Research and Education for Sustainable Agriculture
Universiti Pertanian Malaysia Institutional Report

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Presented at the AAACU Tenth Biennial Convention
17 - 22 January 1995,
National Chung-Hsing University,
Taichung, Taiwan

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Summary

Malaysia has a surface area of 32.86 mill. ha of which 19.37 mill. ha are still under forest cover. Out of 13.78 mill. ha topographically suitable land for agriculture, 5.30 mill. ha have been cultivated mainly with perennial crops (4.72 mill. ha). Only 0.23 mill. ha are irrigated for rice while permanent pastures occupy less than 0.1 mill. ha. There is a strong pig and poultry industry, a patchy ruminant and dairy industry and a fast expanding aquaculture industry. Even though more than half of the population live in rural areas the proportion of employment in agriculture is fast decreasing.

Universiti Pertanian Malaysia (UPM), the major provider of tertiary level agricultural education offers a wide range of programmes in agriculture and environment - agriculture, horticulture, veterinary medicine, forestry, agricultural engineering, agribusiness, resource economics, food science and technology, biotechnology, environmental studies and agricultural education with an annual intake of 800 students. Elements of sustainable agriculture and environment are essentially integrated into the courses offered, the emphasis varying from 5% of the curricula contents in agricultural engineering to 15% in agriculture and 65% in environmental studies. For research on areas connected with sustainable agriculture and environment, government grant totalling RM 35.2 mill. (US$ 13.5 mill.) is received for the duration 1988 - 95. Additionally RM 0.5 mill. is obtained annually from local and international agencies. Yet, only one project "sustainable integrated rural development" focuses explicitly on sustainability.

Problems and constraints encountered in developing sustainable agriculture research and education include rigid curricula, duplication of topics, limited number of problem solving and systems approach in teaching, reluctance of faculty members to embark on systems studies and the long duration of experimental work in sustainable agriculture.

Sustainable agriculture is an imaginary concept with moving targets where sustainable risks are a lasting phenomenon. It merits treatment in its own right. It should be used not only to improve agricultural practices and provide a thrust for technological innovation but also be seen to guide government policy. Many environmental issues - deterioration of agricultural land, forestry, water and coastal resources and sustainability of food production systems need government policy adjustments. UPM can contribute by designing conceptual and theoretical framework on sustainable agriculture so that scenario projections can be made on each outstanding issue, thus providing alternatives for government policy.

Paper presented at the AAACU Tenth Biennial Convention, 17 - 22 January 1995, National Chung Hsing University, Taichung, Taiwan

1. Overview of the Agricultural Sector[1]

Malaysia has a total land area of 32.86 million hectares of whicn 13.78 million hectares are topographically suitable for agriculture. The rest are too steep and hence recommended to be under permanent forest cover. Of the 13.78 million ha topographically suitable land 5.30 million ha have been cultivated (Table 1) mainly with permanent tree crops (4.72 mill. ha). Only 0.23 million hectares are irrigated and entirely used for lowland paddy. Permanent pastures occupy less than 0.1 millio1xhectares. The bulk of the land is still under forest cover, totalling 19.37 million hectares or 58.9% of the country's surface.

Table 1 Land Resources and Agricultural Landuse in Malaysia (Compiled from Various Sources)

	million ha	%
Total land area	32.86	100.0
Topographically suitable land for agriculture	13.78	41.9
Arable land	5.21	15.9
Lowland < 150 m asl		49.0
Upland > 150 m asl		51.0
> 300 m asl		30.0
Irrigated land	0.23	0.7
Permanent crops	4.72	14.4
Permanent pastures	< 0.1	0.3
Forest land	19.37	58.9

N.B. Landuse based on 1993 estimates.

[1] This section and the next (2) heavily draw on Wan Sulaiman *et al* (1993)

Land and soil

Up to 70% of the land surface is covered by soils developed from granite and various metamorphic and sedimentary rocks. These are highly weathered, infertile and acidic. The more fertile soils of the marine and river alluvia make up less than 20% of the surface. Other soils of economic importance are the so-called "problem soils" consisting of 2.4 mill. ha of peats and organic soils, 0.5 mill. ha of acid sulphate soils and 0.36 mill. ha of beach sands and tin tailings soils. The problem soils require special treatment with high financial and technical inputs for sustainable crop production.

Dominant farming systems

The agricultural or farming system is characterized by an efficient well-organised estate sub-sector of large private plantations and smallholder mini-estates, and group farms engaged in the export-oriented production of oil palm, rubber and cocoa taking up almost 50% of the arable land and a less-organised, individually farmed smallholder sub-sector engaged in similar tree crops, food crops and mixed farming of pepper, fruits, vegetables, tobacco, maize, tapioca and others. Almost the entire food crop sector including rice are in the latter category. About 80% of the total cropped land is planted to mono-cultures of oil palm, rubber and cocoa (see Table 2). The livestock production is also dichotomous, featuring a highly organised pig and poultry industry which more than meets the country's needs (Table 3) and a patchy ruminant and dairy industry. There is a heavy dependence on marine fisheries while aquaculture is fast becoming a highly organised industry although still small with inadequate marketing infrastructure.

Table 2: Agriculture Landuse in Hectares 1985-93

Crop	1985[1]	1990[1]	1993[2]
Rubber	1,948,700	1,810,800	1,542,000
Oil palm	1,482,399	1,948,167	2,281,000
Cocoa	303,879	420,000	350,000
Rice	355,000	363,429	365,000
Coconut	334,054	331,496	320,000
Pepper	5,243	9,400	9,727
Pineapple	10,007	7,060	7,100
Vegetables	14,546	14,692	35,945
Fruits	134,000	192,000	217,669
Tobacco	16,184	10,168	12,355
Others	69,026	65,046	65,000

Source: [1]Sixth Malaysia Plan 1991-95.
[2]Economic Report, Ministry of Finance 1993/94; Department of Statistics, Malaysia; Malaysia Agricultural Directory & Index 95/96.

Table 3: Self-sufficiency level (%) of livestock production in Peninsular Malaysia

Livestock	1985	1990	1992
Beef	37.7	24.1	22.8
Mutton	9.2	9.0	7.3
Pork	103.4	131.5	137.0
Poultry	104.3	117.6	115.2
Egg	104.3	111.0	111.9
Milk	4.5	4.7	3.5

Source: Department of Veterinary Services

1.3 *Forest conditions*

In the effort boost agricultural production through large scale establishment of tree crops, vast areas of forest land have been converted to agriculture beginning in the early part of the century and accelerated in the period 1956 to 1990. Today forest land totalling 19.37 million ha comprises 16.78 mill. of mixed dipterocarp, 1.94 mill. ha of swamp forest and 0.65 mill. ha of mangrove. These are gazetted into 15.92 mill. ha Permanent Forest Reserve (PFR) and 3.45 mill. ha Conversion Forest which could be converted to other land uses such as agriculture and infrastructure development (Table 4).

Table 4: Forest Landuse in Malaysia - 1990
(Source: Min. of Primary Industries Malaysia, 1992)

Category	Area (mill. ha)	Condition
Protection Forests without logging - National parks, wildlife & bird	2.13	To remain in virgin state nor clearing activities.
Production Forests timber practices, eg.,	13.79	Designated for extraction of where sound management Selective Management System, are mandated.
Conversion Forests uses	3.45	To be converted to other land (agriculture, infrastructure, etc)

Protection Forest + Production Forest = Permanent Forest Reserve (PFR)

For Malaysia, stability of the forest ecosystem is very important to safeguard water supplies for agriculture, industry and domestic use, apart from maintaining a sustainable timber production level. In recent years, the pace of forest conversion to large scale agricultural production has slowed down as suitable areas decline and the country moved into greater industrialisation. Nonetheless, indiscriminate felling in production forests still occurs causing excessive soil damage and siltation as well as damaging undergrowth and younger trees and slowing down regeneration.

1.4 Agricultural Population

About 10.1 million people representing 56% of the country's population live in rural areas in different types of settlements. The latter could be traditional villages, land development schemes, in-situ development areas or integrated agriculture development project areas. Poverty incidence in rural areas is at 21.8% (1990 estimate), higher than the national average of 17%. But poor rural households experienced the most rapid growth in incomes since 1970 as they diversified their economic activities. The growth and demand for non-agricultural labour encouraged large numbers of self-employed and unpaid family workers to enter the wage labour market. Thus by 1990, employment in the agriculture sector had shrunk to 27.8% of the 6.621 million total employed labour force. Labour shortage in the agriculture sector has caused a shift to less labour intensive crops like oil palm, and use of foreign labour and increased mechanisation. Women make up 28.2% of the agricultural labour force whilst only 2.5% of households are headed by them. About 1.42 million rural youth have participated in agricultural production and development process.

2. Role of Universiti Pertanian Malaysia (UPM) in Sustainable Agriculture

2.1 Education

Tertiary level agricultural education in Malaysia is provided almost entirely by UPM. The university offers wide ranging programmes in agriculture and environment - agriculture, horticulture, veterinary medicine, forestry, agricultural engineering, agribusiness, resource economics, fisheries, food science and technology, biotechnology, environmental studies and agricultural education with an annual student intake of about 800. Elements of sustainable agriculture and environmental education are essentially integrated into the courses offered. The emphasis, however, vary considerably according to programme, from about 5% of the total curriculum for the agricultural engineering programme, 15% for agriculture and forestry to 65% for environmental studies. The number of courses offered by the faculties offering the relevant programmes and the areas or topics covered are given in Table 5.

3.2 Research

University research activities related to sustainable agriculture and environment cover a broad spectrum. Table 6 gives a summary of the scope of research and funding from the Ministry of Science, Technology and Environment under the Intensification of Research in Priority Areas (IRPA) programme. A total of RM 35.204 million was allocated for the duration 1988 - 95 for 31 projects up to 1990 and 38 projects for the period 1991 - 95. An estimated RM 500,000 is obtained annually from other local and international agencies (PETRONAS, ESSO, ICI, UNEP, UNESCO, IAEA, ACIAR, IDRC, winrock, etc.) to conduct research on management of soil acidity, conservation on sloping land, honey bee keeping, urea volatilization and other environment and sustainable development related issues. Only one project funded through the Inter-Institutional Linkages Programme (IILP) - ASEAN/New Zealand focuses explicitly on sustainability - "Sustainable Integrated Rural Development."

3.3 Progress

Environmental elements have been given their due share and importance within the framework of the present curricula and existing courses. With the increased awareness of environmental issues, the contents are now given new perspectives and focus towards sound environmental practices and sustainable agricultural production. This is a departure from the classical approach towards maximisation of yield and profit. Proposals are underway to increase environmental and sustainable development contents in the revised curricula giving the emphasis to agricutlural systems and global agriculture as well as

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Table 5: Sustainable development and environmental related courses offered at Universiti Pertanian Malaysia

Faculty	No. of courses	Areas/topics covered
Agriculture	21	Soil conservation, water management, recycling and organic fertilizer use, management of soil fertility, Integrated Pest Management and Biological Control, ecological cropping systems, germplasm conservation, agricultural waste management, landscaping, soil survey and landuse.
Veterinary Medicine and Animal Science	6	Forage, livestock production
Forestry	8	Sustainable forest manageement, watershed management, natural resources management, forest ecology, landuse planning.
Fisheries and Marine Science	8	Aquatic ecology, toxicology and pollution, inland fisheries management, tropical marine ecology, benthic ecology, limnology.
Science and Environmental Studies	25	Ecology, aquatic biology, tropical forest ecology, genetic conservation and utilization of plants, environmental science, hydrology and water resources, water quality and treatment, EIA, environmental planning and management, environmental chemistry, pollution biology.
Engineering	5	Soil and water conservation engineering, water resources development, resources and agricultural production.
Economics & Management	5	Natural resources economics and policies, forest economics, environmental conservation.

Table 5: Sustainable development and environmental related courses offered at Universiti Pertanian Malaysia (continued)

Faculty	No. of courses	Areas/topics covered
Food Science Biotechnology	3	Biological nitrogen fixation, waste management & and utilization, industrial and urban wastes.
Extension & Continuing Education	6	Environment and development, farmer development education, community development, extension programme development, youth programme development.

introducing a separate course on environmental and resource management. At the Faculty of Agriculture in particular, the number of final year undergraduate research projects between 1988 - 1992 dealing with environment and sustainable development issues were high in the order of 37 -47% of the total number. Research on environmental related projects have increased over the years both in terms of number of projects or programmes and financial support. During the period 1988 - 90, the faculty spent US$ 1505 mill. (64% of total research budget) on 12 out of 19 research programmes. These have increased to US$ 3092 mill. allocation for 15 out of 26 programmes for the period 1991 - 95. These are all positive indicators of the progress in the integration of environmental and sustainable development elements into the faculty activities.

3.4 Problems and Constraints

In the development of sustainable agriculture research and education, the university encountered several problems and constraints, the most important of which are listed below.

Table 6: Research activities and finding via the intensification of Research in Priority Areas (IRPA) Programme

Lead Faculty	Research areas & scope	No. of Projects 1988 - 1991	No. of Projects 1990 1995	Allocation (mill. RM) 1988 - 1991	Allocation (mill. RM) 1990 1995
Agriculture	Soil & crop mngmt., recycling germplasm conserv., agro-ecosystems, IPM, beneficial insects	11	13	3.847	7.885
Vet. Med. & An. Sc.	Mngmt. & conserv. of animal stocks, feeds & nutrition	3	1	2.037	0.534
Forestry	Mngmt. of hill forest, forest plantations, utilizn. of forest resources	3	3	1.503	1.593
Fisheries & Marine Sc.	Fisheries mngmt., capture fisheries, aquaculture coastal studies	4	3	1.821	2.388
Science & Env. Studies	Ecology, biodiversity, env. quality & pollution control, marine & coastal env., groundwater, EIA, planning & mngmt.	7	13	2.021	8.428
Encineering	Soil & water conserv., Ind. & Agrowaste tech., land reclamation	2	4	0.546	0.192
Econ. & Mngmt.	Mngmt. of natural resources		1		0.541
Extention & Continuing Educ.	Health & family dev.	1		0.157	
Total		31	38	11.923	23.281

2.55 RM = US$

Education

- Curricula too rigid to allow substantial inclusion of environment and sustainable agriculture as separate courses or as part of existing courses.
- Shortage of reference materials for teaching purposes.
- Duplication or unwarranted overlapping of topics between courses offered by different departments.
- Limited use of problem-solving and systems approach in teaching.
- Limited number of faculty members capable of viewing agriculture with comprehensive and holistic perspective and having adequate field experience.
- Reluctance of faculty members to adjust or transcend from mono-disciplinary and rational approach to multi-disciplinary and holistic approach.
- Open-ended nature of environmental problems and their lack of clear boundaries are a welcome challenge to some students but too intimidating to others.
- Low priority of extension education compared to undergraduate teaching and research.
- Limited number of faculty members with background on extension methodologies.

Research

- Difficulty in forming effective multi-disciplinary teams of researchers in environment and sustainable development.
- Long-term nature of experimental work on sustainable agriculture.
- Bias of existing evaluation and system towards mono-disciplinary research.
- Lack of academic recognition in systems studies.

3.4 Prospects

The approach in integrating environment and sustainable development into the curricula and research programme was based on the philosophy that natural resources and the environment are the bases of agriculture, thus, their preservation or conservation is vital for sustainable agricultural productivity.Yet sustainable agriculture, encompassing attributes of being ecologically sound, environment friendly, economically viable and socially acceptable is essentially an imaginary concept and cannot be measured. Economic viability is a constantly moving target while attitudes towards sustainability diverge considerably and technological capabilities influence ecological and environmental soundness. The operationalization of sustainable agriculture concept will always involve uncertainties associated with the interdependence of environment and society. The resultant risks for the environment and the economy will have to be weighed against each other before the sustainability concept can be manageably translated into policy terms. Sustainable risks are a lasting phenomenon. Therefore, sustainable agriculture merits to be recognised and treated in its own right instead of being merely infused into traditional subjects.

The concept of sustainable agriculture has been used extensively to improve agricultural practices as well as providing a thrust for technological innovations. Beyond these, the concepts, approaches or elaborations must also be seen to affect and guide government policy. UPM should enhance its capabilities in sustainable agriculture in order to contribute more effectively in this area.

It has been suggested that (Taylor, 1992) prior to formulating policies for sustainable development, a country must have some notion of (1) the relative seriousness of various threats to her ecosystem/society and (2) the prospective viability of alternative approaches for dealing with these threats. In some cases, a country may know with confidence **a priori** highest priority problem confronting her ecosystem/society that should be targeted for attention and alternative approaches that should be pursued to overcome the problems. In many cases, however, existing information is inadequate

to effectively formulate policies to overcome major threats to the long-term sustainability of a country. If so, a high priority need is for research to determine the relative seriousness of various potential problems and to explore alternative ways to overcome these problems.

In the context of Malaysian agriculture major environmental related problems are as follows:

a. Land and soil degradation through erosion caused by conversion of forest to large scale agricultural development, indiscriminate logging, shifting cultivation, vegetable farming on steep slopes and cultivating annual crops on upland soils.

b. Deterioration of forestry resources with loss of biodiversity and genetic variability due to excessive harvesting, forest conversion and disturbance of natural habitats.

c. Deterioration of water resources due to sedimentation from logging and agricultural activities and housing development as well as pollution by agricultural, industrial and urban wastes.

d. Deterioration of coastal resources due to inland and off-shore activities.

e. Health hazards due to heavy use of agricultural chemicals particularly herbicides.

f. Heavy extraction of groundwater that might cause secondary problems such as land subsidence, lowering of water table and salt water intrusion in certain areas.

g. Low productivity of smallholders that could lead to abandonment or poor management of their smallholdings.

h. Sustainability of food production systems.

In all these cases it might be possible to scientifically determine the limits to the burden that may be imposed on the environment with the auxiliary notion that these limits are not fixed but derive from judgements as to the goal to be pursued. Some of these could be derived from the current

research projects. New projects may need to be designed to derive others. These limits or risks can then be weighed against the socio-economic impact of activities that led to them.

The Scientific Council for Scientific Policy (WRR) of the Netherlands identified four 'action perspectives' that may justifiably be labelled as 'sustainable' (Rabbinge, 1994). These have been termed Exploiting, Saving, Managing and Preserving. The exploiting action perspective is based on confidence in the resistance of the environment while in the saving action perspective confidence in the resilience of the environment does not extend across the board. Under the preserving action perspective, the risks to the ecological system are avoided as far as possible while the managing action perspective exhibits little confidence in the resilience of the environment. The four action perspectives have been elaborated in the form of scenarios looking to the year 2040 in respect of the course of a number of basic environment issues such as the world food supply, nature conservation and water management. For each case, comparison is made with a reference scenario which sets out the potential developments given unchanged policies. The results in most cases provide clear evidence of situations that may be regarded as sustainable.

A similar approach initially, perhaps more simplified should be developed at UPM in order to effectively contribute to government policy formulation. Concurrently, courses should be introduced at senior undergraduate or graduate level aimed at a more rigorous treatment of concepts of sustainable agriculture and sustainable development. With the imminent merger of agriculture and agriculture related faculties into a much larger Bioresource and Technology Faculty, prospects are brighter for a stronger promotion of sustainable agriculture in research and education at UPM and for a more effective role in policy formulation.

Acknowledgement

The author would like to thank the Vice Chancellor of Universiti Pertanian Malaysia for consenting to the presentation of this paper and the AAACU for the financial support to attend their Tenth Biennial Convention.

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