planned on a central basis. There is a clear role for education in ensuring that these natural resource managers are well informed of the scientific, technological, and social implications of their decisions.

Modify the Environment

Three biological systems - crop lands, forests and grasslands - support the world's economy. Except for fossil fuels and minerals, they supply all the new materials for industry; except for seafood, they provide all our food. Forests are the source of fuel, lumber, paper and numerous other products. Grasslands provide meat, milk, leather and wood. Crop lands supply food, feed and an endless array of raw materials for industry such as fiber and vegetables ... the share of land planted to crops increased from the time agriculture began until 1981, but since then the area of newly reclaimed land has been offset by that lost to degradation and conversion to non-farm uses. ... The combined area of these three biologically productive categories is shrinking while the remaining categories - wasteland and that covered by human settlements - are expanding. (Brown, 1990)

It is popular to consider all agricultural chemicals to be damaging to the environment. It is however, somewhat naive to assume that all fertilizers are the same or indeed that fertilizers and pesticides are of equal potential danger to the environment or humans. It is likewise unfair to criticize the use of pesticides in circumstances where their use is declining as a result of innovative scientific development of insect resistance in modern plant varieties, for example. Avery (1995) dismisses much of Carson's (1962) thesis in *Silent Spring* in terms of incomplete knowledge of her time. Nevertheless, the argument is persuasive and has had widespread effect which in turn has impacts on agriculture. The imperative for wider understanding through education about natural resource management and agriculture has never been greater. Thus we should consider - *Fertilizer - An Essential Input*.

Fertilizer - An Essential Input

Mr. Normal Borlaug, a prominent agriculturist ... told a meeting of the Overseas Development Institute yesterday: "some people say that Africa's food problem can be solved without the application of chemical fertilizers. They are dreaming. It is not possible". He said that the environmentalists advocating traditional farming methods failed to recognize the rapid growth in population expected in the Continent .... Sub-Saharan Africa has the lowest use of fertilizer in the world and soil nutrients were so low that other efforts to raise crop productivity would not be successful until fertility was improved. (US Financial Times, quoted in Avery, 1995).

Irrigation Potential

Irrigation has more potential to increase food production than does expansion of land area. Oram (1995) calculates that irrigation contributed more than half of the increase in world food production between 1965 and 1985. Future potential is associated with agricultural intensification and diversification, and higher value crops. This would suggest that undeveloped irrigation areas - which are said to exceed existing irrigated areas by about 60 percent - should be realized. However, there is a trend against irrigation expansion (Stewart *et al,* 1991) due to: poor past performance, low returns on investment, falling commodity prices, increasing development costs, rising scarcity of good irrigable land, competition for water between users and environmental pressures. For these reasons, Crosson and Anderson (1992) conclude that the potential of irrigation in increasing food production will only be realized to a small degree. A one percent increase in irrigated area per annum from 1990 could add 18 million hectares to the irrigated areas of LDCs by 2000 according to Oram (1995) (Table 2.1).

The *fugitive nature* (Crosson and Anderson, 1992) of water renders it difficult to manage on the same basis as land. Without proposing solutions, they conclude that water management should be the first consideration for natural resource management in agriculture. Current efficiencies of water use in agriculture are low and potential to increase efficiency while reducing impacts on the natural resource base is significant.

Table 2.1 Estimated Increases in Irrigated Areas (percent per annum)
(FAO, 1991)

	1975-80	1980-85	1985-90
World Total	**2.2**	**1.3**	**1.0**
Low & Middle Income Countries	**1.8**	**1.4**	**1.3**
Africa	3.4	2.6	1.4
Latin America	2.7	1.8	1.1
Near East	-0.8	1.6	1.7
Asia	2.0	1.3	1.2
High Income Countries	**3.3**	**1.2**	**-1.4**
North America	4.3	0.5	1.0
Europe	2.6	2.0	1.4
Oceania	0.8	3.0	2.2
Former Soviet Union.	3.8	2.7	1.2
Other	0.8	-0.3	-0.6

Avery (1995) lists the relative water use efficiencies in agriculture as:

Flood irrigation	35-60 percent
Center-pivot sprinklers	70-85 percent
Trailing tube pivots	85-90 percent
Drip irrigation	85-90 percent

Poverty

The link between poverty and natural resource management requires emphasis. Without alleviation of rural poverty among small scale farmers there can be little expectation of natural resource management moving ahead with the knowledge base. We are faced with a situation in which better-off persons can consider the effect of other humans on the environment. It is necessary for all who share such concerns to also acknowledge the wider human plight which affects the environment. As Norman Borlaug (CGIAR, 1995a) quotes Richard Leekie ... *you have to have at least one square meal a day to be a good conservationist or environmentalist*. The imbalance may also be presented in a different way, as has been done by Ponnamperuma (1994) who observed that by the year 2020, some 80 percent of the population will live in LDCs and yet in 1994, 94 percent of the world's scientists served that 25 percent of the population resident in the MDCs. Estimates of poverty in the developing world are presented in Table 2.2.

It is inappropriate for us to place perceived environmental needs above actual human needs - what we need is recognition of the relationship between these issues and the solutions available today and needed for tomorrow. As Indira Ghandi observed in 1972, we cannot expect those living under marginalized conditions to join in environmental causes until their lot has been improved through science and education (Ponnamperuma, 1994).

The linkage between increased purchasing power and reduced rates of population increase has been demonstrated in country after country where economic development has occurred. In the long term, while such increased affluence leads to a rise in per capita consumption particularly of luxury foods, an overall decline in the rate of increase in food requirements can result as population growth rates decline. Investment in poverty alleviation and agricultural improvement through education and research should be the primary objectives of international development.

Table 2.2 Poverty in the LDCs, 1985 -2000 (Millions

below the Poverty Line) (Oram, 1993)

Region	**1985**	**1990**	**2000**
All Developed Countries	1,051	1,133	1,107
South Asia	532	562	511
East Asia	182	169	73
Sub-Saharan Africa	184	216	304
Middle East & North Africa	60	73	89
Eastern Europe	5	5	4
Latin America & Caribbean	87	108	126

Investment

The need for investment in agricultural research and education is stated by concerned organizations; it is easy in these circumstances to preach to the converted. The imperative is to have wider understanding of the dynamics of international food demand and natural resource management. However, we may have confused the public with conflicting statements over the past 30 years. The Box - *The Boy who cried Wolf?* - illustrates some of the confusing statements that have been made over this period.

The Boy Who Cried Wolf?

All quotes are from Mitchell and Ingco (1993)

The outstanding fact in food and agriculture is that the past 25 years have brought a better fed world despite an increase of 1.8 billion in world population. Average food availability rose from 2,320 calories per capita in 1961/63 to 2,660 calories in 1983/85. Earlier fears of chronic food shortages over much of the world proved unfounded. FAO (1988)

In the early 1970s the soaring demand for food, spurred by both continuing population growth and rising affluence, has begun to outrun *the productive capacity of the world's farmers and fishermen. The result has been declining food reserves, sky-rocketing food prices and intense competition among countries for available food supplies.* Brown (1990)

Each year food production in under-developed countries falls a bit further behind burgeoning population growth, and people go to bed a little bit hungrier. While there are temporary or local reversals of this trend, it now seems inevitable that it will continue to its logical conclusion; mass starvation. Ehrlich (1968)

In 13 years India is going to add 200 million more people to their population. In my opinion, as an old India hand, I do not see how they can possibly feed 200 million more people by 1980. They could if they had the time say until the year 2000. May be they could even do it by 1990, but they cannot do it by 1980. Ewell (1968)

One common theme which can be drawn from discussions concerning natural resource management and the role which agriculture plays, is the need for continued development and dissemination of knowledge. The need for such knowledge will grow in response to new problems. It should be expected that this will increase at rates higher than in the past, as we move into more intensive production systems and understand more fully the intricacies of the ecosystems in which we manage agriculture. Several studies have indicated the very high rates of return possible from investment in agricultural research. The same may well apply to broader natural resource management research and certainly includes the benefits which accrue from agricultural and natural resource management education. The World Bank (1992) suggests that agricultural research is among the best public investments available - yet support is declining, a trend which, if continued, weakens the chances for environmentally sound agricultural intensification - are we - *Biting the Hand that Feeds?*

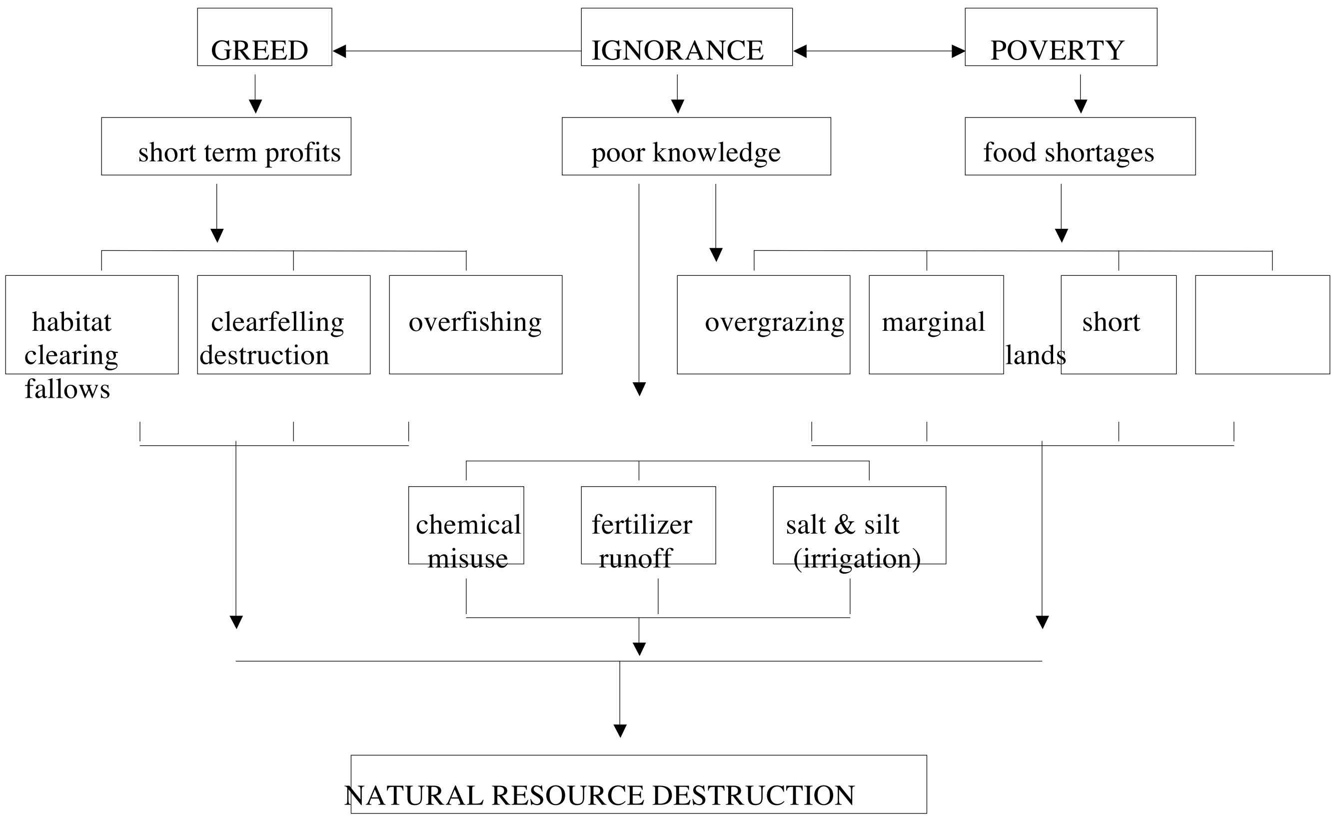
Biting the Hand that Feeds?

To meet projected gaps between demand and supply for food ... will not *be easy; since rates of growth of cultivated areas, irrigation, and fertilizer use have declined since the 1980s and there are uncertainties concerning the impact of environmental regulations, climate change, the outcome of international trade negotiations, and the growth of global economy which could retard expansion of land and water resources and impede technological change. Even if the current slow growth of cultivated and irrigated areas can be accelerated, the achievement of the production goals will place heavy demands on increasing yields of stock and livestock, both through better use of existing knowledge and more efficient input use; and through development of new knowledge and technology. It is argued that the former is likely to make the largest contribution during the 1990s although in the longer term, new knowledge - perhaps especially through biotechnology, will have a major impact. In this context, the cut-backs in international and national funding of agricultural research, and the declining support to agriculture generally by development assistance agencies in recent years are a matter of grave concern.* (Oram, 1994)

Edwards-Jones (1994) in a report to the International Service for National Agricultural Research (ISNAR) noted the need for research concerning natural resource management programs to include social elements in addition to common technical elements. This is not a new approach. Agricultural sciences have traditionally recognized the necessary interactions between soil, plant, animal, climatic and socioeconomic systems in determining the appropriateness of technologies and the likelihood of their adoption. These same principles are critical in any approach to natural resource management education and research.

The challenges to natural resource managers, and educators and researchers is broad. The International Food Policy Research Institute has identified three areas for action namely: food security and nutrition; poverty and economic growth; and human resource development - and presents these in terms of current status and future trends, changes that are needed and highlights for action (IFPRI, 1995). This provides a context for natural resource management and highlights the critical role of sound scientific and moral education concerning natural resources.

Figure 2.2 Human Conditions and its Environmental Impact



Of course natural resource deterioration is not related solely to poverty and ignorance. Wanton destruction also occurs. If we are to understand the dynamics of the system, which is presented in Figure 2.2, we must factor in some basic human traits which are somewhat unsavory. Greed and other motivations lead to destruction of environments through such obvious means as overgrazing state lands, disposal of industrial and other wastes, and uncontrolled logging. Regulation therefore forms part of the overall scenario for natural resource management. Regulation in turn is most effective in circumstances in which those being regulated understand the impact of their actions and those who regulate, as policy makers and administrators, have a context in which to understand their responsibilities.

Insofar as agriculture is the main terrestrial resource manager, the concept of being able to reliably produce essential agricultural products becomes the modern context for agricultural education and research. This requires sustaining both production and the productive capacity of the resources.

Sustainable Food Production

It is easier to find references to unsustainable human activity than to those which define practices which are sustainable. This observation defines the essence of the issue of sustainability - when dealing with dynamic systems which involve interactions between biological and human cycles, it is unlikely that we can categorically state which practices and production systems are sustainable. Rather, we can elicit principles to guide education, research and production in agriculture and thus better understand - *The Problem of Sustainability*.

The Problem of Sustainability

If today is a typical day on planet Earth, humans will add 15 million tonnes of carbon to the atmosphere, destroy 115 square miles of tropical rainforests, create 72 square miles of desert, eliminate between 40 to 100 species, erode 71 million tonnes of topsoil, add 2,700 tonnes of CFCs to the stratosphere, and increase their population by 263,000 ... looking further into the future, three crises are looming. The first is the food crisis evident in two curves that intersect in the not-too-distant future: one showing worldwide soil losses of 24 billion tonnes, the other a rapidly rising world population. The second on the horizon is that caused by the end of the era of cheap energy. We are in a race between the exhaustion of fossil fuels, global warming, and the transition to a new era based on efficiency and solar energy. The third crisis, perhaps best symbolized by the looming prospect of a global climate change, has to do with ecological thresholds and the limits of natural systems. We can no longer assume that nature will either be bountiful or stable or the Earth will remain hospitable to civilization as we know it. (Orr, 1992)

The issues of sustainability can be discussed in technical terms, as in this Chapter and in wider philosophical terms as introduced in the next Chapter. In technical terms, issues can be defined in a manner that can lead to new or modified actions. Some of these issues are presented below. The first is the anthropocentric view that human management capabilities are sufficient to maintain a balance between systems and needs. Opponents of this view are wont to quote Old Testament references which imply human dominance over nature and, in the modern era, the alignment of science to that apparent end and its progressive separation from the arts. These views raise questions as to the appropriateness of our current education and political systems to accommodate changes in management approaches.

The second issue surrounds human nature and the ability to mold individuals and society in a manner which limits the impact of greed and selfishness. Orr (1992) notes that a technological approach to sustainability is often based on the assumption that humans will seek to maximize economic benefits in the short term to the exclusion of long term perspectives relevant to perpetual management of natural resources. This view essentially defines humans as unable to control greed or to act for the common good.

A third issue concerns the association of economic demands and deterioration of the natural resource base. It embraces the continuing anomaly for sustainable management of resources, predominantly emanating from MDCs, when those countries continue to rely on the purchase of raw materials and products from LDCs under prices which do not favor natural resource protection or economic development. The purchase of timber from LDCs while protecting one's own national forests is a commonly quoted instance. As the quest for economic development appears to be universal, and indeed it is difficult to argue against equality of economic opportunity, economic growth seems inevitable. Past and current economic activity is seen to be associated with environmental destruction and thus proponents of this argument believe that further economic growth will lead to further environmental destruction.

A fourth issue can be described in terms of the applicability of appropriate pricing policy. The economic argument that allocation of appropriate pricing to reflect the true cost of resource use will lead to appropriate action is countered by opponents who question the available knowledge base and the motives of those in control of resources. The introduction of pricing policies which extend to the poorest of the poor implies the introduction of regulatory systems across wide areas of the globe in which there is little evidence of the influence of economists and policy makers through agricultural research and education systems.

So What is the Meaning in Terms of Agricultural Technology? Because agriculture represents a major intervention in the natural environment, it has attracted the attention of both the well-informed and the well-meaning. Low input, *organic* and other forms of agriculture are proposed in an apparent vacuum of current knowledge about the yield capacities of these systems and indeed their effects on the environment when applied in practical situations (Egan and Connor, 1994). Minimizing soil erosion through the use of minimum or zero tillage agricultural systems is applauded by some proponents of sustainable agriculture while criticized by others for using herbicides for weed control. In fact, low input agriculture is an appropriate description for the agriculture of many LDCs particularly in Sub-Saharan Africa - and it is for this reason that their food yields are the lowest in the world. It is also in these regions where malnutrition and poverty cause farmers to take a short term perspective in feeding their families and to put protection of their environment, perhaps reluctantly but firmly, behind these imperatives.

It is not feasible to suggest that we can return to some earlier idealized view of food production except in special cases to meet preferences of the rich. Our aim must be the use of practices which increase the efficiency of inputs including fertilizers, pesticides, irrigation and mechanization while minimizing adverse impact on the environment. Techniques such as the breeding of disease resistance into plants to minimize reliance on pesticides, crop rotations to reduce the build-up of crop pests, improved tillage and water harvesting techniques, integrated pest management and similar approaches, form the focus of informed agricultural research and education at present. We must build on these through research and wider education to instill an ethic of responsible natural resource management. This is no easy task and relies on people of vision and wisdom. As the Australian Agricultural Working Group on Economically Sustainable Development states, ... *the scientific leadership and human management skills required to achieve such an integrated systems approach should not be underestimated. It has not been done before in Australian agricultural research, and rarely in any part of the world* (Orr, 1992).

The development of sustainable agriculture may be seen as an evolution which spans subsistence and commercial agriculture. MDCs have passed the subsistence stage although it remains active or in-transition to a commercial system in LDCs. Commercial agricultural production systems must now move towards sustainable production systems. Hatfield and Karlen (1993) compare these three systems of agriculture (Table 2.3).

Definitions of sustainable agriculture abound. Malone (1994) embraces the concept of sustainable human development as a societal objective whereby basic human needs and aspirations of future generations are acknowledged in the maintenance of an attractive and productive environment.

Such a statement is consistent with a composite definition of sustainable agriculture tendered by Crosson and Anderson (1995): ... *sustainable agriculture is defined and explained as a production system that indefinitely meets demands for food and fiber at socially acceptable economic and environmental costs. Economic costs are those that enter into prices of marketed agricultural outputs and inputs. Environmental costs do not arise out of market transactions, so they are unpriced. The level at which the economic and environmental cost become socially unacceptable is inherently ambiguous. Ultimately, the limits to socially acceptable costs must be decided through political processes.*

Table 2.3 Features of Subsistence, Commercial and Sustainable Agricultural Systems (after Hatfield and Karlen, 1993)

Defining Dimensions	Agricultural System		
	Subsistence	**Commercial**	**Sustainable**
Social identity	Family	Self	Community
World of reality	Past	Present	Future
Major interpersonal processes	Conflict	Competition	Cooperation
Relationship to nature	Vulnerable to	Control over	Harmony with
Interpersonal relations	Mutual trust	Individual rights	Community needs
Natural Resources	Finite and consume	Develop and consume	Finite, conserve and preserve
Motivational drive	Safety and security	Self-achievement	Community accomplishment
Technological development	Borrowed or serendipitous	Supported faith as solution	Controlled for collective good

Sustainability and Image

Considering agriculture as natural resource management, Hatfield and Karlen (1993) observe that distrust by non-agricultural groups of today's agriculture may be justified. Reactions by scientists against allegations of pesticides contaminating the environment have proven to have been ill-founded. Similarly, nitrite contamination of groundwater was initially denied and is now accepted. Likewise the presence of pesticide residues in food while initially denied is now accepted to occur in some cases. This poor public relations record is countered by the terms in which scientific statements are generally made such as ... *within the constraints of present analytical techniques, no significant levels of the contaminant were determined*. The intent of such statements may not be clear to the scientifically illiterate. Agriculture as the major terrestrial natural resource manager must accept responsibility for the information it disseminates, and agricultural education represents a primary medium for such a change in approach.

There is cause for hope in terms of public image. Recent global newspaper articles concerning the conferring of resistance to leaf-blight in rice through genetic engineering indicates that a short message can be conveyed to the public. Public statements by agriculturists are made daily, such as in the case of new and safe pesticide developments (Peeples, 1994). Some are presented in most eloquent terms such as one concerning Integrated Pest Management - *Win Win with IPM*.

Win Win with IPM

... IPM is not prescriptive: it is not a single universal remedy. Rather it presents an attitude that can guide both farmer and scientist in the formulation of a proper mix of technologies which best meets the technical, environmental and socio-economic circumstances of any particular situation. It does not specifically say that all biocides should be banned, or that the risks in molecular biology are too great, or that every farmer needs to use either computerized information systems or for that matter, dung beetles. It does not dogmatically espouse the cause of organic farming or alternative agriculture. It is not a new alternative to chemical, biological or cultural methods. "IPM", says the Australian entomologist, Dr. Max Whitten, "is more than that - it really represents a no-holds barred approach; it is devoid of the luxury of any specific ideology but with a prudent eye to cost effectiveness, durability and environmental friendliness" (Tribe, 1994)

The works of Avery (1995a; 1995b) are based on the premise that food production systems of the world have effectively created the maximum possible space for nature and wildlife through the high efficiency of food production on more productive land. Borlaug (1995) presents graphs which indicate the areas of land saved by the introduction of modern cereal varieties in China. These are based on the levels of yield increase that would have been expected had modern varieties not been developed and they indicate significant saving of sensitive land. If the USA is taken as an example, it is estimated that the 1990 harvest of the 17 most important food, feed and fiber crops would have required an additional 188 million hectares of land of similar quality if the technology of the 1940s had been employed. These are compelling reasons for continued investment in agricultural research and the education which underpins the research resource.

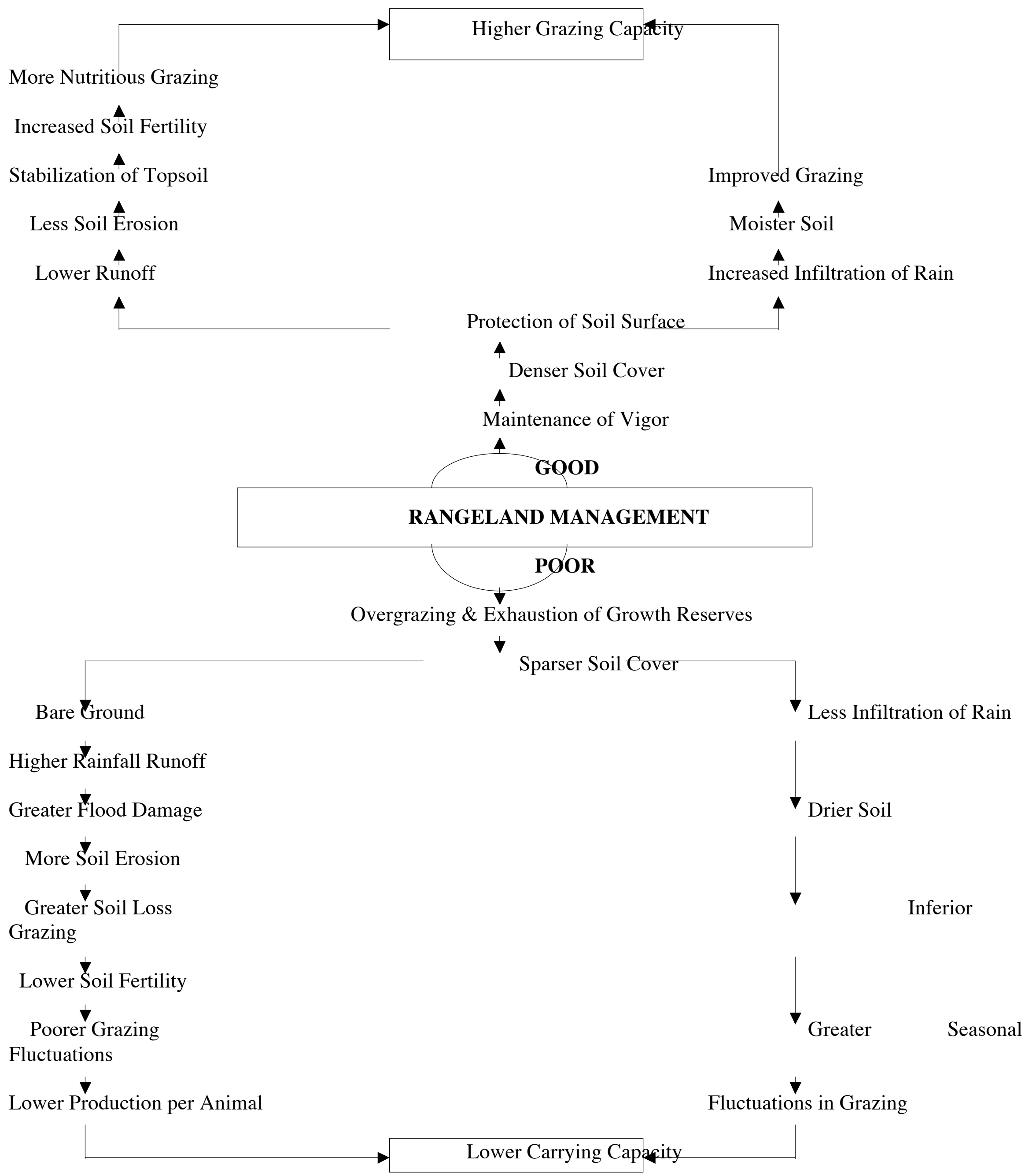
However, invoking the land saving capabilities of modern agriculture begs the question of the management practices utilized on agricultural land. This is where the outputs of research such as integrated pest management and rangeland management techniques come to the fore. Roberts (1965) presents a diagram which highlights the relationships between management and carrying capacity of rangelands. The desirable outcome from the flow chart (Figure 2.5) meets the dual objectives of higher carrying capacity and improved environmental outcomes. This common approach to agricultural research is one which we would do well to publicize further.

The example of rangeland grazing management provides an interesting inter-connection between agricultural research and associated technological innovation with sociological understanding. The benefits from the application of such technology are far more easily realized in situations where ownership or rights to manage the resource are clear. The *problem of the commons* as reiterated through the centuries, relates to grazing lands held in common and the associated lack of effective management responsibility and consequent degrading of the resource. Likewise many of the world's nature reserves are held in common with no direct owner. Avery (1995) highlights the compounding difficulty of weak governments acting on behalf of common owners to protect natural resources. In discussing natural resource management we must look to continuing improvements in agricultural management for that major component of the natural resource entrusted to agriculture while at the same time seeking to strengthen the management systems for nature reserves.

People and Agriculture

It is easy in technical investigations to ignore the essential social element of agricultural and natural resource management. The limited impact of the Green Revolution in Africa can be related to the reticence of farmers to utilize fertilizers and pesticides, control weeds and to the lack of sufficient

Figure 2.5 Relationships between Management and Carrying Capacity of Rangelands (after Roberts, 1965)



resources such as draught power and labor (Oram, 1991). This lack of progress may be linked to poverty which is in turn linked to environmental degradation. Lack of incentives for individuals, institutional and infrastructural weaknesses and policy failure are also blamed. Under these circumstances the challenge is to introduce improved practices while developing new environmentally sustainable technologies suited to the local natural resource base. This requires new approaches in environmental and socioeconomic terms.

The huge advances made by agricultural research have, in many cases, proved difficult to transfer to small farmers through extension services or projects. A renewed understanding of the need to consider household socioeconomic requirements (Kennedy and Bouis, 1992) is based on recognition of technically feasible solutions being socially unacceptable in certain communities. Oram (1993) notes that a wider disciplinary base than technical disciplines is needed, including economists, sociologists, anthropologists and information specialists. Associated needs to devolve natural resource management from national to local levels (Gregersen *et al*, 1992), and for community participation, are prerequisites to socially acceptable resource use (ICARDA, 1992; Seegers and Kaimovitz, 1989). This represents a shift in the emphasis and perhaps the elite position occupied by biological systems specialists in natural resource management, research and education.

Involvement of farmers in decisions relating to support services for example, can be seen as part of the wider historical citizen-participation movement of political science. Thrupp and Haynes (1994) suggest that the field of participation, like sustainability, has been ignored in this century. Increasing attention over the past decade by some agriculturists and rural development specialists has raised awareness of the high social costs of conventional approaches to agricultural research and development. This coincides with recent political and economic trends which include movements for increased democracy and the development of representative groups of marginalized sectors of society. *Participation* has become a trendy approach to LDC development projects and its emotional appeal has caused significant shifts in the allocation of international development resources - refer to the Box - *Power to the People*.

With increased focus on *participation* and *empowerment,* there are risks that this simply becomes another band-wagon. It is already possible that the definitions of participation have been diluted and have become superficial with the term's wider use in institutions. Similarly, the claims of advocates of participation that it can produce outcomes in sustainable agriculture and natural resource management through acts of faith ultimately weaken the essence of the message. Participation requires special political and institutional circumstances in order to be effective. Such circumstances occur rarely and are often associated with major periods of change in which participation and empowerment may occur separately from any planned project activity. Ignoring the reliance on political and institutional shifts for the positive outcomes of participation to be realized is a common error of hastily conceived LDC aid activities. The strong reliance of such projects on training and education has clouded the wider role of education in natural resource management.

Power to the People

"Participation" has become an increasingly common buzz word in rural development discourse of the 1990s. Its recent popularity has equaled or perhaps surpassed that of "sustainability" in initiatives for social and agroecological change. The support of participatory approaches is becoming particularly prevalent among social scientists, non-government organizations, and practitioners in research and development (R&D). ... Non-government organizations and social scientists in educational institutions tend to be the most prevalent users and advocates of participatory approaches, but participation is now entering visibly into the rhetoric and use of mainstream conventional institutions as well. ... These efforts have generated an "alphabet soup" of methods and tools ranging from early versions of RRA (Rapid Rural Appraisal) and DnD (Diagnosis and Design) to FF (Farmer First) and PEC (Primary Environmental Care). ... Some of these activities emphasize "empowerment" as a means and/or an end of the participatory development process. (Thrupp and Haynes, 1994)

Some examples of experience with participatory activities form the basis of the 1994 Spring-Summer issue of the Journal of Agriculture and Human Values. The narrow base of most participatory activities is criticized. Farmer-responsive research programs which include on-farm research activity are discussed by Merrill-Sands and Collion (1994) in terms of their relative unpopularity, low levels of funding, and lack of impact. New attitudes to learning are seen to be critical to appropriate participatory extension activities which revolve around the learning mechanisms of the communities rather than the preferred teaching and learning approaches of agricultural research and extension workers (Cornwall *et al,* 1994). This is supported by Thomson and Scoones (1994) who suggest that different knowledge bases of the community, and those outside the community limit the ability to communicate and that as knowledge itself is the product of social interactions and conflicting loyalties, that of farmers is quite distinct from the knowledge base of formally educated persons. One example of community resource management is *The Arabari Experiment* in India.

The Arabari Experiment

The Arabari experiment began in west Bengal in 1970. The objective of the experiment was to determine how to stop villagers from encroaching on the forest for illegal firewood cutting, an activity which was leading to rapid deforestation. Interviews with 1,300 individuals in 11 villages revealed that the villagers were earning a good part of their income by illegally cutting and selling firewood. The experiment, therefore, offered the villagers forest related employment opportunities to compensate for the income earned through encroachment. Employment was offered in the planting of trees and grass on bare patches, and was scheduled to take place during the low employment season. ... In addition, they were offered a revenue sharing agreement with the Forest Department whereby they received 25 percent of the selling price of mature trees in cash and were entrusted with the responsibility of protecting the forest from encroachment. Institutional arrangements were made for the election of representatives on a rotational basis from among the villagers to monitor work and collect and distribute payment. The villagers enforced total protection of the forest including patrolling and they themselves refrained from illegal cutting. ... In 35 years, the degraded forests were *rehabilitated, the villagers were markedly better off and their relations with the Forest Department improved. ... By 1989, there were 700 groups or village protection committees responsible for over 70,000 hectares of degraded lands in west Bengal. ... Similar success with small user groups has been reported in Indonesia, Nepal and Niger.* (Asian Development Bank, quoted in Falvey *et al*, 1991)

Towards an Alternative Approach

It was not the development of agriculture and the production of surplus food which allowed the world's population to grow. Agriculture was adopted as a simple necessity because population rose. Until the last two centuries, in virtually every part of the world most persons lived with the specter of starvation. The ability of Europe to rise above this situation, in common with other societies, lay not in agriculture alone but in changing international relationships which enabled countries to control an increasing share of the world's resources.

Yet agriculture fueled initial economic development in the majority of societies which have achieved rapid economic progress. It is an integral part of the way we have viewed ourselves, formed our values, structured our languages and thought patterns. Today agriculture and food represents the dominant industry in many countries, including the USA, and has become indispensable. The human species could not survive today in its current manner in the absence of modern agriculture.

So, if agriculture is a foundation of civilization, essential to our survival and integral to human cultures, why does its practice attract criticisms such as that in - *Farm Fact or Fiction*? (Chapter 6). The simple answer might be that the opinions expressed in that Box and elsewhere are wrong. However, experience suggests that there is merit in many of the suggestions being made and hence, the ongoing debate concerning natural resource management and the role of agriculture within it, provides us with a basis to strengthen our technological, sociological and economic education and research activities.

Pinstrup-Andersen and Pandya-Lorch (1994) isolate five conditions which must be met if our natural resources are to maintain their productive and recreative capacity for future generations. These five conditions are: (i) renewal of economic growth in all regions beginning with agricultural growth; (ii) policy initiatives to slow rural to urban migration and population growth; (iii) development of rural infrastructure including research, credit, technical assistance and input supply to farmers; (iv) clarification of the role of the State and macroeconomic and market reforms; and (v) natural resource management and control of environmental degradation. The fifth category contains by implication a change in attitude in agricultural research and production practices as well as a change in public perception - all functions of education. To understand these factors more fully, the following Chapter examines some of the philosophies of environmentalists and links these to agricultural education.

Earth's Riches

New millennia crave new visions,
Today's acts but mean and crude;
Factor balance in decisions,
Consider human needs for food.
The world we knew no more persists,
Changed by nature and our might,
Rich strive for more, poor just subsist,
Thus we squander our birthright.

  Poor of the globe inherit the earth,
  Ancient skills now of low use,
  With rising ignorance, hunger, births,
  They seem to say of such abuse:
  "Close to nature I daily toil,
  To produce enough for my family,
  I worship the trees, the water, soil,
  Yet must subvert my homily".

Yet we rich enjoy comfort unpained,
Shared only when it will pay,
To support style that can't be sustained,
Turning backs on the poor as we say:
"Clothed well-fed now introspective,
Good health portent of long life,
Of nature now I am protective,
As I ignore the human strife".

  Consider the cost of comfort and numbers,
  Exploited nature, exploited poor,
  Conscience does not affect our slumbers,
  Knowledge trimmed to give we rich more.
  Man must unearth the buried talents,
  Invest in global values now,
  As strive must all for golden balance,
  Twix man and nature, a new vow.

Chapter 3

Understanding and Education: Environmental Empathy

[they have] *investigated everything handed to us in sacred books*
... They have left nothing of what was held sacred before.
They have only investigated the parts and overlooked the whole,
so much so that one cannot help being astonished at their blindness.
Dostoyevsky

This Chapter discusses knowledge and the forces which form attitudes. It builds on the role of agriculture in natural resource management and proposes a wider view of empathy for the environment as a parallel consideration with technical and social aspects in education. The benefits of education are highlighted, and its role in ensuring a knowledge base sufficient to allow awareness and use of increasingly available information is introduced.

Awareness

Natural resource management is viewed differently by those engaged in technical and development oriented research, and those who eschew a technical approach in favor of idealized concepts of life. Are the two mutually exclusive? Capra (1992) draws parallels between the approaches of scientists, predominantly theoretical physicists and mystics. He suggests that both methodologies are thoroughly empirical in that, while physicists derive their knowledge from experiments, mystics gain theirs from meditative insights. In their respective fields, both of these observations are acknowledged as the sole source of knowledge. The mystic has the universe as his body and his physical body as a manifestation of the universe, according to Capra (1992) and ... *his inner vision* [becomes] *an expression of the highest reality, and* *his speech an expression of eternal truth and mantric power. The physicist, in contrast begins his inquiry on the essential nature of things by studying the material world and as such becomes aware of the essential unity of things and events including the physicist's consciousness as an integral part of this unity.* He claims that the mystic and the physicist also share similarities in the conclusions they reach.

This approach seems as difficult for the traditional mystic as for the traditional scientist to accept. From the perspective of this Chapter, it is important to recognize the fields of thought which unite these alternative means of searching after truth. They may form a basis for the resolution of apparently opposing arguments concerning environmental interaction and management.

Knudtson and Suzuki (1992) claim that we have failed to achieve the promised technological utopia and that scientists are increasingly questioning the assumptions underpinning scientific investigations. They present statements from leading scientists and others whose philosophical viewpoints on the relations between humans and the environment support veneration of nature. However, the very questioning of the limits of scientific knowledge by scientists should be recognized as part of the scientific method rather than a criticism of it. It is too easy to frame such comments in terms which appear to cast doubt on the scientific pursuit of knowledge and its accomplishments thus far. Just as we must respect the religious-like views of concerned philosophers, we should also retain *Respect for the Scientific Method*.

Respect for the Scientific Method

...scientific elders speak out on what they suspect may be inherently sacred, or spiritual, dimensions of our nature. One remarkable public statement titled "Preserving and Cherishing the Earth: An Appeal for Joint Commitment in Science and Religion", was issued at a recent international conference on the environment and economic development in Moscow, attended by religious, political, and scientific leaders from 83 nations. Importantly, it was signed by a number of the most respected and articulate scientists of our times, including astronomers Carl Sagan, and Freeman Dyson, physicist Hans Bethe, atmospheric scientist, Steven Schneider, and biologists Peter Raven, Roger Revelle, and Stephen Jay Gould. One of the most scientifically daring passages states: ... "As scientists, many of us have had profound experiences of awe and reverence before the universe. We understand that what is regarded as sacred is more likely to be treated with

care and respect. Our planetary home should be so regarded. Efforts to safeguard and cherish the environment need to be infused with a vision of the sacred" Knudtson and Suzuki (1992)

These statements may be understood in different ways according to the readers' perspective. However, they do indicate the wide context in which scientific investigation has been taking place. It is not new for scientists to acknowledge factors beyond their understanding or even to acknowledge personal religious viewpoints. It is important that we realize that those elements which are not understood in scientific knowledge are investigated in a context which acknowledges all of the variables concerned including humans, as noted in the previous chapter, while maintaining respect for the subject. In the words of Albert Einstein ... *one cannot but be in awe when* [one] *contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries to merely comprehend a little of this mystery each day. Never lose a holy curiosity* (Clark, 1971).

The work of Knudtson and Suzuki (1992) idealizes the understanding and treatment of the environment by hunters and gatherers. They note for example that Bushmen in southern Africa have developed strategies to ensure provision of a wide range of food resources which have sustained their lifestyle for some 10,000 years. Similarly, the !Kung Bushmen of north-eastern Botswana apparently understand their natural surroundings to such an extent that the habits of animals and growth phases of plants are utilized to manage the environment to provide adequate food and other essential supplies through periods of different seasonal availability. Knudtson and Suzuki (1992) aim to introduce us to the *ecological consciousness* of such peoples and to suggest that such a level of consciousness is needed on a wide scale today. This is consistent with the theme that a broader base is needed for natural resource education, including agricultural education. However, it is also possible to gain the impression from such publications that primitive societies hold the clue to management of the natural environment for today's circumstances. Vast differences in population density require us to challenge such suggestions and indeed it now appears that primitive communities had their own impact on the natural environment.

Sorensen and Epps (1993) surmise that, in Australia, one wave of aboriginal migration probably led to the extinction of mega-fauna through improved hunting technology or increased demand on food resources. The dingo or native dog accompanied another wave of immigrants some 8,000 years ago and is believed to have eliminated several mainland indigenous animals particularly the Thylacine and the Tasmanian Devil which only survived on the island of Tasmania. The effect of such extinctions on native flora together with the impact of fire used as a hunting tool has not been estimated. The later introduction of exotic plants to Australia has been linked to these and other migrations, such as the Macassans who are believed to have introduced the Tamarind tree.

Romantic opinions about environmental management based on the wisdom of primitive societies, and religious views of the essential intangibles associated with minimizing impact on the environment, provide a useful alternative viewpoint. We cannot dismiss these approaches out of hand. In more pragmatic terms, we must be aware of popular views in more developed countries (MDCs) that food and other biological primary products can be produced by primitive techniques or organic farming, for example. It is necessary to widen the understanding of the general public about the limitations to our knowledge and about world demands for food. At the same time, we should acknowledge that adjustments to agricultural production technologies in the main food producing countries of the world are possible and necessary.

Bread Baskets of the World

It seems popular to refer to Australia as the Bread Basket of Asia; a vast agricultural producer selling its products into an increasingly rich Asia. Whether those who coined the phrase intended that it be understood to mean that Australia had the technical capability to meet such a demand is now irrelevant. Of course, Australia is a major exporter of agricultural products in terms of the proportion of produce consumed domestically. However, the environmental constraints of Australia, in particular the distribution of rainfall and irrigation, limit its capacity to feed more than a few countries let alone one-quarter to one-half of the world's population.

Likewise, a viewpoint in the USA that the nation can produce sufficient food for the world still retains currency. In a recent proposal for collaborative university and international research center action, proponents felt the need to advise the USA Congress of the reasons that preclude the United States from being able to feed the world (University of Florida, 1995). They note that the economic and environmental burdens of attempting to feed the world would be intolerable because lands not currently used for agricultural production are either of marginal productivity or sensitive to disturbance, and that returns from such areas would be insufficient under a market economy regime. They also note that less developed countries (LDCs) would not have the foreign exchange available to pay for food imports at prices required by USA producers and that, in the unlikely event that this situation changed, extensive investment in infrastructure for ports, storage, transportation and handling facilities would be required. In any event, they note that imported food sold at world prices is unlikely to reach the poorest segments of communities who would remain unable to afford it.

The Global Need

There is a clear need for increased natural resource management knowledge to be generated and disseminated. This knowledge embraces those fields of importance to the public and those known to be important to natural resource solutions by practitioners in the field. The context of these deliberations extends beyond technical research into social, economic and policy areas. Oram (1993) notes the need for strong policies on sustainable natural resource management and highlights this as the primary area of deficiency in the implementation of sustainable agricultural knowledge to date. *The IFPRI Response* (1994) through its Environment and Production Technology Division accepts the challenge of accelerating food production in LDCs while focusing on the programs which accommodate environmental and social concerns.

These approaches embrace the ingredients seized upon by the public commentators in their desire to contribute to the natural resource management debate. While the implied need for accelerated research in natural resource management areas is emphasized in IFPRI and other CGIAR documents, there is a wider need for education of the public in the general principles of natural resource management, and of scientists in the broader context of their scientific investigations.

The IFPRI Response

Priority topics for action in international research are:

- *arresting deforestation and resource degradation in the forest margins of the humid tropics;*
- *sustainable intensification on fragile rainfed lands;*
- *environmental degradation and agricultural productivity in irrigated areas; and*
- *property rights and communal action.*

IFPRI (1994)

The Imperative of Education

The imperative of a wider educational approach to the environment and agriculture is implied in the discussion of natural resource management thus far. Hulse (1992) translates Francis Bacon's title *Nam Et Ipsa Scientia Potestas Est* as *True Scientific Knowledge Is Itself Power.* If we accept the broader meaning of knowledge implied in *Scientia,* we might well state that the power derived from knowledge is directly related to the ability to apply and impart that knowledge. The knowledge which education should seek to impart rests on all of; technical areas, social areas, and on understanding of interaction between these, and of such abstract components as aesthetics and psychological comfort.

The IFPRI (1995a) 2020 Vision is one of this decade's important documents. It highlights the technological aspects of knowledge demand in terms of agricultural education and research and emphasizes basic literacy and skills development in adults. It also notes the need to strengthen extension systems or, by implication, mechanisms to disseminate improved technologies and techniques. In recommending that each country allocate initially one percent rising to two percent of its total agricultural output to agricultural research, one might well provide an estimate of the proportion (25%?) of those percentages which should relate to agricultural education. Such allocation would enhance the roles of education in both maintaining reliable training of future researchers and providing the essential knowledge-base necessary for effective dissemination of technical and related information. However, the IFPRI document may not adequately acknowledge the critical role of natural resource management education including agricultural education. One way of emphasizing the relationship between education in natural resource management and economic development is illustrated in Figure 3.1.

The deficiencies of many LDCs in terms of inadequate staffing, core financing and under-equipping of national agricultural research systems have been listed by Tribe (1994). Another analysis (Prichard, 1990) identifies the first of the most important constraints limiting such systems as being shortages of well trained scientific and technical staff - refer to the Box - *Education for Research*.

The Task Force on Research Innovations for Productivity and Sustainability (University of Florida, 1995) quotes the National Research Council of the USA in defining the current research agenda as follows; ... *solving the problems of competitiveness, a high quality food supply, and natural resources and the environment will require much more new knowledge than was required to solve previous problems ... as an example, ... genetically engineered biocontrol agents for pest management ... will likely take a tenfold increase in understanding of the biology of such agents and their survival and action in various ecosystems before such engineered biological controlled agents can be effectively developed and used.* The Task Force also defines research as basic, strategic, applied or adaptive and seeks to include technology transfer as part of the research and development continuum. This is a useful approach and one used by many funding, service-provider, and user groups in research and development. Nevertheless, it also begs the question of the role of education in both providing a knowledge framework among persons targeted to receive information and knowledge and in the continuous creation of research, development, extension, production, processing and marketing capabilities related to agriculture.

Education for Research

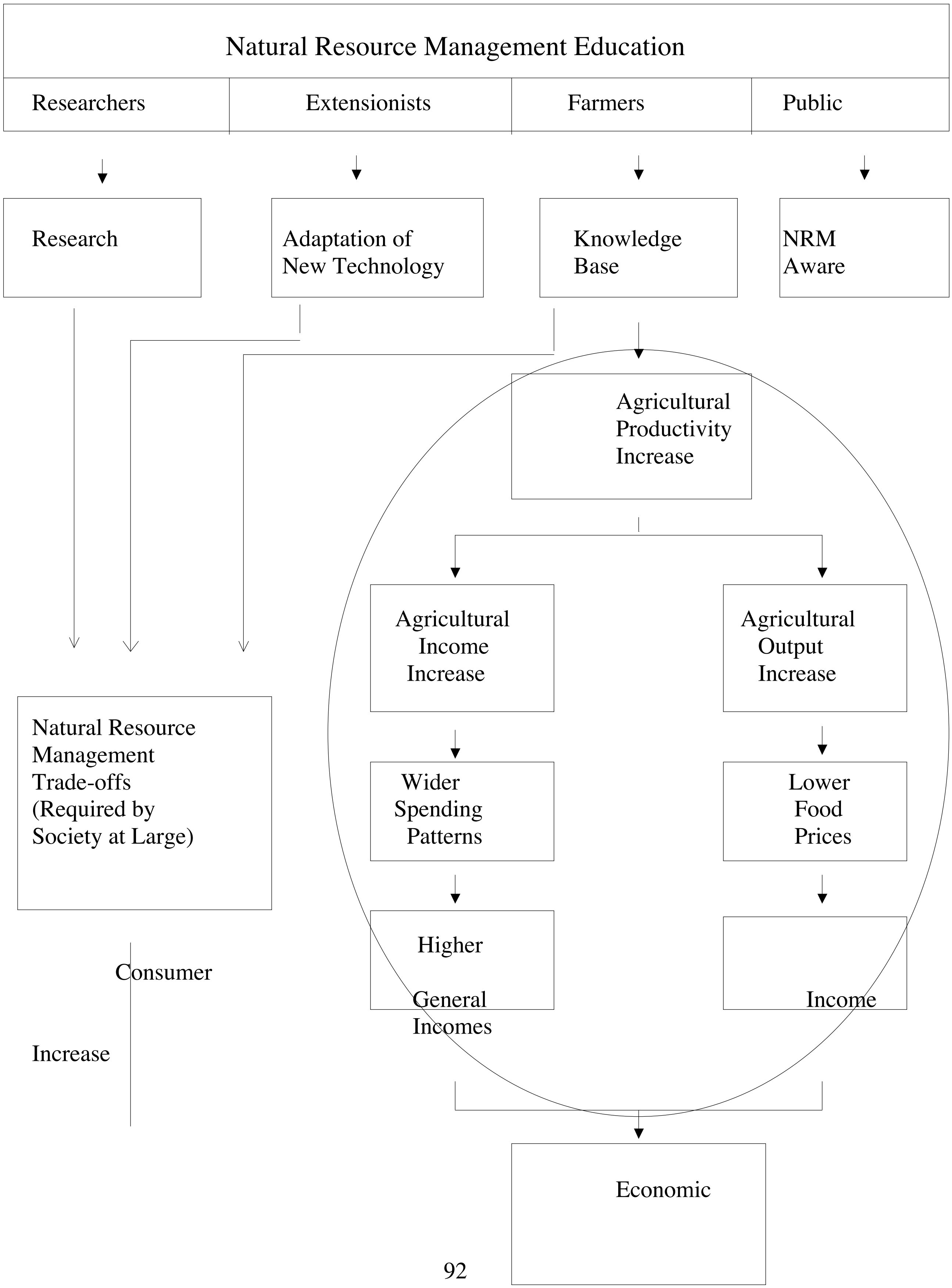
The most important constraints which limit the development of strong agricultural research systems were:

- *shortages of well trained scientific and technical staff;*
- *lack of government commitment to research as exemplified by budgetary cuts;*
- *low levels of funds for operational expenses;*
- *low salary levels and poor incentives for research staff;*
- *lack of personnel management procedures and policies;*
- *inadequate research priority setting, planning and programming;*
- *lack of well established research/extension linkages*

Prichard (1990)

The economic role of agricultural education is acknowledged by Rostow (1987) who attributes a portion of the growth of countries such as Thailand and Malaysia to education systems which have enabled their populations to accommodate new technologies and ideas. Schultz (1964) also notes the essential nature of appropriate higher education for the development of human resources which are necessary to accommodate the major changes associated with the modernizing of agriculture.

Figure 3.1 Natural Resource Education as the Driver of the Agricultural Engine of Economic Development - the broken line encircles the model commonly referred to as *agriculture as the engine of growth*. ... [*Therefore, the higher proportion of the work force in agriculture and the greater the proportion of family budget spent on food, the larger the effect on economic growth and poverty alleviation of productivity increases in agriculture* (CGIAR, 1995).]


Natural Resource Management Education
Researchers
Extensionists
Farmers
Public
Research
Adaptation of New Technology
Knowledge Base
NRM Aware
Agricultural Productivity Increase
Agricultural Income Increase
Agricultural Output Increase
Natural Resource Management Trade-offs (Required by Society at Large)
Wider Spending Patterns
Lower Food Prices
Higher
General Incomes
Income
Consumer
Increase
Economic

The classical demand profile for graduates of agricultural education has changed significantly in recent times (Falvey and Maguire, 1996). In the past, the researcher had to be a good scientist, the technical specialist had a subsector label, and the extension worker was a generalist. All three layers were supplied by agricultural universities or faculties of agriculture - but this has now changed. Scientific advances in genetics, microbiology, chemistry as applied to agriculture and natural resources, have made it increasingly likely that pure scientists complement agricultural scientists in agricultural research. The field of extension remains open to agricultural scientists yet the skill-mix there has also changed from the classical profile and continues to change. The treatment of farming as a business, the increasing sophistication of agribusiness, and major demographic shifts in rural populations has created a demand for skills which come from faculties other than agriculture. The imperative of natural resource management introduces further demands on such agricultural education. For many LDCs, the traditional beacon of agricultural education may be dimming.

In MDCs, such as Australia, the importance of relevant education and training for agricultural producers continues to rise (Sorensen and Epps, 1993). Notwithstanding debates concerning the practicality of university-based learning versus the need for imparting skills for the owner-operator who must be both manager and laborer, the over-riding impression that one gains from such analyses is the rising levels of knowledge among those engaged in agricultural production. The same applies to those supplying services through advice, sales, financial services, and general information in a changing agricultural environment. Coupled with this is an increased responsibility to understand the implications of natural resource management - this rests firmly on knowledge of the interrelationships of biological and social systems in the long term. Arguments such as those of Sorensen and Epps (1993) that those concerned with the teaching of agriculture should maintain close contact with the production aspects of their science, remain applicable to the area of natural resource management.

It is also becoming clear that the interactions between the biological, chemical, physical, and social sciences concerning natural resource management require a firm basis in practical management skills and outcomes related to real-life situations.

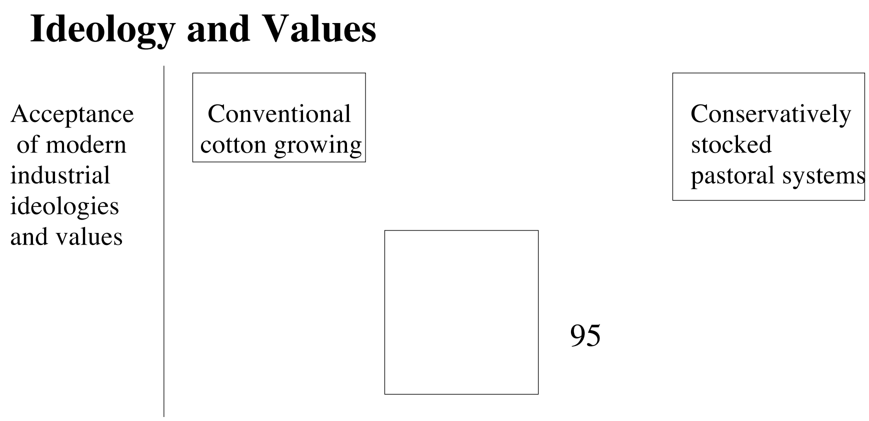
Public Environmental Education

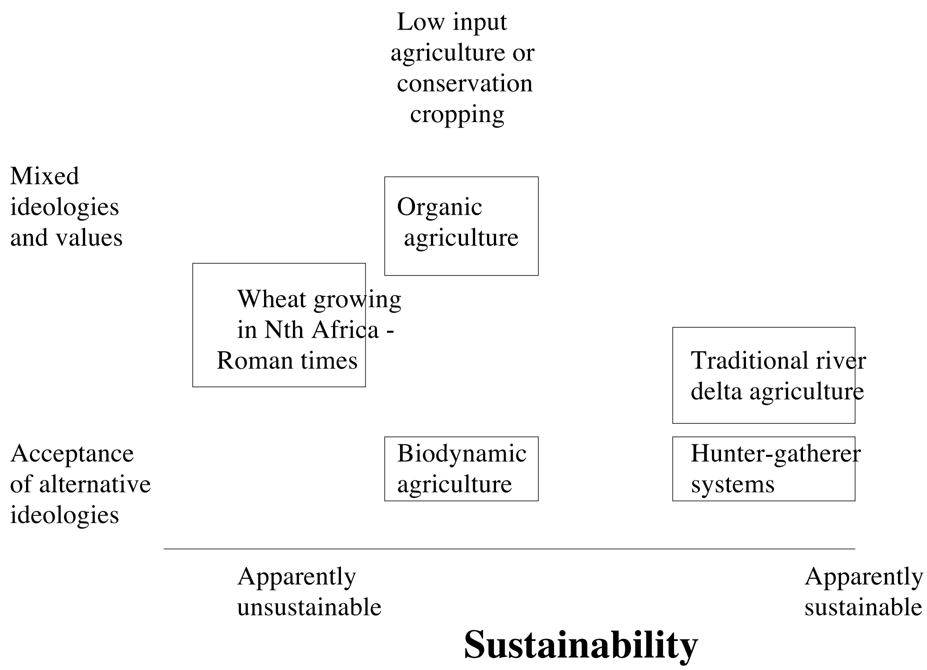
The challenge of sustainability is not one which should be entrusted solely to agriculture as natural resource management educators. It includes moral principles which provide guidelines for the wide use of natural resources and equitable care on behalf of future generations. The New Zealand Natural Heritage Foundation (NZNHF, 1995) acknowledges the need for an environmentally educated populace while allowing individuals to develop their own professional and personal codes and environmental values. The role of tertiary institutions is one of responding to the needs of environmentally aware learners. Likewise industry, professional associations and other interest groups will demand such a response from the tertiary education sector. Recasting institutional objectives in terms of environmental ethics and responsibility may become a hallmark of progressive institutions. Management of such institutions would be based on concepts of sustainability and environmental management with curricula across all faculties reflecting such responsibility.

> ***Environmental Education***
>
> *The sectors of education considered in such terms have been categorized as follows:*
> - *professional and vocational environmental literacy;*
> - *personal environmental literacy;*
> - *environmental competency* [incorporating] *real knowledge concerning environmental management within a context of, for example, global food production, industrial production and consumer demand.*
>
> Ali Khan (1992)

The map of perceptions of sustainability of agricultural systems against ideology (Figure 3.2), indicates that not all forms of modern agriculture are necessarily unsustainable. Nevertheless, there may be a need for a shift in public attitudes to agriculture. In quoting John Stuart Mill, ... *no great improvements in the lot of mankind are possible until great change takes place in the fundamental constitution of their modes of thought*, ... the New Zealand Natural Heritage Foundation concludes that education plays the central role in raising awareness of the whole population while also developing understanding and skills to implement the principles of sustainability. Thus the role of education is wider than that of the technical elements of natural resource management including agricultural education. It includes the creation of an environmentally literate and competent populace with tertiary institutions adopting environmental sustainability as a central pillar of all curricula. The New Zealand investigation notes the critical role of tertiary institutions and of cross-disciplinary courses; the essential cross disciplinary nature of agricultural education provides a basis for such environmental education although the poor representation of the arts in most courses weakens their value for this purpose. An approach which ensures a firm scientific understanding matched with appreciation of the humanities is needed. Agricultural education is undergoing major change in most of the world and thus has the opportunity to refocus on the wider social goals of today. Refer to the Box - *Environmental Education*.

Figure 3.2 Map of Agricultural Systems in the Dimensions of Sustainability and Ideology (after Reeve, 1992)





It is easy for environmental management discussions which are unhampered by consideration of global food production needs and scientific limitations, to suggest that, for example, primitive societies have been the only people who to live sustainably. Orr (1992) has gone even further in suggesting that perhaps education is part of the problem because cultures with higher levels of formal education have tended to become the most environmentally destructive. Such statements, which in fairness have been presented to provide a context for the argument of broader environmental education, ignore the imperatives of today. It is no longer possible for us to assume that the arguments of even a decade ago are current in terms of the global food debate. Exponential increases in food demands to be supplied from a finite and perhaps diminishing resource base must be considered in the emotion surrounding some elements of the environmental debate. While we must be careful in separating the wheat from the chaff, there is much to be learned from the social and ethical statements concerning natural resource management which need to be instilled more clearly into agricultural education.

Paarlberg (1995) has captured the essence of some unproductive elements of the debate between environmentalists and agriculturists concerning sustainable agriculture in LDCs. The debate itself has distracted international policy makers and donors who have responded to lobby groups rather than the, more commonly institutionally based, scientists who are in command of facts which should be included in decision-making. The need for firmer grounding in the principles of natural resource management among policy makers, donors and others is becoming clearer. As H.G. Wells once noted ... *human history becomes more and more a race between catastrophe and education*.

Changes in Agricultural Education

The aesthetic component of the environment has not been factored into agricultural education to a significant extent. There is also a need for resource ethics to be included in such education. The reductionist approach of the scientific method, which it is popular to criticize today, does introduce limitations in attempting to synthesize a broad picture. Holistic thinking, presented by some as a palliative, may not synthesize the essential knowledge created by science unless it is applied by persons with a sound understanding of the implications and applications of that knowledge. Roberts (1995) lists important goals in education as not only knowledge, but the instilling of interest, abilities, understanding, attributes and ideals - with knowledge as a means to these ends.

In economic terms, Barr and Cary (1992) reveal the anomaly between conventional approaches which view land as rationable according to price mechanisms and the value of financially unproductive native forest areas. The equations of Young (1992) provides an indication of an integrative approach to economics which may link social and technical sciences. Refer to the Box - *The Value of Everything*.

The Value of Everything

Far from understanding the *cost of everything and the value of nothing*, the new economics of Young (1992) attempts to value a wider context for natural resource management and agricultural production.

The efficient price for a resource = the marginal cost of supplying the resource to the user
+ the marginal cost of any lost ecological functions
+ the marginal cost of any co-lateral pollution
+ the marginal cost of lost future options
+ the marginal cost of lost existence and bequest value

Increasingly, economists are recognizing that ecological systems maintain economic ones and that it is dangerous to assume that economic activity does not influence the capacity of ecological systems to maintain that activity. Young (1993)

A recent Internet conference sponsored by the Food and Agricultural Organization (FAO, 1995) presented better management of knowledge and technology as a part of the solution to improved food security for the next century. It also noted that the style and content of agricultural education continues to be dominated by approaches and examples from MDCs - Refer to the Box - *Northern Research for the South?*

All agricultural institutions, and particularly those in LDCs, would benefit from major reorganization (Oram, 1993). He suggests that this should be based on determining the types of people who will be required in future to meet the needs of sustainable agriculture and natural resource management. These people would need expertise in such areas as:

- agroecological definition, resource inventory and determination of sustainable land use systems;
- measuring, monitoring, evaluating, technical and physical causes of resource degradation;
- social, demographic and economic factors and constraints affecting choices of technology, farmer behavior and land use associated with sustainable farming and agroforestry;
- intersectoral conflicts and the interdisciplinary and macropolicy analytical needs of their resolution;

- the ability of plants and animals to withstand environmental stress and to use inputs more efficiently;
- minimizing use and maximizing safety of chemicals;
- increasing water use efficiency and management;
- ecological and economic comparative advantages relating to trade and adoption of technologies and policies such as crop and livestock integration;
- agricultural management information;
- information science and technology transfer capability;
- evaluation of impacts of research and extension.

Northern Research for the South?

The Internet Conference convened as part of the 50th Anniversary celebrations of FAO in Quebec noted the dominance of northern (MDCs) influence in southern (LDCs) food and related research, viz.;

- *research* [that is] *strongly concentrated in the north and responding to incentives from a market economy while the needs in the south are most often subject to economies of subsistence,*
- *research that is concentrated on developing know-how for tomorrow while countries in the south have not yet integrated present technologies;*
- *research and development which is focused on men while in many regions of the world it is the woman* [who] *ensures 80 per cent of the food production;*
- *sustainable development which is difficult to reconcile with socioeconomic needs of farmers in many regions of the world; and*
- *technology transfer which can inhibit the development of local technology ...* [for example] *food aid can discourage local production and markets*

FAO (1995)

In addition to these new needs, Oram (1993) has also identified apparent anomalies in the numbers of research scientists per disciplinary area across LDCs. He notes, for example that crop science generally allocates priority to plant breeding, pathology and entomology, while crop agronomy and IPM (Integrated Pest Management) would appear to be underemphasized. Animal sciences which receive some 15 per cent of scientific resources appear underserviced when the contribution of livestock to agricultural GDP is assessed at around 30 per cent; the situation may in fact be worse in areas other than animal health because approximately 50 per cent of those resources are allocated to veterinary science and much of the remaining proportion to animal breeding, thus leaving pasture, fodder and animal nutrition and management areas grossly underserviced. However, the largest deficiency highlighted by this analysis is the paucity of input from the social sciences in most LDCs and Eastern Europe. Those social scientists engaged in public sector institutions are predominantly economists rather than sociologists and related disciplines. While such expertise exists within universities, the availability of these staff to provide policy advice, research and other functions relating to overall natural resource management and food production is limited. For those persons who are the resource managers, there is a need to ensure that they understand both technical and social factors.

LDCs must adapt their institutions to accommodate existing knowledge for today's requirements as well as to participate in the international development of knowledge and information. In this way, technical change and institutional development can be related (von Schilfgaarde, 1992). This challenge is most readily met through continual upgrading of human resources through better education and training and increased flexibility in institutional structures. A critical role is available for universities within the agricultural knowledge systems in LDCs. Nevertheless, as noted by Oram (1993), investment in university education by national governments and by international financing institutions has been regarded as an area which provides private benefit to students and does not spread the benefits of international assistance widely. This short-sighted approach has produced the current weaknesses in human resources, particularly in areas which inter-relate disciplines such as physical, biological, social and informational sciences.

Human resources are needed for further education as teachers, for research as researchers, and to assist in policy formulation relating to the adoption of new technology and the introduction of sustainable resource management practices. Oram (1993) notes that *... the first step should be a crash program to upgrade their academic staff capacity in the relevant disciplines and to restructure their curricula and degree courses. Research capacity of many national universities is weak, hence their ability to produce M.Sc. and Ph.D. graduates is limited. Training the trainers is an area where international assistance could be particularly valuable, through overseas scholarships, exchange programs, special courses, and postgraduate collaboration between universities.* While LDCs depend on technologies which degrade the natural resource base, they in many cases, do not have the scientific and technically trained staff with the discipline bases necessary to generate more appropriate mechanisms of natural resource management. Priority policies usually focus on sustained food production and economic growth.

The few outstanding universities in LDCs in the agricultural and natural resource management sciences are often mistaken in MDCs as representing what is possible across the board. These exceptions trace their privileged positions to unique histories which are difficult to duplicate and, unfortunately, such institutions do not appear to place as much emphasis as they once did on the interdisciplinary scientific approaches of agriculture and natural resource management. From an outside perspective, it is difficult to assess the impact and level of integration of universities in agricultural knowledge systems in developing and transitional economies. For example, in Hungary the fragmented nature of higher education and research institutions severely limits the impact of both education and research and renders it some two to three decades behind that of other western European countries. The need for change in agricultural and natural resource management education in both MDCs and LDCs is increasingly recognized; the need for change and strengthening may be greater in LDCs.

The impact of education on economic development and hence the creation of choices in environmental management terms is illustrated by the experience of the World Bank in terms of - *Returns to Education*.

Returns to Education

In reviewing the evidence for 60 developing countries over 23 years, the World Bank found that those countries that focused on human resource development and had sound macroeconomic management experienced an annual GDP growth that was a whopping 2.5 per cent higher than most that did neither. ... It is interesting to note that if two countries' GDP were 100 at the start of the period and one followed sound macro-management policies and focused on human resource development [and another] *did neither ... at the end of the 23 years, the GDPs would stand at 342 and 197 respectively, a difference of 145, a difference almost 1.5 times the total GDP of 23 years earlier.* Serageldin (1995)

Information or Knowledge

Economic development has been separated into the four phases of; hunting and gathering, agrarian, industrial, and infotronics (IBIS, 1995). Reliance on electronic knowledge and information services is predicted to accelerate from this, the early stages of the infotronics age. Agriculture has relied on information for improved decision making as a means of advancement throughout the ages. For example, Tribe and Peel (1989) note the importance of meteorological station networks throughout Australia some one hundred years ago as a basis for understanding longer term environmental trends. The utility of information in agricultural and other natural resource management fields relies not only on the quality of that information but on the ability to understand and apply it.

Extension or technology transfer is increasingly referred to as a continuum with research. This conceptual viewpoint is limited insofar as it assumes that pieces of information on new technologies are inherently valuable in the absence of a knowledge-base to assimilate that information. IFPRI (1995) notes the mixed performance record of public sector extension in LDCs. It calls for innovative approaches to strengthen communications between researchers and farmers while noting that the importance of information for agricultural systems will increase dramatically in the next two decades. Information dissemination can be expected to accelerate through satellite communications, radio, video and the Internet - this is discussed further in Chapters 8 and 9. While reviewers with a research orientation may call for improved linkages and innovative approaches to extension in order to overcome apparent deficiencies of the past, failure to acknowledge the critical role of education in providing a knowledge-base and as the context of extension may in fact be limiting the success of existing extension programs.

The role of education in providing an essential level of knowledge among producers provides an essential underpinning to a sustainable farming system. This role of agricultural or natural resource management education is a critical component which is easily overlooked if extension is interpreted in isolation from the utility of the disseminated information.

Knowledge of extension and its modes of operation is limited. Anderson and de Haan (1992) note the relatively brief history of extension and the limitations placed on it through public institutions. In a situation of increasing need for greater food production from a finite resource base, and with these conditions magnified in LDCs with high population growth rates, the need for widespread understanding of natural resource management principles is not only desirable but critical. The role of natural resource management education, including extension, can be conceived in terms of:

- providing a knowledge base for land managers to accommodate new information
- education of extension agents to be more than simple repeaters of technical information
- education of an increasing and constant pool of informed and broadly based scientific researchers who can accommodate their results in a natural resource management context

- informing the wider public of the essential trade-offs between food production and popular perceptions of the environment.

Within this context, the current natural resource management education systems of both LDCs and MDCs appear to offer great opportunity for change. Some crucial aspects of current agricultural education systems are examined in the next Chapters.

The New Religion

Pater God of ancient man
unknowable and unknown,
successive great religions
placed You above, upon a throne,
Then science through Newton's pact
parted values so home-grown,
became our means of knowing all
The need for You overthrown.
 Now with nothing thought unknowable
 just unknown at this juncture,
 awaiting scientist's keys to heaven -
 we want it now not later,
 Yet in this age of knowledge
 we crave for something greater,
 and take for god, Environment
 and Nature's magic aura.
Damascus Road revelation
or returning to the past?
for our ancients worshipped nature
before Church fixed Your image fast.
Environment as our new god -
will the scientist be aghast?
or can she bring new values
mix care with fact, and make it last?
 Philosophy, return to womb -
 mere verbal paraphernalia,
 Divorce yin from yang, care from power
 there is nothing chancier,
 Soul's renaissance, regained paradise -
 role of intelligentsia,
 Man in nature, arts *with* science
 the true meaning of *scientia.*

Chapter 4

Higher Education in Less Developed Countries

Upon the education of the people of this country,
the fate of this country depends.

Benjamin Disraeli

Higher agricultural education is discussed in terms of funding, quality, institutional arrangements, and disciplinary mix. International assistance, the applicability of models from MDC universities, and the implications of underfunding of natural resource education are related to the need for significant changes in agricultural education.

Why Higher Education?

The relationship between higher education in natural resources and development in less developed countries (LDCs) has not been widely researched. The benefits of education are well recognized as providing skills, knowledge, values and attitudes associated with civic order and sustained economic growth and poverty reduction. Better educated workers deal more effectively with rapid changes and more highly educated workers are more commonly found in new technology industries where they receive relatively better payment (Mincer, 1989).

Within the natural resources field, the Green Revolution created a wide need for information concerning the management of the more complicated inputs of irrigation, fertilizers and pesticides. Rosenzweig (1995) has confirmed that farmers engaged in traditional farming practices without the benefit of new knowledge or information, experience difficulty in obtaining the returns possible from enhanced agricultural production systems; in this way, *Education Supports Economic Growth*.

In discussing education in LDCs, one must first consider primary and secondary education. An OECD (1994) report suggests that sub-tertiary education should create basic competencies in language, science and mathematics, communication skills and the development of attitudes consistent with the workplace. Such competencies are said to provide a foundation for subsequent education and training. Vocational education is also following this trend of providing general competency. The report therefore sees higher education as being the creation of academic and high level vocational skills which include specialized in-service training and continuing education.

Education Supports Economic Growth

Education is also about culture; it is the main instrument for disseminating the accomplishments of human civilization. These multiple purposes make education a key area of public policy in all countries. Its importance is recognized in several international conventions and in many national constitutions. ... The civic purpose of education - the sharing of value throughout society - is becoming more salient in light of the widespread political liberalization of the past decade. ... Education is critical for economic growth and poverty reduction. Changing technology and economic reforms are creating dramatic shifts in the structure of economies, industries, and labor markets throughout the world. The rapid increase in knowledge and the pace of changing technology raise the possibility of sustained economic growth with more frequent job changes during individuals' lives. These developments have created two key priorities for education: it must meet economies' growing demands for adaptable workers who can readily acquire new skills, and it must support continued expansion of knowledge. World Bank (1995b)

A report of a seminar of the Economic Development Institute of the World Bank observes that a society which is well educated and informed is better able to make fundamental decisions for itself because its people can objectively consider social and cultural innovations (EDI, 1993). This assumes societal benefits from the provision of individual freedom through allowing the pursuit of inner aspirations and personal thirst for knowledge. While not related absolutely to personal income, it is seen to be related to quality of life. A secondary benefit from higher education is the existence of a pool of well trained and skilled persons readily able to adapt to changing market needs. It also allows informed persons to include natural resource management considerations in their decisions for investment and management. On the basis of these points, the report suggests that education is ... *arguably the best form of investment for the future*.

In the pursuit of economic and social development, LDCs will increasingly find themselves linked to worldwide economies requiring a level of technological sophistication which has its roots in education (Castells, 1986). In such circumstances, an LDC investment policy should focus on the need to develop human capital (Portes and Kincaid, 1990) - today's euphemism for education.

Perhaps as a devil's advocate, Schultz (1964) suggests that educated persons returning to LDCs may not necessarily possess skills and knowledge appropriate to assist in the economic and social development of their countries. This implies that education has been inadequate in such situations (EDI, 1993). A parallel situation appears to have existed in approaches taken to international development in LDCs when international aid first assumed a major role as an adjunct of the successful Marshal Plan for reconstruction of war-affected economies after the Second World War (Falvey, 1993a). At the individual level Shultz (1965) noted the relationship between education and rice yields in Japan, even though he also observed situations where yields have increased in the absence of any increase in education due to new land being accessed.

With such recognition of the general benefits of education, one must be concerned at the reduced attention paid to the field in LDCs since the mid 1970s (University of Florida, 1995). World Bank lending for university and polytechnic higher education has reduced from 36 per cent of its educational lending in the mid 1980s to some 26 per cent in recent years. This has been associated with a trend away from lending to agricultural universities toward other areas of science (World Bank, 1995c).

Saguiguit (1987) has emphasized the role of higher education in agriculture in providing pre-service training for professional agriculturists. Agricultural education institutions in South East Asian and the Pacific countries may be adequate in some countries, yet in others named in the UNESCO report, such as Bangladesh, Nepal, Papua New Guinea and Sri Lanka, the number of institutions, and the quality of graduates are seen to be inadequate for the future development needs of their countries.

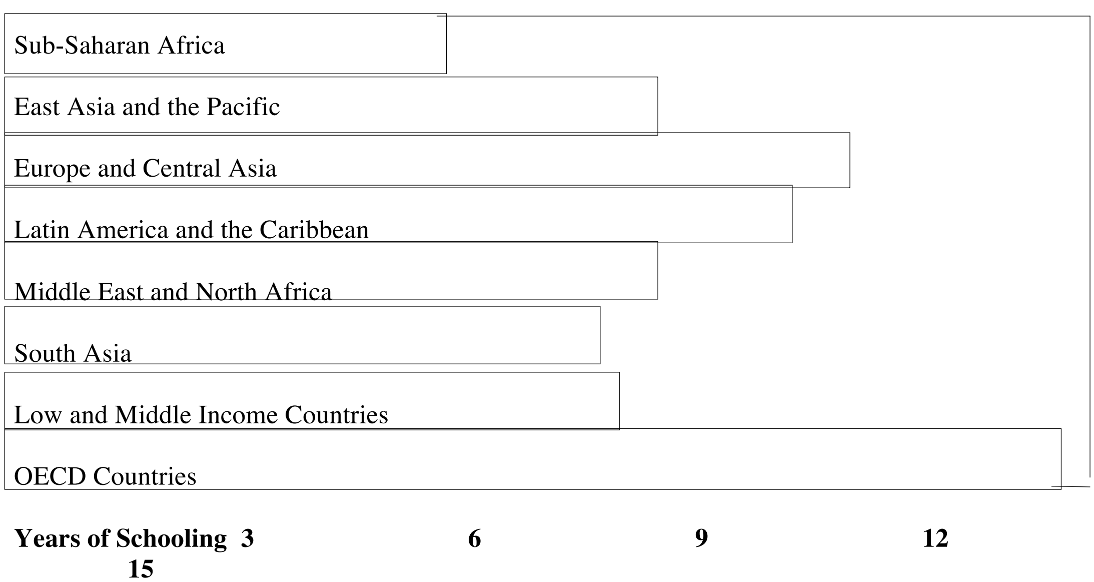
In Africa, the need to develop indigenous capacity in basic natural and social sciences to underpin agriculture, health, engineering and management has been emphasized (World Bank, 1992). It is also necessary to stimulate the professional environment in which such specialized capabilities can continue to be productive. Crosson and Anderson (1995) argue strongly for human capital enhancement as the major requirement for African development. While noting that such an educational investment is a long and uncertain process, they also note that there is little choice and that resources should be reallocated from MDCs for this purpose as a matter of urgency if sustainable natural resource management principles are to be seriously considered. Weitz and Landau (1971) also note that agricultural education is a critical part of development and that agricultural policy is inevitably linked to educational, fiscal, industrial and general development policies. Agricultural development usually follows policy reforms which need support from education to realize their full potential. With land reform in particular, it is possible to demonstrably *Reap the Benefits* of education.

Reap the Benefits

As long as education and agriculture are focused on the present agrarian structure, it will in the best case generate a two tier system whereby the privileged or upper tier produce an ever increasing *surplus while those on the lower tier, comprising the bulk of the rural people, remain bound in agricultural stagnation with a declining standard of living. It is here that the need enters for structural reform and, more specifically, for land reform. Its link with economic development is obvious since only the correction of the agrarian structure can make possible a depth-effect of agricultural education and extension and open up the remote villages for the application of advanced agricultural methods.* Jacoby (1971)

Expected years of schooling by regions of the world 1990 are presented in Figure 4.1. Gradual progression in education levels is evident for all regions, except sub-Saharan Africa where the expected years of schooling decreased between 1980 and 1990 (World Bank, 1995b). If education is an essential underpinning factor for human and economic development, Sub-Saharan Africa is going backwards.

Figure 4.1 Expected Years of Schooling by Region for 1990
(after World Bank, 1995b)



The Alternative - The Noble Savage

Groups which practice hunting and gathering, or even agriculture, while living in apparently sustainable systems are often quoted as having answers for modern day natural resource management (Orr, 1992). Chapter 3 introduced the need for such empathy with the environment in natural resource education. However, it is inappropriate to hold up these societies as having all the answers. The world has such a population that, according to present levels of knowledge, we must continue to rely on the use of intensive technologies. It behooves us to continue to develop such technologies which minimize adverse environmental impacts.

Orr (1992) notes the association between high levels of education, generation of an alphabet, written language, and environmental destruction. This can be measured in terms of the development of cities, agricultural surpluses, soil erosion, institutional and indeed population growth. This is the situation in which the world now finds itself and we must act responsibly from this position rather than draw false conclusions of associations between factors which have operated in the past. Abrogation of rights to protect the environment or other factors are more likely to arise in circumstances where food deficiencies exists. As the grand inquisitor of Dostoyevsky's epic, the Brothers Karamazov said to the revisiting Christ ... *never can they feed themselves without us. No science will give them bread so long as they remain free. In the end they will lay their freedom at our feet and say to us "make us your slaves, but feed us".*

Maintain the Tradition

Although the knowledge that is part of the state of the art is passed on from father to son by word of mouth and by demonstration, this does not mean that what is handed down is not authentic knowledge. In general, farmers who are limited to traditional agricultural factors are more secure in what they know about the factors they use than farmers who are adopting and learning how to use new factors of production. The new types of risk and uncertainty about the yield inherent in factors embodying an advance in knowledge are of real *concern to farmers. ... since traditional agriculture is not introducing new factors, new elements of risk and uncertainty do not appear; they arise only when the transformation gets under way. What matters here is that the state of the art is in fact known, established, and given in the case of traditional agriculture* Schultz (1964)

Land managers and others must have a significant knowledge base of the interactions that occur in their sphere of management. Yet, we cannot assume that individual farmers in traditional farming systems have a knowledge base on which to accommodate the new information which increases daily and is essential for the use of new technologies. New technologies themselves are introduced not only for economic gain, but also for the imperative of increased food for subsistence. Similarly, traditional farmers cannot be expected to understand the accelerating rate of impacts on the natural resource base associated with their own and others' actions. It is eminently reasonable for such farmers to *Maintain the Tradition*.

Universities in LDCs

Universities in LDCs trace their origins to each country's colonial past, with exceptions such as Thailand and China. These origins indicate their ideological positions in the colonial politics and subsequently in the transition from that system in post-independence periods (Castells, 1993). Universities in French African colonies were seen as an extension of the French university system which had a responsibility to orient the better students to further training in France (Sherman, 1990). In the British Colonies, universities were structured on the model of the British Civic University. In Latin America, despite a period of longer independence, the colonial origins of universities as joint state and religious organizations continues to influence the ideology of institutions which, according to Solari (1988), emphasize ideology and status more than economic and labor market interactions.

A period of independence in most colonial countries impacted strongly on universities as they sought to establish critical roles. Conflicts between academic and political behavior led to disenchantment both within and outside universities and was a major contributor to the loss of academic talent from universities of LDCs. Economic development during the past three decades has provided a stimulus to universities in LDCs through the creation of demand for a skilled and knowledgeable population. It also stimulated the creation of a professional elite which in turn required education of its children. These factors stimulated the development of law, humanities and social science faculties to meet the need for producing the administrative skills needed for rapidly changing government systems. Likewise, education and other social services became important innovations for government. Universities in LDCs have been less successful in developing scientific and technical professions, in particular agriculture and natural resource related education. Castells (1993) attributes this to the three factors of:

- insufficient staff expertise in modern technology;
- poor physical facilities leading to theoretical courses;
- limited high technology careers because investment is not attracted without a skilled workforce.

This means that much of the increase in university education is in fields which have little direct impact on development because such courses are supposedly more cost-efficient to mount. Those countries which have deliberately introduced policies to stimulate higher education in technical and related fields (for example, China, Korea, Taiwan, Singapore and Malaysia) are now seeing the benefits of a skilled and knowledgeable workforce capable of international technology generation and adoption. However, educating and training scientists and technologists is subject to heavy leakage to MDCs which eagerly adopt high performers from LDCs.

Different mechanisms have been adopted to strengthen scientific and technically oriented training. These include limiting the number of institutions where major investments are made, which ultimately limits the number of persons and the extent of activity in scientific and related research which can be conducted. An alternative is to strengthen aspects of technical and scientific activity in most institutions - this has been said to include a risk of failing to stimulate interdisciplinary interaction, a critical component of most areas of applied science including natural resource management.

> ***The Education Lag***
>
> *In most, if not all, of the newly developing countries, agricultural education and research are lagging. Often a lag is greater than can be justified by the level of economy and the general stage of development of the nation involved. This results from long entrenched mores and cultural backgrounds with their influence and attitudes towards social responsibility, education, research, and technology.* Peterson and Frazier (1964)

In assessing progress in the universities of LDCs it is common to compare other similar countries. In fact in an interconnected global economic and information system, appropriate comparisons should be made between the pace of development of universities in LDCs and MDCs. As Castells (1993) notes, it is easy to hide behind cultural and historical differences to avoid such comparisons - a stance which will be less acceptable as the information age impacts on all institutions (refer to Chapter 9). Experience in agricultural development in LDC universities (World Bank, 1992) highlights *The Education Lag* between university output in the form of graduating students and workforce needs in an environment of continuing low productivity, rural poverty, and inadequate institutional funding from government. Further compounding this situation, many LDCs have overextended their educational systems by opening new universities (Hoste, 1995).

Natural Resource Management Education

The plight of natural resource management education in LDCs is again illustrated by approaches taken to investment in the sector. Schultz (1964) noted that the transformation of economies from traditional to developed is dependent on investment in agriculture (Figure 3.1). However, such investments have been kept low in order to favor new industrial investment, even in countries where agriculture is the main industry. The problems outlined above for general investment in scientific and technological education, and in particular agricultural education, are compounded by a general shift away from investment in agricultural development. An FAO Symposium (FAO, 1995) suggested that natural resource education would be based on reorientation of agriculture and food science programs as a cost effective and beneficial means of introducing natural resource management skills in LDCs. The production of food remains an imperative - balancing *Food and Environment*.

Food and Environment

Bangladesh has one of the world's most dense populations, making land extremely scarce. Practically no prospects exist for increasing the area under cultivation. Agricultural growth, therefore, has been based on intensification: modern rice varieties now account for almost half of the rice under cultivation, an increasing proportion of land is double or triple cropped, the area under irrigation has more than doubled since 1980, and the use of chemical fertilizers has doubled since the early 1980s. Due to this intensification, Bangladesh has become food grain self-sufficient in good years, a result few observers would have anticipated ten years ago ... Concern is rising, however, that this intensive agriculture may not be sustainable ... yields of modern varieties are declining in areas that have been cultivated intensively for many years ... associated with the length of time that intensive production practices have been employed in each district. Pegiola (1995)

Conceiving agricultural education as a major component of natural resource management will require significant rethinking of approaches to education, research and development. The World Bank (1995a) Environmental Statement - Mainstreaming the Environment - is one organization's attempt to explain such a paradigm shift. In simple terms, this document outlines the impact of current and past agricultural approaches on the environment and balances these with the need to supply food to a rising population. While noting the success of agriculture, this is but *One Step Forward*. We must acknowledge that this has been achieved by the conversion of native environment through expansion of agricultural lands, and exploitation of soil fertility. The subsequent stage of agricultural development has relied on intensification of production on the better agricultural lands and much scope for further intensification in less developed agriculture continues to exist. Improvements in the use of chemical inputs, for example, from experience in MDCs can be adapted to LDCs to reduce environmental and health risks. Nevertheless, the need is to view such interventions in the environment as part of an overall system rather than oriented solely to increased yields.

One Step Forward ....

The past 30 years have been an extraordinarily successful period for the agricultural sector in much of the developing world. In Asia, per capita grain production has risen from 215 kg to more than 279 kg, and the perennial threat of famine has been removed for nearly 200 million people. World grain yields, because of the development of irrigation systems, the availability of high yielding varieties, and the use of modern inputs, has risen from about 1.8 tonnes per hectare in 1970 to about 2.7 tonnes per hectare in 1991. Some areas, however, have not been part of this overall success. In Sub-Saharan Africa, in particular, yields and inputs have stagnated, and grain production per capita has actually fallen in at least 27 countries. Furthermore, agriculture is still vulnerable to the vagaries of storms, floods, droughts, and late rains which have reduced harvest yields this year, causing world grain stocks to *decrease substantially*. World Bank (1995a)

The World Bank's response has been to orient agricultural research and extension to food production imperatives within a context of minimizing impact on the environment. This is similar to other institutional responses for assistance to LDCs.

It is now necessary to look beyond this simple acknowledgment of the environmental impacts of agriculture, and other human activities and consider environmental management education. The critical need to involve universities in national research development to overcome problems in natural resource management is now recognized by the International Service for National Agricultural Research - the international policy advisory body on the subject (Bonte-Friedheim, 1995). In LDCs (and probably also in MDCs - refer to Chapter 6), this role for agricultural education points to a wider and brighter future than does a narrow focus on technological breakthroughs oriented to productivity gains.

Issues in Environmental Education

Agricultural education has been the subject of significant investment analysis and provides a basis for discussing experience with environmental and natural resource education, including agricultural education. Major issues include: access; quality; disciplinary base, and institutional linkages.

Access: The inadequacy of facilities for natural resource management education in most LDCs has been discussed earlier. This imbalance within the offerings of the higher education sector in general is compounded by the inherent problems of access. Low levels of enrollment among poor persons in primary and secondary education are more pronounced in the area of higher education (Tilak, 1989). Inequities are amplified when student subsidies are considered, as they are usually allocated evenly regardless of personal income. An analysis conducted by the World Bank (1995b) indicates that only in the case of primary education is there a firm indication that subsidies favor increased access for the children of poor families. Subsidies offered by governments at secondary, and particularly tertiary educational levels favor the wealthy. Schultz (1964) in a critique of the benefits of assistance to LDCs, contrasts the issues of the inability of the poor to afford higher education with the variable utility of the skills and knowledge gained by tertiary students, particularly those educated outside their own countries.

In addition to subsidies, spending on higher education also appears to favor the wealthy. Table 4.1 indicates the high proportions of tertiary education students drawn from the top 20 percentile of wealthy families. However, despite the cost barrier to higher education, the tuition component is virtually free to students in most countries. The World Bank (1995b) notes that only some 20 LDCs seek to collect tuition fees in amounts greater than ten per cent of recurrent higher education expenditures. Nevertheless, there remains a case for subsidized higher education in fields of public importance such as natural resource management.

The Economic Development Institute of the World Bank (EDI, 1993) in its seminar series suggested that the introduction of policies to improve access to education had led to a decreased ability to respond to labor-market demand. This appears to imply that such wider access had been in fields less costly to offer and poorly attuned to national economic development needs. They note there is a need in such circumstances to assess the balance between traditional academic, vocational, short cycle, distance learning, and full and part time learning, and to fund these in manners appropriate for the education desired. The alternative scenario is painted as over-crowding, declining quality and decreasing relevance to economic development needs.

Table 4.1 Higher Education Students by Family Income as a Percentage of Total Enrollment (World Bank, 1995)

Country	Year	Students from Top 20% of Households by Income

Chile	1987	63
Colombia	1979	67
India	1987	45
Indonesia	1989	92
Japan	1987	46
Malaysia	1979	48
United States	1987	37
Venezuela	1986	77

In a discussion paper concerning women in higher education Subbarao *et al* (1995) noted that within an overall shift of foreign assistance from tertiary to primary and secondary education during the 1980s, a wide variety of specific interventions which aimed to reduce gender disparity had been introduced by the World Bank and other international development agencies.

The use of interactive televideos, computer-based technologies and other electronic means of communication facilitate the widening of access to tertiary education. This is beginning in MDCs and has been demonstrated to provide substantial benefits in some rapidly developing economies such as Thailand, where an open university allows self-paced study through distance learning. While drop-out rates may be higher with such systems, the recognition of qualifications by government assists graduates to attain similar positions and salaries to graduates from traditional universities. The use of such technologies may be more attractive to LDCs than MDCs due to their relatively low costs of establishment for communications equipment, compared to large building and staff infrastructures. Access will be improved greatly through such mechanisms (refer to Chapter 9).

Quality: Quality in higher education is usually assessed subjectively. Included in most assessments however, is definition of the nature of learning experiences which create the educational environment (Ross and Mahlck, 1990). According to the World Bank (1995c), educational quality in all LDCs is of a lower standard than OECD averages. Recent years have seen the introduction of evaluation as a management tool of universities in MDCs and this is expected to flow to LDCs in this decade. As noted by EDI (1993), evaluation of instruction, research and student learning, introduces a concept of accountability to national governments and other stakeholders. In LDCs, where higher education institutions contributing to natural resource education are funded by national governments, improved accountability measures offer a mechanism to improve quality.

The quality of learning is said by EDI (1993) to be in a state of crisis in LDCs, with research activities being underfunded and of questionable merit. This affects both low income countries, such as in Africa and South Asia and middle-income countries, such as in Latin America. Indications of such crises in quality are considered to be; deteriorating physical facilities, poor library resources, overcrowding, inadequate staffing, and insufficient scientific equipment. Outcomes from such systems include low levels of efficiency, poor employment levels for graduates, and limited scientific output of quality (Salmi, 1991).

Quality Crisis in African Higher Education

The scarcity of funding for capital investment and non-salary operating expenses has seriously undermined the quality of education in African Universities. The situation at Nigeria's University of Ibadan [is illustrative] *... "for several months now we have been expected to run a physics laboratory without electricity, perform biology and zoology experiments without water and get accurate readings from microscopes blinded by use and age. Chemicals are unimaginably short. The result of all this is a chemistry laboratory that cannot produce distilled water and hundreds of science graduates lacking the benefits of practical demonstrations.* Osundare (1983) in World Bank (1993)

The World Bank (1993) suggests that graduates of African Universities may be less knowledgeable than those in other less developed regions of the world. This is based on the results of the Graduate Record Examination of the USA where graduate students from Africa have achieved lower scores in verbal, quantitative, and analytical sections than those of students from Asia, Latin America or the Middle East. The report attributes this solely to the *Quality Crisis in African Higher Education*.

The achievements of socialism in fields of education and advanced scientific training research are now under threat from austerity measures associated with political and economic turmoil in most socialist countries - *Tertiary Education in Transition*. In adapting to a new economic system, one fears that some outstanding performances of the past may not be reached again for decades. It should also be noted that these institutions seldom achieved today's western levels of involvement in areas of environmental responsibility and natural resource management.

Tertiary Education in Transition

Despite the paucity of reliable time series data, there is evidence of decline in important education indicators in the transition economies during the 1990s. In Russia ... variations in educational expenditures by rich and poor localities are increasing. In Poland, as in Russia, educational expenditures have declined as a proportion of a shrinking GDP. World Bank (1995b)

Universities associated with natural resource education, predominantly agricultural universities, are constrained by several issues which impact on their quality. Major problems appear to be: the inability of staff to remain current in such circumstances; inadequate research funding; and excessive teaching loads. In a review of USAID experience strengthening agricultural universities in India, Easter *et al* (1989) identify problems which relate to quality as:

- isolation from major world institutions
- poor funding of agricultural research
- centralization of research financing
- introspection associated with recruiting staff
- poor development of new teaching techniques

In terms of natural resource management education, the issue of quality is compounded by a low appreciation of natural resource management principles while maintaining a focus on productivity gains.

Disciplinary Base and Institutional Links: Understanding of interactions from several disciplines is central to sound natural resource management education. This has been the nature of agricultural science courses in major universities. An issue in these courses in LDCs is the ability to draw on an appropriate disciplinary balance to service the linked functions of education, research and extension. Oram (1993) emphasizes the primary area of imbalance as being the neglect of social sciences in courses in most LDCs and transitional economies. The predominant social science in public sector institutions is economics, and appreciation of the wider disciplines of the social sciences is widely lacking in agricultural courses. He links this to the imbalances between research, education and extension and the separation of institutions responsible for these functions. Easter *et al* (1989) in their review of the first 25 years of Indian State Agricultural Universities, similarly note the inadequate development of the social sciences as being a serious handicap to their development.

The existing interdisciplinary base of agricultural courses appears to be under pressure as funding is increasingly tied to the need for short term economic and political objectives. Peterson and Frazier (1964) bemoan the loss of balance in training of Latin American agricultural students. The role and constraints of universities in National Agricultural Research Systems (NARS) and constraints to university research have been highlighted in an FAO Expert Consultation (FAO, 1993) as summarized in Table 4.2 and amplified in Chapter 7.

A measure of appropriate levels of investment of agricultural research has been proposed by the World Bank as the Agricultural Research Intensity ratio (ARI) - research spending as a percentage of agricultural gross domestic product. Tribe (1994) calculates that ARI ratios for LDCs average 0.41% compared to those of MDCs of over 2%. The recommended World Bank target is 2% for all LDCs. The essential role of agricultural and natural resource management education in underpinning the knowledge and skills base for such research and related activities suggest the use of a similar ratio, a Natural Resource Education Index (NREI). This would create further knowledge about levels of investment in natural resource management education and provide international inter-country comparisons of investment in such education.

In a comprehensive review of World Bank (1992) assistance to agricultural higher education, mixed results between major investment projects were recorded. Few projects sought to establish linkages between agricultural universities and research and education support services and of those which did attempt such linkages, objectives were not fully accomplished due to:

- unworkable management;
- inappropriate inputs;
- insufficient universities and governments consensus;
- poor coordination with and direction from NARS;
- professional rivalry amongst scientists,
- suspicion of the university's public political influence.

Table 4.2 Roles and Constraints of Universities in National Agricultural Research Systems (after FAO, 1993)

Roles of Universities	Constraints to University Research	Constraints to Participation in NARS
Providing leadership to stimulate the development of viable societal institutions, e.g. for planning regulation and implementation of development programs	Lack of sufficiently coherent national research policies and programs to guide university research, lack of clear university research policy and inadequate administrative structure for research	Different traditions; a Faculty may be developed by or with the help of one developed country while the Agricultural Research Institute has been developed or strongly influenced by another.
Training for leadership in NARS and in policy making institutions in postgraduate programs	Inadequate research budgets or lack of them (often less than 0.5% of university budget)	Different levels of credentials; staff of one institution may mainly hold Ph.D. (usually the University), whereas others hold M.Sc. and B.Sc.
Producing well trained graduates for satisfying the manpower requirements of NARS and other agriculture based institutions for multidisciplinary research and development	Excessive turnover of academic staff, particularly of senior staff jeopardizing leadership and continuity. Aggravated by shortages of trained technicians, heavy teaching loads, and limited involvement in research	Different ages of the institution; these differences are accompanied by a host of derived differences e.g. the average age of personnel, personal tradition, working conditions, status, etc.
Supporting trends in national,	Little emphasis on social science.	Different levels of experience;

regional and international research through participation in research projects	Interdisciplinary and systems approaches to research, training neglected.	this is usually associated with age.
Initiating new trends in research derived both from client problems and findings of basic research	Lack of formal links with national institutions for research and extension and farmers, especially in multi-faculty universities, and poor links between research and teaching.	Different promotion criteria. Universities emphasize published work and research institutions applied work leading to different priorities and limiting collaboration.
Participation in national policy research	Separation from other faculties of comprehensive universities (agriculture often managed separately)	Different locations; physical separation accompanied by poor means of communication may hamper institutional links.
Participation in rural development through research and extension, especially in agricultural universities	Lack of students from rural areas. Rural students often become good research staff in NARS as they are familiar with agriculture and willing to work in rural areas.	Different sizes, staff motivation, ministerial locations, research criteria. Independence of universities at times limits their ability to join in NARS.

Mechanisms to integrate universities concerned with agricultural and natural resource education and research may be facilitated by the bringing of national research institute and extension personnel together with private sector agri-industry personnel through the governing bodies of each others' institutions. Such mechanisms have rarely been employed in internationally supported projects and would facilitate a focus on the four driving forces for development (Johnson, 1988) of; technical, institutional, and human improvements, and growth in the stocks of physical and biological capital. All four factors are considered to be equally important and any one, two or even three are insufficient to achieve development according to Johnson's thesis. Institutional constraints should be addressed first and conducted in parallel with the creation of additional human expertise, considering the long lead times involved.

The major institutional constraint is that of separation of institutions responsible for education, research and extension. In contrast to the integrated institutional arrangements which grew up around the Land Grant Colleges of the USA, most other countries have perpetuated *A Costly Separation* between these three interrelated functional areas. Other successful systems have evolved, such as that of Taiwan, which has a series of publicly supported research organizations connected to a parallel extension system which maintains contact with all farmers (Lyonberger and Chang, 1968). This system of parallel extension activities, one supported publicly and the other by farmer organizations, provides a mechanism that gives confidence to each of generators, suppliers, and users of information.

A Costly Separation

Educational institutions and experiment stations are usually separate organizations with little cooperation between the two. The extension programs introduced in several countries are also too frequently carried out as separate programs, not embodied in a unified effort of research and education. Consequently the extension personnel lose the stimulus of contact with a large body of scientific fellows and must expend much energy in locating sources of new information. Also, research and teaching programs suffer from lack of contact with professional colleagues working daily in real agricultural problems.
Peterson and Frazier (1964)

The Chinese agricultural support system provides an example of an institutionally separated system in which universities report separately from research institutes to the Ministry of Agriculture (Fan and Pardey, 1995). This leads to weak institutional linkages between research and extension and to fragmentation within extension itself, with particular weaknesses occurring between central and provincial levels. Such institutional weaknesses can lead to unnecessary competition for resources and duplication of activities. Strengthening such systems is a primary function of international development assistance which has developed significant competence in strengthening NARS from a research perspective. Fully acknowledging the role of educational institutions in NARS is now urgently required - refer to Chapter 7.

The International Service for National Agricultural Research (ISNAR), has determined a framework to strengthen the role of universities in NARS (Hostage *et al*, 1995). This is based on the steps: steering committee establishment and consultant selection; sensitization to the study; data collection; analysis of data; preparation of an analytical report; development of recommendations and action plans, and implementation of a short term action plan. Steps are designed to take place within a 12 month period and details within each step are described. Such checklists are useful tools which allow experience from one situation to be compared with another and to test procedures in different cultures. Ultimately, however, the analytical methods and solutions for each situation have such individual variations as to require expert analysis in each case.

Any shift of worldview to conceive what is currently called agricultural education, as the major component of natural resource management education requires greater acknowledgment of the role of environmental factors in agricultural education, research and extension in the immediate term. In the medium to long term, it requires the viewing of individual farmers and agriculturists as responsible stewards of natural resources managing them in a manner seen by all observers as responsible and caring. The rising role of an informed or concerned public may not be fully appreciated, according to Orr (1994) who claims that these factors have been overlooked in the Bruntland Commission Report and the statements of major development agencies. The links between a concerned public voice and education is a critical part of responsible policy formulation.

Foreign Assistance

Foreign assistance through international finance institutions such as the World Bank and the Asian Development Bank or aid donors such as USAID, DANIDA or AusAID, and multi-lateral aid donors such as UNDP and UNESCO, subscribe, in principle, to the importance of continued development of higher education. The experience of rapidly developing economies in Asia has strengthened the argument for significant investment in education under responsible controls. However, the response of foreign assistance may be one of encouraging national governments to reallocate expenditure rather than increasing their own contributions and loans.

The general trend of increased project funding towards primary and lower secondary education is expected to be at the cost of assistance to higher education. Reviews of higher education investment are usually conducted within an educational sector allocation and outcomes balanced against other outcomes in the sector - if more is needed in the primary education sector, funds must be reallocated from another part of the sector. In the case of natural resource management or agricultural education, this places pressure to allocate an increasing proportion of its budget to agricultural or natural resource management higher education. Under these circumstances it is easy for higher education to be inadequately acknowledged in sectoral policy decisions, particularly when rates of return presented in this chapter are used for decision making.

The seven key areas for general education sector reform supported by most major donors and financiers are:

- increasing the priority given to education;
- refocussing education projects to outcomes;
- increasing primary education investment;
- increasing equity of access;
- encouraging greater household participation;
- encouraging flexible and autonomous management;
- increasing cooperation between *Education Partners*.

Education Partners

Partnership will mean cooperation with other donors and other agencies - particularly important as both multi-lateral and bi-lateral agencies increasingly focus their aid on the human resource sectors. Already the Latin America and Caribbean region of the Bank is working in close partnership with the InterAmerican Development Bank on social sector projects, as are the two Asia regions with the Asian Development Bank. The Human Development Department is working with UNESCO to improve the quality of international statistics on education. World Bank (1994)

The policies concerning higher education of the major financier in the sector, the World Bank, are consistent with those introduced above. However, documents introducing the World Bank's interest in the environment and natural resource management sectors do not specifically emphasize a role for higher education (World Bank, 1995a).

World Bank loans for higher education represented 36 per cent of total lending for education in the mid-1980s and by 1985 had declined to around 26 per cent. Earlier loans targeted the training of professionals and technicians, such as through agricultural universities and this too has shifted over the 15 years towards support for universities, providing advanced scientific training and research. Current trends suggest a further shift to develop industrial linkages to teaching and research in science and technology, the introduction of cost-sharing schemes involving industry and students, and improving access to public universities (World Bank, 1995b).

Since the early 1960s, the World Bank has funded some 387 higher education components in 89 countries at a total cost of some US$6 billion of which the organization's share of project cost totaled some US$4 billion. An EDI (1993) report notes continuing World Bank support for science and technology loans such as in Brazil and Korea, and upgrading of university quality in various countries in Africa, sometimes through the mobilization of private funds such as student loan schemes, as is the case in a Kenyan project. Eight loans to China support the development, expansion and quality improvement of a range of institutions ranging from vocationally oriented polytechnics through a national television university, to national and provincial universities. Assistance has also included the analysis of policy reforms needed to support improvements in the education sector.

In terms of agricultural projects, some 469 projects financed various aspects of education, research, extension, training and project management, although only about 25 per cent of these made significant acknowledgment of universities. The total World Bank input to agricultural higher education over this period is estimated to have been some US$700 million compared to total inputs for support services of around US$5 billion (World Bank, 1992). When it is considered that these sums span some 25 to 30 countries over a 26 year period, an annual average input per country of around US$1 million, is a very low level of development investment. This is particularly so when one considers that such projects would have been conducted in countries with significant agricultural bases where agriculture could act as the *engine of economic growth* (Figure 3.1). Inputs by other lenders and donors (USAID is the largest of the bi-lateral agencies, assisting 70 institutions in 40 countries) may be expected to double these figures at best.

Since the Rio de Janeiro Earth Summit, the World Bank has demonstrated an increased commitment to environmentally related activities and as of the end of fiscal year 1995 some 62 Bank projects involving more than US$3 billion of Bank commitments and total investments of nearly US$6 billion have been initiated (World Bank, 1995a). These projects cover such activities as; forest management, biodiversity, conservation, establishment or improving national parks, integrated pest management, soil conservation, land management, watershed rehabilitation and water resource management. Refer to the Box - *The Green Bank*. Most projects appear to include components or activities related to training and education as part of human resource development objectives. However, these are not commonly associated with strengthening of education institutions in their long term capacity to produce graduates skilled in the integration of scientific and social science skills.

The Green Bank

World Bank projects initiated in the period 1993 to 1995 in support of natural resources management include:

Bhutan	Forest Development Project
China	Forest Resource Development and Protection Project
China	Loess Plateau Watershed Rehabilitation Project
Colombia	Natural Resource Management Program
Gabon	Forest and Environment Project
India	Andhra Pradesh Forestry Project
India	Forestry Research Education and Extension Project
India	Madhya Pradesh Forestry Project
Indonesia	Integrated Pest Management Project
Indonesia	National Watershed Management Conservation Project

Lao-PDR	Forest Management and Conservation Project
Pakistan	Northern Resource Management Project
Pakistan	Baluchistan Natural Resources Management Project
Pakistan	Punjab Forest Sector Development Project
Paraguay	Natural Resources Management Project
Poland	Forest Development Support Project
Seychelles	Environment and Transport Project
Tunisia	Second Forestry Development Project
Tunisia	North West Mountainous Areas Development Project
Turkey	Eastern Anatolia Watershed Rehabilitation Project
Uruguay	Natural Resources Management and Irrigation Project
Venezuela	INPARQUES Project

Total project cost - US$2.7 billion of which World Bank financing accounts for some US$1.4 billion. Total active portfolio of such projects in the World Bank totals some US$5.8 billion in total project costs of which World Bank financing accounts for some US$3.2 billion. World Bank (1995a)

A picture of declining lending for agricultural education, and a rise in natural resource management projects without a strong focus on natural resource management education, should be disturbing to those concerned with a long-term shift in attitudes underpinned by knowledge and skills in the professional sector.

Case Studies and Models

The Green Revolution provided a major stimulus to agricultural research with spin-offs to agricultural education. High-yielding seed varieties combined with other inputs such as water and fertilizer created a demand for rising levels of knowledge and skills (Rosenzweig, 1995). A University of Florida (1995) report traces the establishment of agricultural universities to the beginning of the first Green Revolution. It lists the State Agricultural Universities of India, the University of the Philippines at Los Banos and Kasetsart University in Thailand among other successful institutions. However, the success in establishing these institutions and in their rapid development and accomplishments through the last 30 years must now be compared with current states of operation. Some case studies of agricultural universities in LDCs are presented below.

India: Busch (1988) relates the development of today's 28 State Agricultural Universities (SAUs) and the assistance received from the USA from 1952 to 1972. He credits the SAUs with significant achievements in education, research and extension and in producing one of the largest systems of agricultural universities of the world with a capacity to train students to Ph.D. level. Factors contributing to this success are listed as:

- leadership and support from research funding bodies
- State government support
- demand for agricultural graduates
- the agrarian structure of India
- USAID, universities, World Bank and UNDP support
- continuity and commitment of SAU leaders
- a pool of high quality students
- an openness to internal and external evaluation

Easter *et al* (1989) similarly note the strength of Indian SAUs while acknowledging some draw-backs in these services to the most important industry for India. The importance of agriculture to India has been emphasized by Jawaharlal Nehru in 1959, viz.; ... *however much we in India may progress in the domain of science and industry, as undoubtedly we will, the basic fact remains that agriculture is of primary significance to our country and to the world*. Nevertheless, a recent World Bank (1995c) report concerning agricultural human resource development in India found that SAUs lacked a culture in which students are the prime reason for their existence, and that management has failed to demonstrate skills in planning and evaluation. Academic in-breeding and general academic isolation are said to be contributing to a continuing decline in academic standards through a retention of outdated teaching methods, curricula and physical facilities. Funding for education failed to achieve balance with research funding to the detriment of teaching programs. Cultural problems such as seniority overriding capability has impacted on academic administration and compounded management and education concerns.

These constraints are operating in a scenario in which the employability of graduates has declined as a result of the public sector reducing the numbers of new graduates it absorbs and the need for revisions in curricula to cater for different markets for graduates. Ryan (1993) had observed similar issues and recommended significant revisions in the fields of management, academic, administration, curricular and international interaction. Progress is evident, although it is unclear whether the SAUs are *Sustainable Institutions*.

Sustainable Institutions

The successes of India's State Agricultural Universities in their short history needs to be sustained. There are indications that not only the institutions are failing to maintain their success but that vigilance required in research and education for natural resource management has broken down. ... The achievements and impacts of the SAUs system in India have been substantial, especially given the short period of their existence. However, India has had little growth in grain production over this decade. Moreover all nations are now facing a rapidly changing world agriculture. In a volatile world market for agricultural commodities of all kinds, new technological changes can make previously distinct commodities interchangeable, such as the substitutability of palm, coconut and soy oil in the manufacture of bread. In some cases, the high levels of agricultural production have been accompanied by severe environmental deterioration, including soil erosion, aquifer depletion, deforestation, chemical pollution and destruction of wildlife habitats. Finally, the linkages between agriculture, industry and the service sector are being re-examined as the problem of finding employment and income for all have taken on global proportions. Busch (1988)

Brazil: Sanders *et al* (1989) examined the successes of the development of higher education programs for the agricultural sciences in Brazil. Supported by USAID, these programs assisted in the equipping of laboratories and libraries and through the provisions of consultants from USA universities. Maintaining facilities, equipment, and international contact has since proved difficult to sustain in times of fluctuating exchange rates.

The successes in institutional development, particularly for graduate programs and research were attributed to; existing strong undergraduate programs, strong international collaboration and support, and rapid economic development creating an increasing demand for graduates.

Sanders *et al* (1989) note that success in agricultural higher education has been directly related to success in private sector activities. This has been associated with increased demand for university research, faculty consulting, short courses and postgraduates. The incidental higher incomes which accrue to university staff in these circumstances is said to further enhance institutional stability and progress.

China: China's agricultural knowledge system is extremely large, institutionally complex and covers a wide range of agroecological zones and market systems. Coupled with this size and diversity is the rapid pace of institutional and economic change occurring in China and the associated imbalances in funding between public and private sector agencies towards which many qualified research and education staff drift. International assistance to the Chinese agricultural knowledge system has been too recent to form comparisons with those of other countries to which such assistance has been directed over the past four decades. Nevertheless, the review by Fan and Pardey (1995) provides interesting descriptive information concerning institutional and policy options.

The organizational structure of the Chinese agricultural system separates agriculture, forestry, research, and university functions. Separation is perpetuated at provincial level with provincial research institutes and agricultural or forestry education institutions having no direct linkages to national level universities or research bodies. The extension and related activities conducted at prefecture level are similarly separated from the institutions of the provinces. Past linkages between provincial research institutes and the Chinese Academy of Agricultural Sciences have broken down since the cultural revolution and interaction today is based on collaborative programs, leadership of which is usually vested in national centers. Applied and adaptive research conducted at prefecture level is significant and a trend of increased collaboration between provincial and national programs is an important means of coordinating research.

The agricultural university system of China was adapted from that of the Soviet Union in the early 1950s. This system separated agricultural universities and colleges from comprehensive universities with a low emphasis on research in agricultural universities. This has been rectified progressively in recent years in China. The seven key agricultural universities of China administered by the Ministry of Agriculture emphasize research to a greater extent than provincial agricultural colleges which focus primarily on applied research and extension. The major role of both universities and colleges is the training of personnel as is indicated by the estimate of Fan and Pardey (1995) that only some 22 per cent of scientific and technical staff at universities in 1986 were classified as full-time-equivalent researchers. They found that the lack of research resources in universities and colleges affected the quality of training received by students. While the imperative within China remains that of increasing food and fiber production, there are indications of agriculture being conceived within an environmental context among informed advisers.

Benin: The Faculty of Agriculture and departments of other faculties within the main national university are described by Hoste *et al* (1995) as forming the academic component of the Benin NARS. Research is conducted in a National Agricultural Research Institute which reports to government through the Ministry of Rural Development; the university reports through the Ministry of Education. The Institute receives some 95 per cent of the available budget. A need is seen to strengthen university to Institute linkages through:

- redefinition of the role, function, and composition of the National Agricultural Research Council;
- encouraging joint activities through regional committees, appropriate representation, increased financial resources for joint activities, human resource development, joint projects, and development of procedures for utilizing facilities on a joint basis;

- creation of reserve funds to engage external lecturers particularly from the research institute;
- improving the working conditions of all staff and the accommodation for students engaged in research and other internships.

The methodology proposed by Hoste *et al* (1995) which led to these paraphrased recommendations, is a step toward integrating components of the agricultural knowledge system - namely research, education, and extension.

Nigeria: Johnson and Okigbo (1989), have reviewed USAID's lessons from institutional development projects in Nigeria. They conclude that there had been some successes in institutional and manpower development and that both successes and failures were partially attributable to the complex political, social and cultural environment. Frequent changes in policies, programs and commitments within the sector undermined potential success from institutional development projects according to Tweeten (1989). Of particular interest in the analysis by Johnson and Okigbo (1989), is the comment that *... British "rules of the game", educational points of view, and attitudes towards the functions of governments and universities, constrained development of Land Grant orientations at the three agricultural faculties and particularly at the University of Nigeria*.

Hoste *et al* (1995) conducted a more recent analysis targeting one of the country's 36 universities, the Ahmadu Bello University, one of the 23 universities with a Faculty of Agriculture and one of the five with a Faculty of Veterinary Medicine. Three of the 18 national agricultural research organizations are based at the University and the analysis focused on means of strengthening linkages between the University and these organizations. The research organizations report to the Federal Ministry of Agriculture and Natural Resources while the University reports to the Ministry of Education with the financial resources being allocated predominantly (93 per cent) to the research organizations. It was recommended that there be:

- greater involvement of research organization staff in academic programs including research supervision

- improved management coordination of the agriculture and veterinary medicine complex
- joint research seminars and project proposals
- other joint activities including management of journals, research projects, access to research facilities and publication of research results.

Benahnia (1995) has listed the strengths and weaknesses of African faculties of agriculture, primarily from the perspective of involvement in research. These may provide indications of general constraints working against development of LDC universities. Strengths include; qualified human resources, and flexibility in management and attitudes. Weaknesses include; the absence of research policies in government and universities, low budgets, limited staff-time availability, and perhaps most importantly, the absence of linkages to national research institutions. However, this approach to establishing links to universities concentrates on the provision of research services (Abdalla, 1995) and omits the critical role of education in supporting research through producing researchers, extensionists and adopters, and the educational function of extension. The benefit of a university or faculty corporate plan may also have a role in forestalling the imposition of externally preferred models (Zuidema, 1995).

Drawbacks of Models: Each of the case studies mentioned, with the exception of China, have assumed that the integrated institutional system developed in the USA Land Grant Colleges provides the most appropriate model for other countries. The comment of Johnson and Okigbo (1989) quoted above, hints at the frustrations which occur when such an approach is a critical component of project design. The World Bank's review of agricultural higher education noted that the notion of the western research university, and in particular the Land Grant College, provided the context of tertiary education for most international development assistance projects (World Bank, 1992). However, as that review notes, there was not sufficient recognition of the factors critical to the working of these models - *Taking the Approach for Granted*.

The philosophical base of the analytical procedure recommended by Hoste *et al* (1995) and the experience of major agencies in supporting agricultural higher education projects suggests that each situation has its own specific requirements which preempt the application of an externally conceived model (Falvey and Forno, 1996).

Taking the Approach for Granted

Leaving aside for a moment questions of the inherent desirability or applicability of the Land Grant model for developing countries, it is interesting to note that, in the final analysis, the model was not fully absorbed by any countries in the cohort. In many cases, the key elements of Land Grant institutions - tripartite functions, strong university governance, strong constituent support (manifested in both financial and political support) - and the interaction of these elements in a check and balance environment that encourage both institutional autonomy and accountability, simply did not obtain for the institutions supported by the two donors. In most cases, the enabling conditions which spurred the growth of the agricultural economy in the United States and kept university programs relevant to this development - such as the type of agricultural pricing policies, inputs, or services or "ownership" by client groups - did not prevail either. Finally, the basically stable funding from multiple sources at the local and national level - which allowed for the maintenance of a relatively open enrollment and fairly low student fees - was certainly not present in the majority of countries. World Bank (1992)

Rates of Return

High rates of return to education are demonstrated from various analyses (Psacharapoulos, 1994). In general, these indicate higher rates of return for primary than secondary education which in turn exceeds that of higher education (Table 4.3). Jain (1991) and Schultz (1993) also draw the association between rapidly developing economies and universal primary education provision

Table 4.3 Rates of Return to Investment in Education by Region and Level of Schooling (World Bank, 1995a)

Region	Social			Private		
	Primary	Secondary	Higher	Primary	Secondary	Higher
Sub-Saharan Africa	23.4	18.2	11.2	41.3	26.6	27.8
Asia	19.9	13.3	11.7	39.0	18.9	19.9
Europe, Middle East and North Africa	15.5	11.2	10.6	17.4	15.9	21.7
Latin America and the Caribbean	17.9	12.8	12.3	26.2	16.8	19.7
OECD Countries	n.a.	10.2	8.7	n.a.	12.4	12.3

Becker (1964) notes the contribution made by higher education to self-sustaining growth through the impact of graduates on the spread of knowledge. Similarly, the World Bank (1995b) notes that ... *estimated social rates of return of ten per cent or more in many low and middle income countries indicate that investments in higher education contribute to increases in labor productivity and to higher long term growth ... not all of the external effects of higher education - such as the benefits from basic research and technology development and transfer - are fully reflected in the earnings used in calculating these rates of return*. It is likely that rates of return to higher education are higher than stated under most current conditions and that under conditions of increasing primary and secondary education, rates of return to higher education would be higher again.

The high rates of financial return to individuals from higher education are usually based on the private benefits achieved upon graduation. From an individual's perspective, the low financial cost of attending subsidized institutions catering for a small number of persons, provides benefits through higher personal salaries. In economic terms, the benefits to a nation are more difficult to calculate and figures such as those presented in Table 4.3 can only be regarded as indicative.

The high operational costs of traditional higher education institutions are not commonly appreciated when such institutions are initially conceived. The high costs of establishment and maintenance of agricultural universities compared to the humanities, and their association with increased agricultural production is also poorly realized (Hill, 1964). A World Bank analysis of funding mechanisms for higher education notes that higher education in general poses a budgetary problem in LDCs because it is considerably more expensive than other forms of education (Albrecht and Ziderman, 1994). Traditional higher education costs between five and 40 times as much as primary education. The costs on the other hand of failing to maintain an active agricultural knowledge system may be counted in terms of declining yields and environmental condition and reliance on purchased technology from abroad.

Part of the cost of higher education is attributable to buildings. Where distance learning has been utilized as in Korea, costs have been found to be of the order of ten per cent of those in conventional systems (Lockheed *et al*, 1991). Despite higher drop-out rates from distance education, the lower costs, for example in Thailand where the cost per student at open universities is calculated as one fiftieth that of conventional universities, leads to significant rises in rates of return. In terms of private financial benefits to graduates, those graduates from Thai open universities receive salaries which are only some two per cent less than those of private university graduates (Tan, 1991). However, education in the agriculture and natural resources area cannot be conducted in its present form solely through distance education. Improvements in communication technology (refer to Chapter 9) may allow increasing components of these degrees to be offered through distance education, although one would be hard-pressed today to find academics willing to acknowledge that full courses could soon be offered through distance education.

The general argument that public investment in education should focus on primary and secondary areas with household financing being called upon to fund higher education, commonly through fee-based courses, is a partial answer to the costs of higher education. It is however, inappropriate for natural resource management and related education. Where higher education has been conceived predominantly as a private good and so relegated to private sector funding, the popularity of courses which impart high private benefits leads to major biases in the offerings of universities. In particular, those subjects which relate to general knowledge and culture may suffer as may those areas related to national issues such as natural resource management and agriculture, where the major employment prospects for graduates exist in the public sector with concomitantly limited salary prospects. The startling transitions occurring in Eastern Europe are a testament to the biases that can enter higher education under such circumstances. For example, courses such as management and accounting are in high demand in Romania, compared to educational fields which cater for public good sectors such as natural resource management.

In agricultural fields, education can also assist in reducing income inequality between rural and urban areas. This benefit which accrues across the country cannot be assumed to be rewarded through private salary benefits of graduates. The dual educational inputs necessary for rural development, that of wide basic education and higher education in relevant fields to allow appropriate research and adaptation of technologies from similar environments, form part of the stimulus for wide economic and social development.

The Future

Patel (1993) notes that there will be, for some time to come, a need for special considerations in policy settings for higher education in LDCs due to - *Differences Between LDCs and MDCs*. Lele (1995) observes that through the 1960s and 1970s the USA educated large numbers of scientists from Africa, Asia and Latin America who in their turn were an important input to the Green Revolution, particularly in Asia. She notes that despite the decline in USA and other aid, the USA continues to train approximately one-third of those developing country nationals receiving foreign advanced degrees. Similarly, other countries including Canada, the United Kingdom, Germany, the Netherlands, France, the Nordic Countries, Japan and Australia continue to contribute to varying extents in such natural resource management education.

Castells (1993), in concluding that higher education remains a development policy priority for LDCs, observes that these countries will be unable to compete for the necessary resources on an open world market in the short term, and will need to improve the quality of their universities through such means as:

- (re)training in centers of excellence in MDCs;
- enticing nationals working in MDCs back;
- engaging (temporary) visiting foreigners;
- accessing private and public talent;
- establishing joint activities with technologically advanced organizations.

Differences Between LDCs and MDCs

... despite the new wisdom that there is no such thing as development economics and that the same policies work in industrial and developing countries alike, clearly some problems need to be tackled much more urgently in the developing world. Questions of quality of education, of unemployment among the educated, of social relevance, of how much education to import and how much to produce at home, and of the need for positive discrimination in favor of those deprived of opportunity for long periods in the past are likely to be more urgent and more difficult to resolve in new emerging, poor democracies than in well established, affluent societies. While the problems among developing countries will also differ, we should not import the controversies of the north uncritically into the south. Much less should we borrow solutions wholesale from them. Patel (1993)

These factors are seen as being able to underpin the creation of a sound university which is defined as one with an appropriate institutional setting and a high quality staff profile supported by appropriate equipment and infrastructure. Chaudhry and Al-Haj (1985) also emphasize the need for strong, integrated home-grown institutions rather than imported models from MDCs. Accessing international courses through electronic means will create a greater demand for competent local tutors and teachers.

Strengthening of universities concerned with natural resource management in LDCs will probably attract continuing investment from development agencies. However, the mechanisms utilized to do this remain controversial, particularly the extent of adopting foreign models for institutions and training of faculty abroad. Hill (1964) noted some 30 years ago that the proportion of faculty who could be trained abroad would always be limited, thereby suggesting that the selection of personnel to take up this responsibility should be a strategic concern in faculty and university management. Schultz (1964) likewise takes a commonsense approach to the issue - *Support Your Local Product*.

Support Your Local Product

A low income country can either import particular skills and knowledge or produce them at home. There are two ways of importing: one by inducing foreigners to come and offer their skills; the other by having some people go abroad and acquire a command of such skills and then return ... When students from low income countries enroll in the United States, for example, more often than not they acquire skills and knowledge that are appropriate to the economy of the United States rather than to the circumstances that will confront them when they have returned. ... The conclusion that emerges, however, is that as soon as possible, such instruction should be acquired within the low income country concerned. Schultz (1964)

As the ethos for agricultural education shifts towards that of natural resource management in MDCs, interactions between LDCs and MDCs will facilitate the concept being introduced in LDCs. This does not mean that the concept is poorly appreciated in LDCs - it may mean, however, that the proportion of the society which acknowledges the approach is limited, and that other imperatives receive priority, such as immediate food needs and participation in rapid economic development and a global economy. These forces are significant and will continue to divert attention from the concept of agricultural and forestry practice within a construct of natural resource management including the historical, caring, and other humanities-based components of that approach. In this context, CIFOR, the Center for International Forestry Research, provides leadership a comprehensive view of the forest ecosystem combining biological, physical, economic and social variables (CIFOR, 1995).

Discussions concerning higher education commonly include links to primary and secondary education while neglecting vocational training. In the fields of agriculture and forestry and related pursuits within the bounds of natural resource management, the vocational aspects of education and training also require consideration. This is the focus of the following Chapter.

Fortress University

Born a child of a poor country,
although much richer than my peers,
I entered university,
It was expected for these years.

My subject choice by system made,
I reviewed the assessment list,
Agriculture suited my grade,
I became an agronomist.

For me, a government career,
It suits wider family needs,
There is access to privilege here,
Although not much to prestige.

College life more accessible?
equal chance to all should we give?
The grad's lot is regrettable,
Who on his own salary must live.

Once extensionist to the poor
to help poor peasants grow more rice,
But they had not been trained before,
Why should they accept my advice?

More farmers, few agronomists,
College knowledge to enlighten?
We can but act as chauvinists,
unless we learning widen.
Perhaps this is my true purpose,
Education now extending,
through an active training service,
with all parties comprehending.

Chapter 5

Vocational Education and Training in Less Developed Countries

Integrity without knowledge
is weak and useless,
and knowledge without integrity
is dangerous and dreadful.

Samuel Johnson

Education and training in agriculture includes both the technical and vocational training and the university sectors. The relatively short history of vocational training in LDCs, its poor status compared to higher education, links to employment and other social policies, and traditional association with MDC models, provide an opportunity for greater inclusion of natural resource management principles.

Vocational education and training (VET) in LDCs derives its traditions from MDCs and from skills training in apprenticeships and guilds; *Vocational Education in Asia* traces modern institutionalized form from its origins last century. The orientation of general education to vocational skills however, is a more recent phenomenon associated with the introduction of social and economic development plans (ADB, 1991). Policies concerning skills development or vocational education are now common throughout Asia, with the noteworthy exception of Singapore. This is related, sometimes overtly, to social policies promoting wide employment which in turn encourages a vocational orientation in secondary schools. This Chapter focuses primarily on vocational colleges at tertiary level.

A range of VET systems exist around the world and particularly in Asia. These vary from full integration of education and training within formal school systems, to full separation between academic and vocational schools. In other cases, separation is made between educational institutions, vocational training institutes, and industry training. The relative degrees of separation appear to be a function of the individual history of a country. Discussions considered that ... *neither total integration nor total separation of education* [and training] *is desirable* (ADB, 1991). Industry-based training is suitable for some fields while others benefit from formal and non-formal schooling systems.

> ***Vocational Education in Asia***
>
> [VET] *systems have a long history in the region. In India, it dates back to the 19th Century, coinciding with the inception of the railway network. In Malaysia, institutionalized technical education can be traced back to 1906 when a technical teacher school was set up to train technicians for the Malaysian railways and public works department in Kuala Lumpur. In Pakistan, a technical training center was established in Peshawar during World II (1941) to train skilled workers in various engineering trades for war material production in the army and ordnance factories.* ADB (1991)

Definitions

Defining VET is difficult. The separation of systems described above is further complicated by somewhat unnecessary separations between education and training introduced by international organizations such as the International Labor Organization (ILO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). ILO limits its activities to training while UNESCO focuses on education. This leads to one organization referring to vocational education while the other refers to the same activity as vocational training. It should be noted that these two organizations are now conscious of the need to integrate their education and training activities.

Murugasu (1991) defines Technical and Vocational Education and Training as including all forms of training provided in formal and non-formal sectors which leads to a skilled occupation. It is based on practical training and knowledge provided in both schools and training centers. A similar definition is employed by Middleton *et al* (1993) who focus on training for skilled workers and technicians. Their book, while primarily related to skills training in LDCs, provides economic, psychological and educational research information which further defines the area and effectiveness of VET.

The database available for VET and its relationship to other forms of education is of relatively poor quality (Bhowon and Chinapah, 1993) reflecting our *Poor Knowledge in Training*. Likewise, there is concern that demand for graduates of VET may not be accurately assessed and Dhanini (1993) has noted the difference between public and private perceptions on the issue. In general, private companies in LDCs do not view skills shortages as a major problem and large companies provide their own in-house training.

Poor Knowledge in Training

The problems [surrounding poor data availability] *arise mainly because:*

- *existing education statistics are generally not reliable*
- *statistics are often out-of-date and hence of limited use in informing policy decisions*
- *statistics are often collected as a matter of course, and too little critical reflection on the underlying periodical framework, the comparative perspective, and the purposes for which the data are intended*
- *the information collected focuses more on counting inputs than on assessing achievement and monitoring labor market outcomes*

- *educational research is usually not available or is not used to complement statistics in monitoring education systems.*

World Bank (1995)

Differences from Developed Countries

MDCs base VET in a wider education and training context, than do LDCs, with the aim of ensuring a flexible workforce able to acquire new skills in changing circumstances. High technology industries require specialized skills, and emphasis in VET is placed on providing the essential knowledge and skills necessary for further learning for such new circumstances. Murugasu (1991) notes three general models utilized in MDCs:

- the school model with a wide range of general, technical and vocational programs through full-time vocational schools
- the dual model based on apprenticeship programs requiring both school-based vocational training and part-time industry training
- the mixed model which emphasizes industry-based training on a non-formal basis to a greater extent than does the dual model.

Recent changes in Eastern European economies provide further insight as to the differences between MDCs and other countries. From the 1970s, in the USSR, education was oriented to training young people for employment in social and economic development. This system was extended to other socialist economies. Over time, the system shifted from industry training to school-based training with increasing responsibility of the Ministry of Education or a separate Ministry of Higher (and Specialized Secondary) Education. This general drift towards increased formal training was viewed with concern by some who considered it politically consistent yet educationally limiting.

In its document - Priorities and Strategies for Education - the World Bank (1995) notes the current sharp drop in student enrollment for vocational and technical programs in Romania, among other transitional economies. This is in contrast to an increased demand for higher education at the same time. Despite this perception of the personal value of a university degree in such circumstances the general fall in employment levels expected in economic transitions may impact more on university than VET graduates.

Institutional Rigidity

In considering the educational requirements for Sub-Saharan Africa, The World Bank emphasized the critical role of VET. However, they note that formal schools may not be the best source of such vocational skills development. This thesis is presented in more philosophical terms by Orr (1992) who implies that institutionally based VET emphasizes the *status quo* rather than instilling of values or attitudinal changes. The ADB-World Bank (ADB, 1991) Conference noted specific problems which vocational schools face, foremost of which is inflexibility and possible irrelevancy of programs. Incorporated in these criticisms is an inability to remain up-to-date with the rapid technological changes required to service industries.

Training To Do What?

... too much specialization in vocational courses involves a risk of not being profitable in the future job should world-wide technologies which impact developing countries change. On the other hand, the three Rs are important in every type of job, although their immediate effects on productivity may be smaller than occupation-specific skills. Furthermore, while still in school, basic skills enhance the ability to learn vocational skills, and vocational courses showing the relevance of basic skills can feed back and improve learning in general education courses. So there is complementarity both in learning and later in use of the more general and more applied concepts and skills.
McMahon *et al* (1992)

Inflexible curricula and weak linkages to industry have their own impact on the quality of training such that students could ask - *Training To Do What?*. This leads directly to aid investment decisions to reduce expenditure on formal VET. Nevertheless, political imperatives associated with youth employment and rural to urban migration may be expected to continue to override such advice in the foreseeable future. Bishop (1989) has noted that benefits of vocational training are directly related to the congruence of training and the subsequent job of the graduate.

Modes of Delivery

School-based training is favored by Lauglo (1991) in situations where technology and occupations are expected to change in response to government policies. They are also favored in those countries with social policies to provide training linked to employment. However, such linkages to employment are often weak and, especially in times of economic recession, this can lead to decreasing relevance of training. In addition, the complexity of organizing apprenticeship programs often prevents their implementation in LDCs, even though it may reduce government investment requirements. Dougherty (1991) further observes that the worker development orientation of VET assumes that supply and demand for different skills are independent of each other, and that the primary objective of VET planning is to ensure a ready supply of workers. Education and training become more complementary when VET is considered from an in-service perspective for *Person Power*.

Person Power

A general outcome on the discussions on manpower planning was that planning based on manpower forecasts is not very useful except in new major development thrusts or initiatives (e.g. petrochemical production). The approach can also be effective when enterprises *are planned or existing ones expanded. The forecast period should not be long and periodic up-dating of data is crucial. Macroeconomic planning is, however, a useful and important tool, for formulating economic development policies. New methods are, however, needed to determine manpower requirements ... manpower planning must be closely linked to industries' needs. Joint Government - industry effort must be ensured to allow start up, shut down and other changes.* ADB (1991)

Contrary views of the superior benefits of in-service training as a basis for VET were expressed in the discussion at the VET Conference (ADB, 1991) at which studies for countries as diverse as the USSR and Indonesia also suggested higher rates of return from vocational school education than from general academic education. The implication was drawn that school-based VET is efficient and should be sustained. This leads to the conclusion that an appropriate response to weaknesses in VET is modification of existing school-based training rather than a wholesale switch to in-service based training. This is one viewpoint. Other discussions concerning modes of VET delivery emphasize the benefits of in-industry training. As the World Bank (1995) notes ... *international experience suggests that vocational and technical education and training are most effective when they follow a sound general education and are job related.*

The responsibility of the private sector in providing in-service training is critical in terms of providing a training venue, prospective future employment, and meeting training costs - at least in part. Much of the World Bank's (1995) argument rests on analysis of the rates of return to various types of education which, according to the type of analysis utilized (for example, Psacharopoulos, 1989), can suggest that the rates of return for both VET and higher education are well below those of primary and secondary education.

The World Bank's (World Bank, 1994) policy study of education in Sub-Saharan Africa similarly concludes that vocational training is better provided to persons who have secured initial employment, with the possible exception of some general skills such as typing and accounting. Perhaps the most comprehensive collection of arguments against school and college based VET in general is that of Haddad *et al* (1990) which lists tens of studies which suggest that skills training in vocational schools is neither the most cost-effective nor the most educationally effective method of such training. Metcalf (1985) has summarized much of this research and concludes that:

- informal firm-based training is more cost-effective than school-based VET;
- short courses appear to have higher rates of return than longer courses;
- pay-offs for skills-based training may be higher for those who have only completed primary school than for those who have completed secondary school.

Many of the studies referred to have been conducted by or on behalf of the World Bank as is appropriate considering that it is the largest international financing institution for VET. The conclusions of these documents have far reaching implications for VET in general - refocusing of lending and donor assistance for VET in LDCs should stem from this. Overall, such studies conclude that skills-oriented training should be industry-based with institutional training providing a general underpinning for teaching of generic skills. An early study (Bennett, 1967) noted that enrollments in vocational education, as a ratio of general secondary education, rose up to a GNP per capita income of US$500 before declining with further increases in income levels. The application of VET funds to equivalent situations today in providing skills to poor or poorly educated persons would appear to be one exception to widespread reliance on industry-based training.

In essence, the arguments that training is more relevant if conducted in industry and is of benefit to those industries and should therefore be paid for by those industries, is similar to current arguments for the funding of applied research activities which incur a private benefit. In this situation, the *Friendly Advice* of the Asian Development Bank is practical, broadminded and colloquial.

Friendly Advice

There may be no single one best mode of training but a common *weakness of institution-based training is inadequate contact with employers and general insensitivity to the labor market. Reach out. Talk to local employers and trade unions and not just to national representatives. Listen to trainees who have been looking for work. If you are disillusioned with school-based training, beware of the romantic view of what training in industry is like. If you are running an employment-based scheme, back it up with evening classes and with a cadre of supervisors and inspectors. Do not assume that a person is given any special training, just because he/she is registered as a trainee or apprentice in industry. Check it out. Make sure that top officials pick up the very considerable labor market insights which most teachers who are responsible for placing trainees in industry will have.* Lauglo (1991)

VET in Agricultural Extension

VET is perhaps the least glamorous area of education. The pattern of MDCs, where more academically gifted students are channeled into higher education and those less academically able into VET, is mirrored in most LDCs. The high value placed on general education as a means of maintaining a social and financial continuum with research does not favor VET. The conceptual viewpoint of VET that skills can be taught and form a base for further learning is limited insofar as it assumes that pieces of information on new technologies are inherently valuable in the absence of a knowledge base which assimilates that information into a wider context. The role of VET in agricultural extension is thus questioned by some.

IFPRI (1995) notes the mixed performance record of public sector extension in LDCs. It calls for innovative approaches to strengthen communications between researchers and farmers while noting that the importance of information for agricultural systems will increase dramatically in the next two decades. Information dissemination can be expected to accelerate through satellite communication, radio, video and even the Internet. While reviewers with a research orientation may call for improved linkages and innovative approaches to extension in order to overcome apparent deficiencies of the past, failure to acknowledge the critical role of education in providing a knowledge base, and as the context for extension, may in fact be a limiting factor in the success of existing extension programs.

Extension can be considered to be the extending of the classroom to a wider environment as one component of education, or it may be interpreted to be a mechanism to institute behavioral change. In terms of behavioral change, Hatfield and Karlen (1993) note that we all have greater difficulty acknowledging shortcomings in our own actions than in seeing such shortcomings in the actions of others. Relating this to natural resource management practices, they note the difficulty of extension programs in instituting such behavioral change. In the USA, for example, farmers' knowledge appears to be limited by conditioning to ask for a new technological solution to a problem rather than refining existing knowledge and technologies. Farmers obtain information from their own experiences, indigenous knowledge, literature, research, neighbors, field agents, field days, dealers and a myriad of other sources. The problem does not appear to be a lack of information or sources of information but an ability to integrate this with an existing knowledge base. As Hatfield and Karlen (1993) note ... *while information is an important resource for the sustainable farmer, the critical resource for the farmer is the ability to synthesize this information, and to make the best management choices possible for his/her farming operation*.

Education provides an essential level of knowledge among producers as an essential input to a sustainable farming system. This role of agricultural or natural resource management education is a critical component which is easily overlooked if extension is interpreted in isolation from the utility of the information being disseminated.

Knowledge of extension and its modes of operation are limited. Anderson and de Haan (1992) note the relatively brief history of extension and the limitations placed on it through its common association with public institutions. Reconsideration of the role of extension, particularly amongst international financing organizations, provides an opportunity for better understanding of its place in the continuum which is constituted by agricultural education, extension and research.

In a situation of rising food requirements from a finite resource base, and with the conditions generated by such a dilemma magnified in those LDCs with high population growth rates, the need for widespread understanding of natural resource management principles is critical. The role of natural resource management education including agricultural education, can be conceived in terms of its contributions to:

- providing a knowledge base for farmers to accommodate new information
- education of extension agents to be more than simple repeaters of technical information
- education of an increasing and constant pool of informed and broadly based scientific researchers who can accommodate their results in a natural resource management context
- informing the wider public of the essential trade-offs between food production and natural resource management requirements.

Opinions expressed in internal documents and by staff of international development banks suggest that lending for VET is problematic in many cases - as is lending for education and agriculture according to some. Such statements contrast with more practical calls for action, such as in the World Bank Policy Study for Education in Sub-Saharan Africa (World Bank, 1993), which indicated that the most important activity for international donors is the stimulation of joint training with industry, with a significant financial and policy commitment from industry. Such a sentiment is consistent with the diverse literature concerning VET in general terms. Indeed, such a conclusion is consistent with the predicted future trends derived from the joint ADB and World Bank Conference on VET in LDCs which noted:

- a need for more enterprise based VET
- a need for expansion of formal and non-formal VET
- a greater role for the private sector in providing VET
- a greater emphasis on work experience or vocationalization of education

- more extensive use of technologies to improve VET
- greater cooperation between public and private sectors in providing VET programs
- further establishment of vocational schools

Murugasu (1991) classified VET into three general areas. They are: agriculture, commercial (or business), and home economics (or home science). The first impacts more significantly on natural resource management and therefore warrants further attention.

Agricultural VET

Advanced agriculture relies on a combination of management inputs. Just as fertilizer, irrigation, and other physical inputs are required, the ingredients of management are critical and best applied under circumstances of integrated knowledge. A well educated highly alert farmer, as described by Weitz and Landau (1971), is best able to apply the most appropriate combination of methods and inputs to achieve desired outcomes. Likewise such a knowledge base is essential to the accommodation of natural resource management principles within agricultural production.

However, ensuring a widespread, well-rounded education for farmers in LDCs is not yet possible. Improved service to such farmers from well educated advisers is one substitute, and in the absence of broad education, training of advisers and a few key farmers in technologies and techniques remains a major role of agricultural VET. *Agricultural VET in Sri Lanka* presents an example of the shaky base of such agricultural VET in LDCs. Schultz (1964) similarly emphasizes the important role of on-the-job training as a complementary approach to school or college based agricultural VET.

Agricultural VET in Sri Lanka

Agricultural education was confined to a single school of agriculture providing a two year vocational course. Its medium of instruction was

English, which was not the language of the farmers in Ceylon. There was no organization for training farmers. In the late 1950s, practical farm schools were opened, with instruction in the national languages, but few trainees from these schools went back to farming. In recent years, some of them have been settled in special projects within the colonization schemes, where it is expected their high management capability could be combined better with adequate land and capital resources. In-service training of extension workers has been carried out only at irregular intervals. With aid from the FAO, attempts have been made recently to set up regular training schemes for all extension officers. Andarawewa (1971)

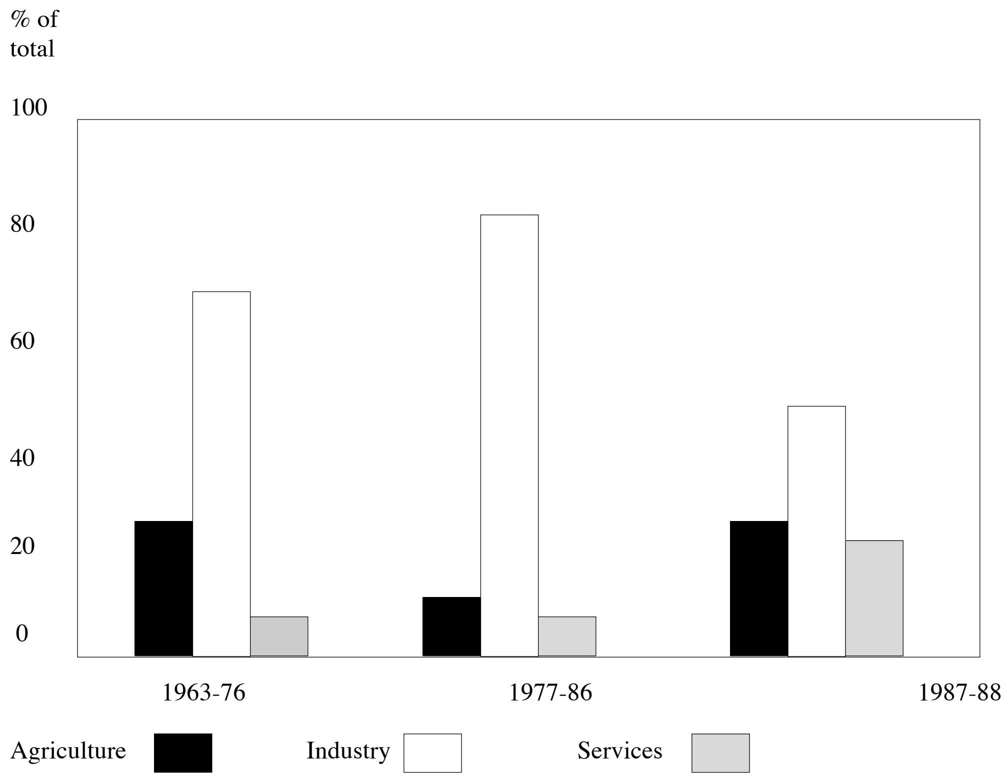
Analysis of the relationship between education and economic growth has provided an indication of the benefits of agricultural VET (Tilak, 1989). Such analyses, in many cases, mix education and training under a generic term of agricultural education. Often it seems that, in many cases, that it is in fact VET which is being referred to in terms of imparting specific skills and ability to apply technology in agriculture. In discussing these analyses, Moock and Addou (1993) note the need to compare the use of similar inputs in situations with variable education and training levels of farmers. The outcomes of such analyses appear to confirm the benefits of some skills-based training for increased agricultural productivity. This conclusion might be stretched to suggest that VET can similarly impart the application of environmentally sensitive technologies which are not necessarily related to immediate economic outcomes. A survey of 18 studies linking farmer education to efficiency of activities confirms the common economic relationship and further supports the contention that farmer training could be a critical aspect of resource management (Lockheed *et al*, 1990). In reality, farmers in fact are managers of terrestrial resources and their actions follow traditions, levels of knowledge and personal imperatives, rather than centrally stated policies on resource management.

The skills required in agriculture vary with technology type and rate of change (Welch, 1978). While knowledge for subsistence farming tends to be passed on between generations, changing technology requires increased knowledge and ability to utilize new techniques. New skills in such areas as the maintenance and repair of machines becomes more important. It is in these areas that agricultural VET links to the wider education and training sector. Skills needed in modern agriculture are more transferable to the wider economy than are skills relating to subsistence agriculture. Agricultural VET can therefore be seen to contribute to the general economy and as a mechanism for bringing new persons into the agricultural sector who have skills relevant to new practices - even in a situation of declining total numbers in the sector. Middleton *et al* (1993) observe that rural VET institutions have been most effective when their objectives and curricula are closely aligned to the specific skill needs of individuals entering self-employment, including farming.

However, VET in rural areas should not be restricted to agricultural training alone. The agricultural sector, in moving from a traditional to a higher technology mode as is or expected to be the case in most LDCs, will lead to displacement of persons who should be empowered to move into alternative careers through appropriate training. For this reason, VET institutions in rural areas need to overcome their specific problems in attracting appropriate staff to offer the range of training that will effectively impart a wider range of skills. In a period of transition, wage employment related to agriculture is increasingly found in government ministries. However, as Middleton *et al* (1993) found, re-orientation of VET to train agricultural extension agents and technicians can become socially inefficient when such agricultural services are fully staffed or government hiring is constrained. This has been well demonstrated in Thailand for example, where rapid expansion, assisted with World Bank and other funds, created a new agency with extension agents required for each sub-district in the country. Such an expansionary trend in agricultural education tends to run counter, in the short term, to the general trend of decreasing employment in agriculture as a proportion of total employment opportunities in developing economies.

The relative contributions of international support, using the World Bank, as the primary indicator, compared to industry and service areas is presented in Figure 5.1.

Figure 5.1 Average World Bank Support for Vocational Education and Training by Sector, 1963-1988 (after Middleton *et al*, 1993)



Competence and Equity

Short specific vocational courses run through schools have been most successful in early stages of development in European cultures (Schultz, 1965). This contrasts with the longer formal courses more commonly provided by vocational colleges. It also appears to contrast with the suggestion of Weitz and Landau (1971) that migrants within Africa with limited skills, benefit from short vocational courses to widen employment opportunities in rural and urban areas. There is however, a wider issue concerning the nature of vocational education and its functions.

Agricultural VET has serviced agricultural extension in many LDCs, particularly when stimulated by foreign assistance. Byrnes and Byrnes (1971), in determining that the separation of agricultural VET from extension can cause a lack of focus, proposed a number of remedial innovations. These included a focus on people, and the role of education as a means of behavioral change. In this manner, the indissoluble nexus between agricultural education and extension is clearly seen.

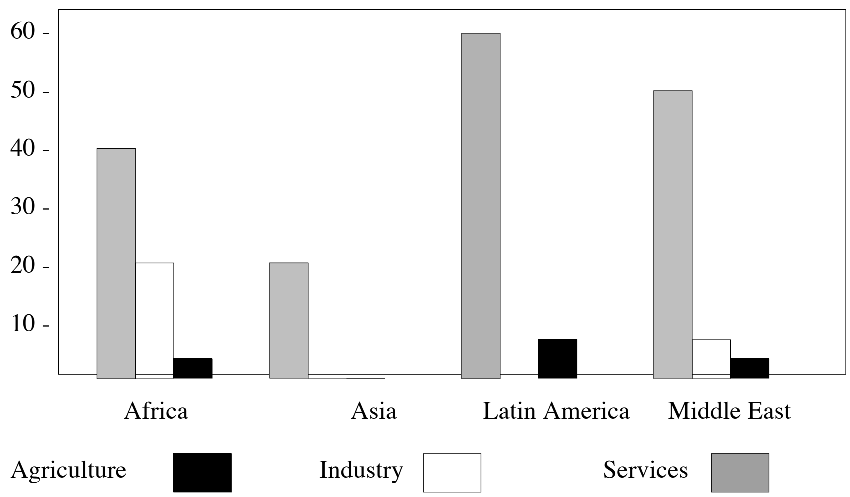
Certain levels of competency are required from agricultural VET including; technical, economic, science, farming, and communication skills. Matching competency to tasks in employed or self-employed situations is a critical challenge, particularly where the improved mobility between rural and urban areas is included as a social objective of VET funding.

Multiple skilling is an objective of many training programs. Zarraga and Green (1985), present these as the development of everyday life-skills and skills for particularly work assignments. An FAO (1985) presentation of case studies of various extension and training interventions in LDCs indicates that many have failed to meet their objectives fully as a result of mismatching of competency needs and training outcomes, and the large social transition which accompanies economic development in rural areas.

Equity in access to agricultural VET is generally discussed as being less problematic than that of higher education. In terms of gender equity however, Figure 5.2 indicates very low percentages of females in agricultural VET. This information, while it may only be indicative, is of concern in that the functions of agriculture in developing economies commonly involve both females and males. In periods of economic transition, males appear to be more mobile than females, thereby increasing the proportion of females responsible for agricultural production. Whether mobility is a cause or an effect of VET raises the question of equality of opportunity in such a circumstance.

A further equity issue of importance in agricultural VET stems from its essential rural focus. Policies supporting the funding of rural VET colleges have assumed that educational offerings in rural areas should differ from those in urban areas. This leads to rural students being disadvantaged by the limited opportunity to gain mobile technical skills. In some case, there exists an overt policy aimed at reducing rural to urban migration especially for young people. In periods of economic transition, as can be expected in most LDCs if development programs are successful, mobility of skills, migration and other significant social changes occur. In any case, as Middleton *et al* (1993) observe, such anti-mobility policies have usually failed.

Figure 5.2 Female Vocational Enrollment (%) by Field of Study
(after Middleton *et al,* 1993)



Demand and Needs

In countries with large rural populations and policies favoring their education, the majority of students in vocationally oriented colleges have been drawn from urban areas (Byrnes and Byrnes, 1971) and continue to be today. As such colleges are frequently aligned with agricultural extension training, criticism focuses on competence for that task. In the face of criticism of such colleges, foreign assistance donors often seem to react by making further investments in re-training those already trained by the VET system.- refer to the Box - *Unvetted VET Investment*.

Unvetted VET Investment

Wherever one goes in the developing world, one is likely to find growing restlessness about mounting criticism of the ability of local agricultural systems to cope effectively with development problems. While agreeing that development depends upon education, most development specialists find themselves attacking existing *educational systems as being dysfunctional. Typically, rather than attempting to correct the problems they launch ambitious programs to train already educated people.* Byrnes and Byrnes (1971)

The pervasive perception that VET colleges exist to service less academically gifted students is a major impediment to their function. In agriculture, the perception can cause VET to be seen as a substitute for higher education. The unrelated image of agriculture as a low status occupation involving persons with high manual yet not so high intellectual skills, is reinforced through such a perception.

Agricultural extension is a widely accepted approach to imparting information and technology which requires new skills. Its original integration with education and training has been lost somewhat in those countries which separate the functions of research, education and extension (refer to Chapter 8). The orientation of VET to the requirements of specific agricultural extension employment requires an external monitoring function to maintain relevance of course offerings.

The almost total separation of agricultural VET from research functions limits the automatic introduction of new knowledge through personal experience of staff and thus requires some formalized process to ensure regular updating of programs in *Training for Extension*. Middleton *et al* (1993) notes that institutional autonomy in curriculum development leads to potentially greater efficiencies in some colleges run by non-government organizations, as compared to publicly run institutions. Recent renewed interest in partnerships between farmers and suppliers of services of development (Merrill-Sands and Collion, 1994), suggests that area-specific interactions between development, social transition and education may best involve organizations willing to operate on a partnership basis with farmers.

Chowdhury and Al-Haj (1985) support the contentions of Byrnes and Byrnes (1971) that training for agricultural development is confounded by:

- divergence of views of development specialists as to the essential components for development

- varying levels of commitments to and expectations from development among key persons in different socioeconomic sectors of LDCs
- major differences between the educational backgrounds, experience and commitment of national leaders.

Such disparate approaches between VET and other education is linked, by some observers, to the separation of the arts from the sciences, an area not commonly considered in VET debates with their skills focus; others see it as simply the biases of educational systems. Andarawewa (1971) reporting on Sri Lanka in the 1960s notes ... *the education system has been oriented towards the teaching of arts and humanities as against technical or vocational training. Therefore, the majority of graduates of both high schools and universities do not have the competence to direct, undertake or manage development.*

> ***Training for Extension***
>
> *The effectiveness of extension however, rests heavily on the training of field agents. Both agricultural schools and sectoral training agencies managed directly by Ministries of Agriculture provide pre-service training. The need for continuing in-service training and upgrading for extension staff has led to considerable development of the sectoral training agencies. Training is highly specialized; extension agents must learn communication and monitoring skills as well as technical skills. Training of extension managers is also important.* Middleton *et al* (1993)

Future Agricultural VET

In reviewing literature concerning VET and agricultural VET in particular, one might well ask whether it has a long term future as it is currently conceived and implemented. The issues include such points as those included *VET Heal Thyself!* Major issues, it could be argued, may be addressed through industry-based in-service training on the one hand, and supplemented self-help schemes for short technology-oriented training on the other. However, a significant infrastructure in the form of existing colleges and schools, trained teachers and societal expectation works against any such proposal. Perhaps the over-riding conclusion is the need for a balance of approaches to VET to work in parallel and in conjunction with each other to minimize the impact of inherent system weaknesses.

A World Bank (1991) policy paper isolates the following areas for future action in the VET sector:

- encouragement of employer training
- creation of responsive policy environments
- reducing regulation of private providers
- improving the effectiveness and efficiency
- assessment of appropriate training objectives
- improved market orientation in planning
- improved institutional responsiveness to market forces
- using expensive training resources efficiently
- building capacity for policy implementation
- diversifying sources of finance

VET Heal Thyself!

Issues for agricultural VET in LDCs include:

- a tendency to drift towards broad based education, sometimes mimicking universities;
- political imperatives using agricultural VET as a social engineering tool to retain rural youth in the country side;
- the separation of publicly funded colleges and schools from the industries in which graduates must work;
- conflicting views of agricultural VET leading to inadequate funding, low status and equivocal educational outcomes;

- shortages of qualified teachers experienced in the respective industries which they serve;
- separation of training from information dissemination as a natural outcome of colleges separated from farming and agribusiness communities;
- significant gender imbalances which place additional pressure to generalize education in favor of mobile skills which enhance urban employment opportunities for males;
- poor linkages with agricultural and other universities for science and philosophical underpinnings on the one hand and industry for practical relevance on the other.

These issues are being addressed in developing a national strategy for agricultural colleges in Thailand (DOVE, 1995). The approach being taken in that case is oriented to the needs of employers and students in determining the allocation of resources and the educational product itself. It recognizes that a totally market-demand driven system has less relevance to agricultural VET than to industrial VET, yet embodies the important aspect of a philosophical commitment to orient activities to required outcomes. Employers of agricultural VET colleges expect graduates to be ... *skilled workers and technicians* [who] *can work independently with a minimum of supervision, who are practically oriented, interested in agriculture, trainable and capable of quickly adopting new skills, with the right work attitudes and social communications skills*. This was not seen to be deliverable from colleges operating in relative isolation from employers or from staff who had retreated behind college walls.

With agricultural VET colleges in most of Thailand's 75 provinces, the relevance of a nationally controlled system and curriculum is being questioned and consideration given to local industry-based Advisory or Executive Boards. Increased financial autonomy, reorganization of lines of authority within colleges and within the national college coordination system are seen as pre-conditions to addressing specific educational issues including quality assurance. The need for national policy makers to take an interest in reorienting the agricultural VET system is noted to be a pre-condition to a successful outcome.

From a broader natural resource management perspective, the outcomes of the FAO (1995) Electronic Conference concerning working with farmers in partnership while strengthening training provides indications for *Training for Natural Resource Management*.

> ***Training for Natural Resource Management***
>
> *1. Adopt a participatory approach for joint action between partners (local populations, especially the food insecure, farmers' groups, NGOs, governments) ... 2. Establish new research partnerships with women ... 3. Develop and implement training methods and approaches to help all levels in organizations, and in interaction with farmers and the food insecure, to adopt behavior and attitudes which are truly participatory, non-dominating, and empowering. 4. Finance more national and international fully participatory research, integrating all natural resources departments and institutes with full linkages to the global knowledge system and adequate documentation of indigenous knowledge ... 5. Enable local people especially the food insecure, to strengthen their indigenous know-how, to express their needs and priorities, and to meet these by encouraging relevant research, development and dissemination of technology which they can control.* FAO (1995)

In considering the role of VET in natural resource management education, agricultural training must be designed within appropriate resource management principles. The original purpose of VET remains valid, *viz.*; the training of technically able persons to work in areas of agricultural production, environmental protection and management. If, as argued elsewhere, agricultural higher education will progressively shift to a broader natural resource management education context, agricultural VET may be seen within the broader agricultural education shift. In that circumstance, one might expect agricultural VET to include a wider range of natural resource management principles and techniques. For example, plowing of fields would acknowledge techniques conducive to minimal tillage, minimal use of weedicides, low potential for erosion, and protection of high risk and environmentally important areas. Discussions concerning VET have not ventured far along this path. Nevertheless, it appears that agricultural VET is poised for a period of change in the light of funding imperatives, and the general trend of allocating government services and funding to industries. The opportunity to expand agricultural VET to incorporate skills and techniques of environmental protection and management is now before us. The retention of government responsibility, at least for such public good elements, needs to be emphasized.

Education and training for natural resource management in LDCs builds strongly, both in terms of logic and responsibility, on existing agricultural higher education and VET. Insofar as agricultural education approaches in LDCs have borrowed heavily from MDCs, some further comment on the origins, and current and expected future trends for natural resource management education in the MDCs is warranted. This forms the substance of the following Chapter.

Education Skills

You think we want only technical skills,
for employment as of old, in factories and mills;
While suited to some who seek such tether,
it is not suitable for all, or forever.

With new interests, new knowledge develops,
further learning more than retraining envelops,
a context for specialties must provide,
Education, training - one not the other deride.

As the doctor requires sound skills to act,
mixed with knowledge, learning and access to fact,
So in fields of agriculture, we yearn,
We need more, please don't deny us the right to learn.

We work in farm and laboratory,
in regulation and other such tasks advisory,
which require knowledge for learning clients,
We need more than rote-skills, we can't be compliant.

That invisible barrier break down,
Let enlightened action illuminate the gown,
No longer binding us to this one caste,
Training to education as one, thus bound fast.

Chapter 6

Education in More Developed Countries

Let knowledge grow from more to more,
But more of reverence in us dwell;
That mind and soul, according well,
May make one music as before.
Tennyson

This Chapter introduces the origins, current issues and opportunities for the future of agricultural education as a component of environmental education. It builds on the discussion concerning universities and vocational training in LDCs while noting that past trends of LDC institutions following those of MDCs may be breaking down, and that relations between institutions should continue to change with the advent of new communication technologies.

History

Formal environmental education in MDCs preceded its development in LDCs. A primary form has been through agricultural education in its many guises. The pressure on agricultural education today can be appreciated through an understanding of history.

The university tradition which has developed over the past seven centuries is one of the remarkable features of international life (Van den Bor *et al*, 1989). The clearly defined culture of universities which allowed peripatetic scholars to roam Europe in medieval times continues to allow modern academics to move between countries, largely unaffected by the limitations of language, religion and politics or culture. It is within this international culture, which potentially extends to all countries, that agricultural education first developed during the 1600s.

An essay attributed to Cressy Dymock published in London in 1651 includes a proposal ...

> *for the erecting of a Colledge of Husbandry and in order thereto for the taking in of Pupills or Apprentices and alfo Friends or Fellowes of the same Colledge or Society ...*

The Institute of Agricultural History at the University of Reading dates the opening of the Academio Dei George in Florence at 1753 (Creasey, 1995) and Beveridge (1991) records a Chair in Agriculture as being established at the University of Padua in 1764. One summary of the early history of agricultural education may be styled *The True (1929) History of Agricultural Education*.

The True (1929) History of Agricultural Education

Ferindand Kindermann (1740-1801), a Bohemian, sometimes called "father of industrial education", under the patronage of Maria Theresa, founded an elementary school in which agriculture, music, and religion were taught along with the three R's. This plan was also followed in other schools. In Bohemia an agricultural school was opened at Tirnova in 1791. ... In Hungary agricultural schools were established at Zarvas in 1779; at Nagy-Michlos in 1786; the Georgicon Academy at Kezthely, founded in 1797, was for 50 years "the model agricultural college of Europe". ... Near the end of the eighteenth century Frederick the Great undertook the development of agricultural schools as a part of a broad plan for improving the agricultural condition of Prussia, and his example was followed by his successors. ... Albrecht Thaer (1752-1828) successfully engaged in practical and scientific farming, and when visitors to his farm at Celle, in Hanover, became numerous he began in 1802 to give them instruction, and this led to the establishment of the agricultural institute in that town. "In 1806 he founded the agricultural school at Moeglin, near Berlin, which became famous, and which was raised to the Royal Academy of Agriculture, 1824." ... In 1811 the academy at Tharandt, in Saxony, was founded and a little later than the agricultural college *of the University of Leipzig. In Wurtemburg, the agricultural college of Hohenheim was founded in 1818, which had a large model farm. This institution was very successful and attracted much attention in other countries. ... About 1820 Matthieu de Dombasle founded at Roville, near Nancy, the first school of agriculture worthy of that name in France and almost entirely with private means maintained it for some time. In 1829 the school at Grignon and the following year the school at Grand-Jouan were founded by pupils of Dombasle and later became State schools.* True (1929)

Creasey (1995) traces the University of Hohenheim in Germany to its forebear, the Agricultural High School founded in 1818 and the French National School of Agriculture at Gignon to a foundation date of 1827. The origins of agricultural education in Europe appear to be either far-sighted university appointments or private initiatives, such as the formation of the first Italian school of agriculture. The latter, established by the Marquis Ridolfi in the 1830s (Saint-Martin, 1987), served the sons of farmers without the requirement for fees due to an apparent reluctance of farmers to pay for education.

The establishment of a Foundation Chair in Agriculture at Padua was followed by the establishment of a similar chair at the University of Edinburgh in 1790 (Fleming and Robertson, 1990). The first appointee at Edinburgh, Professor Andrew Coventry is regarded as the founder of the Scottish system of agricultural education. He was active in discussions with farmers, landowners, and students and has been described as a researcher and extension worker (Beveridge, 1991). The Scottish system provides an appropriate basis for describing the subsequent development of successful agricultural education systems. It was based on a philosophy that education, research and advisory activities were parts of a whole, an ethos which the Land Grant College (LGC) system of the USA was to progressively adopt.

Scotland: The Scottish system evolved to link colleges of agriculture established between 1899 and 1904 with the universities. The colleges had the objectives of maintaining a teaching institution for agriculture in different regions of Scotland and, providing extension teaching to associated counties. The linkages between colleges and universities continues today through selected joint appointments.

Private Gain and Public Loss

The most serious cuts are the withdrawal of grants sustaining such advisory work and research and development as directly benefiting farming and industrial interests which, in the government's view, should pay the full cost for what they get. Clear-cut though the implementation of this kind of economy may seem to be, the very strength of the Scottish System, the interdependence of all its activities, suddenly became its greatest weakness as work promoting private gain had to be disentangled from that leading to public good. Williams (1989)

Soon after the establishment of the colleges, agricultural research institutes were established such as the Rowett in 1912. This completed an integrated system of research, teaching and extension, with staff who could accept responsibilities beyond their nominated institutions. As Beveridge (1991) notes, ... *since the second World War a complete network of field advisory officers and staff covering all of Scotland has developed and been administered from the Colleges, while, within the Colleges wide-ranging specialist backup services have been built. ...* Recent revisions to the system have led to the privatizing of advisory services, centralizing of college administration, and a commodity focus for research. These changes are seen by some as a *Private Gain and Public Loss*.

United States of America: The agricultural education system of the USA is widely recognized as having been a major contributor to agricultural development in that country and beyond. The so-called *Land Grant Colleges* evolved to integrate research, teaching and extension activities within each state. While it is sometimes suggested that the concept was developed with foresight in the late 1700s, the original concept was for teaching in rural areas to which a research function was subsequently added, and later a formal extension activity. As Penders (1971) observes, the extension function was added in recognition of the need to extend educational activities to those unable to attend colleges, and to ensure the dissemination of research results from the universities and related research stations.

Land Grant Colleges

The LGC system ... has contributed substantially to the economic growth of the nation, led the research and application of science to agriculture and other fields, supported elements of national security and adapted to changing societal needs over a period of some 130 years. It is not possible for other institutions or nations to readily duplicate the LGC system. ... LGCs are so named from the initial federal legislation (the first Morrill Act, 1862) which granted land to States for sale in support of at least one college of agriculture and mechanical arts among other disciplines. A subsequent act (the Hatch Act, 1887) led to the creation of research facilities through the Agricultural Experiment Stations (AES) which were to form part of the LGCs. A further act (the second Morrill Act, 1890) provided a firmer funding base for LGCs and created additional LGCs for black persons in states continuing to practice racial segregation. The Cooperative Extension Service (CES) was added to LGCs (the Smith-Lever Act, 1914) to enhance the application of practical information beyond campuses. The recognized strength of the LGCs in integrating research, education and extension thus developed over a period of some 50 years, not as a single enlightened event ... (Falvey and Bardsley, 1995)

Malone (1994) separates the development of LGCs into four phases. The first concerns their formation in the 1860s with the objective of developing the human resources necessary to support agricultural expansion. The second phase occurred under the influence of scientific and technological developments surrounding World War II which oriented colleges to research and technology development. The third phase built on the successes in science and technology and accommodated political imperatives to apply these resources to the well-being of citizens throughout the country. This was to be accomplished through continued research, promotion of scientific knowledge and talent in youth, stability of government funding for freedom of inquiry, and integration with wider social development issues. Through this period, an emphasis on technologies which advanced USA interests through the Cold War received priority. Once the Cold War threat was removed, funding for science and technology declined and the relevance of higher education and scientific research came under increasing government scrutiny. The fourth phase is that which is presently occurring - which Malone (1994) sees as ... *forging a new social compact between the nations' universities and colleges and the several levels of government*.

Both the Scottish and USA systems retain strong organizational links between research, teaching and extension. The separation which occurs in other countries between institutions responsible for research and extension and those responsible for research and education introduces additional costs and inefficiencies in the development and delivery of new information and may loosely termed *The European System*.

The European System

There is no formal link between the Agricultural University on the one hand and applied agricultural research and rural extension on the other. This factor is explained by the European concept of university teaching which must be "free", that is, not socially committed. With the exception of Scotland, there is no tie between rural extension and the agricultural university in any other European country. Meanwhile a certain change has become noticeable in this respect: the Agricultural University in the Netherlands strives to obtain more freedom in agricultural research and is developing certain initiatives in order to be more directly concerned in the pre-service and post-graduate training of extension personnel. Penders (1971)

While the Scottish (and possibly Northern Ireland) system, shares a philosophy with the USA, new systems developed elsewhere, such as in Australia, perpetuated a separation of functions.

Australia: Agricultural education in Australia followed similar developments in the United Kingdom and its colonies. Colleges of Agriculture were established in South Australia [1885] and Victoria [1886] and subsequently in other states. Tribe and Peel (1989) observe that colleges were established to train young people for farming as indicated in a Hawkesbury College prospectus *the primary objective ... is to train young men in the practice and science of agriculture, and as far as possible to fit them for the profitable management of farms*.

In recent decades, colleges have progressively separated from their forming State Departments of Agriculture to merge into universities, some retaining their focus on vocational education. During the early part of this century, universities began the establishment of faculties of agriculture, an event which in itself had an impact on the development of the existing agricultural colleges. Interactions between *Colleges and Universities* were initially common as indicated in the statement of Sir Samuel Wadham.

Colleges and Universities

In Adelaide, Roseworthy Agricultural College became formally associated with the University [of Adelaide] *in 1905 when students with the college diploma, who had matriculated, were given status in the Faculty of Science, and permitted to take a B.Sc. degree after passing a special two year course, while science students could spend two years at the college in partial fulfillment of the requirements of that degree. The course did not make much progress until the foundation of the Waite Institute in 1924 led to a great upsurge of interest in the subject. Melbourne went a stage further in 1905 and created a faculty: however, this had no special staff until 1911, when the State Government provided 1,000 pounds a* *year for five years for the salary of the first professor, the late Dr. T. Cherry, whose appointment lapsed in 1916 while he was on active service overseas*. Wadham (1951)

Linkages between Australia and the USA can be seen in the history of Australia's agricultural education. The establishment of colleges, notably Dookie and Longerenong in the State of Victoria, owe much to local interest in the establishment of LGCs in the USA. However, subsequent events in Australia, in particular economic hardship in the depression of the 1890s, led to different levels of development of agriculture in the two countries. Once universities were established, remnants of USA influence reduced, and Australian graduates entering post-graduate education commonly studied in the United Kingdom, although this shifted gradually towards the USA over time. With the establishment of Ph.D. degrees in Australia, initially at the universities of Melbourne and Sydney in the 1940s, interaction between the systems declined and the proportion of Australian students holding graduate degrees from Australia progressively rose.

In the post-World War II period, increased Federal and State funding led to greater emphasis being placed on vocational courses in the sciences and social sciences and on research. A trend to produce students who were useful upon graduation was seen as inevitable in applied fields such as agriculture, medicine, law and teaching (Rowe, 1960).

Reeve *et al* (1988) traced the origins of agricultural education in Australia through to the development of environmental education. Rising environmental consciousness among staff and students in Australian institutions produced a bias against study of the physical sciences (Bessant, 1978) in the short term, and in the longer term, influenced course structure and content. Shifts in employment opportunities as well as perceptions of the need for environmental studies affected subject areas such as geography and planning.

Agricultural to Environmental Education

The transition from agricultural to environmental courses has not necessarily been smooth and has only just begun. The logic which suggests that agricultural education should conceive itself as a major element in natural resource management education is confirmed by the number of institutions which now offer courses styled as natural resource management. Nevertheless, some persons believe that the science base of agricultural education limits its ability to evolve into the broader environmental sphere. Orr (1994) for example, sees traditional streams of education as biasing the approach which can be taken to an integrated subject such as the environment; he would prefer *Liberal Arts Agriculture*. The purposeful inter-relationship developed in agricultural courses suggests that Orr's criticism may not be universally correct. It also suggests that, the essential integrity of those agricultural courses which seek to promote interactions between social, economic, technical and political effects on agriculture, should provide a sound basis for broadly based environmental education. However, one impediment to a simple shift from agriculture to natural resource management education is the image of agriculture in the broader society.

Liberal Arts Agriculture

The modern agricultural dilemma … began when agricultural sciences were isolated in research institutions and from there evolved into technical disciplines whose purpose was to do one thing: increase production. Consequently they were not rooted in any coherent and sustainable social, philosophical, political, and ecological context which would have meant doing many things simultaneously. In this setting a great many assumptions about nature, technology, farming, rural life, and the consequences of applying industrial techniques to complex biological and cultural systems went unchallenged. ... It might have been very different had agriculture evolved instead within liberal arts colleges. Instead of becoming a series of disjointed technical specialities, agriculture might have come to be regarded, and rightly so, as a liberal art with technical aspects. In this context of liberal arts colleges, *agriculturists might have learned to see farming not as a production problem to be fixed, but as a more complex activity, at once cultural, ethical, ecological, and political.* Orr (1994)

Image

There is a stereotyped perception, as identified by Meyers (1993), that agriculture is represented by farming. While staff within agricultural institutions may view such public perceptions as being based on ignorance and consider that those who care to be informed can see a wider picture, government funding critical to most agricultural education systems, is increasingly influenced by such public perceptions. The situation can reach counter-productive levels with the public believing that *Agriculture is Irrelevant*.

Gherty (1995) in his presentation to the American Dairy Science Association highlighted the need for industry and universities to work together to counter image problems. However, such approaches as are now becoming more common tend to focus on immediate problems of those engaged in today's production agriculture. There remains a need for recognition of the concerns of the general public in environmental terms and, indeed, a role in educating the broader public about the realities of agricultural production and environmental care.

Agriculture is Irrelevant

The public, for example, tends to see agriculture as a competitor for natural resources - land, air, and water - and fails to appreciate that these same natural resources ensure a reliable supply of high quality food at reasonable prices. [LGCs] *are generally seen as concerned with the special interests of farming and business, not with food supply and nutrition. That is to say, colleges of agriculture would* *generally be classified as irrelevant by the American public*. Meyer (1993)

Image problems may stem from both current and historical agricultural practices. However, it makes no sense to criticize past practices in the light of today's new knowledge. As pointed out by Egan and Wilson (1995), the best agricultural management practices of any particular time have usually been those utilized. Notwithstanding such a generalization, disasters have occurred. Tribe and Peel (1989) provide a history of agricultural development in Australia and highlight the natural resource disasters which occurred through ignorance of development in a new environment. Rapid levels of innovation and recognition of the need for research and education derived from such circumstances - a case of *Learning Fast*.

The poor image of agriculture has not been assisted by the relative neglect of farmer education. This has allowed interested parties to criticize the knowledge levels of persons charged with managing the bulk of most countries' terrestrial resources. Campbell (1983) claims distressingly low levels of farmer education in Australia in the face of evidence pointing to its link to the adoption of new practices. In the 1960s, less than two per cent of the 6,000 to 8,000 persons entering farming in Australia each year had any formal post-secondary education. This figure was the lowest proportionally among developed countries (UNCSTD, 1979).

Campbell (1983) anxiously countered the erroneous conclusion of UNCSTD (1979) that low levels of tertiary education and high levels of productivity in Australia indicate that such education is unnecessary. He went further and notes that among the children of farmers it has been more common to take general degrees in the humanities rather than higher agricultural education, because agricultural education was seen to have been picked up by growing up on family properties. While Campbell did not place this in a wider environmental context, if he had done so, he may have been able to make an even stronger case for higher levels of education among those who are charged with the responsibility of managing natural resources. The general public, with its rising concern over management of the environment, will be less likely to allow land and water management to be practiced on the basis of inherited knowledge - it may either require confidence in broadly based knowledge of factors beyond the technical aspects of production agriculture, or insist on the introduction of regulations over the activities of agriculturists.

> ***Learning Fast***
>
> *By the middle of the last century the lack of valid and precise criteria for measuring natural resources led to disastrous attempts to over-extend the cultivations into unsuitable marginal lands and these experiences resulted in the first development of scientific methods of using natural vegetation as a guide to climatic boundaries. In particular, Goyder's use of natural vegetation to delimit areas of South Australia for arable farming was a major advance. The importance of seasonal weather patterns and their association with particular crops became generally recognized and with this recognition came the development of State, and later Commonwealth, meteorological stations. The establishment of station networks was particularly important* [and facilitated] *rural settlements between about 1870 and 1910. ... Prior to the turn of the century, soil and land descriptions were based on simple and variable criteria but, between 1900 and 1910, the first use of standardized soil and land descriptions appeared.* Tribe and Peel (1989)

The importance of informal and vocational education in Australia suggests that statistical generalizations do not provide an accurate indication of the depth of education of those engaged in agriculture. The figures of Table 6.1 which compare educational participation in OECD countries indicate wide variations between countries and should warn us against extrapolation. It is also conceivable that low participation rates of farmers in education may be of slightly less concern where there is a well-trained service sector for agriculture.

Meyer (1992) discusses the historical origins of the USA LGCs and their problem-solving approach to education and research. By implication, one assumes that LGCs have maintained a close contact between the public and universities. However, with the decreased proportion of the population required for agricultural production, an outcome of technological innovation itself, the link with the wider population has also been lost in these institutions. The fact that this linkage has broken down also suggests that the focus of such education is large scale production agriculture. The general public is becoming aware that, as Wofsey (1995) noted ... *good environmental decisions require a good knowledge base*. While arguing for sound environmental research utilizing principles developed in the applied sciences, Wofsey's comments can be extended to include the need for sound scientific and sociological education in environmental principles.

Table 6.1 Educational Performance in 1991: Selected OECD Countries (OECD, 1993)

Country	Tertiary Qualifications (% of persons)	Participation (%) in Univ. Education	Natural Science Degrees (%)	Engineering Degrees (%)
Australia	31	18.3	14.1	5.3
Canada	40	20.8	6.0	6.5
France	15	21.7		
Germany	22	9.3	9.1	18.9
Japan		15.9	2.9	22.8
Netherlands	20	9.6	7.6	13.1
New Zealand	23	17.5	8.3	4.9
United Kingdom	16	13.8	10.0	10.7
USA	36	25.5	4.7	7.1
OECD Mean	**19**	**17.5**	**7.4**	**12.1**

It is clear that change is occurring in agricultural and environmental education. The further changes needed, particularly for agricultural education to become a primary focus for a natural resource management, are discussed more fully in the next section.

Changes in Agricultural Education

The circumstances surrounding agricultural and related education have changed significantly since the traditional approaches to education for the sector were designed. Changes continue and the need for a responsive approach oriented to client needs is clear. Some of the many changes that are occurring include: declining state funding; allocating costs according to perceived private benefits with state funding focusing on areas of wider public good; possible oversupply as a result of a boom in recent decades in the number of institutions and courses serving the sector; increased public interest in and demand for access to education, and the emergence of regionally based institutions as entry points to an increasingly integrated system.

The magnitude of attitudinal changes and the results of a drift towards agribusiness in preference to interaction with the general public are two of several factors giving rise to concerns about future directions for USA universities (NASULGC, 1993). Anderson (1994) has identified further societal changes of relevance and outlined a reform in an agricultural course which will have ramifications beyond its university in New Zealand. The small and competitive nature of universities involved in agriculture noted in one Australian study (Derera *et al*, 1994) is a constraint to responding to industry needs and to a unified system to service the sector. The integration of vocational and university levels of agricultural education and interaction with and ownership by stakeholders involving the largest provider in Australia appears to be meeting the challenges of declining government funding and popularity among students (Falvey and Bardsley, 1995).

Gherty (1995) defines the changing context for agricultural education - *Change of Life* - in terms of economic shifts of the production base, in his example for the dairy industry, and expansion of information availability. As a consequence of change, it is impossible to maintain a curriculum that is up-to-date in all technological areas. For these reasons, industry may prefer to have universities produce well rounded students with such skills as:

- basic chemistry and mathematics
- basic knowledge in an agricultural major
- strong written skills
- decision making ability

- problem solving skills
- ability to engage in continual learning.

Change of Life

… the speed of change is propelling you toward an even more vital future. Pause, if you would, and think about just how fast things are changing. By tomorrow morning there will be [in the USA] *33 fewer dairy operations, nearly 300 fewer cows in production, 55 brand new food products in US grocery stores, and 246,000 more mouths to feed world-wide, including 7,000 here in the US. And, for those of you working to keep up with your reading, there will be 150 new books on the market, and the total volume of information available in print or electronic form will have increased by six per cent. As the world around us changes and the volume of information increases, we are clearly moving into an age where knowledge is increasingly valuable in the marketplace and in the workplace.* Gherty (1995)

Surveys of the expected future requirements for agricultural education identify the main areas as; closer liaison with agricultural industries, skills in financial and risk management, communication skills and marketing (Falvey, 1996; Kilpatrick 1996). Incongruous objectives appear to arise from such investigations, such as the need for a graduate to be immediately employable equipped with useful skills in contrast to the need for appreciation of general principles. Trends towards informal, whole-of-life and flexible modules in delivery of agricultural courses appear to be common across a range of countries.

Addressing industry requirements while at the same time acknowledging environmental concerns, is an appropriate future role for agricultural education (Shute, 1989). However, this can lead to a narrow focus on minimizing environmental effects within a production paradigm. Perhaps a broader approach of natural resource management might allow more effective consideration of alternative practices on any given area of land. Malone’s (1994) solution to renewal in agricultural education is to focus on interdisciplinary activities, industry and new technologies - a *Cascade of Knowledge*.

Cascade of Knowledge

Successful global development of this cascade will require:
Fostering interdisciplinary collaboration of unprecedented intensity among physical, biological, and social scientists, engineers, mathematicians and scholars in the humanities.
Forging new modes of communication among academia, business and industry, the several levels of government, and private organizations at both national and international levels.
Marshaling the emerging technologies of computers and communications to create national and global audiovisual networks among individuals and institutions. Malone (1994)

The decline in need for agricultural workers is not a directional force on agricultural education as much as it is a shift in the mode of agricultural education. From an industry perspective (for example, Gherty, 1995) the primary strategies for improvements in agricultural education may well be; a commitment to a customer focus, development of a clear vision, development of core competencies, attainment of the critical mass necessary to succeed, a commitment to continuous improvement, and a focus on teamwork. However, there is a wider context than industry alone in *Educating Future Agricultural Scientists*. We must go beyond disciplinary competence and include an ability to integrate all of those disciplines which impact upon the environment. Reassessing the conceptual approach to agricultural education is, what Roberts (1991) has termed the new education.

Educating Future Agricultural Scientists

For the United States to remain a leader in agricultural production and to continue to compete successfully in an international market into the next century, we must develop agricultural scientists and teachers who are outstanding in their disciplines, culturally diverse, and competent in global issues. American agriculture for the twenty-first century needs a well trained labor force capable of lifelong learning in a world of rapid and variable change. We need intellectual capital from all segments of our society. We need institutional environments that bring together the nation's best scientists and educators who operate in multi-disciplinary modes to address the increasingly complex problems facing our agricultural and natural resource systems. And we need access to knowledge and expertise worldwide. USDA (1995)

New Education

Roberts (1991) argues that the element of ethical behavior has been lost within a Keynesian economic approach to production and markets. Assessments of agricultural education are commonly narrow as a result of their focus on modifying existing systems progressively and accommodating new political imperatives which are commonly financial in nature. Roberts asks … *can such values be nurtured by university programs like the Harvard's "moral reasoning and social analysis"?* Roberts presents the three challenges of:

- development of an ecological conscience
- extending ethics to environmental responsibility
- expanding human rights to include other animals.

These far reaching suggestions may be difficult for some concerned with agricultural education to accommodate within their current courses. However, their genesis may be seen in the well integrated agricultural science courses in subjects and profiles such as agricultural communication, rural development, natural resource management, animal welfare, psychology, and welfare and resource economics. From such beginnings could grow an all-embracing approach to environmental management with some additional supplementation of historical context and environmental ethics. The difference is that between *The Joy of Conquest* over nature and living within an understanding of nature.

The Joy of Conquest

Men will unite to get everything life can give, but only for joy and happiness in this world alone. Men will be exalted with the spirit of divine, titanic pride, and the man-God will make his appearance. Extending his conquest over nature infinitely every hour by his will and science, man will every hour by that very fact feel so lofty a joy that it will make up for all his old hopes of the joys of heaven. Dostoyevsky (1982 reprint)

The Present Paradigm

Meyer (1993) quotes Keynes … *the difficulty lies not in new ideas, but in escaping from old ones*. The old, and indeed present, ideas of agricultural education include such factors as a production bias, inadequate accommodation of social factors - particularly those of the community at large, and consideration of environmental matters as merely a supplement to the disciplines underpinning agricultural production.

Existing agricultural education systems are commonly described as integrating disciplines to provide a sound understanding of soils plants and animals in ecosystems.

Similarly, institutional arrangements for agricultural education reflect a sometimes unwitting focus on production agriculture. For example, organizational arrangements within the LGCs reflect the functions of research, teaching and extension oriented to production agriculture as distinct from institutional integration of disciplines around ecosystem and social themes.

The functions of LGCs which are important to their organizational structure are; Academic Programs (AP), Research (AES) and Extension (CES). International Programs was often added to these as a functional area to coordinate the large inputs to USAID through LGCs. However, with major contraction and redirection of such USAID programs, the role of International Programs is being redefined in various ways, one of which is the development of relations with peer institutions in other countries. Organizational structures surrounding the main three functional areas have been documented for NASULGC (1993) through a survey of Directors of AES and CES functions in each state and territory. Four distinct organizational categories were determined in the 50 states and four territories. These were:

Focused on Agriculture, Centralized: - in which AP, AES and CES are equal functions reporting to a single administrator who reports to the provost or vice president. The integrated structure is commonly referred to as a college or institute within the university. The structure is seen to have strengths in its integrated agricultural focus and weaknesses in entering into interdisciplinary approaches outside the college or institute.

Focused on Agriculture, Geographically Decentralized: - in which the competing interests of activities and remote campuses are recognized. AES and CES functions are integrated at each site and form part of a college or institute while AP is coordinated centrally. The strengths and weaknesses of this approach are seen to be the same as those of the previous approach.

Partial Separation from Agriculture: - in which one of the functions is separated from the others, usually although not exclusively, AP. The structure commonly arises from attempts to bring a function close to related functions such as AP to other academic programs or CES to other outreach programs. The system has strengths of building strong internal university linkages for the function concerned and weaknesses in the agricultural knowledge continuum.

Full Separation from the Agricultural Core: - in which each of the three functions are aligned with similar functions rather than with each other. Each function reports through its own director to the university president. This system is seen to have strengths of developing each function to high levels and weaknesses of inhibiting the integrated approach for which LGCs are well known. The past successes of the LGC system are considered to be in jeopardy by many analysts today.

Within the USA system, and possibly to a greater extent in institutionally separated systems, recurrent criticisms of the second cousin status (Yabsley, 1982) accorded extension have stimulated organizational rearrangements and re-emphases. Such attention by management to organizational arrangements can cause a shift of attention from the larger evolving picture. It can lead to an orientation of repairing today's apparent problems, sometimes against past injustices, while ignoring significant shifts in the requirements and responsibilities of agricultural education. We are in such a situation today in which we must view the wider framework in which agricultural education is now offered - and must be modified to be more useful in the future.

One recurring argument within agricultural education is the relative muddiness of the boots of agricultural scientists. Campbell (1983) eloquently argues against both this absolute requirement and statements that agricultural education institutions should be located in rural areas. The integrated nature of the natural and social sciences which form agricultural education necessarily draw from a wide range of faculties in large universities. Outside the USA, such institutions are not commonly based in rural areas. Just as Campbell (1983) noted the distraction that outdated arguments provided from getting on with that day's task, so re-organizational arrangements relating to research, teaching and extension, may divert attention from the larger shifts occurring globally. Such a shift today may be a tempering of *The Industrial Metaphor*. Another change is electronic communication leading to a reconsideration of the relevance of physical location. The direction of shift can lead to agricultural education either being marginalized as a component of business and science, or to it becoming the principal integrator of disciplines essential to responsible natural resource management.

The Industrial Metaphor

Since 1945, mainstream agriculture, by which I mean that espoused by agronomy departments in Land Grant Universities, the United States Department of Agriculture, and major farm organizations -

has pursued a model of agriculture based on the industrial metaphor. Its goal has been to join land, labor, and capital in ways that maximize productivity. Farming is regarded, not as a way of life but as a business. Like other businesses, this has led to highly specialized farmers that grow one or two crops, or raise thousands of animals in automotive confinement facilities. Like other businesses, agribusiness invested heavily in technology, became dependent on "inputs" of chemicals, fertilizer, feed, and energy, and went heavily into debt to finance it all. Farmers were advised to plow fence-row to fence-row, buy out their less efficient neighbors, substitute monoculture for crop diversity, cut down windbreaks, and replace people with machinery. Orr (1992)

The very causes of the success of USA universities in servicing production agriculture lead to the criticisms that they have not been environmentally conscious and that their services have not been offered on an equitable basis. Hightower (1973) criticizes the promotion of agricultural technology and the concentration of service on the highest income farmers without paying attention to the problems of poor farmers and rural communities. The debate continues in both MDCs and LDCs as to whether organizations funded by a government should be directed towards those who can look after themselves or pay for services or to those persons who are in need of their assistance. In part, debate is stimulated by the structural adjustment occurring in most economies which impacts particularly on small rural communities. The issue is an old one as indicated from statements of Bailey (1911) when he was Dean of the College of Agriculture at Cornell University and noted a bias towards assisting those farmers better able to demonstrate success.

Changes in Universities

A series of analyses conducted by Meyer (1995) concerning a change in direction of LGCs notes that a general approach to change needs to be based on such common understandings of such matters as :

- Most public concerns or problems are multi-disciplinary in nature, while faculty and most departments are disciplinary.
- The academic freedom which guides staff to find the truth and teach it is the prime reason for the protection offered by tenure.
- The nature of basic and applied science differs. The aim of basic science is to establish truth and refute conjecture, while applied science is the direct application of scientific truth and theory to problems of professional practice.
- Universities are commonly based on the philosophy that teaching and research is conducted for the public good.
- Committee decision making in universities is endemic and means that quality can better be determined by individuals than by institutions.

Instituting change under such conditions represents a challenge uncommon in other institutions. Yet the very nature of universities requires that essential elements be retained lest the universities simply become replicas of professional consulting companies or training schools.

A separate study notes the need for a clear vision and leadership and management skills to effect any change in agricultural education institutions. The bases for the changes considered in his study were population shifts from rural to urban areas, the international as distinct from national character of economies, the declining political influence of agriculture, and the realization that the natural resources of soil, land, and water are not the preserve of agriculture alone. Meyer (1992) questions whether the LGCs of today are, in fact, ... *academic crown jewels or country cousins*. The need to address issues within the natural resources management sphere, while remaining part of larger institutions, represents a balance which must be managed in today's agricultural institutions.

In testing various missions of LGCs, Meyer (1992) noted wide divergence in apparent approaches to both the present and future. The future represented some conflict between building on the existing agricultural base (52 per cent of respondents) compared to expanding beyond the agricultural base (26 percent). The latter view is represented in the statements of one respondent that … *the future mission will focus on environmental issues, economic considerations and urban problems, as well as rural and production agricultural concerns*. Such responses may cause concern among those who consider there is an urgent need to broaden agricultural education to take a natural resource management perspective. Malone (1994) commenting on the same general issue quotes the need for a broad vision (Proverbs 28:18) … *where there is no vision, the people will perish*. He believes that concerned persons must share a vision before any significant change can be made to agricultural education institutions. The history of these institutions in fact indicates *Constant Change* and the current groundswell and rising awareness of the need for change suggests that the USA may lead in defining a new role for agricultural education.

Constant Change

American higher education has never been static. For more than 350 years, it has shaped its programs in response to the changing social context. And as we look at today's world, where there [are] *disturbingly complicated problems* [such as in] *higher learning, we conclude* [that we] *must, once again adapt. It would be foolhardy not to reaffirm the accomplishments of the past. Yet, even the best of our institutions must continually evolve. And to sustain the vitality of higher education in our time, a new vision of scholarship is required, one dedicated not only to the renewal of the academy, but ultimately to the renewal of society itself. ... Higher education's vision must be widened if the nation is to be rescued from problems that threaten to diminish the quality of life … we need scholars who not only* *skillfully explore the frontiers of knowledge but also integrate ideas, connect thought to action and inspire students.* Ernest L. Boyer quoted in Malone (1994)

Two factors which continue to confound discussions about the future of agricultural education within a natural resource management context are the relative levels of vocationally oriented subjects in agricultural courses, and the rising influence of the urban populace on matters relating to agriculture.

Vocational Agricultural Education

The difference between vocational and university education for agriculture may not be as clear as is commonly assumed. Eddy (1956) noted that … *the LGCs have developed from institutions which were little more than trade schools*. Likewise in Australia, Campbell (1983) noted that agricultural colleges have progressively been upgraded to become degree granting institutions somewhat akin to university faculties of agriculture. However, Campbell applauds the two states of Victoria and Western Australia for standing against this trend and retaining skills-based vocational education as a primary focus in agricultural colleges to complement the integrated science-based offerings of universities. Falvey and Bardsley (1995) in discussing the revitalization of agricultural education in the Australian university system identify the need for distinct and high quality skills-based courses and degree courses with pathways between the two. They also note features from the LGC system worthy of emulation; one of these was the practical orientation to agriculture maintained through industry involvement.

Agricultural education may be perceived as a vocationally-oriented professional education. The separation of funding and organizational arrangements between university and vocational education in many countries introduces an artificial barrier which requires innovative management to overcome. Nevertheless, we must acknowledge the essential difference between skills-based training and the acquisition of general knowledge for integrating a range of disciplines. Universities can accommodate a shift of agricultural education to natural resource management education, while vocational education must adopt a focus on skills known to be appropriate at a particular time for agriculture within that construct. Orr (1994) distinguishes the kinds of knowledge needed to build a sustainable society as either intelligence or cleverness. He equates intelligence with long range aims associated with integration of all components while cleverness takes a shorter term approach which fragments intelligence. He personifies cleverness as the rational technician informed about technologies and methodologies yet unconcerned and uninformed about the wider picture in which these activities take place.

If one accepts this perspective, there is a clear need to introduce a wider understanding in both university and vocational courses.

The above distinctions are reinforced in discussions concerning technical agricultural education. Hall (1972) notes that skills training is commonly dropped when cut backs and rationalizations occur in agricultural education within the integrated Scottish system. He also notes that … *the long term well-being of vocational agricultural education requires an annual recruitment of good university graduates* - thereby suggesting that teachers in vocational institutions require a breadth of knowledge to understand the application of skills even if the curricula of such courses is more oriented to technologies and skills. Within Australia, separate funding mechanisms apply to vocational and university education yet recent policy decisions have amalgamated institutions offering both types of education and training, thereby heralding a period of greater integration of courses.

Preconceptions as to the distinctions between training and education lead to confusion as to the roles of institutions. In arguing for strengthening of vocational education nearly 25 years ago, Hall (1972) noted that pressure on university under-graduate training for graduates to be job-ready has already vocationalized university education in Australia far more than is admitted, and that the LGCs of the USA have never shied away from such a vocational orientation

Urban Influence

Fite (1981) has noted a general trend towards better educated farmers becoming more efficient, consuming their neighbors' farms and the associated decline in rural populations. Commercial farmers have become a minority of American society and their political influence has waned as a consequence. This places agricultural education institutions which service that sector in a vulnerable position, particularly when it is recognized that the majority of their funds come from government levies or taxes. Others have presented this in more alarming terms concerning the loss of personal and local knowledge about rural geography, life and indeed contact with the land. The Dean of Agriculture at Cornell University in the early part of this century, Liberty Hide Bailey, believed that it is essential to take special pains … *that all people, or as many of them as possible, shall have contact with the earth and that the earth's righteousness shall be abundantly taught* ... Farm life taught the relationships between work and food, seasonal variations, biological diversity, and the concept of stewardship. The drift of persons from rural to urban areas is associated by many with a shift in societal values. In the case of Australia, Campbell (1983) has noted the benefits of urban and *Country Contact*.

> ***Country Contact***
>
> *… given the growing scission between city and country … there would seem to be a need for greater emphasis to be given in high school social science curricula to promoting a better appreciation of the inter-dependence of the rural and urban sectors of the economy, of the role and aspirations of farmers and country people generally, and of the hazards with which they have to contend. Conscious efforts in this direction seem to be vitally necessary in such a highly urbanized society.* Campbell (1983)

It is curious that in discussions of this social phenomenon, various commentators refer to the loss of political influence of agriculture and agricultural education in the same breath as commenting about the value of land maintained by rural dwellers on behalf of society. With such a demographic shift, city-based agricultural education should feel even more confident of its progressive move towards a wider brief of natural resource management education.

Environmental Education

Environmental education can be conceived in different ways, two of which are the modification of existing offerings such as agricultural education to meet wider societal requirements, and a completely new way of thinking. The second is reminiscent of the parallel thinking of de Bono (1995) which may give rise to such questions as to the type of intelligence that should be sought within University education. Orr (1992) expresses concern about the manner in which such important areas as harmony with nature are considered in all existing educational structures.

Groups concerned with completely new approaches to environmental education should also be concerned with the influence of government and industry financing of education and research. From such concern arises such questions as - why do we seem to know so much more about chemical as distinct from other means of pest control? These questions are useful means of analyzing the sources of information and biases which may exist in the production and education systems surrounding agriculture. However, such questions evoke strong emotions which may cloud real consideration of their intent. Orr (1992) advocates alternative modes for understanding ecosystems through integrative science supported by personal holistic world-views. This can lead to the dangerous situation of environmental education being classified as a new discipline with specific courses, units or departments created to cater for it. Institutional rigidities seem to favor such structural approaches. This may in fact perpetuate some of the deficiencies highlighted by the movement to introduce an environmental appreciation and understanding in existing education.

In common with a growing group of thinkers, Orr (1994) challenges our conception of nature as something to be dominated, and calls for something like ecological enlightenment through *Environmental Politics*.

The type of renaissance thinking called for in this approach is difficult to conceive as having institutional origins. Perhaps we should be satisfied if our existing institutions adapt to such new ways of thinking in a timely manner. Thus, the practical outcomes of such deliberations may be some blending of humanities with pure and applied sciences. Some institutions will adapt before others and the more traditional ones will be the slower to respond to such concerns as (Orr, 1992):

- ecological sustainability
- appropriate scale
- cultural and ecological diversity
- re-evaluation of the goals of industrial society
- justice, peace and participation

Environmental Politics

Environmental education is unavoidably political. At the heart of the issue is the total demand humans make on the biosphere and the way we have organized the flows of *energy, water, material, food, and wastes, which in turn affects what political scientists define as the essential issues of politics: "who gets what, when, and how?" The symptoms of environmental deterioration are in the domain of the natural sciences but the causes lie in the realm of the social sciences and humanities. To assume that technology will absolve us from our own folly is only to compound the error. Whatever its many advantages, technology has varying political, social, economic, and ecological implications that we are now only beginning to recognize. Without political, social, and value changes, no technology will make us sustainable. More to the point, do we equip students morally and intellectually to be a part of the existing pattern of corporate-dominated resource flows, or to take part in reshaping these patterns toward greater sustainability? These represent two very different visions of post-industrial society and two very different orientations to the political realm.* Orr (1992)

In Europe, environmental education is developing at different paces in different countries and institutions (Kuenen, 1986). At some universities it is interpreted to be a field which requires simple renaming of courses and units. Even where the content of courses is changed, the issue of interdisciplinary teaching and research remains a challenge as does the inclusion of political concerns and influences. The absence of such an approach at secondary level places an additional constraint on the teaching of environmental matters on an integrated basis at tertiary level. Moreover, the disciplinary base of universities leads to proponents of environmental education basing it on a particular discipline. *Biological Integration*, such as used in the biological or agricultural sciences may be an appropriate mechanism for building such courses.

Biological Integration

Some consider the biological approach and in particular the principles of nature conservation to be the central point of reference for all considerations. There is sound reasoning behind this. Man, being in so many ways comparable to animals, should observe the influence of pollution as seen in animals. Also, it can be maintained that many of the effects of pollution are of a biological nature and that therefore nature conservation and its inherent research, on the *one hand, leads to the understanding of the pollution process and, on the other hand warns of the dangers as yet not manifest in man himself Pollution of the environment can be defined as the interference with, or the interruption of, biological cycles.* Kuenen (1986)

The benefits of a closer association with the earth are argued by a number of environmental education thinkers. Such discussions have some parallels in discussions concerning changes in agricultural education and a progressive separation of students from practical activities. The wider societal implications of separation from the earth and manual labor is said by some to be related to underlying changes in societal values which, by implication, are assumed to be undesirable. Such beliefs have formed part of the redevelopment of Israel for example, where physical work and education were combined with *Singing to the Soil* to apparent effect in instilling such values.

Singing to the Soil

Epstein believed in physical work as part of national education: "There is nothing like working in the field to develop body movement. The child at first needs to be trained in large, rough movements in order to develop the senses." Hurgin attests to his didactic and national work thus: "Do you know how to sow garlic? - Epstein sings to his pupils in the garden, and, right there, plants the fork in the ground and carries out the act of sowing as he points out the name of everything. And, thus, together with the melody, with the teacher's pleasant voice and the smell of the earth and its secrets, the [Hebrew] *language is absorbed into the soul of the child as an experience, by the emotions and brain and all its senses."* Dror (1993)

Six principles important to the rethinking of education as it relates to the environment are (Orr,1994):

- all education is environmental education
- the goal of education is mastery of one's person
- knowledge carries responsibility for its use
- we do not know something until we understand its effects on real people and communities
- matching ideals and reality through decisions made in the management of education institutions themselves
- learning methods are as important as content

These principles form an interesting blend of the philosophies of integrated courses in applied sciences, such as agriculture and the underlying ethic of university education. To some, they will not seem distant from current realities in universities while to others they must appear as radical if environmental education is to be conceived in the manner proposed by Orr (1994).

Modifying Existing Programs

Meyer (1992) in commenting on the LGCs during the current period of major transition concludes that emphasis will shift from production to food quality and environmental concerns. In a separate discussion, Meyer (1993) suggests that it is now opportune for universities to reduce their dependence on government and to develop self-managed missions consistent with the changed environment in which they must operate. Consultation with urban environmental and consumer groups will become an imperative with food production and environmental quality recognized as dual outputs of the agricultural and agricultural education systems. In striving *Towards Relevance*, the theme of Meyer's works is that the LGCs will never be the same.

Towards Relevance

It becomes increasingly evident that changes in the agricultural industries, expanding general interests in environmental quality and food safety, competition for natural resources, and the pressure of a growing population will force the [LGCs] *to address a broader interface of agricultural issues and issues relevant to society in general. A reduction in the focus on agriculture must be anticipated, along with an increase in emphasis on life sciences, food quality, environmental concerns and rural - urban interfaces.* Meyer (1993)

These changes are already occurring as is evidenced in the changes in the names of LGCs. However, the shift is not entirely from agriculture towards environment as is clear in Table 6.2. Such changes were occurring as early as the 1970s in the USA with the addition of environment or life sciences to the names of colleges at Davis and Madison, for example (Brien, 1977).

Table 6.2 Changes in Land Grant College Names (Meyer, 1992)

NAME	1962 (%)	1974 (%)	1988 (%)
Agriculture	86	64	58
+ Home Economics	14	8	8
+ Natural Resources	0	6	8
+ Life Sciences	0	14	14
+ Environment	0	4	2
Without Agriculture	0	2	6
Miscellaneous	0	2	4

In Australia, Reeve *et al* (1988) have traced the origins of environmental education through the development of agricultural education to current offerings in environmental and agricultural fields. The implication underlying that analysis is that agricultural education will continue to expand to incorporate environmental education. A recent policy statement of the National Board of Employment, Education and Training (NBEET, 1995) provides confidence that this may occur through the application of ecologically sustainable development (ESD) principles to research funding in universities. By classifying research proposals into ESD neutral, weakly ESD, strongly ESD related and strongly ESD focused, projects attract differing levels of scrutiny in the application process and additional funding for high priority areas relating to the environment. Such *Environmental Research Incentives* are likely to be applied for the major research funding mechanisms in Australian Universities, the Australian Research Council (ARC), and may have wider application.

The question remains as to the target for education provided through agricultural institutions. If it is to be for wider environmental education, and if the current trend towards increasing numbers of students being drawn from urban backgrounds continues, then a broadly based natural resource management education may be appropriate. However, the Land Management Task Force in Australia (LMTF, 1995) raises the continuing concern of the low formal levels of education of those charged with managing the country's land resources - farmers. Poor access to formal institutions has been partly remedied through the provision of government extension services and electronic communications may now remove a further barrier - refer to Chapters 8 and 9. The Task Force concluded that higher education conferred advantages in economic terms in farm businesses, and that it did not matter whether it was wife or husband who had such education but rather that an ethos of ongoing learning had been instilled. The challenge to provide relevant education to agricultural producers continues to face agricultural educators. At the same time, the additional challenge of meeting the requirements of a broader education system also faced the same groups.

> ***Environmental Research Incentives***
>
> *We believe that a methodology could be used effectively across a range of research programs beyond those funded by the ARC. By using such a monitoring process consistently and nationally, with periodic assessments, it would be possible to gauge the extent to which the national research effort is contributing to the national strategy for ESD. A consistent national approach in this area would provide an information base against which to make assessments of the relationship between the national strategy and the national research effort. Such broad information would better inform ESD-related policy decisions.* NBEET (1995)

Education for natural resource management in MDCs appears likely to develop from the agricultural education systems which have existed for centuries. These courses, where they have preserved their fundamental philosophy of integrating social and natural sciences in an applied manner provide a suitable basis for natural resource management education. Much of the above discussion has focused on the logic of expanding such agricultural education to represent environmental education within the specific interest of natural resource management. The threats of reduced funding resulting from low demand and relatively high costs to the public sector which face agricultural education, provide today's opportunity for such a shift in education emphasis. Agricultural education has shown a steady decline in popularity amongst entrants to university education, probably as a consequence of the major demographic shifts from rural to urban areas and lack of contact between the two. In such circumstances the logic of expanding agricultural education is supported by the imperative to modify agricultural education to serve a greater number of persons in the wider community. Extension and electronic communication are critical to this development.

The changes that will be made in agricultural education in MDCs will most likely influence those similar institutions in LDCs. However, as the pace of change in the world continues to accelerate, we can no longer expect LDCs to simply copy the experiences of MDCs. Developments in LDCs should now be seen as partnerships with MDCs using new communication technologies for peer interaction and exchange of courses and information. Organizations which link MDCs and LDCs in agricultural research and education include many international development agencies and the International Agricultural Research Centers of the Consultative Group on International Agricultural Research (CGIAR) - these are discussed further in the following Chapter.

Universum

Transmission of values in all societies,
in the form of knowledge, an enculturation,
This is the origin of universities,
Essential strong pillar of civilization.

India's first university Nalanda,
like Byzantine's, time can't erase,
these great precursors of Bologna, Ravenna,
and of Paris', Oxford's and even of today's.

But if Padua's first faculty professor,
to review today's arts and sciences was retained,
he might reveal to his intimate confessor,
that Aristotle's heritage was not maintained.

That there's an absence of decorum and patrons,
replaced by seemingly ungifted student hordes,
acting as data-absorbing automatons,
as if university no learning affords.

That faculty staff are engrossed in paid research,
which is not related to everyday teaching,
their fear of censure, replacing past's fear of Church,
as heights of mediocrity, they are reaching.

That the impact of government and merchant power,
on teaching, research and behavior scholarly,
in requiring outputs, not ivory tower,
Making university quite like factory.
No longer elite, should he hang-head in sorrow?
at access for all, as knowledge cast before breeze,
Yet perhaps universities of tomorrow,
are those with demanding post-graduate degrees.
For of such would he in warm Padua regale,
of personal excellence in fields quite awesome,
of independent thought, he has sought as the Grail,

Integrated with all knowledge, *sancta santorum universum.*

Chapter 8

Educational Outreach: Extension

Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?

T. S. Elliot

This Chapter considers extension as a component of education and reviews some past and current approaches. It discusses the future of extension in the current policy environment of privatization; it links extension to curricula, and introduces a basis for reuniting education and extension through new communication technologies.

Origins of Educational Outreach

The origins of extension are traced to advice given to Irish farmers affected by the potato blight in the 1840s (Zijp, 1992) and subsequent developments in the USA, Canada and Europe through the 1860s (Penders, 1971). The first of the major USA agricultural colleges was established in 1862 under the Land Grant policies (refer to Chapter 6). Demand for local information and for its inclusion in education led to the creation of research stations. However, rural extension was not formalized until a major cotton disease destroyed crops in the southern States and the Federal Department of Agriculture responded by recruiting special staff to help control the disease at source. This action created interest in the demonstration of new techniques to the public and ultimately led to the first county extension agent being appointed in 1906.

By 1914, a service was created with the aim of extending information and research results obtained at universities and research stations. The Cooperative Rural Extension Services was based on Federal, State and County support and interlinked with the Land Grant College (LGC) activities of classroom teaching and research. This gave rise to the close relationships between research, teaching and extension which was a hallmark of the Land Grant system.

In recent decades, extension has been discussed as an agency of behavioral change, social engineering, a simple extension of classroom education, and as an adjunct to research. Perhaps as a function of its social science base in a field dominated by technicians and scientists, extension has not always been held in the same high regard as research.

Extension in less developed countries (LDCs) was adapted from the experience of more developed countries (MDCs) giving rise to what may appear to be fashions over *Four Decades of Extension* to the 1990s. The current decade appears to focus on assessing the responsibilities and roles of government in extension, the introduction of new technologies and increasing the efficiency of extension activities.

Four Decades of Extension

In the 1960s the main focus was ... the diffusion of innovation theory, with attempts to categorize farmers on the basis of the speed with which they adopted new technology. ... However, being good communicators did not solve all extension's problems. ... Indeed the 1970s were a time of constraint identification. ... But even knowing all major constraints and having some solutions did not solve the problem of running an extension service. ... The 1980s concentrated on the management side of extension services, with the Training and Visit (T and V) system of extension as a major example. ... The 1990's are likely to show an interest in a more systematic approach to agricultural information.
Zijp (1992)

Investments and Inputs

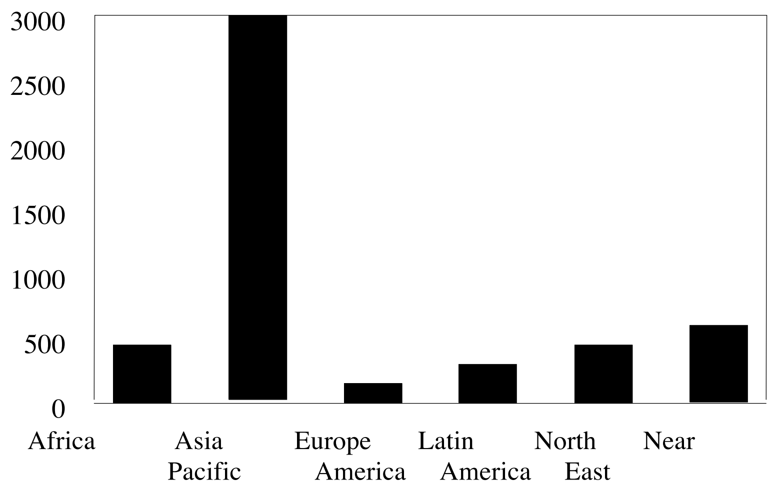
A survey of 207 extension institutions in 113 countries conducted in 1989 confirmed the government dominance of financing of extension and its high level of separation from agricultural education institutions, specifically universities. More than 80 per cent of extension work is conducted through a Ministry or Department of Agriculture, and a further ten to twelve percent is supplied through non-government organizations, universities and parastatal organizations. An estimated five percent is conducted through the private sector (Swanson *et al,* 1990).

Over the past decade, extension services have increased significantly with approximately one-half of today's extension services being created in the last ten years. The majority of extension resources target larger commercial producers while small marginal farmers receive an estimated one-third of all resources. It is estimated that about 40 per cent of expenditure is related to traditional extension activities and less than 20 per cent to mass media. Total expenditure for the world in 1990 was estimated to be in excess of US$6 billion. By far the major expenditure was made in the Asia and Pacific region (Figure 8.1). The following figures indicate current commitments to and characteristics to agricultural extension (Zijp, 1992; Oram, 1993):

% Public Budget on Agriculture	*7% (2.2% in North America; 9% in Africa and Asia)*
Extension % of Agriculture Funds	*12% (1% in North America ; 22% in Africa)*
Extension % of GADP	*0.5% on average*
Persons Engaged in Extension	*Approximately 600,000*
% Extension Staff in Government	*In excess of 90%*
% Extension Staff in Field Work	*Approximately 80%*
% Female Field Workers	*Approximately 13%*
Farmers per Extension Worker	*1,800 (1,684 in Africa; 233 in North America)*
% Subject Matter Specialists	*14 (12 in Latin America; 45 in North America)*
% of Staff with Degree	*28 (12 in Africa; 90 in North America)*
Extension US$ per Farmer	*2.3 (1.9 in Africa; 101 in North America)*
Extension US$ per Extensionist	*4,281 (2,745 in Latin America; 23,599 in North America)*

The major source of funds in LDCs has been the World Bank which, since 1964, has lent around US$2 billion to some 80 countries and has plans to invest an additional US$150 million per year (Table 8.1). Much of this expenditure has been associated with construction, transportation, equipment, incremental staff costs, and in-service training (Zijp 1992).

Figure 8.1 Annual Public Expenditure (US$ millions) on Agricultural Extension (after Anderson and De Haan, 1992)



A major portion of investment in extension services relates to staff. An FAO (1984) analysis of global extension staff highlights serious deficiencies in Subject Matter Specialist (SMS) knowledge of natural resource management principles among other deficiencies, and the low numbers of women extension staff.

Table 8.1 World Bank Projects and Allocations for Extension, 1965-1988 in US$ million (Zijp 1992)

Period	Number of Projects	Total Cost	Extension Portion (%)	Bank Portion (%)
1965-69	6	109	9	5
1970-74	51	2000	122	63
1975-79	181	11 245	1187	562
1980-84	175	18 841	1865	792
1985-88	99	10 036	1386	641
TOTAL	512	42 231	4569	2063

Agricultural extension has generally accepted some responsibility in natural resource management through such means as soils and water care programs. However, the fiscal reliability of large publicly funded programs separate from educational institutions may be questioned. Declining numbers of farmers in MDCs and the allocation to private costs of inputs leading to private benefits, is changing the nature of agricultural extension. These effects must be expected to carry-over into LDCs, even though the numbers of farmers are several times higher and the ability of farmers to access education may be more limited than, for example in North America.

However, before addressing trends in agricultural and resource management extension, it is important to understand the alternative approaches which have been employed in agricultural extension.

Behavioral Change

Natural resource management education includes the role of agricultural extension as a behavioral change agent through *Knowledge, Learning and Information* and in enticing farmers to *Make the Change*, that is, adopt practices consistent with environmental protection. However, although behavioral change is a field wider than agricultural extension, all to often agricultural extension is viewed as a unique activity which must learn from its own mistakes in isolation from other similar behavioral change mechanisms. Change can be forced by strong government action or, as is more commonly the case, may rest on voluntary behavioral change which requires (Padgitt and Petzelka, 1994):

- An awareness of the problem
- Knowledge of alternatives
- Motivation for change
- Resources to implement changes

Awareness of the problem, as a prerequisite of behavioral change, is addressed through extension by highlighting unrecognized problems. As with all aspects of human endeavor, farmers may be aware of general issues concerning natural resource management, yet not relate these to their own individual actions. For example in the mid-western region of the USA, most farmers had observed that erosion had become so severe and widespread that land values had decreased: yet 90 per cent of those expressing this opinion reported having little erosion on their own properties (Bultena *et al*, 1990).

Knowledge, Learning and Information

Knowledge *is an attribute of the human mind. Knowledge is the result of a lifetime of learning and forgetting. Knowledge cannot be transferred. Parts of knowledge may be coded into information, sent, received and decoded. That information may add to someone's existing knowledge, which would constitute learning.*
Learning *happens in three areas: (i) Cognition (or know-how); (ii) Skills; (iii) Attitudes. Those differences are relevant: it matters whether a farmer knows how to make money but does not have the ability or skills to keep book, or does not want to do accounting.*
Information *... means organized data. Data come from the outside and are inputs into a sensory system, like our eyes and ears. Data can be transformed - or organized -into information. Organized data, or information, can only inform, if they add something to the knowledge of the observer which would then be learning. Technology* [is included] *in the term "information".* Zijp (1994)

Knowledge of alternatives to current behaviors is constrained by the conditioning of farmers to seek an immediate solution to a problem rather than creating a knowledge base from which to consider options. A second constraint is the poor availability of historical and technical records. Much activity on farms is conducted by feel rather than record which introduces a subjective element which may cloud consideration of alternative solutions as Padgitt and Petrzelka (1994) note ... *to a considerable degree, sustainable agriculture alternatives involve a transition from substituting capital for labor to substituting management for capital.*

Motivation for change is clearest in circumstances where change is essential for survival. This may be in economic or environmental terms, such as the impact of rising salt levels in mismanaged irrigation schemes. In terms of natural resource management, reacting to environmental pressures which challenge survival is more likely to represent an economic decision than an informed environmental decision. Agricultural extension must acknowledge the influence of self-interest, economic motivations, and other influences on decision-making to understand the motivations for change.

> ***Making the Change***
>
> *Farmers change their techniques in two ways: (a) they may decide to increase the use of an input with which they are already familiar (factor substitution, as when they decide to weed more intensively, to apply organic fertilizer, or to make simple improvements to their land), or (b) they may adopt techniques that are new to them, in which case they have to go through a learning process. In either case farmers will make only those changes which they think will reduce costs of production (including the implicit cost of family labor and the opportunity cost of land). That a technique is highly advanced does not necessarily mean that it will reduce production costs ...* Binswanger and Pingall, 1988 *in* Gnaegy *et al* (1991)

The principle **resource for change** is information in the form of experience, extension information, word of mouth, extension agents, and historical knowledge. These resources readily compound to an excess of information channels, providing information that may at times be, or appear to be, conflicting. This circumstance highlights the limitations of information dissemination alone as an objective for extension; information does not have an inherent value in this circumstance unless it can be assimilated through the learning process to knowledge.

Natural resource management relies on a sound knowledge base to assimilate new information provided through extension programs. Failure to acknowledge the underlying role of formal education can lead to the farmers viewing *Extension as a Threat*.

Communication and Technology

Technology transfer is spoken of in the same breath in extension, just as the *D* of *R & D* (Research and Development) is assumed by research agencies to acknowledge the need for useful research results to be adopted. These views can lead to extension being considered as an activity separated from formal education, to the detriment of both extension and education. Ongoing innovation in communication technologies is providing a unifying mechanism for the field and provides a return to its origins by linking extension to education.

Extension as a Threat

Some farmers are threatened with the idea that they have to become more "management smart". Individuals, organizations, and institutions committed to sustainable agricultural issues need to realize these farmers may be lacking in the necessary management and analytical skills to successfully farm in a more sustainable manner ... These opportunities need to be in an environment where there is continuous dialogue between the farmer and the individual(s) providing assistance; where farmers are actively involved in their on-farm decisions, and where they are made aware of what their farming practices are and what steps are needed in order for practices to be more environmentally benign yet maintain acceptable production and profit levels. Padgitt and Petzelka (1994)

Technology transfer to LDCs can be effective if they link with international technology generation and dissemination systems (Bianchi *et al*.,1988). International R & D includes the outputs of National Agricultural Research Systems and International Agricultural Research Centers (refer to Chapter 7) and is thus not restricted to MDCs. MDC governments increasingly view extension under a generic approach to *Creating Innovation*.

In both LDCs and MDCs, the proportion of the population involved in farming is declining, and in MDCs has reached quite low levels. Agricultural policies are increasingly influenced by environmental policies and it is more than coincidence that an organization such as GreenPeace with its five million or more supporters in 30 countries can offer important lessons in extension. For example, Zijp (1992) observes that GreenPeace canvassers talk to approximately 40,000 persons per night in the USA, and that worldwide, its 46 offices in 26 countries with some 1,000 full-time staff connected by electronic mail, is an efficient extension mechanism. Linking environmental messages to agricultural messages may not seem appropriate to some persons, particularly when environmental groups are critical of agricultural activities. However, if extension is conceived as the imparting of knowledge as well as information, then that knowledge must include an understanding of the natural environment. Similarly, the messages of GreenPeace must increasingly include information which places the practical imperatives related to agriculture in a wider environmental context.

Creating Innovations.

... an adequate understanding of innovation requires an examination of the capacity to adopt, defuse, commercialize and create innovations, as well as an examination of the impact of technological trajectories and broader structural influences. ... innovation is a series of complex and variable processes which are not amenable to clear description or simplified modeling. Some details of this complexity may never be predictable because of the inherent unknowability of future technology and the chaotic features of technological trajectories. However, a large part of the complexity is due to many strands of commercial, industrial and technological expertise that need to be taken into account. This suggests that better decisions are possible and that decisions devolved to those with detailed expertise will usually be preferable to generalized prescriptions.
DITAC (1994)

A comprehensive discussion of technology applicable to the transfer and use of agricultural information has been prepared by Zijp (1995). He examines ten information technologies and their applications to agriculture including; CD-ROM, computer networks, desktop publishing, expert systems, geographic information systems, interactive video, packet radio, radio and interactive radio, satellite communications, and linear video. The lack of information channels to poor rural communities in LDCs is said to be overcome, in many cases, through new technological innovations in communications. Overall, radio communication is seen to offer the first ready means of enhanced communication. Higher communication costs in remote areas is said to be acceptable based on experience in Alaska and Northern Canada, where native people spend more than three times as much as their urban counterparts on long distance telephone calls, even though their average income is lower. This premium placed on communication by persons in remote communities may be considered to be an indication of the demand for an information conduit. Electronic communications offer cost reductions from traditional extension network systems, although most reviewers support parallel systems rather than complete replacement of field extension workers with radios or other electronic communication mechanisms.

Enhanced learning from such mechanisms as interactive video is attributed to the involvement of sight, touch and hearing to consolidate messages being received. This confirms the successes of effective field extension agents where interaction between humans involves more than single media messages. New technologies may be approached more openly by remote communities, for example, preliterate Indians in Brazil have learned to use camcorders after fifteen minutes of instruction (Annis, 1990). In Ecuador, literacy trainers were able to produce audiotapes after about one hour. Learning to use computers and fax machines through the pressing of appropriate buttons was also taught in remarkably short periods to villages in Guatemala.

In an assessment of extension approaches for LDCs on behalf of the World Bank, Mody (1992) reaffirmed the importance of the *Farmer First* extension communication system. She concludes that the approach to information dissemination must be more important than the hardware itself.

Farmer First

I recommend a farmer-first extension and communication system to you, to be fleshed out differently in each setting after local pilot projects. What will be common across countries is clear accountability to farmer clients, monitored by a continuous audience research and evaluation process that may be undertaken in-house or contracted out. ... Information may be recorded by field workers on video, audio or strictly on paper, based on budget and farmer preferences. The bottom-up process is important not the hardware. ... If you are attracted by the accountability of a farmer-first client-based extension communication system with goals evaluated thorough constant audience research and monitoring, the behavioral science tradition in communication has a message-design process to recommend to you. Mody (1992)

Zijp (1992) favors a shift in World Bank allocation of investment in extension to privately owned channels of communication. He sees a rapidly changing world in which communication technologies will allow extension to be conceived from an entirely different viewpoint. In such a vision, use of computers by LDC farmers is conceivable, as is the use of satellite communications - developments which concern Conway (1994) who feels that computers can lead to specialization and imperfect matching of information and education.

Communication of natural resource extension information focuses on institutionally organized systems. In some cases, obeisance and in others, lip service, is paid to the involvement of farmers through "bottom-up" processes to include the aspirations of farmers and at the same time motivate them to predetermined changes. Merrill-Sands and Collion (1994) propose an alternative approach based on farmer partnerships with researchers. The benefits of anthropological analysis can, they contend, increase the efficiency of communicating appropriate outcomes from research activities and hence improve adoption rates while at the same time increasing the relevance of applied research. This approach reduces the responsibility of extension agencies considerably and provides further evidence that an appropriate context in which to understand extension is that of education. Distance education programs, computer-aided learning, short on-farm courses and other educational activities are the preserve of extension institutions in many countries. Yet these are functions that are also undertaken by educational institutions, often in parallel with little coordination. Extending education, training, knowledge, and information beyond the walls of the academy is a responsibility of natural resource management education.

In Australia, linking technology, work and learning has been an increasing concern of government (NBEET, 1995). The imperative for the education and training system has been defined as - learning across the lifespan. Vocational learning is seen as an initial activity which can lead to an attitude to lifelong learning of skills which in turn can enhance lifelong employability.

Electronic communication highlight a growing information gap between those who are part of that information system and those who are not. Such a conclusion has also been drawn for LDCs relying on traditional means of knowledge dissemination - this implied criticism of continued reliance on traditional agricultural extension systems highlights a need to reassess approaches to international assistance for extension. Tribe (1994) has estimated that 80 per cent of the world's new knowledge accrues to less than 10 per cent of its population. Those excluded through illiteracy and poverty in LDCs appear to be further marginalized in terms of education expenditure - for example, Japan allocates some $700 per person compared to a Nigerian figure of some 22 cents. These inequities are wider than those of distribution in wealth and are likely to widen that gap.

Research Focus

It is common for agricultural research documents and *R & D* agencies to assume that agricultural extension exists primarily for the extension of research results to users. For example, a University of Florida (1995) document promoting increased allocation of funds for USA universities to assist in international agricultural research, discusses the link between research and extension and identifies the five areas of essential activity as; basic research, strategic research, applied research, adaptive research, and technology transfer.

Such an approach omits the essential link of education to complete the agricultural knowledge system - the continuum between research, education and extension. It appears to have been possible, although perhaps financially less efficient, to separate research and extension from education in some cases, particularly where a purely commercial or individual gain was the output of research and extension. In terms of natural resource management, such a separation is less appropriate, because the benefits accruing from information generated through research and imparted through education and extension, may in fact not lead to individual benefits yet nevertheless require changes in the behavior of the individuals concerned. In such circumstances it is necessary to *Extend Knowledge* not just information.

Extend Knowledge

It is a relatively simple matter to show a farmer how to apply inorganic fertilizers and pesticides, and the rapid, obvious and short term responses that these treatments produce seem convincing evidence that they are beneficial. It is a much more difficult matter to persuade a farmer that, in the interests of long term sustainabliity inputs such as fertilizers, pesticides, water and fossil fuels should be used strategically and sparingly in association with the variable range of husbandry practices that produce benefits which, although substantial, are not immediately obvious. When moving to alternative and sustainable systems of management farmers need to have an understanding of the biological and ecological interactions, nutrient cycles and related husbandry's which together determine what is sound farm management. Tribe (1994)

Fuller and Waldorn (1989) note the need for agricultural science to remain in close contact with agribusiness, farming, and the rural environment in order to remain current. They refer to the relationships which serve the mutual interests of universities and the agricultural sector as outreach. The role of the universities in providing outreach activities is seen as an integral part of their responsibility which, if not implemented effectively, detracts from the impact of agricultural education. Agricultural education itself includes the extension of that education to farmers and other potential learners. Realizing that persons need to *Learn to Learn* and that learning takes place in many forms apart from formal classroom-based teaching is an essential aspect of education. Formal education has inculcated an approach to teaching and learning which is narrowing and may in fact be counterproductive in changing circumstances.

Learn to Learn

This [traditional] *method of learning has been dominant for generations in many countries, and the result is that learners have learnt how to learn. They believe that formality, distance and passivity are essential elements in good learning. Other forms of learning are not entrusted precisely because they lack these elements. Though didactic learning has its place, it has become so ingrained that it easy to forget that there are other ways of learning for children and adults alike and that learning also takes place outside academic institutions. ... But* [this] *requires a change in attitude by all concerned - not least by the learners themselves who are used to passive forms of learning. Active experiential forms of learning can seem very strange to them, and it often takes time before they realize that they are learning this way.* Bernard van Leer Foundation (1995)

Extension Systems

Extension systems vary between cultures in MDCs. In the case of LDCs there has been a tendency to adopt a prescriptive approach based on a western, often a USA, model or on policies of major lending agencies, in particular the World Bank.

In MDCs, systems which link farmers and other information users directly to researchers and educators are seen to be the most efficient, responsive and durable. The Danish Agricultural Advisory Service is one example of such an efficient service. It is managed by users through farmer organizations. It is partially supported financially through an Act which also requires advisers to be impartial and economically independent. Advice is offered in all areas of farm production with the service operating at both local and national levels. The local service of approximately 90 advisory centers is run by local farmers' unions and local family farmers' associations. At the national level, the Danish Agricultural Advisory Center supplies local centers with technology and research outputs.

With 3,400 staff of which some 900 are advisers, the Danish Advisory Service is engaged in all aspects of farming including management, with accounting services providing a valuable input to other advisory services for individual clients. More than 50 per cent of advisers and some 80 per cent of technicians and assistants, are employed in the accounting departments of the advisory service (DAAC, 1992). The demand for these services has increased with the sophistication of agricultural production and natural resource management with all additional advisers being paid for by farmers. Education and in-service training are conducted in short courses as an essential part of the overall education ethos of the extension service. The importance of education and training in Denmark can be understood from the requirement that prospective purchasers of farms must demonstrate participation in appropriate education and training activities. As farms are no longer inherited in the traditional manner, this implies training at least for every generation and new owner, with such training instilling an ethic of continuing education. The linkages between urban and rural concerns over the environment are considered in the design of education and training activities to ensure an urban understanding of the requirements of farming and a rural understanding of the concerns of urban dwellers.

Other approaches seek to emulate the Danish model or have evolved their own culturally specific models. Taiwan, for example, operates efficiently through a dual extension system, one side of which is supported publicly while the other is financed by local farming associations (Chaudhry and Al-Haj, 1985). Over time, these systems have interacted to provide an efficient mechanism for delivering knowledge and information to farmers.

The institutionally separated model described by Falvey and Forno (1996) is based on state or federally funded extension officers gathering information for farmer clients from research reports and researchers. The separation of these organizations from education institutions tends to preclude an educational element in advisory services which might otherwise instill an ethic of continuing learning. While it appears to be effective in imparting information of commercial benefit to recipients, it does not optimize benefits of knowledge and behavioral change in non-commercial areas important to natural resource management.

The LGC system is commonly viewed as a successful integration of extension with teaching and research. Extension services are increasingly paid from county funds thereby linking users more directly to funding than would federal or state supported systems. Extension personnel are staff of the university and are engaged in teaching or research in addition to extension activities (Falvey, 1995). Such dual responsibilities of extension staff maintains linkages to research and teaching and enhances the relevance of all three areas. The definition of extension as a separate field in such systems can be an artificial construct as it may include distance education, short courses, farm demonstrations, personal advice, discussion groups, and public information services.

While the LGCs had been the basis of extension development in some LDCs such as India, the overriding influence of the World Bank and its support for the so-called *Training and Visit System* has lead to wide-spread introduction of that approach through the major period of investment, the 1980s.

The Training and Visit System

The T and V System is an institutionalized approach to providing maximum direct contact between extension agents and farmers. Extension agents are supported by informed specialists who act as resource persons. While it is stated that the system must be adapted to suit individual conditions, concern has been expressed that the system is inflexible and costly.

The T and V System

The Training and Visit (T and V) system of agricultural extension aims to build a professional extension service that is capable of assisting farmers in raising production and increasing incomes and of providing appropriate support for agricultural development. The system has been widely adopted *in many countries. Considerable variation in the system exists within and between different countries, reflecting particular agroecological conditions, socioeconomic environments and administrative structures. To be successful, the Training and Visit system must be adapted to fit local conditions. Certain features of the system, however, cannot be changed significantly without adversely affecting its operation. These features include professionalism, a single line of command, concentration of effort, time-bound work, field and farmer orientation, regular and continuous training, and close linkages with research.* Benor *et al* (1984)

Key positions in the T and V model include the Village Extension Worker, the Agricultural Extension Officer, and the Subject Matter Specialist. The Village Extension Worker is the only agent making contact with farmers and all other parts of the extension service aim to improve the efficiency of this position. The Village Extension Worker gains information from the Subject Matter Specialist on a programmed basis and plans visits to farmers on non-training days. The Subject Matter Specialists has a higher level of education and accesses information which is imparted through training sessions and in response to *ad hoc* questions from Village Extension Workers. The Agricultural Extension Officer oversees a group of Village Extension Workers and assists in organizational arrangements and access to training and information. The Agricultural Extension Officer must spend more than half of her/his time visiting Village Extension Workers to ensure that farmers are being visited regularly (Benor *et al*, 1984).

The T and V system places great faith in field staff with limited qualifications (Oram 1992). Level of competence is seen as a major barrier to effective communication between extension and research staff (Von Schilfgaarde, 1992). Such levels of competence may be reflected in the statistics that, in 1990, less than 15 per cent of personnel in low income countries had university qualifications. The system is costly as a function of very high staffing ratios (Zijp, 1991) and one can honestly ask - *Has it Delivered?*

Has it Delivered?

T and V's weaknesses lie in the high cost of covering farmer needs through "armies of low-level staff" which are literally bankrupting some countries; the low cost-effectiveness of poorly-trained staff; and especially from the viewpoint of developing sustainable land use systems; their limited capacity to deal with problems which cut across single crops as well as the efficient use of inputs in the prevention of pollution and health hazards through misuse of pesticide. Answers to the more complex problems are supposed to be provided by the SMS [Subject Matter Specialists] *but their disciplinary limitations cast serious doubts on this.* Oram (1992)

Even in countries which have not been influenced by the T and V system, large numbers of staff are often sustained in agricultural extension systems. Fan and Pardey (1995) record that China's national agricultural extension system had some 300,000 employees in 1987 of whom some 193,300 were classified as professional and technical staff. However since 1987, the number of professional extension workers has declined markedly. Approximately 90 per cent of professional staff are located at county level where technology demonstrations and training activities are conducted.

Agricultural extension is often justified in general terms by yield increases. However, it is not possible to define the proportion of increases attributable to effective extension and hence extension systems worldwide are subject to funding pressure. The debate concerning the future of extension appears to be polarized between revisions to management structures and introduction of new information technologies. *Promotion and Extension* as practiced in commercial companies is easily overlooked in such debates.

Promotion and Extension

Commercial advertising uses the "five P's": People, Product, Price, Place and Promotion. Companies like Coca-Cola or Unilever certainly know their five P's. Their challenge is in achieving a cost-effective balance.

Rather than making restrictive and exclusive choices, the [World] *Bank should assist government in opening debate on these questions:*
•People: who are the future clientele of extension? Only farmers or also others, like researchers or policy makers?
•Product: what kind of information is needed? Production only or also accounting or organizational skills for assistance?
•Price: Who is going to pay, particularly for recurrent costs?
•Place: How is information transferred? For instance is the cost of staff with unreliable vehicles justified if the objectives could be reached by using new communication technologies?
•Promotion : Who are suppliers of information? Public or private, or a mix of the two, and who sets the conditions for them to work under?
These are not trivial questions. The problem is not that the answers are not known. More often the problem is that conclusions are reached without sufficiently considering the questions. Zijp (1992)

Throughout this book, agricultural education is proposed as a basis for natural resource management education. The disciplines required for appropriate natural resource management education are those included in agricultural education in its various guises including extension. We may conclude that concerns held for extension internationally suggest that significant changes will be introduced and that associated opportunities exist to widen its perspective. Even within currently beleaguered extension systems, a production and commercial focus dominates any context of natural resource management. If extension is indeed the extension of education and hence the sharing of knowledge and an ability to learn, significant shifts in its approaches, design, and conduct are required.

Education, Equity and Competence

Rostow (1987) in his political analysis of recent times notes the beginning of a human resource revolution in LDCs. For example, the nominal pool of scientists in India has increased from 190,000 in 1960 to some 2.4 million in 1984, a figure above all other countries except the USA and the Soviet Union. The overall increase in *Higher Education Participation* is seen as a key to further rapid development. Regardless of debates over educational quality, this increased resource inevitability leads to new technologies being developed and adopted and provides a basis for interaction between scientists, engineers and entrepreneurs across the international system. This resource may underpin a period of rapid technological growth in LDCs over the next two decades.

> ***Higher Education Participation***
>
> *Overall, the proportion of the population aged 20-24 enrolled in higher education in what the World Bank calls "lower middle income" countries rose from 3% to 10% between 1960 and 1982; for "upper middle income" countries the figure increased from 4% to 14 %. For Brazil, fated to be a major actor in this drama, the proportion rose from 1% in 1965 to 12% in 1982. In India, with low per capita income but a vital education system the figure rose from 3% to 9%. To understand the meaning of these figures, it should be recalled that* [in 1950] *the proportion for the United Kingdom was 9%, for Japan 10%.* Rostow (1987)

Securing the benefits of extension requires a structure such as the following proposed by Ransom (1993):

- Telecommunication and other linkages
- An integrated market system for information
- Skilled scientists able to adapt to technological change
- Active participation in international research
- Institutional integration of research-extension-education

While these may appear onerous, they may be met in a range of circumstances for the critical extension component of projects in LDCs. Chaudhry and Al-Haj (1995) note the need for competencies in technical, economic, scientific, farming, and communication fields as the essential basis for effective technology transfer. This implies that technology transfer will probably take place in the absence of an active extension system and that therefore the real function of extension is to accelerate the rate of adoption. While this begs the question of extension as a component of knowledge development as distinct from information transfer, it does highlight a justification for funding extension systems in LDCs. In these terms, Byrnes and Byrnes (1971) believe that the broad training of agricultural courses, particularly in LDCs, may be insufficient to engender essential *Extension Worker Qualities*. Jurlano (1995) notes one example of the poor esteem in which extension officers are held in the Philippines' coconut industry as a function of their perceived low levels of competence. Such opinions abound in LDCs where young or inexperienced staff are assigned to roles of technology transfer or behavioral change with inadequate personal competence or backup.

Extension Worker Qualities

When extension workers demonstrated a readiness to carry on above and beyond the call of duty, the farmers skepticism was substantially reduced. Actions that were perceived favorably included getting into the paddock to plant rice, remaining in the barrio to work on Sundays and Holidays and arriving for evening classes despite heavy rains and bad roads. Not surprisingly ... the high communication fidelity category was significantly more likely to consider the value of "enjoy working with farmers" as of high importance in their job. ... But to "enjoy working with farmers" is not enough. The extension worker must have the farming competency necessary to cultivate an innovation in the way it should be cultivated, even if the practices required appear strange to farmers. Contrary to the frequently expressed criticism that agricultural graduates perceive themselves as being too important to engage in such undignified work as farming, we believe that much of this avoidance behavior results from feelings of inadequacy and insecurity - they simply never have the opportunity to learn farming skills. Byrnes and Byrnes (1971)

Competence in extension staff might also be related to gender. Farming activities involve women at least as much as men. When the decision-making factors concerning input purchasing and management are considered, many cultures in LDCs assign a significant role to women. Yet the model for extension services is overwhelmingly a male to male relationship. Saito and Spurling (1993) observe that while men and women farmers share many characteristics, divisions of labor influence gender responses to information and productivity constraints. Oram (1993) concludes that the true value of women in extension and society is undervalued through current approaches to extension and that there is a need to *Balance the Message*.

Various criticisms are leveled at current extension practices despite apparent widespread successes; perhaps it is that current approaches are now seen to be outmoded. Many of the criticisms are based on opinion - how does one readily assess the economic benefit of institutional commitment to agricultural extension? Where are extension services continuously measured and assessed? In those circumstances where extension is considered merely as a means of accelerating technology transfer, one must acknowledge the conclusion of reviewers such as Gnaegy *et al* (1981) that research and development agencies tend to produce innovations that are considered risky, unprofitable or unsuitable by farmers. More specifically, Zijp (1992) isolates the major issues for further review in the case of World Bank funded extension activities:

- a lack of common purpose in public extension
- a lack of accountability in relation to clientele
- changes in information needs
- an expanding audience
- a lack of policy consistency

Balance the Message

The role of women in national extension services is minimal: the average across 73 developing countries is only 8-11% of total professional extension staff. The majority consist of "home economics" staff, very few are involved in on-farm advisory work, even though much of the field work is performed *by women and in some societies, especially in Africa, they manage the farms. The estimated share of economically active females is 43% of the total active population in the low-income African countries, where women represent only 9.6% of the extension force. This undervaluing of the true role of women in society is also reflected in their access to education; creating a "chicken-egg" situation by restricting the availability of trained female staff.* Oram (1993)

Repairing an obsolete system may not be the solution. Consideration of extension in a wider knowledge construct, wider even than its original focus in LGCs, may expand the narrow technology transfer aspects of extension which persist in some LDCs while integrating it with the wider role of education in natural resource management.

Information technologies may partially substitute for face-to-face communication. Information technologies can transfer information - but can they impart knowledge? It appears that distance education utilizing newly developed information technologies can create a learning environment in which knowledge and ability to further develop knowledge is created. Within such a process, information is transferred and behavioral change can occur. This context provides a clearer opportunity for *University Extension*.

Curricula

If we suggest that extension operates as part of education, and that natural resource management principles should be included in both formal and informal learning, then we must consider the curricula of current courses. Umans (1993) traces the developments of forest science from applied biotechnology and economic research to include social and ecological dimensions. This philosophy still underlies the courses, as they do for agricultural courses (Lucas, 1986). The general nature of such curricula is claimed to incorporate all variables which apply to agriculture, forestry and the natural environment. Critics suggest that such breadth must be at the expense of depth, although

MDC trends of wider access to undergraduate education have thwarted attempts at depth in many undergraduate qualifications. A comparison of courses relating to natural resource management against the Tbilisi declaration principles for one institution concluded that most programs provide students with skills and knowledge to identify and solve environmental problems. However, courses do not generally encourage students to become more sensitive to the total environment, and few subjects aim to develop attitudes to environmental issues which would allow full participation in environmental decision making (Parkin, 1994).

University Extension

Experts tend to agree on the increasingly important role of the universities in technology-lead economic development (Rama, 1984). Yet universities are systems whose internal logic and social dynamics cannot be easily adapted (even newly created universities) to the new historical role they are being called upon to play in the global information economy. Thus to examine the interaction between economic development, technological transformation, and higher education we must analyze the structure and functions of universities as social institutions. Castells (1993)

Agricultural courses may have focused on integrating scientific knowledge, often through the use of biochemistry as it applies in soils, plants and animals. They may also take a focus on the agribusiness chain dealing with production parameters, processing and marketing of product (Wallace, 1994). Other approaches also exist; however, these two suffice to indicate the past emphasis of such courses on science and commercial outcomes. Progressive shifts in the role of agricultural education, particularly in MDCs, may see a balance struck between commercial and environmental outcomes from agricultural education. Agribusiness and natural resource management are not mutually exclusive in such circumstances. While a focus on agribusiness may be partially driven by the need to attract agribusiness funding for education (Schroder and Pollard, 1989), agribusiness companies themselves must also be aware of sound natural resource principles and research.

In considering how to increase environmental inputs into existing education, a UNESCO (1986) report concludes that:

- *...something must be dropped from the existing requirements for students and replaced with elements relative to the development of environmental studies....*
- *...the introduction of courses on environmental problems* [must] *be supported by a group of scientific high-ranking persons at the university...*
- *...advanced students could join in some research project and have some special educational arrangements made for them ...*
- *... the complete analysis of a real or imaginary case which would be related to the actual experience of the students in their daily environment...*
- *...the more teachers are aware of the implications of their own subject for the environmental issue, the more reference they will make during their own teaching activities...*
- *...integration of different aspects of one problem has become of importance...*

The link between education and extension has been made in terms of adult education and extension processes (Pollard and Bardsley, 1993). A shift in demand for knowledge, particularly from adults, is possibly leading to a refocusing of education away from teaching towards learning environments - refer to Chapter 9. Agricultural producers are viewed as inquiring and experimenting people whose processes of learning vary; they also wish to control their own learning processes in seeking solutions to problems as they arise. As a function of this demand, distinctions between extension and education are breaking down, particularly in the area of formal education conducted in an institutional setting. Fixed syllabi taught to groups of young learners are seen to be complemented by workplace training and education, recognition of prior learning through work and life experiences, and allowing learners to engage in self-directed learning through personalized study programs. Apart from the logic of assisting the growing trend which binds adult education and extension philosophies, the cost-effectiveness of such activities in education is seen to be a further driver. An additional benefit would be the encouragement of a continuous learning ethic among individuals in rural communities to assist them to adjust to changing circumstances and to thus retain control over their own futures.

Inter-disciplinary approaches to science are said to be increasing (UNESCO, 1986). This approach fits philosophically with many existing agriculture and forestry courses. A tendency to focus agricultural education on commercial outcomes, is greater in vocational education and training than in higher education (McMahon *et al*, 1992).

The major foreign influence on development in LDCs is international lending agencies. In its publication - Mainstreaming the Environment -the World Bank (1995a) lists its approaches to the natural resource management sector and the subsectors of agriculture and forestry. While the list of worthy investments does not explicitly highlight the need for revisions in agriculture and forestry education to reflect a natural resource management approach, one must expect this as the next major step for the Bank.

Environmental Extension

Conceiving extension as a component of education provides the context for introducing environmental management principles and concerns. Orr (1992) proposes a slow but effective development of an alternative approach to education of *Concern and Communication*, which is environmentally appropriate. Similarities between institutions taking this approach include commitment to: ecological sustainability; appropriate scale; cultural and ecological diversity; revaluation of the goals and direction of industrial society; and justice, peace and participation.

Concern and Communication

For members of environmental studies programs what does ecological thinking mean? How to we recognize it in hiring decisions? Few would argue that the process of academic credentialling is without flaws . Yet attainment of a Ph.D. and publication of scholarly work [is used] *to provide a benchmark to judge individual qualifications. But increasing specialization has substantially narrowed the focus of scholarship. Most active scholars communicate to a small number of colleagues with similar interests through a growing number of highly specialized journals. ... Given the present knowledge explosion, however, we are building a tower of Babel with each discipline and subdiscipline having its own jargon, theories, and paradigms understood only by a small number of the elect. The social costs of this system are incalculable. The survival issues on the human agenda, which involve whole systems of knowledge and many disciplines, receive little attention. Given the present structure of academia and its hiring, tenuring, and promotion procedures it is not at all clear how we will identify, debate, research and ultimately contribute to decisions that lead to farsighted, just, peaceful, and sustainable results.* Orr (1992)

Extending this concern beyond the academy together with knowledge, information and skills may become the extension approach of the future. This need not necessarily replace specific technology transfer functions where they are justified and fit within an overall environmental ethos. Nevertheless, it does represent a major shift in the overall conception, management and staffing of general extension systems. Such shifts are already evident in MDCs such as Denmark (DAAC, 1992), and in Australia where Landcare programs and services of such departments concerned with natural resources and the environment complement technical, commercially oriented advisory services (Barr and Cary, 1992).

A similar sentiment was expressed by Imberger, on his appointment to the United Nations Board on Sustainable Development; he observed that humankind's very mastery over nature may lead to its destruction (Campus Review, 1996). By removing a fear of nature, the center of most religions has been removed and hence individual and societal responses to the environment must be redeveloped.

Simple relabelling of courses may be occurring to accommodate a perceived shift in fashion. In such ways, titles such as Farming Systems may be changed to Resource Management (Ravenborg, 1992). The intellectual wrangling in the CGIAR to ensure that dual challenges of assisting the poor and preserving or enhancing the environment is one international testimony to the difficulties of transforming production-oriented sciences, such as agriculture and forestry, to a wider environmental context. In taking such a lead, the CGIAR provides an example to its supporting donors for their other programs, and to LDCs for their own activities. The relationship between education and CGIAR centers (refer to Chapter 7) provides a link to natural resource management extension

Changes in approach and information technology in natural resource management (*IT in NRM*) which are already occurring in extension also point to a future which is able to accommodate a broader environmental perspective.

IT in NRM

It is rare for farmers and pastoralists to have access to information on environmentally sound practices. It is also difficult for those responsible for natural resource management to analyze the complex relationships between natural resources and economic, environmental, and social factors that affect them. Developing as well as industrialized countries are using IT to support environmental planning, monitoring, and natural resource management. World Bank (1994)

Interactive Technology

Interactive technology allows information to be manipulated far more efficiently in terms of both time and costs. Crawford *et al* (1995) observe that higher education has pioneered educational applications in administration, instruction and access to education. However, LDCs may not have benefited to the same extent as MDCs. Enrollment expansion and decreasing operational funding create the opportunity for interactive technology to offer cost-effective solutions if the essential capital expenditure to start that process can be accessed. Innovations relevant to LDCs include; intelligent tutoring systems, interactive distance education, computer mediated instruction, data retrieval and electronic libraries.

In developed countries, use of interactive technology is rapidly increasing. The number of Internet subscribers continues to increase at a rate of around 15 percent per month. Perhaps the most widely used example of the development of such technologies is that of the State of Maryland in the USA which has provided access for 96 percent of its residents to the Internet. However, in LDCs the *Barriers to Interaction* continue to exist.

Barriers to Interaction

The Pan-African development information system network was established by the United Nations Economic Commission for Africa. It is one of the largest networking projects in Africa, yet it has fewer than 20,000 subscribers. During its implementation it experienced problems with (i) a lack of skilled personnel to install and configure data communication equipment and software; (ii) insufficient mastery of computer-mediated communication software; (iii) unavailability of direct phone lines for communication links; (iv) poor communication lines; (v) management and administrative problems; (vi) unavailability of hardware and theft of equipment; and (vii) under-appreciation of the benefits of personal contacts made through networking. Crawford *et al* (1995)

The capabilities of interactive technology are hardly realized. The social dimension of their use means that training and confidence building are critical parts to wider usage. The benefits to fields of natural resource management appear to have been realized slowly to date.

A Future for Extension.

In prognosticating a future for extension, we must recognize changing trends in governmental attitudes to funding. This takes the form of rationalizing apparent government subsidies in MDCs and of fiscal responsibility in times of rising debt in many LDCs. While governments have traditionally been the dominant funders and providers of extension services in LDCs (Umali and Schwarz, 1994), this may not be the case in the future. The inherent differences in needs between MDCs and LDCs in terms of information and knowledge, must be acknowledged in conjunction with the trend to date of LDCs adopting institutional arrangements which mimic those of the MDCs.

In MDCs, far reaching shifts in agricultural extension have occurred. In New Zealand in 1995, the number of advisers engaged through the government's service had declined to less than a third of its numbers prior to its rationalization. A major policy and fiscal shift drove this radical change and has stimulated an increase in fee-for-service consulting with the number of private consultants doubling in a market free of public extension services. The New Zealand case stands out as a brave approach which forms a part of a wider restructuring of the economy. Yet the principle of privatizing extension services is being addressed in various ways in many MDCs. The essence of most debates is the division between *Private or Public* benefits derived from such services. Cary (1995) concludes that eliminating public delivery of extension includes inherent risks associated with cycles in agricultural production and shifts in the balance between private and public delivery over time. Concerns over the ability of a privatized technology transfer service being able to meet the goals of sustainable agriculture have also been raised in the USA (Kenney and Vorley, 1995).

Private Versus Public

The reconsideration of the public delivery and funding of extension may represent responses to political fashion and budgetary circumstances. It also represents a significant recognition of the changed nature of agriculture in developed economies and changed circumstances in the wider economies of many nations. ... Agriculture has become more commercialized and little differentiated from other commercial businesses. Cary (1995)

In LDCs, extension has been said to require a long term human capital development program and a problem-solving orientation for all farmers (Mody, 1992). This can be achieved by linking farmers to research systems to strengthen communication of research results and minimize the need for extension *per se*. It can also be supported by defining strategies according to individual requirements and by acknowledging the wider lifestyle requirements of farmers rather than focusing on introducing or imposing a single technological message. Zijp (1992) includes this approach and links it to privatization and communication trends in his projection of *A Bankable Future(?)* for the World Bank.

A Bankable Future

Key words for future lending include: (a) Digitalization - providing the possibilities to make machines "talk" including Bank workstations with workstations in rural areas ; (b) Localization - improving ownership and accountability, for instance, of radios; (c) Linking - by investing in obsolete satellites, transponders, optic fibers, which requires cross-sectoral cooperation; (d) Educational Science - to make use of experience gained in reactive radio programming; (e) Private Sector - which is rapidly expanding channels but also providing the information itself, including the production of off-the-shelf software, (f) Language Training - with English Training receiving a lot more attention; (g) Multiple uses of what may become "Rural Information Centers", providing a workstation for farmers, extension staff, and local researchers to access the rest of the world for information, education, problem solving, and possibly entertainment. Zijp (1992)

The Landcare movement in Australia (Scarsbrick, 1995) is an interesting phenomena involving farmers and conservation lobby groups through a focus on environmental problems and the influencing of government investment. Its output orientation allows the engaging of private or public sector delivery of extension with individual Landcare groups operating on a basis of community action in their immediate area. If we expect to see increased privatizing of extension services in MDCs, we might assume that a private system would substitute those elements of the public extension service which impart a benefit able to be captured by an individual. Those elements which serve a wider public, which includes most of the aspects of natural resource management, are likely to remain the preserve of the public sector. Thus whether trends in MDCs are followed by LDCs with respect to private good aspects of extension is not of immediate relevance to extension for natural resource management. It appears that both in MDCs and LDCs, extension concerning environmental management will be conducted within the public sector and by concerned citizen's groups. Insofar as the public sector remains the major funder of agriculture and forestry education, reestablishing the linkage between extension and education seems possible and existing, albeit sometimes tenuous, linkages may not be threatened by privatization.

Extension has much to offer when it is conceived as part of the wider learning environment of education. New technologies in communication are widening access to education and providing the link between what has, for the past three decades or so been called extension, and education. The next Chapter discusses the means by which persons learn and beneficial uses of technology.

Sensibility

I thirst for knowledge
and drown in information,
I have problems, need solutions,
this the source of irritation,
I dig for information
and am buried in data,
Where to go for answers
to my *alma mater*?
Who converts data to information
- information to knowledge?
Is it the shy boffins
who among the libraries forage?
Is it researcher or teacher
is it both, or is it I?
The whole world changes far too fast
on whom can I rely?
The researcher is translator
she speaks, I do not understand,
The teacher needs a classroom
long time inputs does she demand,
Researcher, teacher, willing student
this the essential flow,
But surely this is quite elitist
limiting who can know,
Teacher extends her message
- elastically it pulls me back,
To the dreaded classroom
separated from life's fact,
Lips move explaining all
but I do not hear one word,
Perhaps I seek to act by instinct
live life like fish and bird,
I hope to gain the knowledge
yet despair, can't comprehend,
Mere advise on each issue
no new knowledge does extend,
I look for easy solutions
and am blinded by my fear,
And I realize that knowledge flow
requires me in its sphere,
From my cell of ignorance
I must myself release the latch,
To feel and love the fabric
not just to darn and patch,
To love to learn the only path
I am no more forlorn,
And now my senses sated

I face learning's bright new dawn

Chapter 9

Learning Natural Resource Principles

A state without the means of some change
is without the means of its conservation

Edmund Burke, 1729-1797

In this chapter, traditional agricultural and natural resource management education is challenged from the viewpoint of learning. Electronic communication technologies are presented as a bridge between LDCs and MDCs and as a means of increasing overall quality of, and access to education.

The history of agricultural education introduced in Chapter 6 highlights progressive changes in teaching and extension. In many ways, these reflect the general changes that have occurred in higher education in more developed countries (MDC) over the past 200 years. In the USA at the turn of this century less than one percent of the population attended college - something slightly over 200,000 students. By the end of the Second World War, the number of undergraduates had risen to 1.4 million and in 1994 exceeded 13 million. In catering for such change, institutions have necessarily modified their approaches to teaching. This same scenario has applied, in general terms, to universities in both MDCs and less developed countries (LDC).

Initially agricultural education focused on the preparation of leaders and technicians. In both cases residency was a requirement to enculture students with the values of the establishment. This approach effectively determined curricula and modes of delivery with new technologies for delivery being absorbed to further the enculturation process. Increasing numbers of students necessarily led to teaching being based on a lecture system as a simple expediency to allow the experience and knowledge of lecturers to be shared with the greatest possible numbers of students. This approach in agricultural and other education remains the common focus of educational institutions today.

In LDCs, agricultural and natural resource management education has followed patterns of MDCs. Even those countries with relatively new systems have adopted an approach based around lectures by permanently employed lecturing staff. Today, new technologies in communication allow the imparting of information and knowledge more efficiently than the lecturing approach by itself. Yet as described in Chapter 8, such technologies are most likely to be thought of as adjuncts to existing systems and adapted to further the central pedagogical model based on lecturing. In this way, tele-lecturing or video-conferencing is commonly conceived as a simple means of spreading the words of the lecturer to a wider audience. While there is obvious merit in the employment of such new technologies, it may now be appropriate to ask whether such an approach is improving the learning environment for students.

Learning

Definitions of learning may well be changing - we are all *Learning About Learning*. Differing opinions can be easily elicited within institutions about the knowledge which individual students *must* learn. In an environment of rapidly expanding knowledge and a quantum of knowledge in every subject area which exceeds the teaching time available, it is now unrealistic to cling to traditional views of the content and expected outcomes of undergraduate study. The view that an undergraduate education provides a sound understanding of a body of knowledge or even an adequate preparation for a career may be outmoded. Employers are beginning to recognize that the essence of a graduate is a person who has acquired essential skills including communication, analytical thinking, conceptual ability and reasoning, combined with sufficient knowledge to access information as required.

Learning About Learning

Is our definition of learning changing? And if so, why? What now constitutes the learning we are seeking - e.g. is it mastery of a body of knowledge, critical thinking ability, communications skill, preparation for a career or useful life, the ability to find needed information, the ability to interact with others? If colleges and universities themselves change in response to society's definition of learning how are our institutions responding to today's meaning of the word? Does our current teaching infrastructure, with its emphasis on the traditional classroom, provide an effective base to serve a newly defined view of learning? Twigg (1995)

Large employers of agricultural graduates, such as banks engaged in lending to agriculture, now recognize that the best graduates that they can engage are those who have a distinct capacity to continue to learn. They recognize the continuing role of education in the lives of all professionals and no longer expect that an individual can have mastered the content of any discipline in a three or four year undergraduate program. Such an approach is similar across the professions. If courses are still designed on the past assumption of producing a graduate who has mastered the knowledge of a field, major shifts in curricula and teaching must take place in order to meet the needs of a changed environment for graduates. Changes have occurred throughout society yet their implications beyond simple applications to teaching may not have been made clear to those delivering educational programs within institutions.

At the same time as technology is changing, the profile of students engaging in formal education has also changed significantly. General trends across MDCs indicate a declining percentage of undergraduates in their late teens and early twenties. The traditional view of an undergraduate of a young adult living in university residence engaged in full-time education has been estimated to constitute less than one half of students engaging in higher education in MDCs. Mature students, who often engage in part time education, have created new demands on educational institutions. This is a consequence of better informed purchasers of educational services associated with the wider life-experience of mature students. The service orientation of education is reinforced by the views of such students who demand delivery in educational and personal terms as distinct from traditional indicators more easily demonstrated by prestigious institutions, such as staff qualifications, class size, research grants, and student recreational facilities. This new element of consumer choice appears to cross boundaries of tradition and prestige, particularly in that segment in MDCs which focuses on the gaining of knowledge and information from education. The traditional lecture-based approach to teaching may not, under this circumstance provide the most appropriate learning environment. This is a major market shift, from a supply-driven (technology-push) approach of teaching students about science and the role of technology to one of learning-pull in which students exercise choice and demand.

The Employment Environment

The timing of education is also in flux. Global economic changes have removed the concept of whole-of-life employment and introduced the concept of an individual graduate's employability and flexibility to move to new careers. We are now conditioned to believe that new graduates should expect to move from employer to employer through their careers yet we have not all taken the step of realizing that this implies changes in careers in addition to changes in employer. The rapid rise in continuing education and retraining which arises from this realization, has yet to be recognized by the majority of higher education institutions including those concerned with agriculture and natural resource management. One might postulate shifts in career for a graduate today from farm advisory services, to private consulting, to agribusiness advice, to on-farm environmental management - diverse and to some, seemingly conflicting, career changes - yet all conceivable within the changing employment environment which awaits today's graduates. Whole-of-life learning is now a necessity for a serious professional in natural resource management.

The challenge for educational institutions is to prepare students for whole-of-life learning and to instill an appropriate ethic to engage in such learning. Those institutions which recognize the need to instill and service such an ethic are beginning to understand the implications this has in terms of teaching and creation of appropriate learning environments. Yet the composition skills represented in most teaching faculties is one of the major management challenges facing such institutions and in effect, can create an inertia against rapid change in the creation of new learning environments.

The changing demand for education is reflected in the places where knowledge is gained. Educational institutions can no longer claim any monopoly on accredited learning conducted within their own campuses. Accreditation, often by organizations separate from teaching institutions such as professional bodies, applies to workplace learning, home study, and a variety of other technology-based systems - especially in the USA. Distance education has extended the classroom beyond traditional boundaries and indeed across the globe. The university cannot be viewed solely as a physical location; if the physical location has importance, it may as a venue for short intensive and socially oriented adjuncts to learning. The learning environment spans that of the students and the information imparted by those responsible for managing the learning environment - it includes the computer link to remote homes and offices, discussion groups and, many may simply conceive the main campus as an administrative location. New *Tools of Learning* are needed to participate in this information revolution.

Tools of Learning

New visualization tools give us capabilities in addition to text in order to imagine, analyze, to communicate. Powerful creative tools are available to produce newsletters, design homes and offices, create music. Electronic communications tools are creating global communities; computing and networking are shattering and reshaping individual jobs and entire industries. Are our colleges and universities preparing graduates ... ? How many of our faculty can use these tools skillfully themselves? Twigg (1995)

How We Learn

As we understand more about the process of learning, we are in a position to create learning environments that suit individual learning requirements and which can accommodate the increasingly diverse learning styles of students. The ubiquitous experience of parents and teachers of students who fail to realize their full potential in traditional lecture-based systems may in fact be a recognition of the differing learning styles of individual students. Traditional lecture-based systems are strongly oriented to verbal and mathematical logic, not the least in the traditional approaches to agricultural education. Those persons who learn more efficiently in environments where knowledge is presented in spatial or in personal terms may be under-serviced by traditional agricultural education - witness the students who comprehend field explanations of concepts much faster than they do lecture-based explanation. They may also represent a resource in terms of a less mechanistic approach to life that is important in a broader definition of natural resource management. Such *Preferred Learning Styles* may also be reflected in psychological profiles.

Preferred Learning Styles

Another widely used tool, the Myers-Briggs Type Indicator (MBTI) has contributed to our understanding of individual differences in the learning process. The MBTI describes four patterns of preferred learning styles: The ES (concrete active), the IS (concrete reflective), the EN (abstract active), and the IN (abstractive reflective). These patterns are not evenly distributed in the general population. The ES pattern is the most frequent, representing 50% of high school seniors; the IN is the least frequent representing about 10%. Recent studies have shown that the largest group of college students consists of concrete active learners, who learn best from concrete experiences that engage their senses, that begin with practice and end with theory, and so on. As Charles Schroder recently pointed out in Change magazine, the overwhelming majority of college faculty prefer the IN (abstract reflective) pattern creating an increasing disparity between teacher and learner. How many of our institutions are aware of the results of this important research and are moving to customize their courses? How can our faculty respond to diverse learning patterns when their primary pedagogy consists of classroom lecture? Twigg (1995)

Changes in the System

The traditional system of agricultural education is already changing. Fueled by a declining role of agriculture in the economies and minds of decision-makers in most of the MDCs, agricultural education has experienced a decline in popularity. A parallel trend in LDCs arises from investments and hence incentives being placed firmly in favor of new industries as distinct from agriculture which is perceived to be an existing industry and one which is tied to difficult social issues. The role of information technology is critical to such changes and provides a mechanism to catalyze the shift between agricultural education, as it has been traditional conceived, towards natural resource management education while retaining utility to commercial interests.

Information technology now makes it possible to reconsider approaches to such education. In the past while distance education was offered, initially through the form of correspondence study, it could not be considered to be the major form of learning. This situation has now changed with technology allowing instruction to be offered to students in any place at any time, and indeed for those students to be persons from a range of backgrounds, not necessarily possessing the prerequisites previously considered essential to enter courses. In general terms, knowledge about the way in which students learn in this new information environment allows us to plan for future mechanisms which service the needs of natural resource management education. However, we have not seen significant changes in the servicing of these needs, presumably because we are tied to traditional modes of delivery.

Our systems have been based mainly on servicing the needs of a student population resident or attending the university on a daily basis, and on the role of teaching. In addition, understanding a body of prescribed knowledge was considered to be the best basis for preparation for life and career. This may have been an effective mechanism in the past. However, the approach in which knowledge generated through research conducted by faculty staff who then deliver it to students solely through lectures, may now be limiting student learning opportunities. The challenge to individual lecturers is significant, and one which requires support in the period of adjustment and in the schooling of new lecturers to accommodate new technologies and new approaches to learning. Faculty staff need to understand the biochemistry of the *New Student Body*.

The Student's Dilemma

Today's students express frustration with the rigidity of university systems and institutional unwillingness to acknowledge the benefits and reality of engaging in education and work experience simultaneously. Dissatisfaction is also evident with traditional time-based structures which create personal inefficiencies in the use of time across the year. Added to these frustrations are those of routine university life, such as one hour classes scattered randomly through the week, difficulties in car parking, lecturers who cannot always be at the cutting edge of their fields, and subject entry criteria which provide virtually no acknowledgment of one's previous knowledge and experience. Such issues are raised across both MDCs and LDCs and must be added to those listed in Chapters 4 and 6.

The New Student Body

Today's student population [in the USA] *is characterized by heterogeneity: in age (only 43% are under age 25), sex (women account for nearly 55% of all undergraduates), ethnicity (more than one student in six is not white) and economic means (students from all socio-economic classes attend college). Now that approximately 14 million students attend college, American higher education is a mass phenomenon. Residential education alone simply cannot serve the needs of today's students: it is too expensive and is often inappropriate. Clearly residential education remains a suitable option for the minority of college students who match the pre-1960's profile. But for the millions of working adults who have already experienced their own rites of passage as they entered adulthood, all-night bull sessions in dormitories, pep rallies and football somehow lack in appeal.* Twigg (1995)

If teaching-based instruction is inherently limited by the preferred learning modes of individual students, it may also be possible that the preferred learning approach of an individual varies across a lifetime. Experienced professionals seeking continuing education may not prefer teaching-based modes of learning. Certainly a generation growing up with electronic means of accessing information and information linked to entertainment, creates demands which traditional universities in MDCs are already finding difficult to meet.

Changes in student demands are supported by questions about the relevance of educational mode to subsequent life experience. This arises through such questions as - *professional employment seems to be based around team assignments and task completion as distinct from memorizing information for re-presentation in a two hour written examination - why then should that approach not be used for part of the educational experience?* Rimmington (1996) describes the current model of agricultural science courses as leaving little scope for students to develop their analytical skills and incorporate their own life experience. He introduces the benefits of information technology and in particular, multimedia as an adjunct to traditional teacher-based lecture delivery, while noting that such innovations are essentially improving the efficiency of existing systems rather than providing different or new delivery systems.

Experience with electronic learning indicates that today's students in MDCs prefer to access resources through the World Wide Web rather than through printed media. Learners appear to prefer self-paced, interactive electronic learning activities which are based on well designed electronically deliverable courses. Design of these courses on a modular basis facilitates learning, structuring of courses, and access by persons taking other courses. Modules also provide a basis for continuing-learning programs for both professionals and sub-professionals. Electronic delivery of information also appears to be preferred over linearly available information such as videos and paper-based systems. By digitizing video educational material, learners are able to link to a range of information. An important conceptual element of such new approaches is the central position of the learner in accessing information through such means:

- Interactive video conferencing
- E-mail
- Electronic conferencing
- World Wide Web
- Computer aided learning and a general server
- Digitized video tapes accessed via a general server

- Electronic library document delivery

The learner therefore has choice of access to a range of learning resources which can be chosen to suit preferred learning modes and circumstances. The role of academic staff shifts from teaching to one of planning a learning environment, convening activities, and tutoring. While this may imply a reduced role to some, it emphasizes the critical importance of well informed researchers and mentors to facilitate learning processes. In some ways it represents a return to the historical concepts of professors in universities.

Students have increasing power as clients or customers of educational institutions and are already influencing the future of universities. Such a future for universities around the world may be indicated by the electronic offering of the Harvard MBA (Rimmington, 1996). The quality association of the name coupled with electronic access can lead to individual institutions offering those areas in which they excel and have a reputation in conjunction with other institutions with compatible or related offerings. The impact of the Internet is already being felt and institutions would do well to focus on their strentghs - to only *Focus on That at Which You Excel*.

Focus on That at Which You Excel

If the constraints of demographics and conventional delivery methods apply, then the current model may be optimal. However, use the Internet and they no longer apply. Consider a system in which there are, for appropriate courses and course elements, no universities as we know them. In their place are independent providers of subject units, others who broke customized courses to suit the needs of individual learners and employers and still others who provide independent assessment of key attributes of people who have completed such programs of study for accreditation purposes. The latter would act for the accreditation bodies of professional institutes. Each of these players could deliver their services on the Internet. Rimmington (1996)

It is easily argued that such a system removes the social component of education and would lead to a few large providers operating around the world with less scope for the competition which has traditionally been one mechanism for encouraging excellence in universities. However, the outcome may more likely be the accessing of the best courses electronically with local institutions increasing the value of that information through supporting, adding to, and adapting these courses. In other words, an institution which currently offers the full range of subjects necessary for natural resource management courses may choose to shift its investment in, for example, a large number of staff covering all specialties and seek to specialize in specific areas, and make those specialist courses available internationally and to maintain their currency. For areas in which an institution does not excel, courses could be imported or exchanged with other institutions. This would both improve the quality of specialist courses and enable better use of scarce resources.

Collaborative activities and working in teams is possible utilizing Internet. The ability to engage in learning at different times would further widen access to education - thereby addressing a chestnut criticism of higher education. Practical experience in laboratories and field situations could form a continuing component of intensive sessions requiring physical presence, although some skills-based activities could also be prepared for electronically. For example, electronic packages which allow virtual surgery on domestic animals can be used to teach anatomy and surgical skills to an extent, and to introduce moral issues prior to students practicing those skills on real animals.

Rather than spelling the demise of the traditional university, these innovations are likely to allow preservation of excellence in major centers and roles for many institutions in adding local value to current world knowledge. Changes may be perceived as a revolution within institutions whose staff refuse to embrace the opportunity. Nevertheless, these circumstances suggest that those institutions which will be regarded as the great universities of the next century may well be those which seek such opportunities and act quickly. Networks of leading institutions may be expected to work together for students choosing the subjects which make up their courses. In such a world, learners would keep accessing the educational services of the institution throughout their lives. Such a scenario could conceivably make current levels of public funding of university systems seem generous.

The Manager's Dilemma

Management of agricultural and natural resource management education today offers new challenges. Providing education in a situation of constant real reductions in finances tends to orient management to cost-cutting and borrowing funds from the future. Such borrowing occurs in the form of reduced investment in equipment and maintenance and an increase in the proportion of budget allocated to teaching staff salaries. The problem is not restricted to agricultural faculties.

In countries where income of departments and faculties is tied to student numbers, whether it be through government allocations or student fees, government fiscal policy and market pressures on such income create a new management environment. The seeking of external funds has already added a new dimension. These responses are predictable and correct insofar as they operate within the past paradigm of lecture-based teaching. An alternative, which appears to be being embraced by young and innovative institutions, is to accommodate new technologies for education beyond individual classrooms. Even the terminology of such innovations is curious; extending such education beyond the classroom is in fact not an innovation, but the time-honored practice of outreach or extension common to agricultural education (refer to Chapter 8). However, such distance education is not usually well developed in agricultural or natural resource management courses, possibly as a result of these courses being offered from traditional departments, faculties and institutions.

Requirements for practical instruction, teamwork, laboratory learning and so forth are commonly claimed as a reason for rejecting distance education as a mode of natural resource management education. Such reasons should now be challenged as the technology of distance education and the needs of students have changed. In MDCs, greater numbers of persons gain access to tertiary institutions and in LDCs, higher education appears to be a burgeoning sector. The content, quality and outcomes from undergraduate degrees may need to be reconsidered. Perhaps the role of undergraduate degrees is increasingly one of general education for a larger proportion of communities, and that of postgraduate qualifications a focus for persons gaining mastery over a body of knowledge and specializing where appropriate.

Private sector provision of education, while feared by some in publicly funded systems, is as old as the function of education itself. In recent times, in MDCs, new private providers have entered the market place in response to niche opportunities. It should be instructive to agricultural and natural resource education that two areas where private providers have demonstrated some success are environmental appreciation courses, and vocational training oriented to the provision of skills which lead to employment. Small or new private providers perform a valuable service both in terms of their provision of education and as risk-takers in the assessment of expanding market segments in education which can then be followed by larger, more traditional institutions. Such benefits accrue regardless of perceptions concerning the relative qualities of offerings.

Perhaps there are also lessons for higher education institutions to learn about the use of expensive capital facilities from experience in the efficient use of schools in LDCs. Utilizing such facilities in two or more shifts has provided increased access and better use of capital resources. Improved efficiencies in the use of the most expensive components of agricultural and related education may be an appropriate starting point for managers. In MDCs, the high proportion of budget allocated to staff would suggest that both academic staff and capital items should be used as one focus for the efficiency in education delivery. Once again, the promised benefits of new communication technology would appear to facilitate the allocation of high staff costs to a potentially wider number of students. Alternatively it would allow increased academic quality by marginalizing poor teachers introducing real location-free choices of learning packages. One should also assess the year-round use of capital facilities. Extending the learning year to a full year of intensive use of facilities fits well with a short residential requirements associated with distance education. This does mean that staff need spend more time teaching - in fact good programming could allow better structuring of staff time and hence greater research and teaching efficiency. Such an approach represents a more intensive use of facilities than do Summer Schools and other programs which are often claimed to extend the academic year.

Practical training, and in some cases laboratory activities, may in fact be able to be linked more closely to industry. The inclusion of compulsory practical experience in industry as a component of some agricultural undergraduate qualifications has demonstrated benefits to each of students, employers and education institutions. In management terms, this may increasingly be seen to be the identification of the core activities of education. It is conceivable the core of education does not include ownership of all physical assets required for instruction, or face-to-face teaching as a dominant methodology. If the essence of education is to provide a learning environment and the knowledge and skills consistent with a field of learning, timetabling of staff teaching would focus around those times when students attend intensive courses at the main institution - with staff time being otherwise flexibly allocated to research, supervision and assessment activities.

Learning in Natural Resource Management

Changes are occurring in agricultural education which creates both a threat and an opportunity. The threat in those institutions and courses which do not adapt to changing stakeholder requirements is one of declining enrollments and funding and possible absorption within broader faculties, such as a faculty of science and economics. The opportunity as described, relates to conceiving agricultural education as a major subset of natural resource management education and thereby broadening the impact of such education on the general community. The opportunity appears to apply in MDCs where agriculture is increasingly marginalized in both political and urban consciousness terms. It also appears to apply to LDCs where agricultural education often fails to attract appropriate funding when competing with high technology industry development, and perhaps social investments.

In a period of change, it may in fact be easier to adjust to new technologies as part of the general changes occurring in agricultural education - particularly in undergraduate programs. It would appear that higher degrees are the ground for creating broad understanding of the interactions between a range of fields over which a graduate can demonstrate some mastery of knowledge. Higher degrees would also retain their traditional focus for those who wish to specialize in a particular aspect of natural resource management education. Some of the trends being discussed here are summarized in Table 9.1. How realistic are these notions? - the beginnings of an international agricultural and natural resource education system using electronic technologies to create the virtual university are introduced in the next section.

Table 9.1 Past, Present and Future Characteristics of Higher Education

Past	Present	Future
Lecture-based	New technology supporting lecture-based learning	Lectures available through electronic communication supported by residential schools
Full rounded courses	Employer demands set skills of graduates - for example, ability to learn	Provision of continuing learning service
Whole-of-life career	Career changes	Need for retraining and continuing learning
University managed accreditation	Professional body accreditation in some fields	Independent accreditation
Correspondence learning for disadvantaged	Distance education available as second-class alternative	Distance education as main delivery mode - development of institutional Business Plans around wide offering of services
Agricultural extension separated from education	Cost squeezes in both areas	Integration of education and extension in distance education
Lecturer culture determines learning environment	Increased student influence in teaching assessment	Range of learning environments available to suit profiles of students
Reasonably well-funded	Reduced public investment	Improved efficiencies of delivery
Timetable based on lectures	Timetable based on lectures	Timetable based around residential schools of distance education students
Low utility of capital	Low utility of capital resources	Increased efficiency through

resources		scheduling for intensive sessions for more students
Bachelors degree a rounded degree	Bachelors an introductory degree	Higher degrees for rounding and depth
School leavers as students	Increasing proportion of mature-aged students	Students of all ages engaged in continuous and basic learning

The Virtual University

In an era of virtual reality in entertainment, creation of a virtual university should not be difficult to conceive. Forward thinkers, such as those involved in A*DEC (1996) have developed the concept as an alternative to traditional agricultural education. A*DEC, which grew from the AgSat consortium of Land Grant Colleges in the USA has enlarged its focus from satellite technology thereby recognizing that such communication is only one of many modes of offering education at distance. The goals of A*DEC are set out in the organization's strategic plan which calls for it to … *develop and provide responsive high-quality and economical distance education programs and services to diverse audiences.* Primary emphasis is placed on services relating to:

- food and agriculture
- nutrition and health
- environment and natural resources
- community and economic development
- children, youth and families.

Enhance Academic Productivity

The following points reflect the forward view of A*DEC:

1. *Investments in knowledge codification, delivery systems and assessment techniques will decouple the provision of learning from the certification of mastery.*
2. *Information technology will place the advantage with the learner rather than the institution by creating a more effective market in learning as opposed to a controlled allocation of scarce teaching resources.*
3. *Given the tremendous knowledge base already extant in their communities, higher education institutions have a significant advantage in capturing this new market in learning - but only if they invest their resources wisely. If universities use the business as usual, non-adaptive strategy - other organizations will cherry pick the knowledge base and intellectual property that colleges and universities have helped to develop but they have been unable to exploit in terms of revenues. The result will be research universities will lose out competitively and non-traditional providers will take over a great share of the education market.*
4. *Higher education's core values will be at risk if more and more undergraduate education shifts to non-traditional providers. Ironically, those research institutions which are most adaptive, most flexible, and most capable of developing information technology utilizations, seem to have the least incentive to do so. Their very strength permits them to maintain the traditional ways.*
5. *Institutions have a great deal to lose or gain depending on their decisions about technology, if colleges and universities fail to adapt effectively, other kinds of institutions will take up the challenge.* A*DEC (1996)

A*DEC aims to be a global competitor engaging in local adaptation and implementation of educational programs. It will combine research, communication and instructional capacities to provide services at any time and any place via a range of services including Internet, audio conferences, video tapes, satellites and printed publications. The organization seeks to develop an international reputation for degree programs, extension, certificated programs, and conferences of the highest quality. Its approach is based on a shared vision of concerned educators in agriculture and natural resource management who seek to *Enhance Academic Productivity*.

The A*DEC approach issues a clear challenge to existing providers of agricultural and natural resource management education. The challenge is to chose between change or atrophy - to take the risk that the future will lie in command of delivery mechanisms or that the current wave is just like previous waves of technology such as the overhead projector and the personal calculator. The vision of A*DEC has been taken further by a consortium of the Governors of Western Universities in the USA (SmartStates, 1996). The consortium aims to:

- create a virtual university which shares the goals of expanding access to a broad range of post-secondary education
- reduce the costs of provision
- provide accreditation of skills and knowledge acquired through advanced technology-based learning at home or on the job
- shift the focus of education away from lecture rooms and instruction
- create quality performance standards that are widely accepted and demonstrate new approaches to teaching and learning.

In particular, Governors are looking for more effective use of State investments and see higher education as a spur to the development of information technology networks. The experience of agricultural extension in assessing means and situations in which individuals learn and are motivated to continue learning, is of direct relevance and offers a unique advantage to agriculture courses adopting this approach.

While the potential for such a virtual university is great, there is a need for incentives to encourage use of such a service on the part of both teachers and learners. Students would be reticent to accept an alternative to traditional university education unless certification is accepted by employers and universities as being equivalent to other types of learning. Universities themselves may be reluctant to embrace such technology because of the significant changes it requires of both management and academics. Incentives need to be put in place to maintain quality of any service which develops outside traditional providers which do not enter the field; non-traditional providers will rely on the depth of understanding of a field of knowledge existing within traditional universities. If traditional providers do not accept the opportunity, it is better that development occur by using the entrepreneurial skills of private providers coupled with the depth of knowledge of traditional providers than to relegate new providers to a lower level of knowledge. The criteria to produce a virtual university have been defined by the Western Governors in the words which may indicate the nature of the *Future University*.

Future University

… a virtual university will be: market-oriented focused on developing markets for certified graduates in a wide variety of instructional material; independent - not controlled by those who represent established interests with regard to either delivery of education or its certification; client-centered - focusing on needs of students and employees rather than instructional providers, e.g., flexible and responsive in instructional delivery rather than constrained by the fixed schedules and sequential structures typical of current education delivery; degree-granting - empowered to grant certificates recognized by employers and degrees recognized by both employers and the academic community, initially in a limited number of areas, ultimately from associate to the graduate level across a broad spectrum of fields; accredited - fully accredited by regional and appropriate specialized accrediting bodies for the degrees and certificates it bestows; competency-based - grounding the certification of learning on the demonstration of competency rather than the accumulation of credits or experiences, or judgments about the quality of providers; non-teaching - not providing instruction directly, but drawing upon needed

capacity wherever it exists, both in colleges and universities, and in the private sector and among individual experts as well; high quality - setting competency expectations for certification that will help raise levels of quality for all learners and providers; cost-effective - sharing information technology infrastructure, seeking other economies of scale, forging partnerships, drawing on existing education resources and reducing time to degree by the fullest extent possible to reduce the per-student costs of delivering instruction. [It will also be] *regional - offering opportunities for participation … in a manner that is flexible and adaptive, and interconnected in ways that follow regional economic and social interests; ... and quickly initiated - not requiring lengthy study and developmental work but actually functioning and delivering benefits …* SmartStates (1996)

The virtual university is more than a dream. Business plans have been developed and a number of potential barriers addressed. Its links to consortia such as A*DEC are also becoming clearer. In addressing the core business of education as being the creation of a learning environment, such concepts as the virtual university are possible and provide the opportunity for the lessons of extension and environmental concerns of the public to be accommodated.

Catalyzing the Change

Changes in delivery mechanisms and in the conceptualizing of agricultural education, may occur without any specific management or direction. However, as these trends indeed exist it may well behoove funders of such institutions to acknowledge their responsibility in assisting evolution towards future models. Institutionalized funding mechanisms work against such change by using decision making systems suited to past experience - maintenance of the status quo.

In LDCs, the significant influence of external funding agencies such as the World Bank can catalyze changes. Past projects have focused on large-scale investments in expensive physical facilities, foreign training of staff to learn about mechanisms for education in

MDCs, and implicit assumptions of a lecture-based teaching environment. Investment in the delivery of the essential service of education including those technologies which support its delivery will be a more important form of international development assistance for the future. It will free LDC universities from a position of followers of MDC universities to allow one of partnership or provider-purchaser of education services.

The future of natural resource education, including consideration of new technologies and the need for public understanding of food production imperatives and environmental balances, is discussed in the concluding Chapter.

Plus ça change

Technology changes, old skills now masked
Life's only constancy is itself change
Increasing speed to accomplish our tasks
True values do not from the essence range
E-mail today so crisp, clear, to the point
Distilled of pleasantries, full of meaning
Yet genteel phrase, fine prose doth still anoint
Active like moss on barren rock greening
As 'phone reduced travel, for screen give thanks
Change for the worse, or for enhanced freedom?
Ask the young! they know of its narrow strengths
Out of babes' mouths once more cometh wisdom
    True principles and values in these flows
    Ignore change's details - *plus c'est la même chose*

Chapter 10

Creating The Future

Conservatism discards Prescription,
shrinks from Principles, disavows Progress,
having rejected all respect for antiquity,
it offers no redress for the present,
and makes no preparation for the future.

Benjamin Disraeli

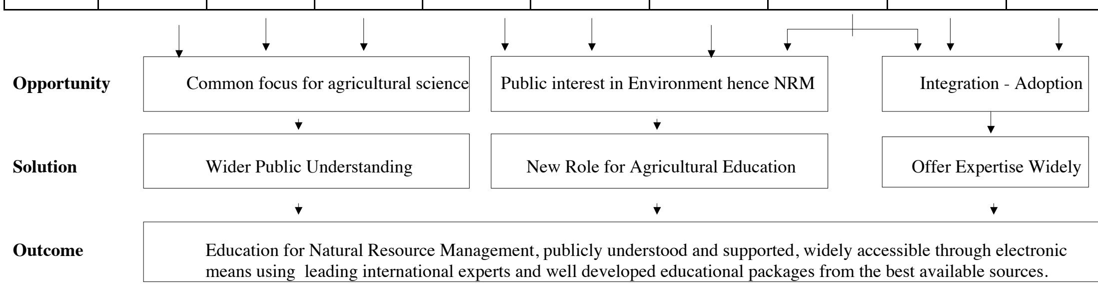
This final Chapter brings together the imperative of education for increased food production coupled with the need to increase environmental consciousness in dealing with students, industry and the public. It suggests that a major future role for natural resource education which is better planned than simply predicted.

The chapters of this book have traced the problems of natural resource management, the imperatives of agricultural production associated with rising human population and poverty, and the need for attitudinal shifts to the environment among the community and educators. The current roles of higher and vocational education and institutions in LDCs and the associated influence of major international development agencies such as the World Bank, have been contrasted with the general shifts occurring in MDCs. The influence of organizations such as the World Bank and the Consultative Group on International Agricultural Research in supporting a visionary approach to natural resource management is needed now and into the future. Likewise, the continuing separation of extension from education and narrowly defining extension as the transferring of research results unnecessarily limits the efficiency of natural resource management education systems. New technologies allow new approaches which overcome historical inequities with respect to access to knowledge and learning. Creating new learning environments is the challenge and responsibility of educators in natural resource management fields. And so we arrive at this final chapter in which it is customary to bind such thoughts together - this is done through Figure 10.1 and through the following discussion.

These streams of thought are bound together through a planned or created future. This created future varies from that of a predicted future to which those involved in education must adjust. It is predicated on the assumption that those involved in education delivery and management have sufficient influence on the future to be able to create a scenario far more beneficial than simply predicting external trends and reacting to them. To understand this approach, some major underlying trends bear reiteration.

Figure 10.1 Towards Improved Natural Resource Management Education: ***Integrating the Themes***

	Chapter 1 Agriculture and Environmen t	**Chapter 2** Population and Food	**Chapter 3** Empathy and Under-standing	**Chapter 4** Higher Education in LDCS	**Chapter 5** Vocational Education in LDCs	**Chapter 6** Education in MDCs	**Chapter 7** International Agencies	**Chapter 8** Agricultural Education	**Chapter 9** New Learning Environments
Problem	Agriculture seen as unnecessarily harsh on natural resources and scientists seem unconcerned	World population growth requires more food production from current systems	Balance between science and humanities in natural resource management is poor	Concerns about access, quality, and relevance of agricultural education and of investment in buildings	Technological orientation divorced from understanding of natural resource principles and industry ownership	Declining popularity of agriculture and separation from public opinion about the environment	Poor links between research and education in LDCs and an infrastructural bias in investment	Extension is separated from education and lessons about learning are not used in education	New communication technologies not yet being used to potential by agricultural universities



Trends In Agricultural Education

Agricultural education is selected as the most logical precursor for natural resource management education and as the major component of future natural resource management education. This choice is based on the observation that agriculture and its related fields of forestry and national park management comprise the majority of terrestrial managers.

Trends in the field include:

- A decreasing interest in agricultural and related education as distinct from other fields of education
- An apparent increasing appreciation of natural resource management as a *bona fide* approach to intervention in the environment
- A continuing increase in demand for food requiring further intensification of agriculture, development and imparting of new knowledge on production and environmental and social sciences
- An increase in interest in protecting the environment, particularly in MDCs.

A decline in interest in studying agriculture in both LDCs and MDCs appears to reflect perceptions that agriculture is of declining importance in MDCs and offers less personal opportunities to individuals in LDCs compared to high technology or high personal income careers. These trends may be associated, at least in part, with a bias in university entry towards urban students who grow up in an environment increasingly separated from food production and have little informed basis on which to develop opinions and knowledge about agriculture and aspects of natural resource management (for example, Loquet, 1996). In the United Kingdom, Harper (1990) quantifies reductions as high as 46 per cent for enrollments in agricultural national diplomas in contrast to steady levels of enrollment in other subject areas. He relates this to the decline in the numbers of persons engaged in the agricultural workforce as well as a general image of agriculture. Reactions to this downward trend are commonly a focus for institutional marketing - sometimes styled as - *Educating the Consumer*. In LDCs, the trend appears to be associated with the higher status attached to university education in particular, and a perception that such status does not accrue to the majority engaged in the industry of agriculture, that is, peasant farmers. Vocational courses are more directly tied to employment opportunities in both LDCs and MDCs and appear to suffer from a narrow view of declining numbers of persons engaged or needed in commercial agricultural enterprises.

Educating the Consumer

Centers of agricultural education are already responding to the changing employment environment in a number of ways. Many have raised their marketing profile considerably to attract more students. Others have diversified into other rural subjects and offer their courses in a more flexible and modular format. The entrepreneurial approach has become more important in many colleges as they seek to augment their funds from alternative sources of income. ... There will continue to be a need for agricultural courses in the future. However, they must have an appropriate blend of subjects and teaching approaches to meet the changing needs of the future. A recent survey by the Business and Technician Education Council highlighted the areas ... [consumer perceptions, environmental issues, languages, computing and IT, leisure, recreation and tourism, financial and business management, diversification, food quality and hygiene, mechanization and automation, health and safety, and legislation] ... *for prominent coverage in the Higher National Diploma in Agriculture courses for the future.* (Harper, 1990).

The trend of restyling agricultural courses as natural resource management or similar names probably reflects the development of natural resource management as a field of student interest. However, the development of this interest does not stem only from agriculturists, and it necessarily requires a stronger underpinning of the social sciences than is common in many agricultural courses. While management of parts of the natural environment, and seeking to control as many variables as possible for intensive food production systems may be seen as natural resource management by agriculturists, it may remain an area of concern to other exponents of the general principles of natural resource management. Agriculture continues to be seen as a pillager of the environment in many cases. The trend for agriculture and natural resource management to be considered as parts of each other is not matched by environmental education including management, as distinct from appreciation and understanding, of ecological aspects of the existing environment.

Meyer (1993) has noted the tendency to rename USA colleges and faculties to include such names as resource management or natural resources, sometimes to the exclusion of the word *agriculture*. In Canada, Curtis (1985) describes a market analysis in demand and supply terms for the introduction of a new natural resource planning and management course. That analysis investigated the interest of prospective students and employment prospects for graduates. Such an approach is valuable for those courses oriented to employment, as are many courses in applied science fields. However, most educators involved in the field would appear to believe that employment demand is only one indicator of the benefits of agricultural or natural resource education; other benefits include a wider societal need for such general education among decision-makers of any community, regardless of immediate post-graduation employment destinations.

The overriding trend which must underpin discussions concerning natural resource management education is that of the rising gap in food production and consumption in LDCs. The imperative to produce food is likely to influence environmental protection decisions in all nations. Attempts to separate wealthy nations from the problems of poor nations in such circumstances would be ill-considered. Even if we choose that path, our attention will ultimately be driven back to increasing the efficiency of food production in all areas of the world through political pressure as well as for humanitarian reasons. It should similarly focus our attention on improving the efficiency of assistance provided from MDCs to LDCs in the form of aid, joint agricultural research, shared international education programs in agriculture, and development finance. The International Food Policy Research Institute predicts that the gap between cereal production and consumption in LDCs as a whole will widen further in coming years (Pinstrup-Andersen and Pandya-Lorch, 1994). While those rapidly developing economies of East Asia may be able to fill this gap through imports, poorer countries will lack sufficient foreign exchange to purchase necessary imported food. These poorer countries which include most of Sub-Saharan Africa and South Asia will remain a major concern to the world. Population predictions provide varied scenarios most of which indicate a stabilizing of the population at levels which would demand more than twice as much food as is currently produced. Accomplishing this task in a scenario of decreasing land availability, decreasing availability of the requisites of high input agriculture such as water, fertilizer and biocides, and in an environment of declining funding for agricultural research, represents a challenge of unprecedented proportions for agriculturists (Falvey, 1996). Reproducing the positive outcomes of the Green Revolution will require substantial incremental investment in agricultural education and research across the globe together with the sharing of expertise, some 80 per cent of which exists in the MDCs.

The Responsible Response

Education for the generation, application and management of new technologies in food production is a responsible response to demands of the immediate future. However, this does not mean maintenance of the *status quo*. Rising interest in protecting the environment, particularly in MDCs may be expected to lead towards an understanding that natural resource management is an essential component of environmental understanding. This will be a significant progression from the view that food production systems are unnecessary adversaries of environmental protection. While they may well be in many circumstances, they must be seen an essential function of human existence and thus managed in an environmentally sensitive manner. The responsible outcome, that of understanding the need for natural resource management based on principles of minimizing negative impacts on the environment while maintaining essential human values, such as the right to eat, represents an area for community education. This is a responsibility of educators in these fields.

Community education in such matters implies mechanisms to extend information at various levels to large numbers of persons. This responsibility of natural resource management educators is only beginning to be realized. As identified in New Zealand (NZNHF, 1995), introducing such principles to all forms of education is an imperative. It is a situation analogous to compulsory English subjects in secondary school or compulsory humanities subjects in science-based courses in many of the world's great universities. This is quite a separate proposal to that of reorienting agricultural courses - yet it can be implemented in parallel.

The responsible response not only requires changes in the dissemination of information to the broader community but also changes to the content of natural resource management courses. Insofar as these courses are likely to evolve in many cases from agricultural courses, the unifying themes of such courses should now be open to challenge. The common use of biochemistry as a natural integrator of disciplines relating to the soil, plant, and animal sciences may well be applicable to understanding the principles for natural resource management; but we should not automatically accept that is the only one. Likewise, the use of agribusiness as an integrator between aspects of farm production, product processing and marketing may not be applicable to natural resource management in all situations. It is obviously applicable to food production systems in a commercial environment but requires some additional balance to represent the full spectrum of understanding necessary for natural resource management. Coupled with such considerations of the philosophies underpinning curricula for natural resource management is the changing role of undergraduate degrees. As these become more widely available, can they be considered to be the same degree that was offered to a smaller proportion of a society in the past? This question will become more pertinent when we consider the broader implications of natural resource management education being offered through new electronic means to greater numbers of persons.

A tendency in some agricultural courses to highlight the importance of research and to encourage students to aspire to research careers may also be open to challenge for undergraduate courses in natural resource management. The efficiency of encouraging large numbers of students into a research approach when only a small proportion may in fact achieve or aspire to careers in such a field raises questions as to the efficiency of such courses for those graduates who seek employment in other fields. Nevertheless, the role of educating future agricultural researchers is critical to meeting future challenges.

It is interesting to contrast what may be considered flaws in agricultural present courses with those in environmental studies/sciences courses which are predicated on a philosophy surrounding environmental destruction by science. The latter courses while strong on ethics may be weak on scientific rigor while the reverse may be said of agricultural courses. The strengths of the two approaches may be most beneficially experienced if the approaches can be brought together in a single program. If agricultural education accommodates such a paradigm shift, it will be better placed to provide solutions to the problems outlined in Chapters 4 to 8.

Relationships Between MDCs and LDCs

There has been an historical trend for agricultural education in LDCs to follow the structure and approaches of MDCs. This trend has been strengthened by the delivery mechanisms of aid and international finance although, even in the absence of such interventions, governments of LDCs themselves have sought to emulate the approaches of MDCs. Whether this is appropriate should always have been open to question but at this time should particularly be so. There exists a need for LDC scientists to participate in a global community of peers. However, this need not mean that the organization in which such an individual in a LDC works is a replica of organizations in MDCs. The special problems of LDCs, such as high population levels, low levels of access to higher education, high levels of mobility of educated persons encouraged by poor reward structures, together suggest the need for specially designed approaches to agricultural education and research in LDCs.

The implementation of a widely accessible approach to natural resource education in MDCs and among responsible, and informed persons in all countries, may in fact be exerted through international finance and aid. Just as United Nations' sanctions in response to human rights abuses have been effective, so informed and considered approaches to the design of assistance in natural resource management fields may influence such education and research in LDCs. The same argument should apply to most other sectors. Lest this approach be seen as somewhat theoretical, let us remain aware of the opportunities to introduce electronic means of communication and learning environment in LDCs. Electronic systems can cater for huge numbers of persons at relatively low costs when compared to past foreign assistance and investment in agricultural education projects which consume substantial investment in buildings and staff.

The formula which required one highly educated lecturer to teach in his or her field to a group of 30 to 100 students in a classroom may no longer be relevant. As natural resource management education involves more use of distance electronic education, the knowledge and teaching skills of such individuals may be extended over larger numbers of learners. Concerns over assessment loads, cheating, lack of teacher-student interaction and a host of others, all present academic management issues for the future. They will be solved and may eventually be seen in the same context as past concerns over the use of electronic calculators as compared to mental arithmetic. The influence which major international financing institutions such as the World Bank, and leading international agricultural research centers such as those of the CGIAR, can be brought to bear to increase the efficiency of agricultural education in LDCs. The leaders and best teachers in each field should be the most accessible This will be the advent of the new wave of technology in education - whether it is owned and controlled by universities or not. Indeed it is a responsibility to utilize knowledge of technologies to such ends and to thus create a desirable future rather than simply react to whatever comes along.

A Designer Future

Some components of natural resource management education in the future may be:

- A sound understanding of the role and benefits of education
- Enhancing community understanding
- Natural resource management education as an essential component of all courses
- A reduction in the numbers of providers through a retreat to quality

- Appreciation of the role of technical experts and links to skills-based and higher education
- Enhanced appreciation of the role of researchers and improved efficiency in their-training
- Addressing of imbalances between the proportion of scientists working on major international food production issues between LDCs and MDCs
- Shifts in public attitudes towards natural resource management
- Resurgence of emphasis on food production agriculture by major international development agencies
- Recognition of the current comparative advantage of some MDCs in the science and technology of agriculture
- A shift from environmental awareness-raising towards viable industries which are based on environmental improvement
- Broadening agricultural education to include aesthetic and emotional components.

The benefits of education are illustrated in many analyses of economic development. For example, Tribe and Peel (1989) note the favorable circumstances for early agricultural development in Australia, one of which was access to knowledge and education. In the USA, Hightower (1973), criticizes the lack of access to *Education Across Distance* causing non-uniform agricultural development in the early days of the Land Grant Colleges of the USA.

Education Across Distance

… all these agencies [including Land Grant Colleges] *relieve first the good farmers. They aid those who reach out for new knowledge and for better things. The man who is strongly disadvantaged by natural location or other circumstances, is the last to avail himself of all these privileges ... The failure of a great many farmers may be less a fault of their own than a disadvantage of the conditions in which they find themselves. It is fairly incumbent on the state organization to provide effective means of increasing the satisfaction and profit of farming in the less-fortunate areas as well as in the favorable ones …* Liberty Hyde Bailey, Dean of College of Agriculture at Cornell University in 1911, quoted in Hightower (1973).

Broadening agricultural education to include aesthetic and emotional values is likely to be based on the development of greater ecological consciousness surrounding our place in nature. Developement of a land ethic, as distinct from a view of land as an asset to be used, is extolled by Roberts (1995). While the success of civilizations has historically been measured partially in economic terms, it has also been measured in terms of creativity and even spiritual values, and we should see the factors of economic necessity and environmental care going hand-in-hand in that context in the future. Technical education may be used to be introduce students to the need to embrace creative fields and the humanities in a global appreciation of natural resource management in the medium term future and beyond. Reviews of agricultural and related courses in the USA (for example, Kellogg, 1995) and Australia (for example, McColl and Chudleigh, 1991) tend to focus on technical aspects of agricultural and related education. The future introduction of humanitarian and social science values into agricultural education will likely be in a manner far more consequential than the extension and economic components of agricultural courses of the past and present.

A higher level of community understanding of environmental considerations and natural resource management will allow more rational discussion of, for example, the imperative of intensive food-production agriculture. It will also assist in allocation of appropriate public research funds for those public-good areas related to improved food production and improved environmental management. Such a situation may be analogous to the community wisdom which developed after the fifteenth century purging of witches; Clark (1981) quotes contemporary accounts of that time, *viz*; … *wheat inexplicably rotting in the fields, sheep dying of unknown causes, vineyards smitten with unseasonable frosts, human disease and impotence on the rise*. The immediate response through the publication of *The Hammer of the Witches (Malleus Maleficarum)* became what Huber (1993) describes as the medieval environmentalists' *Silent Spring*, through simple community misunderstanding of wider factors impacting on their environment. The Medieval period of witch-hunts passed and after massive purges, the effects of animal and plant diseases were seen in context. So may we see a general community appreciation of the imperatives of food production and of natural resource management as an overarching context.

The future should also seek increased attention to the inclusion of natural resource materials in all education. Pomerantz (1991) in evaluating education materials, concluded that insufficient attention has been paid to specific resource management issues and that students were not encouraged to develop analytical skills or environmentally conscious behavior. He noted that the challenge for natural resource education at elementary level is to make children aware of resource management issues and to then involve them in an informed and participatory level later. In New Zealand (NZNHF, 1995), the responsibility for introducing *Wider Environmental Education* in the community has been seen to lie with tertiary education in the first instance. Such education would be complemented by specific environmental competency which, in that document, is somewhat akin to the agricultural education metamorphous in to natural resource management education.

Wider Environmental Education

Sustainable living requires an environmentally literate and competent citizenry, and nowhere is this understanding more important than at tertiary levels of education, where tomorrow's leaders, teachers, managers and decision-makers are educated and trained. The principle of environmental sustainability should be central to all aspects of the tertiary education system - it's policy-making, management practices, its curricula, research programs, and all of its relationships and partnerships beyond the institution. (NZNHF, 1995)

A reduction in the number of agricultural education providers should be expected despite the above comments supporting its role and potential expansion. Some rationalization may relate to courses failing to adapt to changing requirements of funding resources and students. In other cases, it may seem a logical decision from the point of view of overall university management to fragment small agricultural faculties into their component disciplines within the faculties of science, social science and economics. In the USA, it has been suggested that by the year 2025 there may be only 25 land grant universities remaining - less than half the present number. Associated with such a rationalization should be an emphasis on quality and expertise in specific aspects of natural resource management. The ability of electronic communications to extend education further than previous distance education mechanisms will allow these entities to impact wider numbers of students. The creation of A*DEC (1996) and its predecessor *AgSat* provides a glimpse of future mechanisms for accessing natural resource management education. In likening the A*DEC approach to a supermarket in which potential purchasers can browse products on display and select those that suit, in terms of subject quality and presumably price, the need for leading lecturers at all institutions decreases. A*DEC management notes that while the supermarket analogy is appropriate, *mom and pop* stores will also continue in those cases where specific colleges require their own agricultural or natural resource management presence.

The trend to link high quality skills training programs to higher education may be expected to continue. The advantage of technical training for vocational purposes has been well established. Its linkages to higher education degrees in technical fields acknowledges the blend of skills and integrative knowledge that form those qualifications - this may apply to most of the professions. In discussing the engineering profession, Tribus (1978) claimed that persons involved in technology may be better placed to see future developments yet reticent to enter decision-making concerning such futures - refer to the Box - *The Silent Prophet?*

The Silent Prophet

… one overwhelming advantage is the technically trained person's ability to see much further into the future, insofar as the physical world is concerned than non-technical people … the engineers can construct mental or computer models of the world. They can even make crude models of social behavior. By these means they see just a little more into the future than their neighbors … [however, they] *stand around waiting to be invited into the decision making process … unfortunately, the only time they are apt to be invited in is when the situation has deteriorated so badly that it has become desperate.* (Tribus, 1978).

The role of research in natural resource management will become clearer and specific pathways will be developed to train new researchers. The efficiency of such training within present university systems is seen by some to be below capabilities. Linkages between research providing organizations, particularly in the applied sciences, and institutions charged with training such researchers will become stronger. This will lead to the graduate studies of future researchers involving accomplished research institute staff as lecturers and supervisors of their projects which in turn will be conducted increasingly in the laboratories and fields of research organizations.

The role of the university would be in those areas of its greatest strength namely, maintaining a balanced picture of the context in which research is conducted, quality control and associated accreditation. It may not be necessary in the future for applied science components of universities to employ the staff in all of the fields of services offered in their sphere of influence. This may enhance the role for the broadly based and up-to-date persons within universities to coordinate and manage such specialist inputs.

The imbalance in the scientific capability between LDCs and MDCs is likely to be partly redressed in the future as an essential response to increased food production and increased capability in natural resource management. However, this may not be simply the production of greater numbers of research scientists in LDCs. It may take the form of a greater responsibility for scientists in MDCs to utilize their expertise as widely as possible. Such expansion of responsibility may be facilitated through electronic communications as distinct from requiring frequent physical presences of scientists in multiple locations. In this way, the comparative advantage of MDCs in science and technology in the fields of agriculture and natural resource management will become clearer. Such comparative advantage may create commercial advantages for MDCs and be one of a range of future industries in which enhanced environmental outcomes are associated with financial rewards.

A shift in attitudes among informed persons in MDCs can also be expected. This has been introduced earlier in terms of the expected introduction of altruistic and emotional components of environmental subjects into natural resource management courses. Shifts in community attitudes will probably bring a reconciliation between science and the community as a greater understanding of the approaches and expected outcomes of applied science research is gained within the wider community. Changes in attitudes may be related to a general increase in concern for environmental welfare as a component of increasing the levels of comfort of human beings in living together.

Coupled with such understanding may develop a sense of responsibility to extend knowledge to LDCs where adjustment to changing circumstances such as high population growth and apparent helplessness in food production areas overwhelm decision makers. It will contrast with the view of the community expressed by Dostoyevsky that … *secular science … investigated everything handed down to us in sacred books* … [and has] *left nothing of what was held sacred before. But they have only investigated the parts and overlooked the whole, so much so that one cannot help being astonished at their blindness.* By conceiving agriculture as a major component of natural resource management, the integrative nature of existing agricultural courses will be further enhanced in providing a broader context for both research and education. In so doing it should avoid Dostoyevsky's trap of *overlooking the whole*.

The future may also see significant shifts in approaches of financing organizations such as the World Bank and aid donors. Whereas past projects have focused on pre-conceived ideas of the requirements to duplicate systems of MDCs in LDCs, present systems appear to be influenced by commercial interests in MDCs. The future should see increased interest in food production and investment to enhance its production across the world. Evidence of this occurring may be seen in recent statements of the President of the World Bank - refer to the Box - *Agriculture Phoenix*.

Agriculture Phoenix

The consciousness of all members of society about the problems of agriculture must be raised akin to that of the environment as was done at the Rio conference in 1992. After many trips to rural areas of the developing world, Wolfensohn [President of the World Bank] *strongly believes that agriculture is a crucial sector - the economies of many developing countries are nearly 75 per cent agriculturally-based - upon which the bank must focus. If the Bank wants to solve poverty and environmental problems in developing countries, there is no better way than to attack it through intelligent agricultural development. Reducing poverty, improving life in rural areas, strengthening village structures, building family incomes, and increasing employment can be addressed by a strong and focused emphasis on agriculture. Wolfensohn asked himself many times why he had not met with ministers of agriculture on his trips to developing countries.* (CASDC, 1996)

In addition to a focus on food production agriculture, critical analysis of the most appropriate means of broadening education concerning agriculture and natural resource management may lead to a significant shift away from investment in buildings towards communication which links universities and scientists in both MDCs and LDCs. Barriers to language, seen by some as preventing such communication systems from operating, maybe overcome in the same manner that textbook languages have been overcome in agricultural education in the past. Translation of English and other texts into the languages of students has been a major contribution to education in agriculture in many LDCs. Similarly, through electronic linkages, tutorial and language assistance can conceivably be offered by informed persons fluent in the languages of students.

Orienting natural resource management education, and agricultural education within it, to expected future industries in the sector is somewhat hazardous. It is difficult to conceive of the industries that will be important in the year 2050 in terms of natural resource management. Nevertheless, we may see the development of the environmental enhancement industry which regenerates saline and other polluted areas, re-establishment of rain forests and replanting of mangroves, for example, as specialist industries commanding significant income streams for countries with requisite expertise. Another such industry postulated by Ellyard (1996) is that of the waste-into-food industry in which waste from cities is directly converted into a useful product for food production through composting or other mechanisms. Such new industries will form one source of inputs for the design of natural resource management education.

Prophets And Profits

Prophets of the future environmental scenarios for the world commonly paint alarming scenarios. Indeed, the first two chapters of this book introduced some serious concerns. There is a danger in repeating this concern frequently - the wider community may become hardened to the message, and when it becomes urgent the community may have become deaf - another case of *Crying Wolf*. Daily news messages of catastrophes are presented to attract our attention. The over-riding message of concern should be that of the imperative for food production to meet increased numbers of people in the world and the consequences of such increased food production on the environment. The imperative of minimizing environmental destruction while increasing food production is the critical aspect of natural resource management. However, it is curious that such prophets do not commonly include the scenario in which humankind adapts and develops mechanisms to adjust to living on the planet under new circumstances of high population density. Nevertheless, the prophets have woken us up - refer to the Box - *Getting Our Attention*.

Ellyard (1996) expects positive human responses to opportunities that arise in terms of environmental regeneration and other industries associated with living under changing conditions. That profits could arise from such activities substantiates such postulations. It provides one more reason for optimism about the future. Orienting students and the community to understand the emergence of such opportunities for students to lead society in the future represents the path for natural resource management education.

Getting Our Attention

Despite the partiality of their prophecies, the modern environmental prophets deserve credit for alerting the community and, particularly the politicians, to the urgency of the most important combination of issues (population, poverty, hunger and environment) which faces mankind. Their efforts culminated in the biggest international conference that has ever been held - the 1992 United Nations Conference on the environment and development in Rio de Janeiro - which for a few brief weeks focused world attention on a range of critical environmental issues. (Tribe, 1994).

Designing a future for natural resource management education is analogous to a business planning activity. However, it requires a broader imagination of the possibilities that are desirable, the means by which they may be achieved and means to avoid closing-off opportunities.

The issues of today in education relating to natural resource management have been discussed in Chapters 3 to 6. Issues such as quality, access, skills-based training and articulation, declining budgets, staff tenure constraints in management, a focus on staff-designed courses and inputs in contrast to educational outputs, could all be used as a focus for future planning. However, focusing on removal of problems cannot be assumed to produce the best of desired outcomes. Focusing on problems can lead to some issues not being considered, such as the absence of altruism and emotion concerning the environment from agricultural courses, and neglecting to focus on the industries of the next century rather than the industries of today. The desirable outcome of designing a future is to conceive what that future might entail and to design, in this case, the educational programs to suit it and any necessary management systems needed for support. Given the long lead times for change in education coupled with the long periods of study involved for students, such a future perspective would seem the responsible way in which to plan future educational investment.

Elements of a future are emerging, such as introduced in Chapter 9. The *virtual university* may comprise several of today's universities. It would take a client and market orientation and seek to remain separate from traditional management systems of universities. By accessing the best courses available and having them adapted to distance education, a high quality and cost effective new era in natural resource education will arrive (A*DEC, 1996). However, such an apparently innovative approach does not yet represent the complete designing of a future. Nevertheless, it does represent an approach to solving today's problem of access and intransigence in the face of change.

The broadening global debate concerning agricultural and natural resource management education requires a significant push. In parallel with bold attempts to address current constraints and problems, there is a need for long term visioning based on a desirable future for education. Perhaps agricultural and natural resource management education does not require more than a handful of physical institutions, perhaps it does not require face-to-face teaching, perhaps laboratory and field instruction can be conducted on a basis which is far less labor intensive and involve industry to a greater extent. Perhaps LDCs can access both information and knowledge and participate in learning through such innovations as A*DEC; perhaps the provision of learning services does not need to be linked to certification.

The imperative of food production for rising numbers of people, a continued reliance on soil-based agriculture, and the need for continuing research and knowledge dissemination favors continued investment in agricultural and natural resource management education. The role of international finance institutions in stimulating such development in LDCs continues although investment may be better oriented to outcomes associated with improved access and improved ability to apply knowledge. As in MDCs, such outcomes appear to relate to investment in technologies which free education from its physical, institutional and social constraints. In fields as basic to human existence as food production and natural resource management, it is the responsibility of those engaged in delivery, management, and policy formulation to take a wider view of the future of education in these fields.

April 5, 1997 - One Thousand Days

Aged see visions at end of span
as dreams dreamt of hope not fear,
Bow to whom the future doth plan!
they the ones we must revere.

Each New Year, we new resolve,
One day's thought, short in extreme,
Like fin de siècle plans involve
one hundred days of future dream.

One thousand days to our new start,
A new millennium nigh,
What direction for man to chart?
Wisdom with power must vie.

Now the sole time to reconcile,
now the hour for equity,
Undo past wrongs which so beguile,
New epoch's first victory.

Design a future which all trust,
Bad's demise but part of good,
World with all fed is only just,
Built on global sibling-hood.

Then learning that great human gift,
released to all equals,
Lets soft screen glow span knowledge rift,
Thus falls cartel of Babel.

Sixty centuries with no plan,
Success outweighs all failure,
Plan the next for good of man,
Not perfect world, just better.

Lets be revered by future peers,
build a world with less real fears,
forsake the crystal orb and seers;
Last chance for one thousand years.

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