AGRICULTURE and MAN

PRT 2008

PRT 2008 (Chapter 1 - 9)
A University Course

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PREFACE

A course on general agriculture as a core university discipline for all students was mooted in 2004 by the Vice-Chancellor of Universiti Putra Malaysia (UPM). The primary aim of this course is to instill an affection and appreciation for agriculture while fostering an increased awareness of our environment, more so as UPM presents itself as the centre of excellence in agriculture.

The revival in focus on agriculture by the government as an economic force and the re-positioning of UPM as the reference tertiary institution for agricultural studies and research in Malaysia, has made such a familiarization course in agriculture for all freshmen irrespective of their programme of study, even more relevant.

In this text we begin with an overall view of agriculture, defining its importance and scope, while examining different agricultural systems and their economic ramifications. We next trace the evolution of agriculture, starting with the pre-historic era until present times, from a non-directional survival activity along river basins, into an intentional undertaking on a subsistence basis, culminating in its modern day prominence in commerce and industry. An insight is presented on a transformation that saw age-old customs and taboos slowly abandoned through new knowledge inputs, a nomadic culture substituted with a sedentary one, human and animal labour replaced with mechanization, primary production sharing importance with secondary downstream processing.

Agricultural evolution is underlined by agricultural revolution. The causal effects of green and blue revolution such as resource constraints, population explosion, product diversification and non-environmentally-friendly practices are discussed together with the impetus given to the revolution by mechanization, automation, precision technology, biotechnology, sustainable practices and chemical inputs. Physical, chemical and biological including genetic resources that are ultimately responsible for agricultural output are presented. It will be seen that climate, incorporating both temperature and rainfall, and soil determine the type of crop that can be cultivated, resulting in agroecological zones. Natural selection of species adapted to particular niches gives rise to centres of crop origins. Biodiversity as a global resource and its conservation with respect to germplasm is stressed. Depletion of resources underlines the importance of a sustainable farming system capable of maintaining productivity and usefulness to society indefinitely. Sustainability is viewed from the standpoint of economic benefit, environmental conservation and socio-political awareness.

Progress in any field of human endeavour particularly the sciences, has through the ages been achieved only on the back of research and development. R & D in agriculture has seen yields jumped many folds through improved germplasm, disease resistance, pests control, technology and nutrients supply. In many instances this has been accomplished through innovative approaches that do not compromise human safety or the environment. This R & D aspect in agriculture, together with legislative and standards, is viewed with particular references to the Malaysian context. We are justifiably proud
to have an oil palm estate that is the world’s largest, and a company that beats all others internationally in supply of downstream-produced rubber gloves. Development of agriculture in Malaysia is carefully planned with a current Third National Agricultural Policy in place. Food self-sufficiency is emphasized with fisheries and forestry gaining prominence. We conclude the text with outlining various legislative acts governing agriculture, forestry and the environment, and a reference to Malaysian standards, guidelines and accreditation.

This course, Agriculture and Man commenced in 2006 with an enrollment of 5000 students. It will be franchised to several other institutions of higher learning through a distance learning programme, starting in 2007. The planning and conduct of this course by the Faculty of Agriculture is a little contribution by the Faculty towards bringing to fruition the university’s vision.

In writing this text, we have relied on information sourced from various books, journals, published data, some of our own personal knowledge, and inputs from our colleagues, in the form of information and illustrations. We are indebted and especially wish to acknowledge the contributions from Professor Dr. Shamshuddin Jusop, Professor Dr. Zaharah Abdul Rahman, Assoc. Professor Dr. Ridawan Abdul Halim, Assoc. Professor Dr. Mohd. Said Saad, Assoc. Professor Dr. Radziah Othman, Assoc. Professor Dr. Zainal Abidin Mohamed, Associate Professor Dr. Amin Mahir Abdullah, and Dr. Adam Puteh.

Prof. Dr. Yusof Ibrahim
Assoc. Prof. Dr. Tan Yee How
June, 2007.
a. Information about the course

Department: Dean Office, Faculty of Agriculture

Name of course: Pertanian dan Manusia  
(Agriculture and Man)

Course Code: PRT 2008

Credit Hour: 2 (2+0)

This course explores the evolution of agriculture from the beginnings to its present status as a planned and managed activities, driven by economic and technological advancement. Modern agriculture is presented as a science, an art and a business encompassing its role and impact on resource management and human development. Discussion also incorporates Malaysian agriculture scenarios.

b. Information about the authors

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c. Objectives
At the end of the course, a student can:

a. explain the role of agriculture in the development of civilization and well being of mankind. \( \text{(C2)} \)
b. discuss the importance of agricultural resources and their management for the development of sustainable agriculture. \( \text{(A3)} \)
c. explain the importance of agricultural sector in the production of food resources, protection, medicinal and basic industrial resources towards economic development. \( \text{(P2)} \)

d. Course Content
1. INTRODUCTION AND SCOPE OF MODERN AGRICULTURE
   - Definition of Agriculture
   - Importance of Agriculture
   - Agricultural Systems and Practices
   - Downstream Processing
f. Examination

Students are required to sit mid term and final examinations. All questions will be based on the module provided to the students. Questions include objective types (multiple choice, true/false and matching) and subjective in the form of short notes. Further informations will be sent via e-mail or the instructors at the respective learning centres. Total marks for these examinations are 80% (mid term 40%, final 40%)

Sample questions are as follows:

True/False

Malaysia is well known for its expertise in the management in tropical industrial crops such as rubber and oil palm. [The answer is true]

Multiple Choice

Soil erosion due to heavy rainfall in the hilly agricultural areas of the tropics can be minimised by:

a. Planting only forest trees
b. Constructing terraces during planting
c. Planting only cover crops
d. Constructing modern drainage system
e. Constructing terraces and planting cover crops
   (The answer is e)

Short Note

Explain the term sustainable agriculture.

Answer: A farming system that is capable of maintaining their productivity and usefulness to society indefinitely by being resource-conserving, socially supportive, commercially competitive and environmentally sound.
References

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     Domestication of Plants and Animals
   - Utilisation of Human Labour, Animals, Machines,
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   - Values, Customs and Taboos in Traditional and
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   - The Culture of Nomadic and Sedentary Agriculture
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   - Genetic Variation and Conservation of Genetic Resources

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   - Environmental Conservation
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   - Planning and Decision Making
7. ECONOMICS OF AGRICULTURAL DEVELOPMENT
   - Contribution of Agriculture to Malaysian Economy
   - International Trade in Agriculture

8. INNOVATION AND CHALLENGES IN AGRICULTURE
   - Research and Innovation Technology
   - Future Challenges in Agriculture

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   - National Agricultural Policy
   - Education, Research and Development, Extension and Target Groups
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- Future Challenges to Agriculture

9 **Approaches to Agricultural Development in Malaysia.**
- National Agricultural Policy
- Education, Research and Development, Extension and Target Groups
- Legislations and Standards

e. **Evaluation :**

1. Mid Term Exam 40.0%
2. Assignment 20.0%
3. Final Exam 40.0%

Total 100%
CHAPTER 1
INTRODUCTION AND SCOPE OF MODERN AGRICULTURE

Malaysia is currently a major player in research of tropical agricultural products. It strives to continue to enhance excellence in research and development of new agricultural industries and products from its primary commodities and natural resources. Developing new industries from its rich natural resources will assist in the industrialization of the nation, whilst developing new high value products from the agricultural commodities as well as agricultural waste and by-products would further improve Malaysia’s productivity and global competitiveness. Creating new markets for our products will assure the continued significant contribution of the agricultural sector to export earnings. Pursuing integrated agroforestry development and good sustainable agricultural and forestry practices will ensure an ecologically balanced development, whilst increasing the production of major food products which are cost competitive will enhance food security and enable Malaysians better access to quality food at affordable prices.

To achieve excellence in agriculture, human resource development especially in new and emerging areas of agricultural science as well as professional farm managers to run large-scale mixed farming enterprises are essential. Emphasis will therefore be put towards developing those expertise.

The government has always provided the environment for the development of the agricultural sector to be private sector-driven. The public sector will facilitate and enhance the delivery of support services to the private sector enterprises, farmers and fishermen to achieve their business and income objectives. Likewise, state governments have to play a prominent role to support private sector needs as land is under their purview. (adapted from the message of the then Malaysian Prime Minister, Tun Mahathir Mohamad, 1999).
It is the utilisation of natural resource systems to produce commodities which maintain life, including food, fiber, forest products, horticultural crops, and their related services.

It involves farming; the art and science or practice of cultivating the soil, systematic production of crops for food, feed and fiber, and raising of livestock, and at the same time protecting it from deterioration and misuse.

Modern agriculture is a business; it is not only the production, but also the processing of produce into food and non-food items. For example, in oil palm the primary produce is the palm oil. The oil can be processed into many other food items, pharmaceuticals and industrial products, and recently into biofuel; similarly with rubber, cocoa and herbal plants.

There have been continual improvements in agricultural methods, implements and resources that involve specialists such as scientists, inventors, engineers, chemists and economists although many have nothing to do with food production, these specialists are said to be in agriculture.

Modern agriculture incorporates subjects such as agronomy, horticulture, plant breeding and genetics, entomology, pathology, soil science, dairying and animal husbandry.

Present-day farming also adopts some non-traditional agricultural practices such as soilless culture or hydroponics in which high value plants are grown in chemical nutrient solutions.

The packing, processing and marketing of agricultural produce are closely related activities which are also important aspect in modern agriculture.
TOPIC 2. IMPORTANCE of AGRICULTURE

At least 40% (2002 estimate) of the world’s population is employed in agriculture, making it the most common occupation. Asia’s share of the agricultural labour force reaches 86% (India & China = 60%), Africa has 14%, Europe less than 10%, Latin America at about 3.5%, while North America barely exceeds 1% (highly mechanised farming).

Traditional farming, sometimes referred to as subsistence agriculture, ensures the production of enough food to meet the needs of the family. This form of agriculture is practiced particularly in many underdeveloped countries (majority of which are in the African continent), where survival can be a day to day affair.

In the developed and industrialized countries and increasingly so in the more advanced developing countries like Malaysia, farming is an industrial intensive agriculture producing raw materials such as rubber, palm oil, cocoa, fish and livestock for the industrialized nations.

A government is very much dependent on agriculture in difficult times such as drought and other natural calamities to maintain socio-political stability. Those are days when food can become very scarce and as such a country must undertake certain measures of food stock-pile as a form of food security.

More recently, income is further derived from the transformation of agricultural wastes into feeds and fertilizers (organic farms), and oil palm wood press, and high value wooden tiles (water-proof).

Environmental pollution is one of the negative aspects of agriculture. Soil conservation and nutrient management have been important concerns since 1950s; however, increasing contamination of the soil and the environment has, for example, polluted the waterways and wetlands with (1) nitrogen and phosphorus from the inorganic fertilizers and (2) pesticides and other biocides have affected the biodiversity of plants and animals.
TOPIC 3. AGRICULTURAL SYSTEMS and PRACTICES

Practices in agriculture can be broadly categorised into (a) subsistence farming and (b) commercialised farming.

3.1 Subsistence Farming

It is characterised by a low input with a resultant low yield, and inter-cropping. Practices may involve slash and burn (nomadic) and more progressive stationary cultivation.

Subsistence farming involves working on a plot of land to produce only enough food to feed the family working on it. Success is highly dependent on soil fertility, climate, tools and techniques, agricultural practices and available crop types. The land produces enough food to sustain the family in their normal daily activities, but no surplus to take to the market or store for later use. Although it does not promote accumulation of capital, subsistence farming entails fewer working hours. As such it provides the family with the necessities to live a healthy and comfortable life without the stress incurred in modern day living.

3.1.1 Shifting Cultivation.

It is the most primitive form of Subsistence farming and still being practiced in the tropics. As the soil fertility wanes, farmers abandon the plot and a considerable fallow period ensues.

An improvement over shifting cultivation is one in which a family works permanently on a plot of land. This type of land develops from one that has undergone a slash and burn type of cultivation. The soil nutrient quality is inherently poor thus offering scant yields. Under such conditions, repeated cycles of poor harvests result in food scarcity and possibly famine.

Socio-economic conditions may lead a reduction in a farm plot when inheritance tradition requires that a plot be split among the children. However, when a government policy dictates large-scale farming with external inputs, the social fabric of rural society is undermined forcing farm families to migrate to cities.

Raising domesticated livestock for food and small profit, mostly limited to free-range and small enclosures, is now practiced. Examples could be seen in the case of rearing fishes in small
ponds and paddy fields, and the raising of pigs, ruminants (cows, goats, sheeps) and poultry in makeshift sheds.

Subsistence farming (as of 2006) is still practiced in:
- Africa – Benin, Botswana, Congo, Guinea, Rwanda, Madagascar, Sierra Leone and Zambia.
- Central and South America – Mexico, Ecuador and Bolivia.
- Europe – Yugoslavia and Albania.
- Polynesia – Papua New Guinea, Vanuatu.
- SE-Asia – Sarawak, Indonesian Borneo, Laos, Cambodia.

3.2 Commercialised Farming

It is characterised by monoculture or a cultivation of a combination of a few crops. It entails the usage of high yielding modern varieties, large chemical input (pesticides and fertilizers and animal feeds), high technology and extensive mechanisation.

Examples of commercial farming are discussed below:

3.2.1 Tropical Plantation Agriculture.

It is solely a monocropping system dominated by perennial crops which include rubber, oil palm, cocoa, coffee, coconut and tea. It is suitable for a humid-tropical climate exemplified by a forested environment. The produce is typically utilised as raw material in industrialised nations. Malaysia utilises some of these raw materials for her own industries. In fact in the case of cocoa, shortage of raw beans necessitates import from Indonesia and New Guinea. For downstream processing, such as palm oil extraction, large industrialised companies conduct their operations on site. Further processing of the extracted oil into value added products such as margarine and carotenes are conducted at factories elsewhere. Small holdings or peasant units who sell their produce to the government.
3.2.2 Vegetable Farming.
It is labour intensive and involves specialised cultivation in rows and blocks (beds), open or enclosed. The use of machinery has increased efficiency and output. The diversity of vegetable crops requires the use of various techniques to optimise yield. Due to market demand for fresh vegetables, ripening technologies and refrigeration have been developed. Fruit and flower farms face similar challenges.

3.2.2.1 Organic farming.
It involves crop rotation where dissimilar crops are grown on the same plot in sequential seasons to avoid building up of pests and diseases. Rotation also helps balance the fertility demands of various crops so that excessive depletion of soil nutrients is avoided.

3.2.2.2 Hydroponics.
It is the technique of growing plants without soil, taking advantage of the fact that plants absorb nutrients as simple ions in water. Plants grown in a controlled environment can produce more since they are arranged at a higher density. Often higher quality is achievable in lesser time. There is little likelihood of soil-borne diseases, weeds to pull or soil to till. Since it is a water-efficient system, only a small fraction of water is used compared to traditional farming. Plants are placed in a container of nutrient solution in a growing medium such as perlite, vermiculite, peat moss, coco coir, brickshard, sand and gravel.
Systems available include, for example water culture, drip feeding, nutrient film technique (NFT) and aeroponics.

The water culture system is the simplest whereby the plant roots are suspended and allowed to hang down or float into aerated nutrient solution. In drip feeding technique, the most widely used system, plants in the growing medium are flushed with a nutrient solution delivered in a drip cycle, often timer-control operated.

In the case of NFT, plants are grown in channels into which the nutrient solution is pumped constantly. Plants are kept moist by the thin film of nutrient solution as it passes by. This technique is susceptible to power outage and pump failures. The aeroponics is probably the most high-tech type. Plants are grown with their roots suspended in a mist of nutrient solution delivered by a mist sprayer controlled by a short cycle timer.

3.2.2.3 Aquaculture.

It is a purposeful cultivation of aquatic organisms as opposed to simply catching them from the wild. Aquaculture includes mariculture (culture in the ocean), algaculture (production of kelp/seaweed and other algae), fish and prawn farming (raising of catfish, tilapia and prawns in fresh water tanks/net-pans/ponds or salmon in marine enclosures) and the growing of oysters and cultured
pearls. In special cases, semi-aquatic animals such as crocodiles, frogs and snails can also be raised in tanks and ponds.

3.2.2.4 Livestock farming.

It involves raising livestocks (domesticated animals intentionally reared in agricultural setting) to make products such as food or fibre, or for its labour. Raising animals (animal husbandry) is an important component of modern agriculture. Domesticated animals include cows, goats, pigs, sheeps, horses and poultry. Livestock are generally kept in an enclosure or allowed to roam freely (free rangeland).

3.2.2.5 New products and future industries.

As envisaged in the Third National Agricultural Policy (NAP3), the development of biotechnology products, extraction of specialty natural chemicals from biological resources and utilization of oil palm biomass are emphasized to create new higher value industries. Examples include recreational fishery, agroforestry, herbal farming, mushroom cultivation and agrotourism.
TOPIC 4. DOWNSTREAM PROCESSING

Food and industrial processing are downstream activities of primary agriculture. They can be examined from the viewpoint of their primary sources, whether plants or animals.

4.1 Food Processing

4.1.1 Plant Origin.
Fruits are processed for their juices, cordials, jems and jelly, herbal and health products and as pickled and dehydrated ware.

Other sources processed include rice, sugar, spices, cereals, tomatoes, chillies and cocoa. Foods could be packed, canned or bottled as in the case of candies, ketchup, cookies and crisps.

4.1.2 Animal Origin.
Meats are processed into burgers, sausages and nuggets. Fish are dried, salted or canned such as sardines. Dairy produced can be processed as powders, canned milk, cheeses and fermented beverages.

4.2 Industrial Processing

4.2.1 Plant Origin.
Timber can be processed into furniture and building materials; rubber latex can be turned into tyres, gloves, shoes and condoms; palm oil is used for making margerines, toiletries, cosmetics, carotenes and biofuel; cotton and linen are processed into apparels.

4.2.2 Animal Origin.
Leather and silk are made into apparel, footwear, belts, handbags and wallets.
CHAPTER 2
THE EVOLUTION OF AGRICULTURE

The world was formed about 4,600 million years ago. The eukaryotic life forms appeared 3,600 million years later. The first hominid hunters and gatherers were recorded recently in comparison, i.e. about 4-7 million years ago. They have their origins in tropical East Africa, present day Chad, Ethiopia and Kenya. They first gathered wild fruits and hunted. Later on plants and animals were domesticated. A social structure that promoted cooperation was established. This resulted in sharing knowledge on cultivation techniques and later on specialised skills related to domestication of particular plants or animals for food.

TOPIC 1. PREHISTORIC ERA THROUGH THE MIDDLE AGES, and DOMESTICATION of PLANTS and ANIMALS

Recorded history began about 7000 years ago in the Tigris-Euphrates valley. Before that period, about 5000 years earlier human have already started farming during what we called the pre-historic era. Initially, grain crops such as wild rye, barley and wheat were cultivated, followed by peas and beans. The sites where such activities originated were belived to be Western Asia that includes Turkey (then Asia Minor), Iran and Iraq (Fertile Crescent of Tigris-Euphrates), Israel, Jordan and Syria; the Nile valley; Europe (Danube river valley and Macedonia); Indus valley of India-Pakistan; Yangtze & Yellow River valleys of China; and the Tehuacan valley of Central Mexico.

Wheat was the first crop to be grown and harvested (using a sickle) on a significant scale. Cultivation practices changed with climatic conditions and social structure (individual vs community).

1.1 Global Agricultural Evolution

It started between 850-1650 BC. Domestication of plants and animals was a milestone in early agriculture. Full dependency did not begin until the middle Bronze Age when use of metal tools became widespread. Domestication involves deliberate husbandry and breeding of plants and animals. Breeding involves selection of desirable traits brought about by genetic changes.
Domesticated animals act as beast of burden and also as sources of food, milk, leather and wool. These animals are hardy, docile and non-territorial.

Large scale farming was started by the Sumerians who were in the stage of empire building. There was similar expansionary development with the Nile valley inhabitants. There were improvements in Agriculture with the passage of time:

1. Rotating with legumes and root crops.
2. Employing scientific method in agricultural research.
3. Transferring crop and animal germplasms from their lands of origin.
4. Using fuel powered machines to increase yield and reduce labour.
5. Introducing mechanisation.
6. Performing rudimentary food-processing.

1.2 Agriculture In The Middle Ages (500-1500 A.D.)

Much of the advancement was made by the Muslims during the golden era of Osmania (early 9th century). It took place in the Near East, North Africa and Spain, regions that had extensive irrigation and cultivation knowledge. Revolution in agriculture was spearheaded by four key factors:

1. An advance irrigation system that made use of machines, dams and reservoirs.
2. A scientific approach to farming that adopted improved farming techniques aided by published manuals that enabled raising of crops and animals away from place of origin.
3. Incentives in the form of land ownership, workers rights and financial rewards commensurate with efforts.
4. Introduction of new crop and plant species and new cultivation techniques derived from research.

By the 14th century, plants and animals were shuffled across the Atlantic from the old world to the new world. Wheat and cereals from the Old were added on to maize, tomatoes and potatoes. At about this time the concept of agribusiness was introduced resulting from large scale cultivation of commodities like linen and silk for export.

1.3 Modern Agricultural Evolution

It started in the 1950s when yield per land unit has increased many times more with tremendous improvement in agricultural practices.
The 20th century saw a rapid rise in mechanization that enabled farm activities to be performed with a speed and on a scale never imagined before. This led to greater efficiency and higher quantity and quality of production. The Green Revolution has begun. This took between 1940s and 1960s.

**TOPIC 2. UTILISATION of HUMAN LABOUR, ANIMALS, MACHINES, INFORMATION and BIOTECHNOLOGY**

This is a reiteration of the story of agriculture. As had been mentioned earlier, agriculture started with human labour (first confined to family members and later extended to hired hands), with heavy duties performed by animals. Tools and machinery invented decreased burden and increased efficiency. However, some jobs cannot be replaced by machines such as picking fruits and vegetables, rubber tapping and harvesting oil palm fruits.

Agriculture has now moved into the fast lane. Information technology enables quick dissemination of knowledge. Innovative technologies such as remote sensing and precision farming help increased yields and varieties. Genetic engineering creates transgenic life forms superior to their original versions. A brave new world has begun.

**TOPIC 3. VALUES, CUSTOMS and TABOOS IN TRADITIONAL and MODERN AGRICULTURE**

3.1 Traditional Agriculture

In general, it is still practiced in the 3rd world countries such as in Africa, Asia and Latin America. In Europe and North America, as they entered the 20th Century, traditional agriculture has practically become non-existent.

There are well defined characteristics or practices in traditional agriculture:

1. The local agroecosystem is fully utilised. Inputs are acquired in production and processing, and wastes are recycled.

2. The food production is more akin to an art and craft. Knowledge and skills are handed orally from one generation to the next.
3. Food is a question of survival for the community. As such production must be enough and sustainable.

4. Land preparation and utilisation is through gentle use of human labour and animal as land is considered a living entity. No machinery is allowed.

5. Labour is intensive and control of pests and diseases is by cultural means.

6. Natural resources such as rain and natural enemies of pests are fully capitalised.

7. Organic fertilizers, land fallowing and plant-microb symbiosis play important roles in providing nutrients.

8. Native varieties are used as it is believed to have influence on crop performance due to the natural spirit residing in the plants. However, exchange of seeds among the locals within the community is allowed.

3.2 Modern Agriculture

Advances in science and technology have paved the way for man to move from traditional agriculture into modern agriculture which not only relies on findings in biological science but also in related sciences like chemistry (fertilizers & pesticides), physics (remote sensing), medicine and pharmacy (biotechnology), engineering (mechanisation), ICT (transfer of agricultural technology) and economics (efficient farm management) that have accelerated the development in modern agriculture. It is clear that modern agriculture depends on new knowledge, skill and technology. However modern agriculture is blamed for the disturbance in the local ecosystems relating to excessive use of chemicals.
Characteristics that are attributable to modern agriculture:

1. Intensive and mass production as requisites of agribusiness.
2. Extensive use of machinery and electronics, from land preparation to harvesting.
3. Extensive use of chemicals for fertilizers and pests control.
4. Widespread use of clones, hybrids and selected high yielding varieties.
5. Employment of highly knowledgeable and skilled workers.
6. Industrial approach with monocultural system and highly efficient management.
7. No attention given to tradition and taboos by professionals who manage the system.

**TOPIC 4. THE CULTURE of NOMADIC and SEDENTARY AGRICULTURE**

4.1 Nomadic Agriculture

Also known as “slash and burn” or currently as Swidden Agriculture, it is still practiced in Asia (Sarawak and Indonesia), Africa and Latin America. It is an ancient agricultural practice which has its beginnings in the Neolithic era (stone age).

Characteristics of nomadic agriculture:

1. It is short term where planting lasts only for 2-3 seasons. Crops grown are annuals such as beans, root crops, maize and hill padi. The area is then left fallow for a long period. The community leaves to plant on a new site.
2. Cultivation is either on fertile virgin jungle soil or on hill slopes (Gua Niah in Sarawak).
3. Customs and taboos have a place in daily farm activities where the headman plays a significant role in decisions made.
4. Yields are poor, sufficient only for the immediate family and deteriorate every year.
5. There is minimal fertilizer input resulting in loss of nutrients and fertility.
6. If planting is done on water catchment areas flood can result, disrupting the ecosystem.
7. Plant species and valuable herbs are lost through indiscriminate clearing affecting biodiversity.

4.2 Sedentary Agriculture

It denotes cultivation on the same piece of land year in year out where the community remains sedentary. It is performed on a specific area by rural folks on a small scale or in big commercial ventures.

TOPIC 5. INFLUENCE of RELIGION on AGRICULTURE

Islam, and for that matter other religions too, gives a lot of attention on agriculture based on many Quranic versus. One that has been mentioned many times is An Nahl which reveals the importance of bees in producing honey as food but more importantly as medicine. Other versus on plants and domestic animals are found in Surah Al Baqarah (verse 22), Surah Al Kahfi (verses 32-41; 45), Surah Yaasin (verses 33-36) and Surah Luqman (verse 10).

Christians believe that since God created nature, agricultural practices should not contribute in any way to the detriment of the environment. The proper model for the caretaking of nature from a biblical perspective is the Christian stewardship model (Genesis II; Luke 12; 16). The Christian steward of nature first recognizes the nature, like everything else in heaven and earth, was created by God, belongs to God, and is valued by God for itself.
In the Hindu caste system, the *vaishyas* are Aryans who tended cattle. Islam has placed agricultural activity as *fardhu kifayah* where there must be at least a person in a community who is involved in agriculture as a career.

A shaman will perform certain agricultural rights when opening a new piece of agricultural land or starting a crop season, asking for rain in times of drought or requesting for bumper yield.

**TOPIC 6. INFLUENCE of LIFESTYLE on AGRICULTURE**

Modern style of living uses agriculture as a business enterprise rather than as a way of life in times of old. The lifestyle and size of a community influences agricultural activities. Trends such as Valentine’s Day, Mother’s Day and convocation result in the demand for certain agricultural products such as flowers and chocolates. Increase in population necessitates more agricultural output per unit area.
CHAPTER 3
AGRICULTURAL REVOLUTION

Agricultural revolution began with the Green Revolution. This occurred in 1960s as a result of increased food production with improved crop variety and yield. In under-developed and developing countries this revolution elevated famine.

Presently we have a Blue Revolution that aims to provide enough water for consumption and for agricultural irrigation in the world. This must be carried out in a manner which is ecologically sound and sustainable. Water supply has become critical, and the United Nations has estimated that by the year 2025 2.7 billion people will be facing water shortage.

TOPIC 1. CAUSAL FACTORS

1.1 Resource Limitation and Constraints

Since the world population has increased, demand for food has also increased. However, the natural resources for food production such as arable lands and diversity of living organisms are diminishing.

1.1.1 Fertile Land.

Agricultural production is proportional to land availability and its fertility. Arable land for agriculture is decreasing, so agriculture has to move into less arable, infertile and problem areas such as sandy land and tin-tailing soils. The main difficulty is with the water availability due to the physical nature of the soil like its hardiness and silty composition that lead to low water holding capacity. Reduction in fertility is also caused by erosion of surface soils especially along slopes.

Problem soil in the tropics is weathered soil that is synonymous with lack of nutrients and acidic. A low pH causes poor uptake of macro-nutrients like phosphorus, calcium and magnesium. Conversely, micro-nutrients such as ferrum, manganese and zinc become too soluble and easily absorbed resulting in plant toxicity. Addition of fertilizers and lime will help improve this condition.

1.1.2 Labour and Mechanisation.

In Malaysia, agricultural labour force has reduced because not many youth are interested to work in agriculture. This leads to large tracks of abandoned agricultural land, with commercial
agriculture resorting to import labour. However, this problem increases the impetus to mechanise.

All this constraints lead to insufficient food production and increase in food imports (approaching 13 billion ringgit annually in Malaysia). A need to reduce deficit in our balance of trade provided another trigger in agricultural revolution.

1.1.3 Population Increase.
World population increase has not slowed down. Malaysia has 26 million, while the world’s population has surpassed 6 billion. This requires increase in world food supply.

1.1.4 Need for Diversity Of Products.
An agriculturally balanced ecosystem requires product diversity. Niche demands must be fulfilled, for example age brackets and dietary preferences (baby food, fast food, health food, vegetarian food, snacks). Different livestock must be raised and plants cultivated for a sustainable agricultural system.

1.1.5 Trend Towards Environmental Friendly Practices.
Conventional agriculture which is mainly monoculture is highly intensive in nature. It requires high inputs of fertilizers and pesticides. Usually, the input is in excess of what is recommended. Soil pollution can occur when nitrate \( (\text{NO}_3^-) \) and phosphate \( (\text{PO}_4^{3-}) \) fertilizers are not completely taken up by the plants, leach into the soil and contaminate underground water. Contamination from pesticides will enter the food chain leading to biological magnification. As such, a more environmental friendly approach in agriculture is needed.

1.1.6 Technological Advances.
Older technologies use outdated implements which cannot produce quality products in required quantities. Current technologies are needed to get quality and the required quantity with minimum labour input. Knowledge, skill and capital are required to ascertain productivity.

**TOPIC 2. CHARACTERISTICS**

2.1 High Yielding and Disease Resistant Varieties
To increase the yield, high quality germplasm must be used which is achieved through research, for example, MARDI has produced a high yielding padi variety (MR219, MR220) and superior quality rice (MRQ50,
 Similarly, improved rubber clones, fruits and vegetables were produced. Another characteristic selected for is disease resistance that could reduce the use of pesticides by adopting the following methodologies:

2.1.1 Tissue Culture.
This technique involves breeding without seed to produce exact copies in large numbers. The technique involves the use of any growing plant part (e.g., leaf, shoot, meristem) cultured in tubes containing nutrients supplemented with growth hormones. Example are orchids, bananas and herbs like “tongkat Ali” and Tahitian noni. The maturity time is shorter and the plantlet is free of disease and shares the quality of the parent.

2.1.2 Genetic engineering.
This technique involves manipulating genes to produce new breeds. For example, a new breed of papaya resistant to Ring Spot virus and maize that can kill stem borers due to incorporated B. thuringiensis gene.

2.2 Usage of Chemicals and Bioagents
Their use improve yield and quality. When chemicals are used, rates must be followed to minimise environmental pollution. Biocontrol agents are introduced to reduce the use of chemical pesticides. Parasitic insects and predators are biocontrol agents of insect pests while the barn owl Tyto alba controls the rats in oil palm and padi fields. Microbe such as Trichoderma is an antagonist against the pathogenic fungi Fusarium while Beauveria and Nucleopolyhedrovirus (NPV) kill insect pests and mites. Other beneficial microorganisms include nitrogen fixing bacteria, Mycorrhiza and probiotics.
2.3 Precision Agriculture

It is a comprehensive system designed to optimize agricultural production and achieves specific targets through the application of crop information, technology and management practices.

An organic farming system has a specific target for chemical free products disallowing chemical fertilizers and synthetic pesticides. Instead, organic fertilizers like compost, animal excreta and green manure.

Cultural (crop rotation) and biological control methods are adopted to combat pests and diseases. Computers, sensors, GIS and satellites are used to gather and process informations.

2.4 Innovations In Mechanisation and Automation

They save energy and time while producing quality products. They are incorporated in many applications including irrigation, fertigation and controlled environment systems.

2.5 Agricultural Biotechnology

It is a revolutionary technology which employs advanced processing methods and genetically modified organisms to improve yield and quality. It provides new food materials for consumers and environmentally friendly ways of pests and disease control. Examples can be seen in the production of high yielding clones, fast and frozen foods, dehydrated fruits, nutriceuticals, antioxidants, vitamins, cosmetics and enzymes.

2.6 Agricultural Enactments and Schemes

Department of Agriculture in Malaysia encourages good practices to ensure competitiveness in the global market. Examples include Good Agricultural Practice (GAP), Good Manufacturing Practice (GMP), "Malaysian Organic Scheme" (SOM) and Malaysian Good Farm Practice Scheme (SALM). All the above will ensure sound agricultural practices based on environmentally friendly concept to provide healthy products that are safe to eat. There exist a quarantine act to protect the agricultural industry from the import of harmful pests and organisms. Permits are required for importing plants, microorganisms, soils, composts and organic fertilizers.
CHAPTER 4
BASIC AGRICULTURAL RESOURCES
AND THE ENVIRONMENT

TOPIC 1. CLIMATE, WATER, SOIL and
HUMAN RESOURCES

Agricultural food production (crops, livestock and aquaculture) is based on fertile soil and adequate water. In addition, suitable climate, especially temperature is important for optimum production.

1.1 Climate
The world can be divided into four climatic regions:

1.1.1 Tropics.
This region is characterized by high temperature and a lot of rainfall, allowing plants to grow throughout the year. Many agricultural activities are made possible with readily available water and suitable temperatures. Crops grown in the tropics include rubber, oil palm, cocoa, coconuts and sugarcane.

1.1.2 Temperate.
This climate is neither too warm nor too cold and neither too wet nor too dry. The weather, although not extreme is very changeable. Four seasons can be identified, a warm summer, a cool winter, and mild spring and autumn in between. Typically, crops are usually planted in spring and harvested in summer, eg. maize and wheat. However, vegetables can be grown continuously even during the winter season under shelter (glass-houses).

1.1.3 Tundra.
It is characterized by very low temperatures and short growing season with little water and sunshine. There are three types of tundra, namely arctic, antarctic and alpine. The dominant vegetation is grasses, mosses and lichens, and crops can hardly be grown. Crops and livestocks, if raised, can only be done so in restricted enclosures adequate water supply.

1.1.4 Deserts.
These are landscape forms that receive very little precipitation of less than 250 mm. annually. Vegetation is exceedingly sparse. They usually have an extreme diurnal
temperature range, very high in the day and extremely low at night. Agriculture is made possible only with sufficient irrigation.

1.2 Water
Agricultural activity is only possible when there is water, either rain-fed or irrigated. Water is required for seed germination and subsequent growth.

The earliest civilization started along the river banks like the Nile valley in Egypt and Tigris-Euphrates in Mesopotamia (present day Iraq).

In Malaysia, agroecological zones are partially based on the availability of water and dictate the crop type. For example, southern peninsular Malaysia has an average annual rainfall in excess of 3000 mm. which makes the region very suitable for oil palm cultivation. This contrast with Kedah-Perlis region which receives <2000 mm. which makes it less suitable for oil palm but more suitable for rubber and mangoes. Areas which receive high water supply, not necessarily rainfed, but through irrigation are most suitable for the cultivation of padi which also allow for double cropping through the off-season. Example of such areas are Krian (Perak), Besut (Terengganu), Sawah Sempadan (Selangor) and Sawah Ring (Johore), and areas under the administration of authorities like MADA (Kedah) and KADA (Kelantan).

1.3 Soil
Soil is an important agricultural resource. From soil, plants obtain water and nutrients which ultimately are returned to the soil in a Nutrient Cycle shown below. Rain water falls to the ground and soak up by the soil. Nutrient elements which are dissolved in the water are taken up by plants. Water moves from the roots to be distributed throughout the plant and then loses through the process of evapo-transpiration. As the
plant grows, some parts like the leaves become senescent and drop to the ground, then become part of the soil as humus and organic matter. As these parts decompose, nutrients are released back into the soil to be available again, thus completing the nutrient cycle.

There are many types of soil based on factors of soil formation such as parent material, climate, topography, vegetation and time. An example of soil types for Peninsular Malaysia (Main Range to Coastline) based on topography is shown below.

Location A is acid sulphate soil (along the coastline).
Location B is peat soil.
Location C is coastal alluvium soil.
Location D consists of rapidly weathering soil (deep and red).
Location E is easily eroded, shallow soil (esp. when lack of vegetation).
Location F consists of cool highland soils which are less weathered.

Soil type is also identified by its profile. As shown below, an ideal profile consists of 5 horizons (O, A, B, C and R).

Soils can also be classified into 12 orders based on their physical and chemical compositions (according to International Soil Taxonomy). For example, an order known as Histosol consisting of organic matter (such as peat soil) is very fertile. Another example is very sandy Bris soil under the order Spodosol. In addition, in Malaya soil can be classified into >100 series. For example, UPM has four series, viz. Serdang, Bungor,
Munchong and Melaka. Only the Department of Agriculture in the Ministry of agriculture and Agro-based Industry can name the soil series.

1.4 Human Resource
Agriculture cannot operate without workforce. Human labour is required for land preparation, planting and harvesting. In many instances such labour can be replaced with machines. In Malaysia, use of machinery is on the increase but is limited by undulating soil terrain. In such landscapes whereby rubber and oil palm plantations can be found skilled operators are needed. In Malaysia, there is a dire need for foreign labour especially in large and remote plantations.

TOPIC 2. ENVIRONMENT

2.1 Global Agroecological Zones
It is common knowledge that not all agricultural commodities can be produced in all regions in the world. Due to varying soils and climatic conditions, specific sites are suitable for only certain commodities, crops or animals.
The world can be grouped into agroecological zones according to climate, soil and vegetation. Examples of such zones are:

2.1.1 Tundra (very cold climate, low biotic diversity, simple vegetation of mosses and grasses, dwarf trees).

2.1.2 Grasslands (the American Prairies, Russian Steppes, African Savannah and Argentinian Pampas, low fertile land, mild climate, field crops such as soybean, wheat, maize, and livestock).

2.1.3 Deserts (very little precipitation, extreme diurnal temperatures, barren, plants are xerophytic, the African Sahara and Kalahari, China's Gobi, and Arabian).

2.1.4 Tropics (rain and sunshine all year round, rainforest, rubber, oil palm, cocoa, coconut and breadfruit).

2.2 Impact of Climatic Changes
When there occurred climatic changes, different types of plants will result. Effects of climatic changes include the following:

2.2.1 Global Warming.
Extensive use of fossil fuels as power to industries and transportation releases greenhouse gas such as carbon dioxide, nitrous oxide and methane which has increased the world temperature and caused climatic instability. This has led to calamities like hurricanes, floods and droughts. The melting of the polar ice caps causes inundation in the coastal regions and lowlands. The rise of sea water level causes flooding, and inundates and renders coastal agricultural lands less productive.

2.2.2 Desertification.
Expansion of desert areas due to climatic changes (such as one causing drought) and agricultural mismanagement has resulted in less arable land available for agriculture.

2.3 Impact of Pollution.
Extensive commercial agricultural activities and expansionary industrial policies have created polluting byproducts have resulted in an almost irreversible environmental calamity. Among deleterious effects include:
2.3.1 Acid Rain.
In industrialised countries, polluting gasses such as sulphur dioxide and nitrogen oxides emitted into the atmosphere translate into acid rain. It is defined as any type of precipitation with unusually low pH. Acid rain has adverse impact on forest, fresh water and soil, killing off life forms, and affecting crops and animal production.

2.3.2 Heavy Metals.
Heavy metal pollution is deleterious to human, animal and plant health. It is a problem associated in areas of intensive industry and with automobiles. Zinc, copper and lead are among the most heavy metals involved in pollution. Most heavy metals are cations which could be bound to negative charges of some soil particles rendering them less soluble in water. This is less dangerous than the unbound soluble form which is easily transported and available to plants and animals. Continuous use of fertilizer that contain heavy metals such as cadmium contained in phosphate rocks will pollute the soil and render the crops toxic.

2.4 Pesticides.
Excessive use of chemical pesticides which exceed permissible limit especially on vegetables as detected on Cameron Highlands causes undesirable health effects and reduces biodiversity.

2.5 Nitrates
Increase in use of chemical fertilizer and solid wastes from livestock industry results in higher levels of nitrates being washed from the soil into the water ecosystem. This causes an excessive enrichment of the water (eutrophication) leading to rapid algal growth which in turn creates an oxygen deficit and killing off aquatic life.
CHAPTER 5

GENETIC RESOURCES IN AGRICULTURE

TOPIC 1. ORIGIN and DISTRIBUTION of CROP PLANTS

A centre of origin means a geographical area where a plant species, either domesticated or wild, first developed its distinctive properties. Six independent centres of crop origin are recognized.

1.1 Mesoamerica (Southern Mexico, and North Central America).

Maize,
beans,
sweat potato,
tomatoes,
cotton,
papaya,
guava,

Southern Mexico

peppers,
sunflowers,
strawberry,
grapes,
avocado.

North Central America
1.2 Andes and South America.

tapioca, pineapple, groundnut, cotton, papaya, guava, pepper, rubber, cocoa.

1.3 Southeast Asia.

Asian rice, peas and beans, yam, breadfruit, mango, nutmeg, brinjal, cucumber, banana, plantain, coconut, orange, lime, grapefruit.
1.4 China.

Asian rice, soybean, green gram, orange, apricot, peach, tea, cabbage, ginger, ginseng, rape seed, chestnut, turnip, yam.

1.5 Africa. (Sahel Region including Ethiopian Highlands).

Sorghum, cowpea, coffee, melon, watermelon, yam, oil palm, okra, kenaf, brinjal.
1.6 Southwest Asia. (Near East including Fertile Crescent).

Wheat, barley, rye, oat, pea, lentil, carrot, radish, safflower, olive, rape seed, walnut, date palm, almond, grape, apple, pear, plum, onion, lettuce,

TOPIC 2. GERMPLASM and BIODIVERSITY

2.1 Germplasm

It is a term used to describe the genetic resources, or more precisely the DNA of an organism and collections of the material. The term germ plasm was first used by August Weismann to describe a component of germ cells that he proposed were responsible for heredity. It means any material of plant, animal, microbial or other origin containing functional units of heredity. There are worldwide collections of plant, animal and bacterial germplasm for use in breeding new organisms and the conservation of existing species.

2.2 Biological diversity

Biological diversity is often shortened to biodiversity, as meaning the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
There are 3 aspects of biodiversity:

2.2.1 Genetic diversity.
This term refers to the variation (diversity) of genes within a species.

2.2.2 Species diversity.
This term refers to diversity among species in an ecosystem. “Biodiversity hotspots” are excellent examples of species diversity.

2.2.3 Ecosystem (habitat) diversity.
This term refers to diversity at a higher level of organization, the ecosystem. This has to do with the variety of ecosystem on earth.

If the gene is the fundamental unit of natural selection, the real biodiversity is genetic diversity.

2.3 Significance Of Biodiversity

1. It is a global resource being the underpinning factor for the healthy functioning of the earth’s many ecosystems.

2. It provides humans with substantial economic benefits with respect to crops, livestock, medicines, natural products (wildlife, fish, timber) with some 10,000 species of plants and animals exploited industrially.

3. It provides humans with aesthetic benefits.

2.4 Genetic Resource Applications
Agriculture production is increased through the use of improved genetic resources (new variety) created by altering the genetic constitution.

2.4.1 Yield.
Examples can be seen in the dramatic increase of crop yield from 1930 to 2000. Crops yield in rice, wheat, barley, soybeans, cotton and sugarcane has doubled, in tomato and rubber has tripled, and in corn, sorghum, potato has quadrupled.
2.4.2 Pest and Disease Resistance.

Genes responsible for promoting resistance to 16 of these have been bred into commercial cultivars. For example, 16 of such genes have been bred in tomatoes allowing them to grow in areas where they could not otherwise have been grown. These genes have been sourced from wild relatives of the cultivated tomato in which resistance at least 32 major tomato diseases has been discovered.

Insect resistant genes have been also been bred. An added phenomenon is introduction of foreign genes such as *Bacillus thuringiensis* (Bt), which produces an insect killing toxin, into the crop as seen in maize.

2.4.3 Ecological Tolerance.

New varieties with genes sourced from wild relatives have been developed which are tolerant to temperature extremes, salinity, drought and waterlogging.

2.4.5 Green Revolution Examples.

A cultivar of wheat, *Norin 10*, from Japan has been developed which was of shorter stature than typical varieties of wheat through the introduction of 2 genes, *Rht1* and *Rht2*, that caused dwarfing. These genes were derived from a Japanese landrace *Shiro Daruma*. Norman Borlaug speculated that by breeding these genes into Mexican wheat, lodging would be reduced and the plants would respond to fertilizer application. As it turned out, these genes not only reduced lodging through reduced heights, they directly influenced the yield via a more efficient nutrient uptake and enhanced tillering.

2.4.6 Genetic Resources are categorized into six types:

- **2.4.6.1 Wild relatives** are species in the wild from the same genus of the crop or livestock.

- **2.4.6.2 Weedy relatives** are a bridge between wild relatives and domesticated species. In the case of crops, they are neglected varieties that evolved to adapt the natural growing environment. They become more hardy and as good a competitor as the wild types.

- **2.4.6.3 Premitive cultivars or landraces** are the cultivated varieties during earlier times.
2.4.6.4 Modern cultivars are improved strains bred from primitive cultivars.

2.4.6.5 Advanced breeding lines superior germplasm selected from modern cultivars.

2.4.6.6 Genes from other species advanced lines which contain specific desired genes from other species. For example, 90% of the genes in rice could also be found in corn, wheat and barley!

2.5 Biological Diversity Hotspots
These hotspots are the sites where many types of biological organisms exist and constitute invaluable genetic resources. They contain:

1. Higher range or number of species or subspecies found in a particular area.
2. Higher variety of life, including the genetic diversity among members of a population or species, the species themselves, and the range of communities and ecosystems present on earth.
3. Higher variety of life forms that inhabit the earth.
There are 25 recognised biodiversity hot spots in the world. They are the **North and Central America** that is made up of the Caribbean, California Floristic Province, and Mesoamerica; the **South America** that is made up of the Tropical Andes, Choco-Darien-Western Ecuador, Atlantic Forest, Brazilian Cerrado, and Central Chile; **Europe and Central Asia** that is made up of the Caucasus, and the Mediterranean Basin; **Africa** that is made up of the island of Madagascar and Indian Ocean Islands, Eastern Arc Mountains and Central Forests, Guinean Forests of West Africa, Cape Floristic Region, and Succulent Karoo; **Mainland Asia** that is made up of the Mountains of Southwest China, Indo-Burma, and the Western Ghats; and the **Asia-Pacific** region that constitutes the Philippines, Sundaland, Wallacea, Southwest Australia, New Zealand, Polynesia and Micronesia, and New Caledonia.

**TOPIC 3. GENETIC VARIATION and CONSERVATION of GENETIC RESOURCES.**

**3.1 Genetic Variation**

All genetic variation originates from mutations and is increased by sexual recombination. Mutations are rare and random. Genetic variation is essential for evolution. For evolution to occur, the genetic variation must be selected for and expressed in the phenotype. Large amounts of variation are present in natural populations.

To date, 1.7 million species have been identified and named. About 1 million are animals (750,000 are insects), 250,000 are plants, and 69,000 are fungi. A species name consists of two words (binomial system), for example *Zea mays* (corn), and *Homo sapiens* (human). New species are discovered everyday with about 10,000 reported every year.

Species are not evenly distributed on the earth’s surface with diversity increasing with convergence towards the equator. The reasons are there are more land and sunlight (much more growth) near the equator, and greater survival of species due to disruptive glaciers not present.

**3.2 Techniques to Conserve Genetic Resources**

There are two major alternatives for the conservation of genetic resources, namely **in situ** and **ex situ**.

**3.2.1 In Situ** conservation refers to the conservation of important genetic resources in wild populations and landraces, often associated with traditional and subsistence agriculture. This involves combining nature reserves, focusing on the protection of wild races and wild relatives with traditional agricultural practices. Botanical reserve is
one such approach. However, it is expected that traditional farmers would not forego the substantial economic benefits that may accrue by conserving elite varieties. As such this may require direct economic subsidy or conservation of traditional varieties in some other ways. Examples include forest reserves, national parks, agricultural parks, botanical gardens, herbal collections, and zoos.

3.2.2 Ex Situ conservations refers to the conservation of genetic resources off-site in gene banks, often in long-term storage as seed. However, seeds of many important tropical species are recalcitrant which means it is difficult or impossible to store for long periods. Many of these crop plants can also be clonally propagated. Nonetheless, tissue culture and cryo-preservation techniques have not been fully developed.

3.3 Threats to Diversity and Loss of Genetic Resources

Dying species are caused by:

1. Domestication and use of modern varieties.

2. Wanton, irresponsible and thorough wide spread, and often concentrated habitat destruction. Natives species often lost and habitat invaded by exotic weeds.

3. Natural extinctions as a result of competition and natural disasters.
CHAPTER 6

SUSTAINABLE AGRICULTURE

The word “sustain” is from the Latin sustainere (sus: from below; tenere: to hold) meaning to keep in existence or maintain, and implies a long-term support or permanence. As it pertains to agriculture, sustainable describes farming systems that are capable of maintaining their productivity and usefulness to society indefinitely. Such system must be resource-conserving, socially supportive, commercially competitive and environmentally sound. [John Ikerd, as quoted by Richard Duesterhaus in “Sustainability’s Promise”, Journal of Soil and Water Conservation (1990) 45(1): p. 4].

Sustainable agriculture is one that produces abundant food without depleting the earth’s resources or polluting its environment. It is agriculture that follows the principles of nature to develop systems for raising crops and livestock that are, like nature, self-sustaining. Sustainable agriculture is also the agriculture of social values, one whose success is indistinguishable from that of vibrant rural communities providing rich lives for families on the farms and wholesome food for everyone.

In the first decade of the 21st Century, sustainable agriculture, as a set of commonly accepted practices or a model farm economy is merely the beginning of an idea. Although sustainability in agriculture was tied to broader issues of the global economy, declining petroleum reserves, and domestic food security, its modelers were not government policy makers but small farmers, environmentalists, and a persistent cadre of agricultural scientists. They saw the devastation that late 20th Century farming was causing to the very means of agricultural production, the water and soil, and as such began a search for better ways to farm, an exploration that continues to this day.

Conventional 20th Century agriculture took industrial production as its model. This industrial approach coupled with substantial government subsidies, made food abundant and cheap, especially in the developed world. However, farms are biological systems, not mechanical ones, and exist in a social context in ways that manufacturing plants do not. By emphasizing on high production, the industrial model has degraded soil and water, reduced the biodiversity that is a key element to food security, increased our dependence on oil, and driven more and more land areas into the hands of fewer and fewer “farmers”, crippling rural communities.

In recent decades, sustainable farmers and researchers around the world
have responded to the extractive industrial model with ecology-based approaches, variously called "natural, organic, low-input, alternative, regenerative, holistic, biodynamic, bio-intensive, and biological" farming systems.

Sustainable systems share a vision of farming with nature, an agro-ecology that promotes biodiversity, recycles plant nutrients, protects soil from erosion, conserves and protects water, uses minimum tillage, and integrates crop and livestock enterprises on the farm. However, no agriculture is sustainable if it is not also profitable, able to provide a healthy family income and a good quality of life. Therefore, sustainable practices lend themselves to smaller, family-scale farms. These farms, in turn, tend to find their best niches in local markets, within local food systems, often selling directly to consumers. As alternatives to industrial agriculture evolve, so must their markets and the farmers who serve them. Creating and serving new markets remain one of the key challenges for sustainable agriculture.

Sustainable agriculture or farming sustainably means growing crops and livestock in ways that requires a whole-system approach whose overall goals the continuing health of the land and people. Therefore, it concentrates on long-term solutions to problems instead of short-term treatment of symptoms. Sustainable farming is more than just a set of idealistic principles or a limited set of practices.

Sustainability can be observed and measured. There are three objectives which a farm or rural community practicing sustainability has to fulfill. These are economic development, environmental conservation, and socio-political benefits.

**TOPIC 1. ECONOMIC DEVELOPMENT**

Economic profit has to be made through proper production procedures, processing and marketing. It requires selecting profitable enterprises, sound financial planning, proactive marketing, risk control, and good overall management.

A farmer can explore income opportunities other than growing traditional commodity crops. Alternative crops like herbs or mushrooms may be an option. Mixed cropping could offer another economic advantage compared with single cropping. When producing only a single product such as maize, groundnuts or chili, the risk is high because "all our eggs are in one basket". Integrating plant and animal production can distribute overhead cost and risk among several enterprises. Other
enterprises which could be explored are contract farming of seeds of vegetables, rice, or specialty crops which involves only small hectareage, and organic farming. However, these involve niche limited markets.

There must be a comprehensive financial planning in an enterprise. Farm produce also requires marketing plan of some type, ranging from passive marketing to the commodity chain all the way up to directly marketing a retail product to consumers. Market research is essential for big enterprises to understand the market by analyzing competition, consumer trends and prices. Specialty and direct markets such as organic, GMO-free, and other “green” markets may yield more income but require more marketing by the producer.

Characteristics involved are:
1. Net financial worth of the family increase consistently through savings.
2. Family debt decreases.
3. Less reliance on government subsidies.
4. External purchase of feed and fertilizer decreases.

**TOPIC 2. ENVIRONMENTAL CONSERVATION**

It involves keeping the four ecosystem processes (effective energy flow, water and mineral cycles, and viable ecosystem dynamics) in good condition.

Farms become and stay environmentally sustainable by imitating the complexity of natural ecosystems, nature tends to function in cycles, so that waste from one process or system becomes input for another. Industrial agriculture, in contrast, tends to function in a linear function, similar to a factory production line whereby inputs are at one end, and products and waste (such as suspended soil, nitrates, phosphates, and pesticides) come out the other. In sustainable agriculture, the farm is a nature-based system, not a factory.

Biodiversity is important in sustainable agriculture. The simple we try to make agriculture, the more
vulnerable we become to natural disasters and marketplace changes. When we try to produce a single product such as wheat, corn, or soybeans we are taking on a huge risk. If instead we diversify crops and integrate plant and animal agriculture, the overhead will be spread over several enterprises, reducing risk and increasing profit.

In an industrial model of agriculture farming is an industrial factory that is a linear process concern mainly with monoculture whereas a biological model views a farm as an ecosystem utilizing a cyclical process involving a diversity of plants and animals.

2.1 The Farm as an Ecosystem

On any farm, four major ecosystem processes are at work that, if functioning properly, will conserve soil and water resources and eventually reduce the overall operating costs. These natural processes, vis. energy flow, water and mineral cycles, and ecosystem dynamics are observable and manageable.

\[ \text{Energy Flow: Illustration by Janet Bachmann (Sullivan, 1999)} \]

2.1.1 Energy Flow is the non-cyclical path of solar energy (sunlight) going into and through any biological system. The natural world runs on sunlight. Our management decisions affect how much of it is captured and put to good use on the farm. (Savory and Butterfield, 1990).
Energy flow begins when sunlight is converted into plant growth (photosynthesis), continues when animals consume plants, when predatory animals consume prey, plants and animals die and microorganisms ultimately decompose dead plants and animals. Some energy is lost as heat at every transfer point in the food chain.

On the farm, energy capture is enhanced by maximizing, both in space and in time, the leaf area available for photosynthesis, and by efficiently cycling the stored solar energy through the food chain.

Among the tools for capturing more solar energy are growing off-season cover crops, perennial vegetation, and having intercropping. Capturing sunlight and converting it to dollars is the original source of all wealth.
2.1.2 An Effective Water Cycle is typified by little soil erosion, fast water entry into the soil, and a capacity of the soil to store large amount of water. Streams flow year-round from the slow release of water stored in the soil. The water cycle is improved by management decisions that add to or maintain the ground cover percentage and soil organic matter levels. The goal is to get as much water as possible into the soil during each rainfall.

A surface mulch layer speeds water intake while reducing evaporation and protecting the soil from erosion. Minimizing or eliminating tillage, growing high-residue crops and cover crops, and adding compost or manure to the soil maintains ground cover and builds organic matter. Hudson (1994) showed that raising the percentage of organic matter from 1% to 1% in sandy soil increased the available water content of that soil by 60%. Such an improvement in a soil’s water-holding capacity will benefit crop growth, especially during drought.

An effective water cycle can be summarized by having a low surface runoff and evaporation, and a reduction in droughts, floods, high transpiration by plants, and seepage of water to underground reservoirs. (Savory and Butterfield, 1999).
2.1.3 A Well Functioning Mineral Cycle involves the movement of nutrients from the soil through the crops and animals and back to the soil thus reducing the need for fertilizer and feed. In nature, minerals needed for plant and animal growth are continuously recycled within the ecosystem with very little waste.

2.1.4 An Effective Ecosystem Dynamics is indicated by high diversity of plants and animals both above and below ground. Diversity refers not only to numbers of species but also to genetic diversity within species, and to habitat diversity. Greater diversity produces greater stability within the system and minimizes pest problems. Our choices of practices and tools directly affect the level of biodiversity we have on the farm (Table 1).

<table>
<thead>
<tr>
<th>Tools</th>
<th>Effects on biodiversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercropping</td>
<td>Increased</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>&quot;</td>
</tr>
<tr>
<td>Cover crops</td>
<td>&quot;</td>
</tr>
<tr>
<td>Multi-species grazing</td>
<td>&quot;</td>
</tr>
<tr>
<td>Monocropping</td>
<td>Decreased</td>
</tr>
<tr>
<td>Tillage</td>
<td>&quot;</td>
</tr>
<tr>
<td>Herbicides</td>
<td>&quot;</td>
</tr>
<tr>
<td>Insecticides</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

2.1.4.1 Intercropping.

Advancing from rotation to strip intercrops brings a higher level of biodiversity and increases sunlight capture. Strip cropping of corn and soybeans or cotton and alfalfa are two examples.

Intercropping supports lower numbers of pests than pure stands. There are two possible explanations. One is that higher natural enemy populations persist in diverse mixtures; the other is pest insects that feed on only one type of plant have greater opportunity to do so in pure crop stand than they would be in crop mixture. Intercropping also aids pest control by reducing the ability of the pest insects to recognize their host plants. For example, thrips and whiteflies are attracted to contrasting colours of green plants against brown (soil) background, but ignore areas where the vegetation is
completely green consisting of plants and cover crops. Other insects recognize their host plant by smell; onions planted with carrots mask the smell of carrots from carrot flies.

2.1.4.2 Crop rotation.

The first step towards increasing biodiversity and yield on the farm is crop rotation, which helps break weed and pest life cycles and provides complementary fertilization among the crops in the planting sequence. Moving from simple monoculture to a higher level of diversity begins with crop rotations, which break weed and pest life cycles, provide complementary fertilization to crops in sequence with each other, ie. nitrogen-fixing legume crops preceding grain crops such as corn, and prevent buildup of pest insects and weeds. In many cases, yield increased follow from the “rotation effect”. Including forage crops in the rotation will reduce soil erosion and increase soil quality.

When planning crop rotation, it is important to consider that cultivated row crops, such as corn and soybeans or vegetables, tend to be soil-degrading. Since the soil is open and cultivated between rows, microbes break down organic matter at a more rapid pace. Furthermore, row crops have modest root systems and consequently do not contribute enough new organic matter to replace that lost from the open soil between rows; in most cases above-ground crop residues make only minor contributions to replacing lost organic matter.

2.1.4.3 Cover crops, composts and fertilizers.

These are important for building soil. Cover keeps the soil protected. Under natural conditions the soil remains covered with a skin of dead plant material, which prevents and moderates temperature extremes, increases water penetration and storage, and enhances soil aeration. Most importantly, the soil skin maintains soil structure and prevents soil erosion by softening the impact of falling raindrops. Bare ground, on the other hand, is vulnerable to water and wind erosion, dries out more quickly, and loses organic matter rapidly. Soil erosion necessitates the replacement of lost nutrients, reduces water holding ability, and accounts for 50-75% of productivity loss (Pimentel et al., 1995).
Composts and manures, especially those produced on-farm or available locally at low cost, are ideal resources for nutrient recycling on the farm. Compost has a unique advantage in comparison to unaged manure and other organic soil amendments in that it has a (usually) predictable, and nearly ideal ratio of carbon to nitrogen (Parnes, 1990). In sandy soils, compost’s stable organic matter is especially effective at absorbing and retaining water. There are several conventional fertilizers that should be avoided in sustainable farming because of their harmful effects on soil organisms, structure and acidity. These include ammonium sulphate which will result in increasing the soil acidity (< pH). Significant addition of lime, phosphate rocks, and other fertilizers should be guided by soil testing to avoid soil imbalances and unnecessary expenditure on inputs.

Soil removed by erosion typically contains about three times more nutrients than the soil left behind and is 1.5-5 times richer in organic matter (Pimentel et al., 1995). This organic matter loss not only results in reduced water holding capacity and degraded soil aggregation, but also lost of plant nutrients, which must then be replaced with fertilizers. Table 2 below shows the effect of light, moderate, and severe erosion on organic matter, soil phosphorus level, and plant-available water on a silt loam soil in Indiana, USA.

<table>
<thead>
<tr>
<th>Erosion Level</th>
<th>Organic matter (%)</th>
<th>Phosphorus (kg/ha)</th>
<th>Plant-available water (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slight</td>
<td>3.0</td>
<td>69.5</td>
<td>7.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.5</td>
<td>68.38</td>
<td>6.2</td>
</tr>
<tr>
<td>Severe</td>
<td>1.9</td>
<td>44.84</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Source: Schertz et al., 1984.
2.1.4.4 Tillage.
Tillage is the agricultural preparation of the soil by digging it up. Soil is damaged considerably whenever it is turned over. The moldboard plough brings subsoil to the surface and buries the crop residue layer so deep it is unable to decay properly. Virtually no soil residue is left on the surface, exposing the soil to erosion and impairing the water and mineral cycles. Today, millions of acres are being farmed without any tillage at all (no-till) or in such a way that adequate groundcover remains afterwards.

2.1.4.5 Borders, windbreaks, and special plantings for natural enemies of pests provide habitat for beneficial organisms, further increasing biodiversity and stability. The addition of appropriate perennial crops, shrubs, and trees to the landscape enhances ecosystem dynamics still further.

2.1.4.6 Zero Burning.
This approach has been acknowledged by the world as an environment-friendly one that is sustainable. Zero burning is currently implemented in oil palm and rubber plantations. Upon felling, old oil palm and rubber trunks are not burned, but sliced thin and left to decompose. Nutrients such as N,P,K and Mg are recycled leading to 50% reduction in fertilizer cost. The rubber trunk can be marketed whole for the furniture industry.

2.1.4.7 Pest Management.
Prevention of pest problems is a fundamental component of management in any agricultural production system as pests reduce the biodiversity and productivity. Chemical pesticides can be effectively employed to suppress pests; however, there are more environmental friendly methods of control.

Weeds pose one of the greatest challenges to the sustainable production systems. However, weed populations tend to decline in severity as soil health builds. A basic understanding of weed ecology and the influence of cropping patterns on weed communities will help farmers refine their use of cultural and mechanical techniques, thereby reducing the time required for effective weed control. General terms, weed prevention is based on developing a sound rotation, thwarting all attempts by existing weeds to set seed, and minimizing the arrival of new weed seeds from outside the field. Cover crops,
mulch and minimum tillage will reduce weed numbers (Table 3). In estates, weed management may be as simple as adding cattle to convert weeds into cash.

Table 3. Tillage and cover crop (mulch) effects on weed numbers and production.

<table>
<thead>
<tr>
<th>Tillage</th>
<th>Cover crop/mulch</th>
<th>Weeds/m²</th>
<th>Weed weight, kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>None</td>
<td>36</td>
<td>0.66</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>15</td>
<td>0.42</td>
</tr>
<tr>
<td>None</td>
<td>Rye</td>
<td>2.7</td>
<td>0.3</td>
</tr>
<tr>
<td>None</td>
<td>Wheat</td>
<td>0.9</td>
<td>0.21</td>
</tr>
<tr>
<td>None</td>
<td>Barley</td>
<td>0.24</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Source: Putnam et al., 1983

**Insect pests** can have a serious impact on biodiversity and farm income. Sustainable agriculture utilizes biological (natural) control agents, crop barriers, nectariferous shrubs intercropping, and crop rotation to suppress these pests. (Altiere and Liebman, 1994).

**Plant diseases** reduce biological diversity and affect yield. Their incidence can be lessened by having intrinsically healthy plants nurtured by microbially active soil. Healthy soils that suppress root diseases naturally can result from adding biologically active compost with balanced mineral levels. Microbial antagonists are also used to control pathogens. Use of resistant cultivars and clean seeds aid reduction in plant diseases.

**Integrated Pest Management (IPM)** is the basic framework used to decide when and how pests are controlled. It integrates habitat modification and cultural, physical, biological, and selective chemical practices to minimize crop losses. Its primary goal of IPM is to give growers management guidelines in order to make pest control as economically and ecologically sound as possible. Monitoring, record keeping, and life-cycle
information about the pests and their natural enemies are used to rationalise which control measures are needed to keep pests below an economic threshold.

These four ecosystem processes (energy flow, water cycle, mineral cycle and ecosystem dynamics) function together as a whole unit, each one complementing the other. When we modify anyone of these, we affect the others as well. When we build our farm enterprises around these processes, we are applying nature’s principles to sustain the farm for our family and for future generations. When we resist nature’s processes, we incur extra costs and create more problems, hurting ourselves and the ecosystem on which we depend on.

**TOPIC 3. SOCIO-POLITICAL BENEFITS**

Social benefits are provided for the farm family and the community in terms of food security, land tenure, good health and maintaining the fabric of rural communities. It involves keeping money circulating in the local economy, and maintaining or enhancing the quality of life of the farming family.

Decisions made on the farm affect local community. For example, the decision to expand your operation requires the acquisition of your neighbour’s farm. This implies that your neighbour’s farm is more important to you than your neighbour. Other examples of social decisions are: buying supplies locally rather than ordering from out of state, networking with local consumers while adopting a consumer-oriented approach, and relaying information on sustainable food production to neighbouring communities.

Marketing strategies involving direct marketing through farmers markets or road side stalls have a positive impact on the local community. People will choose to support local producers or their neighbours by paying a little more compared to overall market price.

Quality of life of those who work and live on the farm includes good communication, trust, and mutual support. Full family participation in farm planning is an indication that the quality of life is high. Other indicators include talking openly and honestly, spending time together, a feeling of progress toward goals, and a general happiness. However, the quality of life is defined somewhat differently by each individual and family, based on their values and goals.
TOPIC 4. PLANNING and DECISION MAKING

Managing for the three objectives simultaneously (economics, environment and society) depends on clear goal-setting and effective decision-making. Several good tools for goal-setting, decision-making, monitoring, and whole-farm management are available to farmers.

It is useful to assume that if your plan does not work, then a system should be develop to determine as soon as possible if it is not working. For example, if the goals include increased biodiversity, the farmer needs to know quickly if the grazing or cropping system being used is actually increasing the number of plant species in the area of concern. Monitoring is particularly important in sustainable agriculture, which relies on natural systems to replace some of the work done by input products like fertilizers and pesticides. The ability to evaluate and replan is vital to the farmer who wishes to farm more sustainably, especially when part of the plan is not working as intended, then it is necessary to replan. The concept of planning-monitoring-controlling-replanning is a key characteristic of Holistic Management, referred to as the feedback loop.

Farmers selling locally will benefit from differentiating their products and services by qualities other than price, such as fresh produce, specialty items, and locally grown and processed foods. This makes it more competitive in the market place, especially when consumer education and personal contact with the farmer are part of the marketing plan.

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The transition toward more sustainable farming requires not only planning and decision-making skills but also access to appropriate and helpful information. Fortunately, increased interest in sustainable agriculture has stimulated greater investment in research and education. Now, much more usable information is available today than ever before through various means.
CHAPTER 7
ECONOMICS OF AGRICULTURAL DEVELOPMENT

TOPIC 1: CONTRIBUTION OF AGRICULTURE TO MALAYSIAN ECONOMY.

Agriculture is part of the primary sector in the Malaysian economy which contributes to the gross domestic product (GDP) over time. The relative importance of the primary sector to the GDP has decreased since 1970.

Agriculture in Malaysia is characterised by a dualistic system where the plantation sector exists side by side with the smallholder sector. Plantation or estate agriculture is normally single crop cultivation in a land area of more than 40 ha. Crops such as rubber, oil palm, coconuts, cocoa, pineapples and tea are planted. The plantation management is more systematic, using modern technology and hired labour. The smallholder consists of those farmers who cultivate small areas, between 0.4 - 4 ha. Consequently, production capacity is low due to the limited technology and disorganised farm management practices. There are two types of smallholders: (1) the subsistence farmers who cultivate their land for their own consumption and sell the produce in the marketplace or to the middleman. These farmers normally practice mixed cropping systems where vegetables and fruit trees are the main crops being cultivated. Others have mixed cropping and livestock farming systems whereby the farmers grow cash crops and fruit trees at the same time raising chicken, goats or cow on their farm. (2) those that practice monocropping type of subsistence farming. Normally, these farmers cultivate their land with commodity crops such as rubber, cocoa, or oil palm similar to those planted by the plantations.

In the past, emphasis was given to the production of primary commodities from which the country enjoys export earnings. However, agricultural has expanded into secondary downstream processing for value added products. Malaysia’s agricultural development is guided by the National Agricultural Policy (NAP). The development programmes are aimed at expanding food production to improve the food trade balance, increasing export of primary commodities, and ensuring supply of raw materials for local downstream industries.
1.1 Agricultural Growth
In the 7th Malaysia Plan (1995-2000), the agricultural sector grew at 1.2% per annum, lower than the targeted 1.9%. The 8th Malaysia Plan (2001-2005) targets the sector to grow at 3.0% annually. However, during the midterm review, the agriculture sector grew only at 1.5% per annum. Among commodities, from 1995 to 2005, the value of rubber and forestry products has decreased while that of palm oil, livestock and fisheries has increased. In 2005, industrial crop production accounted for 60% of the total value in agriculture with the remaining 40% taken by the food sector, with livestock and fisheries accounted for significant increases (Table 1).

Table 1. Agricultural value of major crops (USD million).

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial Crop</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber</td>
<td>560</td>
<td>310</td>
<td>270</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>1114</td>
<td>1631</td>
<td>1938</td>
</tr>
<tr>
<td>Forestry &amp; logging</td>
<td>1089</td>
<td>893</td>
<td>799</td>
</tr>
<tr>
<td>Cocoa</td>
<td>322</td>
<td>305</td>
<td>314</td>
</tr>
<tr>
<td><strong>Food Crop</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Padi</td>
<td>136</td>
<td>140</td>
<td>177</td>
</tr>
<tr>
<td>Livestock</td>
<td>251</td>
<td>292</td>
<td>383</td>
</tr>
<tr>
<td>Fisheries</td>
<td>517</td>
<td>625</td>
<td>789</td>
</tr>
<tr>
<td>Others</td>
<td>506</td>
<td>581</td>
<td>862</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>4496</td>
<td>4777</td>
<td>5531</td>
</tr>
</tbody>
</table>

1.2 Land Utilisation For Agriculture
Agricultural land use increased from about 5.7 million ha in 1995 to almost 6.0 million ha in 2000 (Table 2), due mainly to the opening-up of new land for oil palm cultivation in Sabah and Sarawak. The acreage in oil palm, pepper, pineapple, vegetable and fruits has increased while that of rubber, cocoa and coconut has decreased. About 400,000 ha of rubber and cocoa land were converted to oil palm.
Table 2. Agricultural land use (hectares).

<table>
<thead>
<tr>
<th>Industrial Crop</th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber</td>
<td>1727000</td>
<td>1430700</td>
<td>1301500</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>2507611</td>
<td>3460000</td>
<td>3100000</td>
</tr>
<tr>
<td>Cocoa</td>
<td>234538</td>
<td>105000</td>
<td>105000</td>
</tr>
<tr>
<td>Pepper</td>
<td>8600</td>
<td>11480</td>
<td>12500</td>
</tr>
<tr>
<td>Pineapple</td>
<td>9081</td>
<td>10233</td>
<td>16000</td>
</tr>
<tr>
<td>Tobacco</td>
<td>10539</td>
<td>15000</td>
<td>12500</td>
</tr>
<tr>
<td>Food Crop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Padi</td>
<td>592410</td>
<td>572196</td>
<td>611000</td>
</tr>
<tr>
<td>Coconut</td>
<td>298740</td>
<td>220000</td>
<td>201000</td>
</tr>
<tr>
<td>Vegetables</td>
<td>42000</td>
<td>51420</td>
<td>77290</td>
</tr>
<tr>
<td>Fruits</td>
<td>244471</td>
<td>297436</td>
<td>379613</td>
</tr>
<tr>
<td>Others</td>
<td>268146</td>
<td>67534</td>
<td>67737</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5743137</td>
<td>5949934</td>
<td>6314977</td>
</tr>
</tbody>
</table>

1.3 Food Commodities

The implementation of The third national agricultural policy (NAP3) to meet the national food requirements as well as broaden the export capacity of the agriculture sector have positive impacts on food production. As a result, the self-sufficiency levels (SSL) for food commodities except rice have improved (Table 3).

Table 3. Self-sufficient level (%) of food commodities.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Padi</td>
<td>76.3</td>
<td>72.0</td>
<td>71.0</td>
</tr>
<tr>
<td>Fruits</td>
<td>88.9</td>
<td>105.0</td>
<td>109.0</td>
</tr>
<tr>
<td>Vegetables</td>
<td>71.6</td>
<td>78.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Fishery produce</td>
<td>92.0</td>
<td>89.0</td>
<td>90.0</td>
</tr>
<tr>
<td>Beef</td>
<td>19.2</td>
<td>16.0</td>
<td>23.2</td>
</tr>
<tr>
<td>Mutton</td>
<td>6.0</td>
<td>6.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Pork</td>
<td>104.0</td>
<td>99.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Poultry</td>
<td>110.7</td>
<td>113.0</td>
<td>123.0</td>
</tr>
<tr>
<td>Eggs</td>
<td>110.3</td>
<td>116.0</td>
<td>109.0</td>
</tr>
<tr>
<td>Milk</td>
<td>3.5</td>
<td>3.0</td>
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</tr>
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55
The impressive growth in livestock production is mainly attributed to the improvement in animal husbandry and the shifting from traditional to commercial farming practices especially in the non-ruminant subsector. Increase in feedlot and expansion of integrated beef cattle farming in rubber and oil palm plantations have contributed to the increase in beef production. However, Malaysia is still not self-sufficient in the production of beef and mutton, with local production catering 24.1% and 7.3%, respectively. Poultry production increase is due to the integrated poultry farming system introduced by fast-food chains such as Kentucky Fried Chicken. Poultry is the most popular meat consumed due to pricing and religious acceptability.

The per capita consumption of fruits and vegetables has increased from 40 in 1985 to 65 kg and from 42 to 64 kg in 2005, respectively. The production growth is due to government efforts in consolidating small orchards into larger organized farms and instituting group farming projects.

**TOPIC 2. INTERNATIONAL TRADE IN AGRICULTURE.**

Over the years, agricultural trade has consistently generated trade surpluses. In 2002, against a backdrop of USD7,375 million exports and USD4,300 imports, a surplus of USD3,075 million was accumulated, due mainly to palm oil. In fact, in 2002, palm oil exports contributed almost 52% of export share in agriculture.

Malaysia is still a food-deficit country. Food imports have continuously far exceeded exports. In 1985, food imports were worth USD0.92 billion, rising continuously to reach USD3.0 billion in 2000. Among the major import items include maize, sugar, wheat, rice, soybean and various food preparations. Raw rubber, palm oil and cocoa beans are imported, processed, and then reexported as final products.

Malaysia itself exports palm oil, rubber, fatty acid complexes, palm kernel oil, various food preparations, sugar and cocoa butter. These items accounted for at least 78% of the total agricultural exports in 2002 (Table 4).
Table 4. Total agricultural imports and exports (USD million).

<table>
<thead>
<tr>
<th>Item</th>
<th>Year = 1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
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<tr>
<td><strong>Import</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Maize</td>
<td>259</td>
<td>255</td>
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<td>Sugar</td>
<td>255</td>
<td>253</td>
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<tr>
<td>Wheat</td>
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<tr>
<td>Rice, milled</td>
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<td>175</td>
<td>134</td>
<td>124</td>
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<tr>
<td>Natural rubber</td>
<td>119</td>
<td>214</td>
<td>180</td>
<td>185</td>
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<tr>
<td>Soybean</td>
<td>145</td>
<td>132</td>
<td>150</td>
<td>167</td>
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<tr>
<td>Food prep.</td>
<td>141</td>
<td>148</td>
<td>157</td>
<td>150</td>
</tr>
<tr>
<td>Tobacco</td>
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<td>199</td>
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<tr>
<td>Cocoa bean</td>
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<td>77</td>
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<td>141</td>
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<tr>
<td>Oil palm</td>
<td>92</td>
<td>15</td>
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<td>TOTAL</td>
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<tr>
<td><strong>Export</strong></td>
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<tr>
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<td>2534</td>
<td>3824</td>
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<tr>
<td>Rubber</td>
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<td>589</td>
<td>427</td>
<td>580</td>
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<tr>
<td>Fatty acid</td>
<td>422</td>
<td>389</td>
<td>322</td>
<td>430</td>
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<tr>
<td>Palm oil</td>
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<td>285</td>
<td>212</td>
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<tr>
<td>Food prep.</td>
<td>96</td>
<td>106</td>
<td>119</td>
<td>142</td>
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<tr>
<td>Shortening</td>
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<td>111</td>
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<td>Cigarette</td>
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<td>Sugar</td>
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<tr>
<td>Pastry</td>
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<td>Cocoa butter</td>
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<tr>
<td>TOTAL</td>
<td>7117</td>
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CHAPTER 8
INNOVATION AND CHALLENGES IN MALAYSIAN AGRICULTURE

TOPIC 1. RESEARCH and INNOVATION TECHNOLOGY

In recent years much of the technological innovations in agriculture have been introduced from local research findings from government agencies (MARDI, MPOB, MCIB, MRB, FRIM, etc.) and the private sector (Golden Hope, Sime Darby, Guthrie, IOI, United Plantation Bhd., Kuala Lumpur Kepong Bhd., Boustead Plantations Bhd., FELDA, etc.).

1.1 Oil Palm

It is Malaysia’s golden crop contributing about RM30 billion to its gross national product (GNP) annually, cultivated in an area in excess of 3.8 million hectares (ha.). Malaysia is currently the major world producer of palm oil. Many Malaysian based companies are beginning to expand through reverse investment into neighbouring tropical regions such as Indonesia, New Guinea, the South Pacific Islands, West Africa, and Latin America which are most suitable for oil palm cultivation.

Research has succeeded in improving the yield of oil palm to 35 tonnes fresh fruit bunches per hectare per year, using the Tenera hybrid bred from the crossing of Dura and Pisifera varieties in early years. In the near future, the yield is expected to reach 40t. ffb ha⁻¹ yr⁻¹ with the use of new hybrids from research in biotechnology.

The research group from Applied Agricultural Resources Sdn. Bhd. (KL Kepong Group) has developed: a) the Dumpy.Yamgambi.AVROS semi-
dwarf oil palm hybrid varieties which facilitate harvesting with improved high yield potential and extends the economic life of the crop, and b) potential high yield clones from tissue culture.

In the near future new hybrids will be bred (including transgenic) that will be able to produce more than 50% oleo-fatty acids. Through the years, mechanization and the development of high yielding dwarf oil palm has increased profit margin with reduction in labour and improved yields. Oil palm is a multipurpose agricultural resource whereby its oil can act as a food constituent, oleochemicals, or biofuel (hitherto, the government has given permits for 20 biodiesel projects with investments reaching RM1.9 billion). The trunk is suitable for biocomposite material, pulp and paper, the leaves can be used for cattle feed, while the palm oil mill effluent (POME), the waste from the extraction of palm oil, can be used as an organic fertilizer. This is in line with the vision of making the industry a sustainable zero-waste industry. Integrated farming with livestock in oil palm plantations are continued to maximize returns from the land.

1.2 Rubber

A lot of technological innovations have been developed in the rubber industry. Being the third largest rubber producer, Malaysia has 1.7 million ha. planted with rubber trees. The Malaysian Rubber Board (MRB) has developed high yield and disease resistant clones producing >3500 kilo rubber ha\(^{-1}\) yr\(^{-1}\). In the 70s it introduced a high grade rubber named Standard Malaysian Rubber (SMR) in the form of heveacrumb which is internationally recognized as high quality raw material. Rubber can be turned into many manufactured goods and used for many purposes. Malaysia has the best system of plantation management in the tropics, all with the support of years of research, especially pertaining to terracing and cover crops.

The MRB has introduced a new innovation in rubber tapping called puncture tapping or microtapping which can result in an increased production of latex. It produces yields, with hormonal stimulation (etheral), comparable to that of conventional excision tapping. New latex-timber clones (LTC) of the RRIM200 series have been introduced of which the trunk can be harvested for the timber industry (labelled as the Malaysian oak) once it is no longer economical to tap for latex. Vitamin E has also been extracted from the latex.

The development of the industry is based upon the numerous products based on rubber such as latex, heveawood and rubber-based products.
Current production is sustained at 750,000 million tonnes yr\(^{-1}\) from 1.2 million ha. of planted rubber. Consolidation of uneconomic-sized smallholdings into estate-type production units are undertaken to achieve economies of scale, and replanting are undertaken as part of reforestation programmes.

1.3 Cocoa

The production of cocoa has declined from 131,000 tonnes in 1995 to 70,000 tons in 2000 due to reduction in planted areas, low market price, adverse weather conditions, labour shortage and high production cost due to pests and diseases. Planted area fell from 400,000 ha. in 1989 to 33,313 ha. in 2005. Malaysia is forced to import cocoa beans from the neighbouring Indonesia to fulfill the requirement of the many processing factories.

In 2002 a biotechnology division of the MCB was established. This division aims to implement research and development in cocoa biotechnology as well as to provide services to the entire cocoa industry by developing new technology, capacity building and innovation. Cocoa biotechnology research includes: (1) agrobiotechnology to improve productivity and production efficiency, (2) biotechnology enhanced-quality of cocoa products with respect to safety and health, and (3) industrial and pharmaceutical biotechnology to obtain new products such as useful bioactive compounds from the cocoa tree, associated microbes in the cocoa environment and cocoa waste.

1.4 Padi

Malaysia currently achieves only 70% self-sufficiency in rice. Among the eight granary areas, the major production centres (rice bowls) are MADA (Kedah-Perlis), KADA (Kelantan) and Sawah Sempadan-Tanjung Karang (Selangor). In 1995, the average national production is 3.8 tons per hectare although some areas in MADA have produced more than 5 tons ha\(^{-1}\). The government aims to raise the yield to 10 tons ha\(^{-1}\) with the use of new technology. Some farmers in Tanjung Karang are now producing >10 tons ha\(^{-1}\). The Minister of Agriculture and Agro-based Industry has declared that Malaysia will strive to achieve 90% self-sufficiency limit (SSL) in the near future.

Mechanisation of rice production and the Consolidation of small holdings to group farming and estatisation (mini-estates in Hilir Perak) were intensified to promote commercialization and greater private sector involvement.
The use of a specially formulated chemical fertilizer in trial plots in Kedah, Perlis and Selangor was successful in doubling padi yield and producing better quality rice. Vita-grow® is a foliar fertilizer developed by UPM that contains complete and balanced plant nutrients that enhances growth in padi, vegetables, fruits and ornamentals. Zappa® is another UPM product that enhances rapid germination and tillering. Environment-friendly good farm practices such as precision agriculture, integrated pest management, and soil and water conservation are also encouraged.

1.5 Livestock

The livestock industry grew at the rate of 3.1% per annum from RM953 million in 1995 to RM 1.1 billion in 2000. The integration of livestock rearing in oil palm plantations (and previously in rubber as well) represented a milestone in the increase in production of beef and mutton. Integration is an effective way of reducing management cost by allowing the livestock to eat away the weeds and having the dung from the animals distributed all over the plantation as a fertilizer. Land development agencies, namely FELDA, RISDA, FELCRA and State governments have participated in this integration programme. There are entrepreneurs who raise cattle in feed-lots, a concept introduced from overseas in the early years. We have developed new breed of beef cattle named Brahmas, a cross-breed between imported Brahman and local Kedah-Kelantan breed. Buffaloes are also now selected for meat purposes. A sheep named Malin, a cross between Australian and Indonesian breeds was also developed to increase local supply of mutton. The Boar goats, a South African breed, are also being raised in large numbers for the same purpose.

Poultry industry is very advanced; we are able to produce broilers and eggs to meet not just the nation’s demand but also for the export market. The fowl pox and the Newcastle disease vaccines designed at UPM are now marketed internationally, while the vaccine against the infectious bursal disease is expected to be available soon. Researches on deer and ostrich have been undertaken by UPM and MARDI to provide alternative meat resources.
1.6 Fisheries

The fisheries industry, particularly deep sea fishing and aquaculture, has received government incentives to further commercialize and establish economies of scale by consolidating small ventures. Aquaculture is the cultivation of natural produce of water (fish, shellfish, algae and other aquatic organisms). Also known as aquafarming, the term is distinguished from fishing by the idea of active human effort as opposed to simply taking them from the wild. Subsets of aquaculture include fish farming (raising of fresh water and brackish water fishes, lobsters and prawns in ponds), mariculture (aquaculture in the ocean which includes raising of mollusks), algaculture (production of algae and seaweeds) and the growing of cultured pearls. Species of fresh water fishes include rive carp, catfish, giant fresh water prawn, tilapia and carp, while brackish/marine fishes include sea bass, tiger prawn and crabs. The government has set the target for fish production of 1.7 million tons by 2010 from the current 980,000 tonnes annually, of which 7% comes from aquaculture. Fishes produces about 60% of the animal protein intake of the country.

The government is encouraging locals to adopt aquaculture by constructing ponds and raising fishes in net cages in rivers, lakes and sea shores. Research has been done on the use of probiotics in improving cultivation of fish and prawns. A rapid detection kit has been developed to detect white spot syndrome virus (WSSV) disease in prawns. Modern technology has been promoted to enhance production while looking into the implications of the environment. Biotechnology is low-key at the moment but will be promoted extensively in the future.

The government has undertaken efforts in unifying individual entrepreneurs by forming consortia to venture into mega-commercial fishing. Mega-fishing ports that manage integrated processing complexes have been constructed in Penang and Sarawak. This will secure economies of scale, modernize operations, enhance ventures into export markets and attract processing of foreign catches in Malaysia.

1.7 Fruits, Flowers and Vegetables

Research has been conducted to improve commercial production of banana, pineapple, papaya, starfruit, mango, durian, guava, watermelon, jackfruit, rambutan, citrus, duku langsat/dokong, cempedak, ciku and mangosteen. Flowers such as orchids is a growing industry. Tissue culture is now used for mass-production of orchid seedlings which are even exported. The vegetable industry has recorded a growth of 7.2% annually. Research on all these commodities have focused on yield
increase, optimise usage of fertilizers, water, and new strains together with pest and disease control. Mushrooms which are strictly fungi but considered as "vegetables" is a growing industry in Malaysia. Research has focused on production biotechnology, cultivation of new species and novel mushroom products.

1.8 Bioagents
Innovations using biological organisms can be found in the form of biofertilizers such as *Rhizobium* and biocontrol agents. UPM has formulated naturally occurring antagonistic fungi effective against fungal diseases of vegetables. Research in cocoa has recently come up with a bacterial formulation that can significantly suppress black pod disease, while species of predatory mites have been successfully mass-reared for the control of phytophagous mites.

1.9 Precision Agriculture
This is a new innovation in agriculture. It is also known as "site specific management". This approach has initially attracted the interest of the plantation sector. It utilises ICT and electronic tools to determine localities (micro-niches) that require specific amounts of fertilizer, pesticide, etc. In the long run it can save management cost and increases yield. Precision agriculture is being practiced partly in oil palm and padi growing areas.

A novel precision integrated system for real-time mapping tractor-implement field performance has been assembled which can also record the implement's geo-position in the field with respect to the tractors measured performance.

**TOPIC 2. FUTURE CHALLENGES IN AGRICULTURE**

There are several challenges now facing the agriculture industry:

2.1 Labour
There is a dire shortage of labour in Malaysia. In agriculture there is great dependence of foreign labour with some estates employing 100% foreigners particularly those from Indonesia and the Philippines. Local youths are less interested in agriculture, preferring to work in factories and offices where they receive higher remunerations and access to city life. Cost of labour has been rising steadily. However, as a transitional measure, the government still adopt a liberal policy on the recruitment of foreign workers for the agricultural sector until such time when a comprehensive foreign labour policy is formulated.
2.2 Price
Increase in the price of fertilizers, seeds, tools and equipments has affected the cost of agricultural production. Market price is also elastic and problematic at times especially when there is a sudden drop in commodity price.

2.3 Crop Choice
Big Conglomerates are not interested in agriculture other than planting oil palm and rubber. Not many large companies are involved in food crops.

2.4 Agricultural Technology
The benefits from prospecting and developing the potentials and applications of new and frontier technologies are yet to be realized. Among these are: a) the use of plant cell and tissue culture techniques as well as genetic engineering to complement conventional plant breeding in developing new crop varieties, b) the use of plant cell cultures to enhance the development of new and innovative products including metabolites such as pharmaceuticals, nutriceuticals and food additives, c) the application of embryo manipulation technology and the use of genetically engineered vaccines to strengthen existing technologies for increasing animal productivity, d) the incorporation of robotics and artificial intelligence as well as computer modeling, including expert systems and computer simulated scenario analysis, and microprocessor control in machinery and automation equipment to reduce labour, and e) the application of advance processing and packaging systems to strengthen and enhance conventional and traditional techniques for better post-harvest handling and storage and longer shelf-life of agricultural products.

2.5 Resources
There is keen competition for resource use in the future between agriculture, forestry, industry, residential buildings, wildlife, recreational establishments, and water catchments. Resources have to be carefully managed in order that agriculture could be sustained. The main challenge in the future is to enable continuous crop production with high yield per unit area. Unfortunately, intensification of agriculture will result in excessive agrochemical inputs which contribute to soil degradation. Therefore, agricultural practices on arable soils must be productive, environmental friendly and sustainable. This calls for efficient water, fertilizer, soil conservation management and new technologies such as precision farming.
Land development will slowly encroach into fragile soils, especially peat and steep lands. This results in soil degradation, example soil shrinkage due to over drainage in peat soils, and soil erosion in steep lands after heavy rainfall. Remedial measures include cultivation of ecofriendly crops.

Water resource management is also an important issue as only 2.1% of the country’s heavy rainfall is being used currently. This low rate of water harvested is partly due to seasonal distribution of rainfall, where water excess causes flooding and need to be drained off. More water storage dams, where possible, should be constructed to reduce water losses. Waater resources should also be managed at the national level as presently it is under individual state jurisdiction.

Land development therefore has to be properly managed which involves multiple objectives decision making. An environmental impact assessment (EIA) has been made mandatory to anyone who intends to develop land commercially, including large scale agricultural development.
CHAPTER 9
APPROACHES TO AGRICULTURAL DEVELOPMENT IN MALAYSIA

The agricultural sector has contributed significantly to the growth and development of the Malaysian economy. We must ensure that the sector's contribution to the national economy and its global competitiveness remain strong in the future. The Third National Agricultural Policy and its Action Plan is a testimony of the government’s commitment to provide for better quality of life for all Malaysians, consistent with our vision to become a fully developed nation by the year 2020. In tandem with the National Development Policy, the Second Industrial Master Plan, Science and Technology Policy, and National Biodiversity Policy, NAP3 to provide the policy framework for the future growth of the agricultural sector into the next millennium. (adapted from the massage of the then Malaysian Prime Minister, Tun Mahathir Mohamad, 1999).

NAP3 covers the period from 1998 to 2010 and seeks to provide for the gradual but effective transformation of the agricultural and forestry sectors as we move into the next millennium. The formulation of the policy was largely guided by the objectives and strategies of the National Development Policy and incorporates several new strategies to deal with expected challenges and changes to the international economy.

The policy retains the objective of NAP2 to maximize income through optimal utilization of resources in the sector. This includes maximizing agriculture’s contribution to national income and export earnings as well as maximizing income of producers. This objective will be achieved in NAP3 through two new approaches to agricultural development. The first is the agroforestry approach which aims at addressing the increasing scarce resources including land and raw material availability. The agroforestry development strategy is also in consonant with sustainable agricultural practices. The second approach is the product-based approach which is to reinforce and complement the cluster-based agro-industrial development as identified in the Second Industrial Master Plan (1996-2005) through strengthening both inter- and intra-sectoral linkages, including the development and expansion of intermediate and supporting industries. These approaches to agricultural development will enable a more effective formulation of policy thrusts to meet the challenges facing the sector and for it to remain competitive in the world market. (adapted from the then Minister of Agriculture, Datuk Amar Dr. Sulaiman Daud’s massage, 1999).
Moving into the 21st Century, agriculture and forestry will be revitalized as a sector that not only supplies food for the population but also raw materials for the downstream manufacturing industries. In addition, this sector will continue to sustain, conserve and protect the environment. The Federal and State Government Departments and Agencies responsible for agriculture and forestry, the private sector, and farmers should work as a team to translate the policy and strategies into reality. In pursuit for agricultural excellence, the whole industries should be prepared to adopt new technologies and approaches in production, processing and marketing in order to enable them to sustain and enhance their performance. This is critical since the country is going through a period of increasing competitive environment, domestically, regionally and internationally. (adapted from the message of the then Minister of Primary Industry, Dato’ Seri Dr. Lim Keng Yaik, 1999).

**TOPIC 1. NATIONAL AGRICULTURAL POLICY**

Agriculture in the 60s was mainly focused on the production of food and export oriented raw materials for the industrialized countries. Approaching the 80s, Malaysia embarked into the utilization of its own raw materials for its industrialization agenda, i.e. downstream activities. The government was looking at agricultural development from two angles, namely as a way of making a living with a self-sufficiency in food and as a source of income with a commercial produce.

The era of agricultural development can be traced through three stages:

1) **The Early Years** (1960-70s).

The indigenous Bumiputras are traditionally subsistence farmers working on smallholdings not more than 5 hectares that are usually planted with rubber, oil palm, fruits, padi, and other miscellaneous crops. These lands are either inherited or customary/indigenous rights. The Colonials were owners of large rubber and oil palm plantations. The majority of Indians work on these estates and their plants as labourers, while the Chinese mainly operate at the management level. The Chinese also acted as middlemen for agricultural produce, grew cash crops, raised animals such as pigs and poultry, and work on rented and abandoned land owned by the Bumiputras.

Although Bumiputras continued to work on their smallholdings, many migrated into new agricultural land development schemes managed by government agencies. The Indians remained as estate workers although quite a number have started raising cattle and goats. The Chinese, while remaining as middlemen, moved a step further by opening rubber estates followed later by oil palm and cocoa. They also intensified raising pigs and poultry which then has become a big business.


In mid-1980, the robust economic growth was catalysed by the manufacturing sector. The parameter of the nation’s macroeconomy began to change, principally transforming the structure from agro-based to an economy that was fast moving towards an industrialised nation, an economic dragon. The Far Eastern Economic Review (1983-84) had published an article relating to the transformation of Malaysia to an industrialised economy.

Agriculturally related manufacturing plants have begun to mushroom, especially in industrial parks and other designated centres throughout the nation. The Federal government has entered into the business and formed Malaysia Incorporated, consisting of government-linked companies, which operate as official government business arm. Malaysians have bought over all the plantations from the British, for example, Guthries, Sime Darby, Dunlop [now IOI], Harrison and Crossfield (now Golden Hope). Malaysia is now the major world producers of rubber and palm oil; IOI is the largest oil palm in the world. Agro-based manufacturing activities in rubber and oil palm have increased with many Malaysian made products such as latex gloves and condoms dominating world markets.

The nation’s industrialization has been catalysed by revenue earned from newfound “black gold” petroleum. However, the food crop sector still lagging in terms of hecetage and export revenue, whether in the form of fresh or processed items. This sector badly needs support in view of its importance for the nation’s food security.

Government support has led to the emergence of some new agricultural sectors:

1) Fisheries involving coastal riverinemand deep sea fishing activities have commenced, with new new fishing harbours in Penang and Sarawak opened. Aquaculture activities in inland water bodies have increased with cultivation of commercial species. Mariculture
has also expanded in islands such as Langkawi. Recreational fisheries and aquariums are new business ventures.

2) **Tourism** industry has been given a new lease of life in the form of agrotourism involving tours to forests, nature reserves, farms and homestays.

Today, agriculture has again attained a position as an important engine for the transformation and growth of the Malaysian economy, and not as a sunset industry.

### 1.1 Evolution of Agriculture and Forestry Policies

To date Malaysia has witnessed the formulation of three agricultural policies, namely NAP1 (1984-91), NAP2 (1992-2010) and NAP3 (1998-2010). We are currently governed by NAP3 which has evolved from the previous two NAPs whereby NAP 1 equates with the "small dragon" era mentioned earlier.

In 1984 when NAP1 was promulgated, new agricultural lands were opened with emphasis on export crops, in particular oil palm and cocoa in order to increase foreign exchange, create employment and eradicate poverty. This era saw the rapid expansion of the manufacturing sector at the expense of agriculture sector whereby labour shortages, rising wages and competition of land resulted.

Subsequently, NAP1 was reviewed and NAP2 introduced. This second agricultural policy placed greater emphasis on sustainable agriculture, expanding food production, agro-based industrial development, greater role of the private sector, biodiversity and conservation. At the international level, the World Trade Organisation (WTO) was established with rapid liberalization of agricultural trade creating increased competition albeit new market opportunities. A financial crisis occurred during this period which negatively affected Malaysia’s food security. NAP2 did not anticipate such rapid and sudden changes in the domestic and international economy and therefore unable to adequately address the issues. This called for the formulation of new policies and strategies (NAP3) to enhance the nation’s global competitiveness and to ensure continuous growth of agriculture.

In NAP3, two new strategic approaches are adopted. The first is the agroforestry approach in which agriculture and forestry are viewed as an integrated entity, mutually compatible and complementary, thereby providing a scope for joint development. For example, it allows for the
production of both agricultural and forestry products on the same land such as rattan and bamboo together with rubber trees.

The second approach is the product-based approach. In this approach key products and markets are identified based on market demand. Strategies to enhance upstream agricultural production and downstream agricultural produce together with niche marketing are implemented. This differs from the conventional commodity-based approach which deals only with primary produce.

1.2 Plan of Action Formulated To Implement NAP3

1.2.1 Enhancing Food Security and Combating Inflation.

The financial crisis has highlighted the urgent need to enhance food security through expansion in domestic food production and lesser dependence on imports. This import substitution measure focuses on establishment of integrated cluster of production, processing, marketing and supporting services industry.

1.2.1.1 Domestic food production will be enhanced through:
   a) Focusing production on major food products that are cost competitive such as fishery products, selected fruits, vegetables and livestock.
   b) Zoning for food production areas.
   c) Provision of infrastructure.
   d) Promoting R & D and good agricultural practices (GAP).
   e) To increase yield and efficiency.
   f) Establishing stronger linkages between producers and the market.

1.2.1.2 Strategic sourcing of essential food products will be undertaken through:
   a) Facilitating joint venture with low-cost countries, for example in the ASEAN Growth Areas and Mekong River Basin.
   b) Government to government arrangement on supply of food to the country.

1.2.1.3 Improving marketing efficiency through reduction of marketing margins and removal of imperfections by:
   a) Reducing market intermediaries with direct marketing and contract farming.
b) Improving marketing infrastructure such as collection centres and wholesale markets in production areas.
c) Improving marketing intelligence.

1.2.2 Increasing Productivity.
Productivity gains in agriculture have not matched up with increases in wages; for example in the early and mid-90s productivity increased by 4.5% per annum while farm wages increased by 49%.

There are several new strategies to increase productivity:

1.2.2.1 New products and future industries will focus on biotechnology products, extraction of chemicals from biological resources, utilization of oil palm biomass, flouricultural products, and aquarium fish.

1.2.2.2 Reducing labour in agriculture from 1.5 million workers in 1995 to 1.0 million workers in 2010 through:
a) Reduction in hectareage of rubber by 505,000 hectares, coconuts by 70,000 hectares, and cocoa by 60,000 hectares.
b) Cultivation of new crops that require less labour such as timber species, bamboo and rattan.
c) Promotion of controlled environment, automated and mechanized systems such as hydroponics.
d) Intensification of R & D in labour-saving technologies in harvesting and tapping.

1.2.2.3 Maximising land resource use by:
a) Promoting agroforestry enterprises.
b) Integrating livestock with plantation crops.
c) Promoting large-scale, technology-intensive, mixed farming ventures.

1.2.2.4 Increasing farm income by:
a) Encouraging vertical integration by promoting value added activities at farm level through large scale commercial farming.
b) Maximizing utilization of agricultural wastes and by-products such as oil palm empty fruit bunches and padi straw.

1.2.3 Promoting Private Sector Participation.
Several mechanisms will be put in place to encourage private sector input:
1.2.3.1 Establishment of agrotechnology parks involves high technology production systems by the private sector such as mechanized operations, controlled environment, and high value materials production.

1.2.3.2 Establishment of incubation centres promote technology transfer and commercialization of research findings by the private sector particularly in biotechnology products and specialty natural chemicals.

1.2.3.3 Land banks or land leases particularly for food production will be made available for private sector participation facilitated by a comprehensive data base.

1.2.3.4 Providing private sector investment in agriculture will be aided by guidelines. A one-stop centre will be established in MoA to serve the private sector. Information services will be strengthened to assist all parties involved in agricultural development.

1.2.4 Enhancing Agricultural Export.
Several strategies have been formulated to enhance agricultural exports:

1.2.4.1 International halal food hub will be developed in Malaysia. Capacity for inspection, monitoring, standardization and certification of Malaysian halal standard will be strengthened. This standard will be aggressively promoted internationally.

1.2.4.2 Market access will be pursued through biilateral arrangements for Malaysian spade products such as palm oil. Credit facilities will also be made available for new palm oil markets.

1.2.4.3 Direct marketing approach will be undertaken to export Malaysian products without going thorough third countries.
1.2.4.4 Malaysia as a major regional distribution centre
for tropical floricultural products and aquarium fish will be
pursued. Appropriate warehousing facilities, global market
networking and quarantine services will be established.

1.2.4.5 Malaysian own brand products will be promoted
internationally in a campaign with workshops, exhibitions
and trade fairs conducted.

1.2.5 Human Resource Development.
Efforts will focused on producing more skill workers in
biotechnology, precision agriculture, mechanisation and
automation, systems engineering and computer, deep sea
fishery, and animal husbandary.

1.2.6 Mechanism for Implementation of NAP3.
The previous two NAPs lack proper and effective mechanisms
for their implementations. In NAP3, more concerted effort will
be required to strengthen both public and private sector
participation. The following mechanisms have been set up.

1.2.6.1 Action plans have been formulated comprising
short, medium and long term actions. Short term actions
include zoning and providing infrastructure and facilities for
production of short term food crops and aquaculture.
Medium term actions include provision of marketing
infrastructure such as wholesale markets; increasing
farmers markets; creating food crop estates; reducing post-
harvest losses; establishing incubator centres; promoting
Malaysia as a Halal Food Hub and Malaysian Brand Names;
and sourcing cheaper raw materials. Long term actions
focus on perennial fruits, ruminants and new products;
strengthening human resource; introducing import
substitution measures; and enhancing R & D.

1.2.6.2 Implementation of the action
plan involves institutional arrangements
being put in place. A public-private
sector coordinating council and a high
level planning and implementation
committee will be established.
Government institutions involved in
agriculture will be reviewed and
rationalized. Resources and manpower
will be allocated in line with the new
policies.
TOPIC 2. EDUCATION, RESEARCH AND DEVELOPMENT INSTITUTIONS, AND EXTENSION SERVICES

2.1 Education
There are centres and institutes that cater to the dissemination and acquisition of knowledge and skills in agriculture. These establishments include Universities, Colleges, Vocational Institutes, In-service Training Centres in various Ministries (MARDI, FELDA, RISDA, FRIM) and Societies such as Incorporated Society of Planters. A degree, diploma or certificate will be issued on successful completion of the course pursued.

2.2 Research and Development Institutions
Agricultural R & D institutions can be found in both the public and private sectors. They are more concerned with working towards practical solutions to problems rather than approaching them from purely an academic angle.

2.2.1 Public Sector
Institutions within the public sector engaged in R & D include Malaysian Agricultural Research Development Institute (MARDI), Malaysian Cocoa Board (MCB), Malaysian Palm Oil Board (MPOB), Malaysian Rubber Board (MRB), Farmer’s Organisation Authority (FOA), Federal Agricultural marketing Authority (PAMA), Fisheries Development Authority of Malaysia (LKIM), Muda Agricultural Development Authority (MADA), Kemubu Agricultural Development Authority (KADA), Forest Research Institute Malaysia (FRIM), Federal Land Development Authority (FELDA) (Sungai Tekam), Malaysian Rubber Development Board (MARDEC), and Veterinary Research Institute (VRI) (Ipoh, Rompin, Johor Bahru-poultry), State Agricultural Research Centres.

2.2.2 Private Sector
Organisations include Golden Hope (OPRS, Banting), Applied Agricultural Research Sdn. Bhd. (Sungai Buloh), FELDA Tun Razak Agricultural Services Sdn. Bhd. (Jerantut, Pahang), United Plantation Research (Teluk Intan, Perak), Guthrie Research Chemara (Negri Sembilan), Agricultural Chemical (M) (Prai, Penang; Selama, Kedah), Applied Agricultural Research (Sungai Buloh, KLK & Boustead), DUPONT Malaysia Research (Prai, Penang) and Sime Darby EBOR Research (Klang, Selangor).
2.2.3 Non-Government Organisation.
Among the active organisations are Centre for Environment, Technology and Development Malaysia (Cetdem Organic Farm, Selangor), Malaysian Environmental NGO (MENGO, Selangor), Malaysian Nature Society (MNS, KL), and Southeast Asian Fisheries Development Centre (SEAFDEC, Terengganu).

2.3 Extension Services
Extension services are provided for transfer of technology (TOT) in agriculture from research institutions to farmers. TOT is principally the duty of the Department of Agriculture (DoA), however other Research Institutes also provide such service directly through training and outreach programmes. Such institutions are Pusat Latihan dan Pembangunan Pengembangan (Telok Chengai, Kedah), MARDI, MRB, MCB, FELDA, Rubber Industries Smallholders Development Authority (RISDA), MADA, KADA, LKIM, FAMA, and National Association of Smallholders (NASH).

TOPIC 3. LEGISLATIONS, POLICIES AND STANDARDS

3.1 Legislations and Policies
Legislation is formulated to regulate the agro-forestry sector with respect to the environment and health of human, plants and animals. There are several Acts which have been enacted such as Pesticide Act (1974), Food Act (1983), Poison Act (1952), Food Regulation (1985), Environmental Quality Act (1974), and Quarantine Act (1976).

Malaysia is a signatory to the Cartagena Protocol (May, 2000), concerned with biosafety. The release of genetically modified organisms (GMO) into the environment is governed by the Bisafety Bill that was approved by the Malaysian government in November 2003.

Malaysia also subscribes to the ASEAN Policy on Zero Burning (2003) that promotes zero burning by plantation and timber companies.

Malaysia has a national policy on biological diversity formulated in 1998 that aims to transform the nation into a world centre of excellence in conservation, research and utilization of tropical biological diversity by 2020. There are various legislations which safeguard the biological diversity in the country such as Wildlife Protection Act (1972), Forestry Act (1984), and Fisheries Act (1985).
3.2 Standards

Under the overall contexts of quality assurance and control, several guidelines have been laid down as the basis for maintenance of standards which are in accordance with CODEX Standards in the agricultural industry. A few examples of such Standards, Guidelines and Certification Agencies for such standards are Good Agricultural Practices (GAP), Best Management Practices (BMP), Skema Akreditasi Ladang Malaysia (SLAM), Skema Pensijilan Perladangan Organik (SOM), Good Fumigation Practices (GFP), and Hazard Analysis Critical Control Point (HACCP).