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TRƯỜNG CAO ĐẲNG ĐÀ LẠT

GIÁO TRÌNH
MÔ ĐUN: NGOẠI NGỮ CHUYÊN NGÀNH
NGÀNH/NGHỀ: BẢO VỆ THỰC VẬT
TRÌNH ĐỘ: CAO ĐẲNG

Ban hành kèm theo Quyết định số: /QĐ-... ngày ………tháng.... năm……
.... của ……………………………………..

Lâm Đồng, năm 2017

TUYÊN BỐ BẢN QUYỀN

LỜI GIỚI THIỆU

Giáo trình ngoại ngữ chuyên ngành được biên soạn cho trình độ cao đẳng nghề BVTV hiện đang được đào tạo tại Khoa Nông nghiệp và sinh học ứng dụng Trường Cao đẳng Đà Lạt

Giáo trình được biên soạn căn cứ trên chương trình khung mô đun phương pháp thí nghiệm và xử lý số liệu trong nghề BVTV

Nguồn tài liệu tham khảo dựa trên nhiều tác giả và các biên soạn giáo trình của đồng nghiệp tại Khoa

Lâm Đồng ngày 02 tháng 7 năm 2017

Tham gia biên soạn

1. Chủ biên: Nguyễn Lâm Thiên Thanh

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GIÁO TRÌNH MÔ ĐUN

Tên mô đun: Ngoại ngữ chuyên ngành

Mã mô đun: MH25

Vị trí, tính chất của môn học:

1. Vị trí: Môn học Ngoại ngữ chuyên ngành là môn học cơ sơ trong danh mục các môn học, mô đun bắt buộc đào tạo trình độ Cao đẳng nghề Bảo vệ thực vật.

2. Tính chất: Môn học Ngoại ngữ chuyên ngành mang tính tích hợp giữa lý thuyết và bài tập, thực hành.

Mục tiêu môn học:

Học xong mô đun này người học có khả năng:

1. Về kiến thức:

- Trình bày được một số căn bản lượng từ vựng Anh văn chuyên ngành về trồng trọt và bảo vệ thực vật

2. Về kỹ năng:

- Vận dụng kiến thức để đọc và dịch tài liệu chuyên ngành

- Viết báo cáo chuyên ngành

3. Về năng lực tự chủ và trách nhiệm:

- Sinh viên có khả năng làm việc theo nhóm, có khả năng ra quyết định khi làm việc với nhóm, tham mưu với người quản lý và tự chịu trách nhiệm về các quyết định của mình

- Có khả năng tự nghiên cứu, tham khảo tài liệu có liên quan đến mô đun.

- Có khả năng tìm hiểu tài liệu để làm bài thuyết trình theo yêu cầu của giáo viên.

- Có khả năng vận dụng các kiến thức liên quan vào các môn học tiếp theo.

- Có ý thức, động cơ học tập chủ động, đúng đắn, tự rèn luyện tác phong làm việc công nghiệp, khoa học và tuân thủ các quy định hiện hành

Nội dung mô đun

Introduction

1. Aims of the course

The aim of this book is to help students of agriculture develop the four language skills and the ability of using the language knowledge in their communication about their specialist subject as well. The book covers the four skills of listening$_7$ speaking, reading and writing, as well as improving pronunciation and building vocabulary. Particular emphasis is placed on reading. The primaty goal of the course is to provide grammartical knowledge, some technical terms and words belonging to the catering field, that is to improve students' ability of using the language according to the professional situations, purpose and role of the participants. Moreover with given terms and vocabulary students can read references, self teach to enlarge knowledge and upgrade specialities.

2. Course length

The course contains ISO classes in the one last semesters in the college. There are 6 topic, 72 practical classes and 5 tests for the whole course.

3. The content of the course

The book is devided into 6 main units and 1 review units. Each main unit focuses on a topic related to a particular professional situation and follows the same teaching sequence.

3.1. Structure of a main unit

Presentation includes suggested questions aiming to provide useful information involved in the topic given in the unit and to develop vocabulary and speaking skill as well.

Dialogue introduces the new grammar of each unit in a communicative context and presents functional and conversational expressions

Language Study The new grammar of each unit is presented and is followed by practice activities. Different kinds of exercises for speaking drills such as pairwork, groupwork, or role-play and for grammatical drill provide more opportunity for student practice of the new language items that have just been presented and increase the opportunity for individual student practice.

Vocabulary developes students' vocabulary through a variety of interesting tasks, such as word map and collocation exercises. Vocabulary activities are usually followed by written or oral practice that helps students understand how to use the vocabulary in context.

Pronunciation These exercises focus on important features of spoken English, including stress, rhythm, intonation, reduction, blending.

Listening the listening activities devolope a wide variety of listening skills, including listening for gist, listening for details and inferring meaning from context. Charts or graphics are often accompanied with these task-base exercises to lend support to students.

Speaking teaches students how to present an issue. Speaking tasks involved the use of the new structures and words given in the unit and concentrate on the topic of the unit.

Reading the reading has two parts: a text and introduction of some dishes. The Readings develop a variety of reading skills, including reading for details, skimming, scanning and making inferences. Sometimes included are pre-reading and post-reading questions in which the topic of the reading is used as a springboard to discussion.

Writing the writing exercises include practical writing tasks that extent and reinforce the teaching points in the unit and help develop students' writing skills.

3.2. Review units

The review units help students consolidate the students' knowledge learned from four previous units with a variety of practical exercises.

Keys, wordlist and appendix are at the back of the book as the reference for teachers and students.

4.The method of study

English for students and teaches of agriculture how to use English for very popular professional situations and will certainly provide students with useful language. In addition,students have the opportunity to personalize the language they learn, make use of their own language and experiences and express their ideas and opinions. In order to learn the most effectively, students must be hard-working, active and try to read more references as well as to memorize vocabulary. Outside the classroom practice is also a good method learning

UNIT 1: CROPS AROUND THE WORLD

1. Vocabulary

1.1. Pre-reading task.

Read the text and write out the names of the edible fruit and vegetables in Vietnam.

1.2. Find the words which have similar meaning.

store (v)	- thing
cleanse (v)	- break down
mineral fraction	- extent / size
interaction (n)	- clean
decay (v)	- keep
measure (n)	- small piece
organic matter	- act to each
particle (n)	- *mineral*

1.3.Grouping. Which group do the following words belong to?

Potato; tomato; pineapple; papaya; longan; wheat; soya; rubber; cacao; rice; cucumber; carrot; lemon; bean; peach; cotton; pear; tea; manioc; orange; coffee; sugar cane; peanut; strawberry; cauliflower; cabbage; banana; water melon . . .

A. Fruit trees

B. Vegetables

C. Industrial crops

D. Food crops

E. Shallow-rooting crops

F. Root crops

G. Tree crops

2.Translation and discussion

2.1. Agriculture of australia

1. Although the agricultural sector is now far less significant in terms of GDP and employment (5 per cent of the workforce in the mid-1990s), the prosperity of much of the country continues to depend heavily on livestock rising and crop farming. The pastoral sector was established in the early days of settlement, when the first Spanish merino sheep were introduced from South Africa, and grazing lands today account for almost 90 per cent of the farmed area. This reflects the fact that, although livestock is raised in all productive areas, much of the pastoral sector is located in the semi-arid zone of Australia; about one-third of sheep and an even larger percentage of cattle are raised on huge properties known as „'station'' in this zone.

2. Australia is the world's largest producer and exporter of wool, particularly fine merino, although income from wool exports is now less than 8 per cent of total export earnings. Overproduction led to a significant fall in international wool prices in the late 1980s; in 19901991 more than 10 million sheep were culled from the national flock in an effort to boost the market. In 1992 Australia had some 146.8 million sheep, which produced 863,000 tones of wool and 41,000 tones of lamb and mutton. Almost half the country's wool is produced in New South Wales and Western Australia. Victoria is the leading producer of lamb and mutton.

3. Cattle are raised in all of Australia's states and territories, but Queensland is the leading producer; it had approximately 40 per cent of the national herd of 24.06 million heads in the mid-1990s. Australia produces both beef and dairy cattle. Dairying is confined primarily to the high-rainfall coastal fringe and to the southeast, especially in Victoria. Farms usually employ high-tech methods. In contrast, the huge cattle stations of the north are more reminiscent of the American „'Wild West'', although the cowboys' mounts these days are as likely to be helicopters and motorcycles, as horses; the road train a large truck pulling

2.2. Agriculture of india

About two-thirds of India's population depends on the land to make a living. Agriculture generates an estimated 28 per cent of gross domestic product (GDP). Most farms are very small - the average size of holding nationally is 2.63 hectares, but more than a third of holdings are considered too small for the subsistence needs of farming family. In term of area sown the leading crop is rice, the staple food of a large section of the Indian population.

Wheat ranks next in importance to rice, and Indian also among the leading producers in the world of sugar cane, tea, cotton, and jute. Annual production of these commodities in the mid-1990s was sugar cane, 275.5 million tones; rice, 82 million tones; wheat, 65.8 million tones; tea, 737,400 tones; cotton lint, 1.9 million tones; and jute, 1.5 million tones. Other important crops are vegetables, melons, sorghum, millet, maize, barley, chickpeas, bananas, mangoes, rubber, coffee, linseed, groundnuts (peanuts), and various spices.

The raising of livestock, particularly horned cattle, buffalo, horses, and mules, is a central feature of the agricultural economy. In the mid-1990s India had about 193 million cattle, substantially more than any other country in the world. These animals, like buffaloes, horses and mules, are utilized primarily as beasts of burden, although the vegetarianism associated with the Hindu custom is followed by few, especially in north India. Lack of pasture and water supplies means most Indian cattle are of poor quality. The country's 78 million buffalo are largely raised in the delta regions. In the dry regions of Punjab and Rajasthan camels (1.5 million) are the principal beasts of burden. Sheep (44.8 million) and goats (118 million) are raised mainly for wool.

Although much farming is still by traditional methods, there has been a significant change in the technologies available since independence. The area under canal irrigation systems financed by the government has expanded enormously; there has been an even greater expansion in the area watered by well-based systems. By the early 1990s about 45 per cent of the total cultivated area was irrigated. The demand for chemical fertilizers and high-yielding seed varieties has increased markedly, particularly since the much-publicized "*Green Revolution*" of the 1960s and early 1970s - which particularly benefited richer farmers in wheat-growing areas like Uttar Pradesh and Punjab states.

a. Is India in Europe?

b. What is Indian agriculture?

c. What agricultural products of India are popular in the world?

1. Comprehension check.

A. Answer the following questions.

1. How many percent of gross domestic product does Indian Agriculture generate?
2. What size are farms in India?
3. What are the main farming products of Indian Agriculture?

4. How many cattle are raised in India?
5. Where are most buffaloes raised?
6. Why are most Indian cattle of poor quality?
7. What are camels in India mainly used for?
8. What is the Green Revolution about?
9. What agricultural products does India export to other countries?
10. Why isn't the raising of livestock in India increased?

2.3. Growth and production of rice

Summary

Rice is one of the leading food crops in the world; it is reported to feed approximately one half of the world’s population. It is known as a semi-aquatic, annual grass plant and is found growing in a wide range of soil types and water regimes: irrigated, rain fed lowland, upland, and flood prone areas depending on where it is produced. Although there are multiple types of rice production the principles of land preparation, planting, management, harvesting, and finally processing are similar throughout the world, apart from the obvious difference between wetland and dry land cultivation.

1. Introduction

Rice *(Oryzae sativa)* belongs to the grass family *Oryzeae*, and is one of the leading food crops in the world. As such, it is a staple of over a half of the world’s population, mostly in Asia. Rice is the second most cultivated cereal after wheat. It provides 20% of the per capita energy, and 13% of the protein consumed worldwide (Juliano, 1994). Rice is known as a semi-aquatic, annual grass plant and grows in a wide range of soil and water regimes: irrigated, rain fed lowland, upland, and flood prone. In other words, it is found in a wide range of areas, from deeply flooded to dry flat fields or hilly terraced or nonterraced slopes.

Most cultivated rice is grown in flooded fields and rain fed lowlands. Irrigated rice is defined as rice produced when water is added to supplement that supplied by natural processes such as rainfall. Rain fed wetland rice production occurs in areas of the world where standing water is expected and desired during the growing season. Rain fed rice production is broken into groups depending on the depth of the water layer: rain-fed shallow water is in water 0 to 30 cm deep, rain-fed deep water is in water 30 to 100 cm deep, and floating rice is in water deeper than 100 cm. Dry land rice production is when rice is produced in aerated soil without standing water.

There are various types of rice based on grain length, width, and chemical characteristics, those being a long grain, medium grain and short grain. Rice grows in approximately 115 countries on every continent except Antarctica. Production practices range from very primitive to highly mechanized.

2. World Rice Picture

2.1. Production

Table 1 shows that rice production has increased worldwide over the last 42 years (1965 to 2007). The increases in total production have been steady on each continent except in 2001 and 2002. In most continents except the Americas and Oceania, there was a decrease in production in either 2001, 2002 or in both years. After that, most continents saw a major increase in production, although there is a pattern of decrease every five years since 1965.

Of all continents, Asia is the largest producer of rice; it was the most stable and saw the fewest number of years of decreased production as compared to the other continents. South America is the one continent with regular decreases. The breakup of the Soviet Union into individual countries has limited the availability of data about that part of Asia.

2.2. Rice Types and Products

There are two main types of rice, *Japonica* and *Indica*, differentiated by the area where they are grown and by their traits when cooked. *Japonica* types grow best in temperate environments and have kernels that are either medium or short in length and are sticky (glutinous) when cooked. *Indica* types have long kernels that are mostly not sticky (non- glutinous) when cooked and are produced in southern Asia and the Americas.

There are three grain types based on kernel traits and cooking qualities which include kernel dimensions of length and width after milling and sizing (Table 2). Within each kernel type is a brown-rice and white-rice type, depending on how much it has been milled.

	Length - Width Ratio of		
Rice Form	Long - Grain	Medium - Grain	Short - Grain

Rough	3.4 and more	2.3 - 3.3	2.2 and less
Brown	3.1 and more	2.1 - 3.0	2.0 and less
Milled	3.0 and more	2.0 - 2.9	1.9 and less

Table 2. Kernel dimension (length-width) ratio as a function of grain type (Juliano,1994).

Cooking quality is of primary importance to millers and processors. These traits depend on the chemical composition of the rice grain. Long-grain rice is usually dry and fluffy (non-sticky) when cooked and is used in parboiled, quick-cooked or processed-rice products. There are also aromatic long-grain types that have a distinct taste and aroma when cooked.

Medium-grain rice is usually moist, sticky and used for dry cereals, soups, baby food and brewing purposes while short grain rice is very sticky. Sake, or rice wine, and beer are made from non-waxy rice. Other non-grain rice products include rice bran, rice straw, rice milk, etc. Low-amylose rice is used for baby food, cereals, and rice bread, while intermediate-amylose rice is used in fermented rice cakes. High-amylose rice is the basis for extruded-rice noodles.

Rice bran is a feed concentrate for livestock and fish. Bran oil is used for human consumption and in pharmaceutical products. The bran itself, though containing protein, has limited use. Traditionally, in many places in Asia, the bran was fed to swine and piggeries, which were often located in the direct neighborhood of the mills.

Rice straw has been used to make coarse paper, as a cellulose source for ruminant livestock, composting and building materials, and as an ultra-pure source of silica. Other uses for rice plants include footwear and headwear, and rice glue from boiling ground rice. One unique use of rice is called rice marble, where rice is placed on book covers during manufacturing for a decorative effect.

2.3. Rice Varieties

Depending on the information source, there are between 40,000 and 80,000 rice varieties made up of old traditional varieties, semi-dwarf varieties, and hybrids. Traditional rice varieties have changed through the years from the land races that were tall, slender in stature with droopy leaves, photoperiod sensitive along with a strong grain dormancy to plants with a semi-dwarf stature, erect leaves, photoperiod insensitive, lodging resistant, a greater harvest index as well as a greater responsiveness to fertilizers - particularly nitrogen fertilizers. Through the years traditional varieties have been collected, catalogued, increased, and distributed by private and public institutions such as the IRRI (International Rice Research Institute, Philippines) and the USDA-ARS (United States Department of Agriculture- Agricultural Research Stations) Small Grains Lab.

Newer conventional varieties from public breeding programs are now adapted to shorter growing seasons, tolerant to a-biotic factors such as saline, acidic or alkaline soils, drought, deep water or flooded soils, variations in ambient temperatures, either high or low, and biotic stress factors due to disease or insects, as well as varieties adapted to specialty-use markets; the latter situation is mainly true for irrigated rice, and less for other rice ecosystems where water control is much more a problem. Hybrid rice varieties from private and public breeding programs have been on the increase as breeders seek to match the best traits of two parents in a short time as well as increase yields to meet the consumer demands. The amazing experience of the Chinese public research institutes is a good example of this.

In recent years transgenic / biotech rice varieties have been developed to meet world food needs as a result of increasing food demand of a growing world population, and to incorporate specialty traits Examples of these are: improved nutritional content of rice by adding genes to increase nutrients such as pro-vitamin A (such as in the GMO Golden Rice program), increased iron content, and phytic acid. The incorporation of other traits such as soil acidity tolerance, disease and pest resistance like Bt rice from China, early maturity, heavier grains, longer grain filling period, and sturdier stems, or even a new plant type, all allow for increased production in areas previously limited in their potential.

The primary goal of plant breeding in past years has been to increase yield, improve milling quality, and to introduce good agronomic traits and some level of pest tolerance, primarily against rice diseases. Morphological traits such as semi-dwarf varieties have been added while trying to hold the grain quality constant. Other agronomic traits of importance to breeders include lodging, days to heading, maturity date and straw strength.

3. Plant Growth and Development

Rice is an annual grass with a life cycle of 80 to more than 200 days from germination to maturity (Figure 1). Very early-maturing cultivars, such as Vendana, grown in dry areas in India, have a very short growth cycle; very latematuring and photoperiod- sensitive traditional types growing in the rain fed lowlands of South-East Asia have a growth cycle of more than 200 days. A distinction can also be made based either on the number of days from emergence to 50% heading (USA) or on the rainfall pattern and water depth. The sensitivity to photoperiod during vegetative growth is an important factor in rice differentiation.

The three main growth stages are: the vegetative phase, reproductive phase, and the ripening phase. The three factors that influence yield are: the number of panicles per unit land area, the average number of grains per panicle, and the average weight of individual grains. The number of panicles per land unit depends on the average number of tillers per plant. The number of grains per panicle is influenced throughout the season from panicle initiation through head emergence by environmental, nutritional, and plant conditions. The average weight of individual grains is also affected by environmental and plant conditions.

3.1. Vegetative Development

Rice stand establishment is important, and a uniform stand is necessary to produce a profitable rice crop. Factors of stand establishment that impact the final stand and yield include: crop variety, seedling vigor, seeding method and date, soil properties, seeding rate, seed treatments and growing environment. The most common rice seeding methods involve: dry / drill seeding, water-seeding, and transplanting, each of them with their advantages and disadvantages. The sowing method determines how much seed is needed for an adequate plant population. Currently, the most common technique for crop establishment in irrigated rice in Asia is direct wet seeding.

In dry / drill-seeded or water-seeded rice, 9 to 15 seedlings per square meter is the goal. Transplanted rice is spaced at 15 to 23 plants per square meter. As row width increases, uniform stand density also increases. Plant populations beyond the optimum density can increase both disease incidence and plant height, leading to increased lodging. Plant populations below the optimum density can result in lower yields, more weed problems, and lower nitrogen fertilizer utilization efficiency.

Factors affecting the establishment of a uniform stand include: field history, soil texture, tillage method, variety, seed treatment, seeding / planting date, and insect problems. Stand reduction, seedling stress, potentially increased production costs, and reduced yields may be affected by seeding date. Seed treatments contain growth hormones to increase the hypocotyls elongation length, particularly on semi-dwarf varieties, protect the seedling from seedling diseases and insects, and aid in stand establishment.

The vegetative parts of the rice plant include the roots, stems, and leaves. The length of the vegetative phase determines growth duration of varieties, e.g. early-maturing varieties have a shorter vegetative growth phase. This phase is characterized by seed germination, seedling emergence, leaf emergence, tillering, and plant height growth. The length of this stage determines the varietal season length group and occurs from germination until panicle differentiation. There can be short vegetative and reproductive stages or only a short vegetative stage depending on the variety.

3.2. Reproductive Development

The reproductive phase occurs from panicle initiation to anthesis and is characterized by a decrease in tillering activity, panicle initiation, then by internode elongation and jointing. The boot stage and flag leaf emergence are followed by heading and flowering. The reproductive phases of plant growth take 30 days depending on variety and environmental conditions.

Panicle initiation starts when the panicle primordial begins to differentiate. The first sign of this is the “green-ring” stage when a bright green band is observed just above the top node. Once this stage concludes, the internode elongation begins. Panicle differentiation is a critical stage in yield build-up as the number of grains per panicle is set at this time.

The internode elongation, also known as the jointing stage, continues until the full plant height is achieved. Panicle initiation means that the panicle itself begins to differentiate into the number of potential grains for each panicle. The number of grains per panicle is the second yield component (number of culms being the first).

Once stem internode elongation is close to completion the panicle begins to increase in size causing a swelling of the flag leaf sheath (boot stage). During this time the flag leaf is completely extended and meiosis occurs in the ovules (immature and unfertilized kernels). At this stage any environmental stress may reduce the grain yield by affecting the number of potential grains.

Heading occurs after the panicle begins to swell in the boot and as the panicle emerges from the boot. Panicle emergence may take 10 to 14 days depending on how many tillers there are on the plant. Heading date is when 50 percent of the panicles have emerged from the boot. There are several types of panicle emergence based on how much of the panicle exert from the boot, from well exerted to enclosed. Once exertion begins, anthesis / flowering are initiated.

Anthesis is depicted when the floret opens allowing the stamens to extrude, and the pistil becomes visible between the floret lemma and palea.

In most cases, pollen is shed from the anthers first while the floret is closed and then sheds more after it opens. The majority of pollen shed occurs between 9 am and 3 pm. Flowering proceeds from the tip of the panicle downward to the base of the panicle as it emerges from the boot. This takes six to 14 days. At this time the second factor of yield, seeds per panicle, is set. Factors that may negatively impact the seed set at this point in the reproductive phase include temperature, wind, rain, and pesticide applications. If ambient temperatures are less than 10 °C or greater than 35 °C some of the seed may be empty.

3.Write paragraphs by topic:

- Crops around the world

- Write out five leading agricultural products of India.

- Write about the raising of livestock in India.

UNIT 2: FERTILIZER'S ROLE IN AGRICULTURE

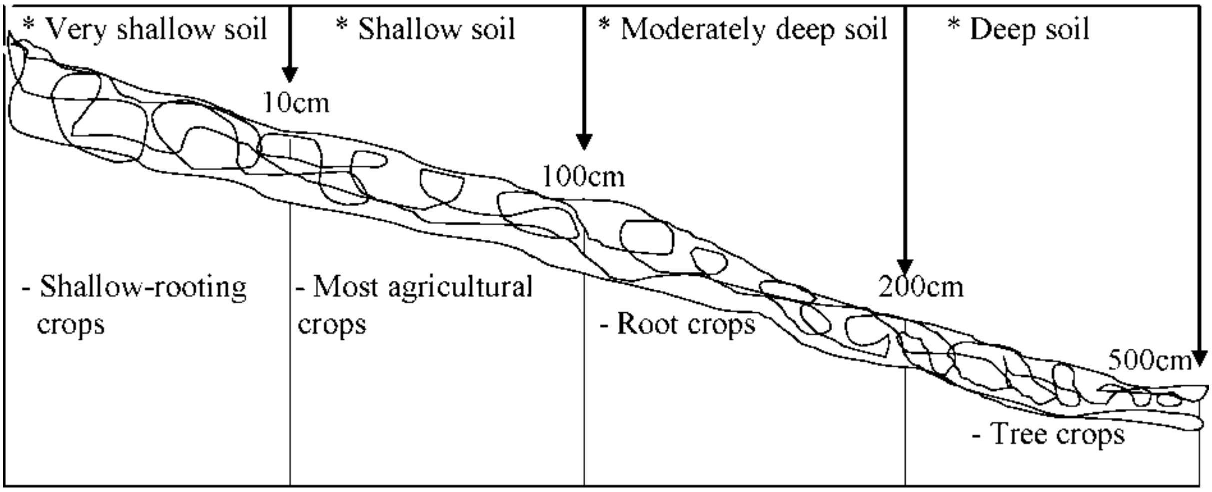
1. Vocabulary

1.1.Look at the diagram and answer the questions below.

Pre-reading task.

Find the difference between soil, land and earth.

1.1.1.Soil profiles.



Exercise 1. *(pair-work)* Now ask and say about other soil-type of the soil profile as example.

A: What is the depth of a shallow soil?

B: A shallow soil has a depth of 10 to 100 cm.

A: What crops is a shallow soil suitable for?

B: For shallow rooting crops.

A: What are shallow rooting crops composed?

B: Banana; pineapple,... (give examples in your own area.)

1.1.2. Soil particle size.

Types of soil	Particle diameter range in mm
- coarse sand	1.0 - 0.2
- fine sand	0.2 - 0.05
- silt	0.05 - 0.002
- clay	< 0.002

Small soil particles are called sand, silt or clay particles, according to their size.

Speaking. (pair-work) Ask and answer about the following soil particles.

Example

A: What is the diameter range of coarse sand particles?

B: Coarse sand particles are between 2 and 0.2mm in diameter.

A: ....

B: ....

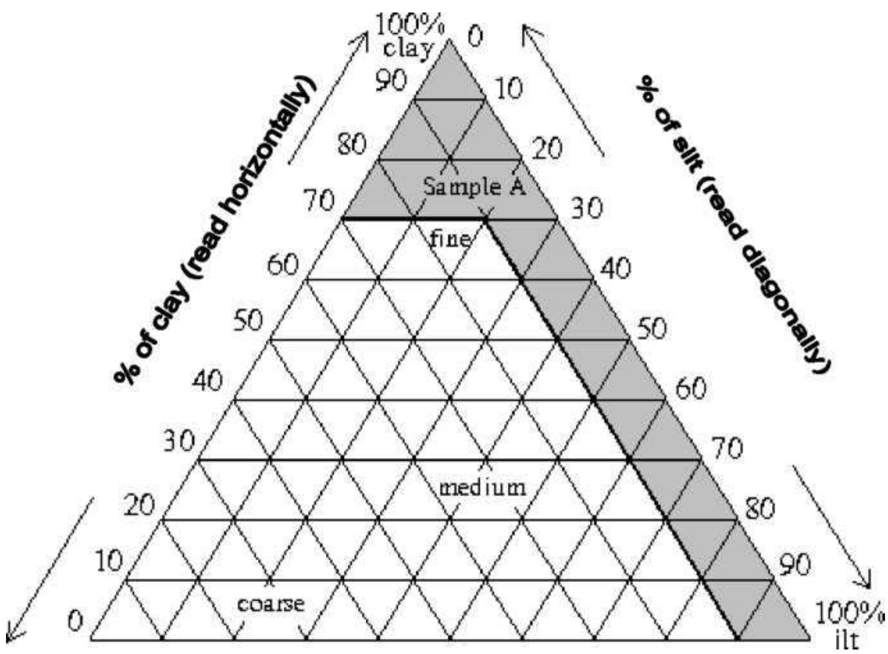
A: ....

B: ....

C. Soil texture and structure.

Soil texture is the proportion of different particle sizes in the soil. Soil with very small particles (clay) has a fine texture. Soil with a mixture of small and large particles (loam) has a medium texture. Soil with large particles (sand) has a coarse texture. The range of textures can be shown on a soil texture diagram. For example, soil sample A has 10% sand, 20% silt and 70% clay. It falls at point A on the diagram. What is the soil texture of soil sample A?

1. Look at soil sample A:



100% *90* 80 70 60 50 40 30 20 10 0

Soil sample A has 10% sand, 20% silt and 70% clay. Thus it has a *...fine...* texture. *Now look at the following soil samples in the table.*

<u>*a. Fill in the blanks.*</u> What is the texture of the following soil samples?

Samples	Sand	Silt	Clay
B	60%	30%	10%
C	30%	50%	20%
D	40%	30%	30%

2. Read and complete the following passage.

Soil with a coarse texture consists of relatively large particles. Thus it retains air in the spaces between the particles, but it does not retain water. Coarse-textured soils are usually well drained. However, many important nutrients are leached out of the soil. These soils are usually red or brown in colour.

A medium-textured soil consists of a mixture of ...(1)... and ...(2)... particles. ...(3)... it retains ...(4)... and ...(5) (6) (7)... are usually imperfectly drained. Therefore important plant ...(8)... are available for plant growth. These soils are usually ...(9)... or ...(10)... with grey mottles.

A fine-textured soil consists of relatively ...(11) (12)... Thus it ...(13)... water, ...(14)... it does not hold ...(15)... . Fine-textured soils are blue or green in ...(16).. . They are ...(17... ...(18)... drained.

The words may be used to fill the gaps.

thus ; water ; small ; soils ; large ; medium-textured ; brown ; nutrients red ; particles ; holds ; small ; air ; but ; poorly ; colour ; usually ; nutrients

2.Translation

2.1.Agricultural fertilizers: nitrogen, potassium, and phosphorus

Anyone who has grown a garden, maintained a lawn, or kept house plants knows that it is necessary to apply a fertilizer to the soil to keep cultivated plants healthy. As they grow, plants extract nutrients they need from the soil. Unless these nutrients are replenished, plants will eventually cease to grow. In nature, nutrients are returned to the soil when plants die and decay. However, this does not occur with cultivated plants. Humans cultivate plants mainly for food, either for themselves or for livestock. When cultivated plants are harvested, the nutrients that the plants extracted from the soil are taken away. To keep the soil productive, it is necessary to replace these nutrients artificially. The kinds and amounts of nutrients that plants need have been determined and can be supplied by applying to the soil substances that contain these nutrients.

A plant contains a great number of chemical compounds. The major compound in all plants is water. The percent of the plant's weight that is water varies greatly from one kind of plant to another, from less than 20% to more than 90%. After the water is removed, the bulk of the dry plant material consists of carbohydrate compounds containing the elements carbon, hydrogen, and oxygen. Using the energy of sunlight in a process called photosynthesis, plants make carbohydrates in their leaves. The carbon and oxygen in carbohydrates come from carbon dioxide, which the plant absorbs from the air, and the hydrogen comes from water absorbed both through the roots and through the leaves. About 90% of the weight of carbohydrates is carbon and oxygen. Therefore, a plant obtains around 90% of its dry weight from the air.

Although carbohydrates account for most of the dry weight of a plant, the plant contains smaller amounts of other compounds that are necessary for its growth. Plants contain proteins, which are essential in the chemical reactions of photosynthesis. Proteins contain the element nitrogen in addition to carbon, oxygen, and hydrogen. Some proteins contain sulfur as well. Plants also contain DNA, which carries the genetic information that controls how a plant grows. DNA contains the element phosphorus, in addition to nitrogen, carbon, oxygen, and hydrogen.

Phosphorus is also significant in the storage and distribution of energy throughout the plant. Chlorophyll, the compound that makes plant leaves green and is central in photosynthesis, also contains the element magnesium. The fluids inside the plant's cells also contain other dissolved minerals which provide the proper environment for the many chemical reactions that occur in the fluid. Among these minerals are compounds of potassium and calcium.

Plants must obtain the elements essential for their growth, other than carbon, oxygen, and hydrogen, from the soil. Thirteen elements essential for plant growth have been identified, and these are listed in the table on the previous page. These essential elements are called nutrients; those needed in the greatest amount are called macronutrients whereas those needed in lesser amounts are called micronutrients.

Among the macronutrients are nitrogen, phosphorus, and potassium. These three elements are those most rapidly removed from the soil by plants. Therefore, many commercial plant fertilizers supply these three essential elements.

Element	Pounds needed to grow 1 bushel of corn	Function
Macronut		
Nitrogen	16	Structural component of proteins, DNA,
Phosphor	4	Structural component of DNA; involved
Potassiu	12	Essential for many chemical reactions in
Sulfur (S)	8	Structural component of some proteins
Magnesiu	5	Central component of chlorophyll
Calcium	5	Influences permeability of cell
Micronut		
Iron (Fe)	0.2	Structural component of a number of
Mangane	0.03	Involved in enzymes for respiration
Boron	0.006	Required for protein synthesis
Chlorine	0.006	Involved in carbohydrate metabolism
Zinc (Zn)	Trace	Component of enzyme for
Copper	Trace	Component of enzymes for oxidation
Molybdenum (Mo)	Trace	Component of enzyme that reduces nitrate to nitrite

The amount of each element is indicated by N-P- K numbers. The analysis information at right (taken from a package of garden fertilizer) shows an N-P-K rating of 15-30-15. These numbers indicate the percent by weight of nitrogen, diphosphorus pentoxide, and potassium oxide in the fertilizer. The 15-30-15 rating indicates that 15% by weight of the fertilizer is nitrogen (N). It also indicates that the weight of phosphorus in the fertilizer is the same as it would be if the fertilizer contained 30% diphosphorus pentoxide (P_2O_5).

The amount of potassium in the fertilizer is the same as it would be if the fertilizer were 15% potassium oxide (K_2O).

The sources of nitrogen used in fertilizers are many, including ammonia (NH_3), diammonium phosphate ($(NH_4)_2HPO_4$), ammonium nitrate (NH_4NO_3), ammonium sulfate ($(NH_4)_2SO_4$), calcium cyanamide ($CaCN_2$), calcium nitrate ($Ca(NO_3)_2$), sodium nitrate ($NaNO_3$), and urea (N_2H_4CO). Phosphorus is generally supplied as a phosphate, such as diammonium phosphate ($(NH_4)_2HPO_4$) or calcium dihydrogen phosphate ($Ca(H_2PO_4)_2$). Potassium comes from potassium sulfate (K_2SO_4) or potassium chloride (KCl), which is also called muriate of potash.

The phosphorus content of a fertilizer is specified as the amount of P_2O_5 because this is the anhydrous form of phosphoric acid. In this sense it is the most concentrated form of phosphate, which is the form of phosphorus required by plants. The potassium content is designated in terms of K_2O, which is also called potash. Potash is a component of the residue left when plant materials are incinerated. The spreading of ashes on fields is an ancient method of replenishing potassium. Modern chemical fertilizers usually contain KCl instead, but the potassium content is still specified as the equivalent amount of potash. Potassium chloride is 52% by weight K. Potash is 83% potassium. Thus, KCl provides only about 2/3 as much potassium as the same weight of K_2O. Thus, if a fertilizer is 25% KCl by weight, its potassium rating, based on potash, would be only 16.

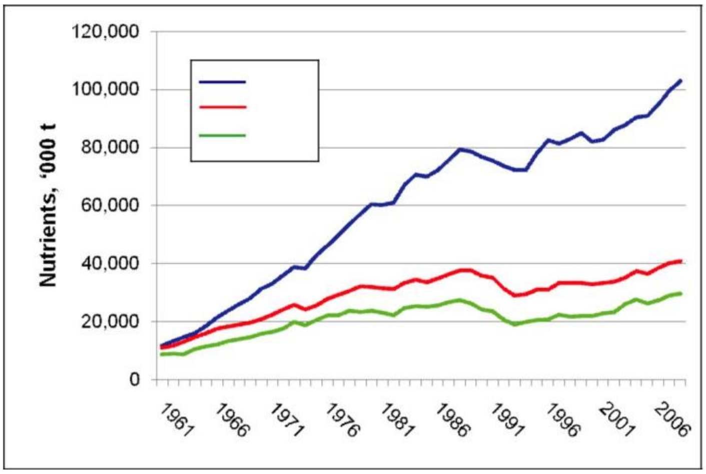
2.2. The Role of Fertilizer in Growing the World's Food

Early in 2008, the world was focused on the food crisis. A doubling of rice, wheat, and maize prices in early 2008 sparked food riots in poor nations and caused some countries to impose limits on crop exports. The food crisis resulted in the Food and Agriculture Organization of the UN (FAO) convening a "High-Level Conference on World Food Security" in Rome where governments and other organiza-tions from 185 countries met to discuss the challenges that climate change, bioenergy, and food prices caused to world food security. By midyear, global attention had shifted from food security to credit as food prices declined and the financial crisis emerged. However, the food crisis has not subsided, but the sense of urgency associated with it has given way to the global recession.

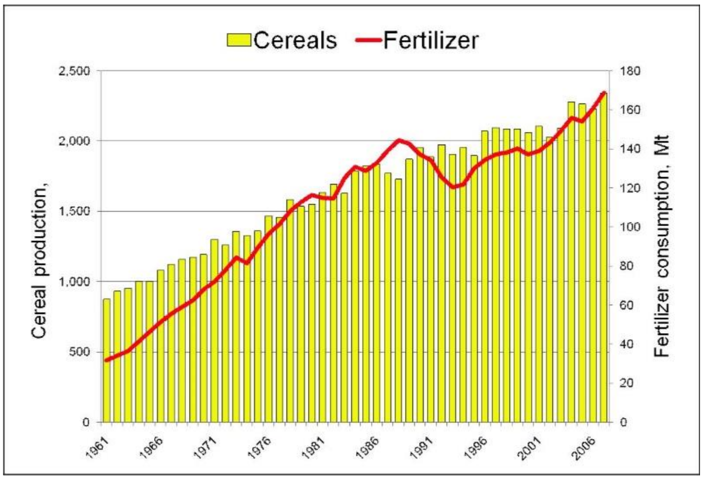
The number of undernourished people in the world reached an estimated 923 million in 2007, up from 848 million in 2003-05 and from the 1990-92 World Food Summit baseline of 842 million (FAO, 2008a). About 98% of the chronically hungry are in the developing world. The world was making progress towards the Millennium Development Goal to halve hunger by 2015. The proportion of undernourished people steadily declined from the baseline of 20% in 1990-92 to 16% in 2003-05, but by the end of 2007 the trend had reversed and we were no longer making progress.

FAO estimates that 37 countries are facing a food crisis. The "Millennium Project 2008 State of the Future" report at-tributes the food crisis to increased demand for food in devel-oping nations, high oil prices, biofuels, high fertilizer prices, low global cereal stocks, and market speculation (Glenn et al. 2008). Food security is one of the great challenges facing humanity. With the current world population of 6.7 billion expecting to reach 9.2 billion by 2050, the 2008 State of the Future report suggests that food production has to increase by 50% by 2013 and double in 30 years. The report's authors identify better rain-fed agriculture and irrigation management, genetic engineering for high yielding crops, precision agricul-ture, drought-tolerant crops, and several other factors required for new agricultural approaches as critical long-term strategies to feed the world, but they say little of the role of fertilizer.

Many believe that plant biotechnology holds the key to producing more food. The genetics and biotech industries have assured us they can deliver increased yields, promising leaps in genetic yield potential of 3 to 4 % per year (Fixen, 2007; Jepson, 2008). Monsanto, the world's largest seed company, promised to develop new varieties of corn, soybeans, and cotton by 2030 that will yield twice as much grain and fiber per acre while using two-thirds the water (Monsanto, 2008). These kinds of technological advances will be required if we hope to feed the world's hungry. However, history suggests genetic advances alone may not be able to solve the world's food shortage. For example, Cassman and Liska (2007) point out the 40-year trend for maize (corn grain) yields in the USA has been linear, with an annual increase of 112 kg/ha or a 1.2% relative gain compared to the current 9.2 t/ha yields. This 1.2% annual yield increase has been supported by the introduction of hybrids, expansion in irrigation, conserva-tion tillage, soil testing, and balanced fertilization, plus the introduction of transgenic insect resistant "Bt" maize. If the genetics industry can deliver on the promised yield increases and if that genetic potential can be converted into more yield, nutrient consumption will increase significantly. Going forward through 2020, Fixen (2007) estimated the extra production from a 3% annual increase in maize yields in the USA would require an additional 18% N, 21% P, and 13% K compared to average fertilizer use from 2004 to 2006.



Future increases in food production will have to occur on less available arable land, which can only be accomplished by intensifying production. And, it must be done in an environ-mentally safe manner through ecological intensification. The goal of ecological intensification is to increase yield per unit of land, i.e. intensify production, while meeting acceptable standards of environmental quality (Cassman, 1999). Food supply and inflation and fertilizer prices made head-line news at the beginning of 2008. Such media attention has made politicians and the general public more aware of the fertilizer industry than ever before. World fertilizer consump-tion increased steadily from the early 1960s through the mid 1980s and then declined through the mid 1990s before starting to rise again. Since 2001, N use has grown by 13%, P_2O_5 by 10%, and K_2O by 13%. Global cereal production and fertilizer consumption are closely correlated.



Fertilizer is a world market commodity subject to global supply and demand and market fluctuations. This past year saw unprecedented demand for fertilizer and record prices. World price for fertilizer remained relatively constant from 2000 through 2006, but in 2007 prices started to escalate. Prices peaked in September and October of 2008 before declining in December. Fertilizer prices increased so dramatically for a variety of reasons (TFI, 2008; IFA, 2008). Rising global demand and a shortage of supply was the major driving force in price increases. Other factors putting pressure on fertilizer prices included: increasing ethanol production, higher transportation costs, a falling US dollar, strong crop com-modity prices, and some countries curbing fertilizer exports.

Despite the recent volatility in the fertilizer market, de-mand is expected to remain strong. Solid economic growth in many developing countries has resulted in more money avail-able to improve nutrition and human diets are shifting from low-protein, starch-based foods to more animal-based protein. The developing world still lags behind the developed world in meat consumption, but people are making the shift towards more meat. Since 1995, meat consumption in the developing world has increased by 16% and in China it has increased by almost 40%. Increasing demand for meat protein means greater demand for feed grains. Demand for feed grain is projected to double between 1995 and 2020 to 445 million metric tons (M t), while cereals for food consumption are projected to increase by 40% to 1,013 M t (Pinstrup-Andersen et al., 1999). World ethanol and biodiesel production is projected to continue to increase over the next decade (FAPRI, 2008). World cereals stocks have been declining and continue to be low despite a record cereal harvest in 2008 (FAO, 2008b). Crop yields for rice, maize, and soybeans in China, India, and Brazil continue to lag behind the USA, which presents a great opportunity to increase yields with better genetics, improved nutrient manage-ment, better water use efficiency, and other BMPs.

In May 2008, the International Fertilizer Industry Association (IFA) forecast total fertilizer demand to increase by an average of 3.1% per annum over the next 5 years

However, the fertilizer industry was not isolated from the global financial crisis in the latter part of 2008, and as a consequence, consumption in the second half of 2008 was down.

Later in the year, IFA adjusted their short -term fore-cast downward for the 2008/09 fertilizer season. Nitrogen use is forecast to increase slightly by 0.5%, but P and K fertilizer use is expected to be down 4.6 and 8.3%,

respectively, compared to 2007/08. However, global consump-tion is expected to recover in the 2009/10 season, with each nutrient expected to increase by at least 3% compared to this year.

Commercial fertilizer is necessary to maintain global crop productivity at current levels and will be even more crucial if yields are to be increased. In many countries fertilization is inadequate and unbalanced, which limits the expression of yield potential and negatively impacts crop quality. Even if the biotechnology industry can deliver on their promise to increase crop yields through genetics and improve nutrient uptake efficiency, fertilizer is still critical to avoid depletion of soil nutrients and ensure soil quality.

It is difficult to determine exactly how much crop yield is due to the use of commercial fertilizer because of inherent soil fertility, climatic conditions, crop rotations, management, and the crop itself. Some crops (e.g. legumes) are not responsive to N fertilization and crops differ in their nutrient requirements. Nevertheless, meaningful estimates of the contribution of com-mercial fertilizer to crop yield have been made using omission trials and long-term studies comparing yields of unfertilized controls to yields with fertilizer. Stewart et al. (2005) reviewed data representing 362 seasons of crop production and reported at least 30 to 50% of crop yield can be attributed to commercial fertilizer inputs. A few examples will be cited here.

It shows the impact of omitting N fertilizer on several cereal crops in the USA. Without N, average maize yields declined 41%, rice 37%, barley 19%, and wheat 16%. Eliminating N from soybeans and peanuts (both leguminous crops) had no effect on yield (data not shown). Had the authors measured the effect of eliminating P and K, the reductions were expected to be even greater.

The Sanborn Field at the University of Missouri was started in 1888 to study crop rotation and manure additions. Commer-cial fertilizer was introduced in 1914. Although application rates have varied over the years, comparing the plots receiving N, P, and K fertilizer to the unfertilized control showed that fertilizer contributed to an average of 62% of the yield of the 100-year period.

The Broadbalk Experiment at Rothamsted, England, has the oldest continuous field experiments in the world. Winter wheat has been grown continuously since 1843. Application of N fertilizer with P and K over many decades has been responsible for 62 to 66% of wheat yield compared to P and K applied alone From 1970 to 1995, growing high-yielding winter wheat continuously receiving 96 kg N/ha, omitting P decreased yield an average of 44% and omitting K reduced yields by 36%.

Fertilizer Best Management Practices

With the recent media attention directed to the fertilizer industry as a result of the food crisis and public recognition that fertilizer is part of the solution to world food security, it is incumbent on the industry to do everything practical to ensure fertilizer is used responsibly and efficiently. Fertilizer BMPs are intended to do that — to match nutrient supply with crop requirements and minimize nutrient losses from fields. The approach is simple: apply the correct nutrient in the amount needed, timed and placed to meet crop demand. Applying the 4Rs — right source (or product), right rate, right time, and right place is the foundation of fertilizer BMPs (Roberts 2007).

IPNI has developed a global framework describing how the 4Rs are applicable in managing fertilizer around the world (Bruulsema et al. 2008). Fertilizer management is broadly described by the four "rights", however, determining which practice is right for a given farm is dependent on the local soil and climatic conditions, crop, management conditions, and other site-specific factors. The purpose of IPNI's framework is to guide the application of scientific principles to devel-opment and adaptation of global BMPs to local conditions, while meeting the economic, social, and environmental goals of sustainability.

Summary

Global demand for fertilizer remains strong. A growing population with the desire and means to improve their diet will ensure fertilizer consumption will continue and will increase. Meeting the world's escalating food needs cannot be achieved without fertilizers. Without fertilizer, the world would produce only about half as much stable foods and more forested lands would have to be put into production. Inorganic fertilizer plays a critical role in the world's food security. It cannot be replaced by organic sources…although where available, organic nutri-ent sources should be utilized…but fertilizer must be used efficiently and effectively. The 4Rs — right source, right rate, right time, and right place — are the underpinning principles of fertilizer management and can be adapted to all cropping systems to ensure productivity is optimized.

3.Discussion

3.1.Answer the following question.

- Why does a coarse-textured soil retain air?
- Give one disadvantage of a coarse-textured soil.
- Why is a medium-textured soil usually imperfectly drained?
- Are the particles of a fine-textured soil predominantly sand, silt or clay?
- Why is the fine-textured soil often flooded after rain?
- Why is rice often grown in a fine-textured soil?

- In which type of soil are root crops (e.g. sweet potato, cassava, etc) grown in your area? Give one reason why you think this is so.

- Soil structure. Define the soil texture as quickly as possible, then write the soil structure.

Soil texture: A: B: C:

A	B	C
■ sand 80%	- sand 20%	- sand 20%
■ silt 10%	- silt 70%	- silt 20%
■ clay 10%	- clay 10%	- clay 60%

3.2. *Speaking.* (pair-work) Answer the following questions.

SOILS

Soils are very complex natural formations which make up the surface of the earth. They provide a suitable environment in which plants may obtain water, nutrients and oxygen for root respiration, and firm anchorage. Soils are formed by the weathering of rocks, followed by the growth and decay of plants, animals, and soils micro-organisms. If a farmer is to provide the best possible conditions for crop growth, it is desirable that he should understand what soils are, how they were formed and how they should be managed.

The topsoil and surface soil is a layer about 8-45 cm deep which may be taken as the greatest depth which a farmer would plough or cultivate and in which most of the plant roots are found.

Loose, cultivated, topsoil is sometimes called mould.

The subsoil, which lies underneath, is an intermediate stage in the formation of soil from the rock below.

A soil profile is a section taken through the soil down to the parent rock. In some cases this may consist of only a shallow surface soil 10-15 cm on top of a rock such as chalk and limestone. In other well-developed soils (about a metre deep) there are usually three or more definite layers (or horizons) which vary in colour, texture and structure.

The soil profile can be examined by digging a trench or by taking out cores of soil from various depths with a soil auger.

A careful examination of the layers (horizons) can be useful in forming an opinion as to how the soil was formed, its natural drainage and how it might be farmed. Some detailed soil classifications are based on soil profile.

I. Check your understanding.

- Read the text carefully, then answer the following questions:

1. What are the four main constituent parts of soil?

2. What should the farmer understand about soil?

3. How many types of soil are there?

4. What soil is called mould

5. How are soils formed?

6. How do you take a soil sample?

7. What can a soil sample tell you?

- Find the words with opposite meaning to the following words in the passage.

  - simple :   - development :   - concentrating :
  - loose :   - deep :   - single :
  - not wanted :   - wash away :   - general :

A. Look at paragraph 2 and say what these words refer to:

line 1: which .... line 9:.......................................

line 2: which .... line 13:......................................

line 8: which .... line 17:......................................

Why is it difficult to cultivate a fine-texture soil?

a. Why is a medium-textured soil suitable for plant growth?

b. What happens to coarse-textured soil in a heavy rain storm?

c. What are the advantages of each type of soil?

d. What are the disadvantages of each type of soil?

e. How can farmers cultivate a coarse-textured soil?

f. How can a fine-textured soil be used most efficiently?

- **Which set of words do the definitions refer to?**

- micro-organism.
- soil materials.
- soil improvers.
- cycle waste.
- force of gravity.

- soil texture.
- soil structure.

1. Get back from used material by treating it.
2. Force that attracts objects in space towards each other and on the earth pulls them towards the centre of the planet.
3. Way a surface of soil looks firm, soft or hard.
4. Way in which the mineral fractions together build the soil.
5. Organism so small that it can be seen only under a microscope.
6. Substance from which soil is built.
7. Way or techniques that assist micro-organisms and nutrients in

   soil in increase.

4.Write paragraphs by topic: fertilizer's role in agriculture

UNIT 3: DISEASES OF TROPICAL VEGETABLE CROPS

1. Vocabulary

Task: Write the terms below with their definitions in the table below. Then add any examples, key takeaways, or other notes.

Key Issue 1 Vocabulary:

- intensive agriculture
- extensive agriculture
- agriculture
- agribusiness
- subsistence agriculture
- commercial agriculture
- Carl Sauer's Theory of Plant Domestication

Key Issue 2 Vocabulary:

- plantation farming
- shifting cultivation (aka "slash and burn")
- pastoral nomadism
- intensive subsistence agriculture
- swidden
- crop rotation
- double cropping
- transhumance
- intertillage

erm	Definition	Examples/Key Takeaways/ Notes
Key Issue 1: Where Did Agriculture Originate?		
	The deliberate effort	This answers our "What" question for this unit. What might be the "Where", "Why there" and "So

<table>
<tr><td></td><td>to modify a portion of Earth's surface through the cultivation of crops and the raising of livestock for sustenance or economic gain.</td><td colspan="2">What” questions with respect to agriculture?

Where questions:

Why There questions:

So What questions:</td></tr>
<tr><td></td><td>Any kind of agricultural activity characterized by low inputs of labor on large plots of land.</td><td colspan="2" rowspan="2">LDCs = Half of people are farmers vs. MDCs=5% of people farm (2% in U.S. yet produce massive surpluses of food)

Low intensity rice cultivation in northern Thailand = 1,000 kg per hectare, per year.

High intensity irrigated rice cultivation in California= 10.000 kg per hectare per year.</td></tr>
<tr><td></td><td>Any kind of agricultural activity characterized by effective and efficient use of labor on small plots of land to maximize yield.</td></tr>
<tr><td></td><td>Agriculture undertaken primarily to generate products for sale off the farm.</td><td>Commercial agriculture:

a. low agricultural density (farmers per arable land)</td><td>Subsistence Agriculture:

a.
igh agricultural density

b. human/anima</td></tr>
</table>

	Agriculture designed primarily to provide food for direct consumption by the farmer and the farmer's family.	b. machine power (hi tech) c. large farms (5% of U.S. farms produce 75% of yield) d. Future: problems with low prices (due to overproduction, notice irony: we pay farmers to produce less in a hungry world) and sustainability.	l power c. small farms d. Future problems: feeding growing populations of LDCs, need to generate income via international trade.
	Commercial agriculture characterized by vertical integration of different steps in the food-processing industry, usually through ownership by large corporations (e.g. Tyson Chicken or Smithfield Pork)	The traditional classification of agriculture as a primary economic activity does not apply to many farmers in MDCs who are engaged in production, research, marketing, and some manufacturing of their products. (Many commercial farmers have to be more tech and market savvy that typical urban office workers.)	
	1. Agriculture had multiple hearths but occurred first in SE Asia with the domestication of root crops such as taro and yams through vegetative planting (replanting cuttings from a source plant's stems or roots). 2. Agriculture began in areas of high biodiversity (diversified, varied habitats and plant species). This richness of food sources allowed hunter gatherers to become sedentary which naturally lead to experimentation		

	with root crops. 3 Later, independent hearths of seed agriculture: SW Asia (barley, wheat, cattle, pigs, sheep, goats, also first area to integrate plant and animal domestication), NE China (rice, millet), Ethiopia (millet, sorghum), and Mesoamerica (beans, potato, cotton, maize).	
Key Issue 2: Where are Agriculture Regions in LDCs?		
	A low density (extensive) form of subsistence agriculture in which farmers grow a variety of crops (aka multicropping) on a cleared/burned field for only a few years until soils are depleted. Then the field is left fallow for many years and the farmer moves on to the next field.	1. Practiced in hot, humid, low latitude tropical rain forests. 2. Only 5% of world's people do this but it uses 25% of world's land area. Why? 3. Rapidly being replaced by cattle ranching, logging, and cash crops. This contributes to climate change, kills off species, destroys cultures. 4. Inefficient (can't support many people), but sustainable for small populations (but populations are skyrocketing in these areas).
	A low density (extensive) form of subsistence agriculture based on herding domesticated animals. Unlike	1. Practiced in dry climates that cannot support crops (swath from Central Asia through SW Asia to North Africa). 2. Only 15 million nomads left but use 20% of world's surface area. 3. Once powerful politically and as carriers of goods and information, nomads are being resettled by

	other subsistence farmers, nomads rely primarily on animal products (meat, milk, skins) for their survival.	governments to make room for irrigated crops, mining, and oil extraction.
	A high density, high labor (intensive) form of subsistence agriculture in which farmers must expend a relatively large amount of effort to produce the maximum feasible yield from a usually small parcel of land.	1. Feeds the vast majority of people in LDCs (and therefore the world). 2. East Asia, SE Asia, South Asia 3. High human and animal labor / low tech. 4. Two types: wet rice (southern China, SE Asia, East India) and non wet rice (northern China, interior India) 5. Uses every inch of land! (terracing/small paths)
	Agriculture performed on a large farm in tropical and subtropical climates that specializes in the production of one or two crops for sale, usually to a more developed country	1. Most farming in LDCs is subsistence farming. Plantation farming is the exception (it is a type of commercial agriculture found primarily in LDCs.) 2. Found in tropics, subtropics (Latin America, Africa, Asia) 3. Plantations often controlled by MDC corporations and crops (cotton, sugarcane, coffee, rubber, tobacco, cocoa, jute, bananas, tea, palm oil) are sold in MDCs.

	The seasonal migration of livestock between mountains and low land pastures.
	In shifting cultivation agriculture, the practice of planting taller, stronger crops to shelter lower, more fragile ones from tropical downpours.
	A patch of land cleared for planting through slashing and burning.
	Harvesting twice a year from the same field. Common with wet rice agriculture especially with new fast ripening rice varieties.
	The practice of rotating use of different fields from crop to crop each year, to avoid exhausting the soil. Mostly associated with intensive forms of agriculture.

2.Translation and discussion:

2.1 Diseases of Tropical Perennial Crops: Challenging Problems in Diverse Environments

The world's oldest ecosystems are found in the tropics. They are diverse, highly evolved, but barely understood. Diseases that impact crops in these regions can be significant contraints to production, especially when they occur in lowland environments with high rainfall and uniform, warm temperatures; respites from disease pressure there are often infrequent. Difficulties in managing diseases in the humid tropics are multiplied when the affected crops are perennial. The favorable conditions for disease development and the presence of susceptible host tissue over long periods make diseases of tropical perennial crops serious management challenges.

This topic is introduced with a few concepts on the occurrence and development of these pathosystems. Peculiar aspects and scenarios that influence the types of and extent to which different diseases develop are summarized. Measures that are useful on annual or short-term crops may be ineffective against these diseases. They are scientifically interesting problems. New vectors, as for mango malformation, or pathogens, as for bunchy top of papaya, are associated with some of the diseases. And some of the diseases are caused by two or more distinct taxa; for example, citrus greening, mango malformation, Panama disease, and tracheomycosis of coffee. Some of the most important diseases are host-specific and are caused by either coevolved or new-encounter pathogens. Resistance, the most effective tool with which many of these diseases are managed, is usually available in coevolved pathosystems but may be uncommon in new-encounter situations. Inadequate host resistance can be a significant barrier in the management of both coevolved and new encounter diseases.

2.2. General tactics are described that are useful against diseases of tropical perennials. The successful management of plant disease utilizes several principles and Agriculture Begins

Agriculture began after the Pleistocene (last ice age) and started independently in several different regions. It developed first in the Near East (sites in the Fertile Crescent and in present-day Israel and Turkey) due to a fortuitous combination of suitable climate and useful plants and animals that could be domesticated. These first farmers appeared at least 11,000 years ago, and were followed in quick succession by others in Northern and Southern China, Mesoamerica, New Guinea, the Andes, and the Eastern United States. Additional areas of independent development may also include Amazonia, Ethiopia, the Sahel, Southeast Asia, and Western Africa.

During agriculture's brief history, humans have utilized numerous plants. At least 3,000 taxa have been used for food and several hundred more have been used for other purposes. In Table 2, the following categories have been considered: beverage, drug, elastomer, fiber, food, insecticide, oil, spice, and timber and pulp.

Despite the large numbers of useful species, only a subset is very significant and few are of major importance. Scarcely more than a hundred species enter world commerce, and among the food crops, few are staples: About 0.5% of the food species supply more than 90% of the world's food.

2.3.Biological Diversity in the Tropics

Biological diversity increases with decreasing latitude. This trend, called the Latitudinal Diversity Gradient (LDG), has been observed for a wide range of trophic levels and life forms. In general, species numbers increase dramatically as one moves from the poles to the equator.

The LDG is one of the oldest recognized patterns in the biological sciences. Humboldt discussed the relationship two centuries ago, and Darwin wrote about it in his famous book. This increase in diversity is most pronounced in tropical rain forests, which are thought to host 50% of all species but occupy only 7% of the world's landmass (162). And it appears to be a general rule on our planet since it is found in the fossil record and re-establishes after mass extinctions.

Plants are among the most prominent organisms that conform to the LDG. Thus, it is not surprising that most of the early agricultural hubs (nine of the above 12) and first crop domestications occurred in the tropics, i.e between the Tropics of Cancer and Capricorn (Table 1). More than half the crops in Table 2, 69 of 126 (55%), originated in the tropics. Some tropical annuals, e.g., rice, potato, and maize, are now also grown in temperate zones during the summer. But essentially all tropical perennials are restricted to the tropics due to their cold sensitivity.

A wide range of habitats is found in the tropics, including humid lowlands, deserts, seasonally dry forests, grasslands, savannahs, montane environments, and swamps

Further diversity in each of these habitats results from variable edaphic, meterologic, and biotic conditions. This vast array of environments enables an equally wide range of plants to be grown; almost every crop in Table 2 can be grown somewhere in the tropical world. For example, important temperate domesticates are grown in the lowland tropics (members of the Brassicaceae and Fabaceae are especially common) and at high elevations where moderate temperatures exist (members of the Fabaceae, Poaceae, and Rosaceae are most notable). Thurston's estimate that twice as many crops are grown in the tropics as in the temperate zones of the world is probably accurate.

Studies that compare tropical and temperate ecosystems are uncommon, and a disproportionate amount of the research on microorganisms has been conducted in temperate zones. For example, in reviewing the literature on fungi and bacteria in forest ecosystems since 1963, Lodge et al. found only 96 references for tropical forests, but 2,411 for temperate forests. Despite this disparity, the LDG is also evident among microbes.

Three groups of nonpathogenic fungi, decomposers, endophytes, and arbuscular mycorrhizae, are very diverse in the tropics, as are fungi in general. Plant pathogens also appear to be more numerous and diverse in the tropics. One group, the flagellated protozoa *(Phytomonas* spp.), is rare outside the tropics, and 60% of the described vi- roid species have tropical, natural hosts .

If one considers diseases of crop plants, there may be an even greater difference between temperate and tropical areas. Wellman (161) found a pronounced temperate/tropical bias among the crops that were well represented in both zones: pumpkin and squash, 19 temperate diseases and 111 tropical; sweet potato, 15/187; tomato, 32/278; common bean, 52/253+; and potato, 91/175. Wellman (159-161) concluded that for every disease that occurred on a given crop in temperate areas there were 10 in the tropics.

Disease problems can be severe in the tropics, especially where high rainfall and uniform, warm temperatures are the norm. These conditions are highly favorable for the development of most diseases, and respites from disease pressure are usually infrequent in these areas. Overall, losses are thought to be 50 to 100% higher in tropical than in temperate regions

Estimates of the proportion of all losses in the tropics that are caused by diseases range from 30% (56) to 50% (161).

Plant pathology began in, and generally continues to be a discipline focused on, temperate climates; comparatively little plant pathological research has been conducted in the developing tropical world. Work in the tropics has made significant contributions to the discipline of plant pathology, but much more would be revealed if resources that approached those used in temperate zones were devoted to research in the tropics.

Perennial crops: Challenging hosts for disease managers. When one considers the total areas planted and annual yields, the most important food crops are annuals. Other than sugarcane (its total represents harvested cane, not a final product), only production figures for maize, rice, and wheat exceed 500 million metric tons per year (Table 2). Although they are minor components of most natural floras, annuals predominate in agriculture for the following reasons: they produce quick results after planting; when stored, they enable escape from unfavorable climatic conditions (particularly the grains and pulses); and when incorporated in fallow or rotation cultures, they facilitate the avoidance of pests and pathogens .

Despite the importance of annual crops, Table 2 indicates that perennial crop plants (those that live longer than 2 years) are more numerous (73 of the 126 [58%]). There are several reasons why these most common hosts are often serious disease management challenges.

Rather than being protected for a few weeks or months, perennial hosts require long-term measures. Since they are long- lived and there are no seasonal breaks in production, perennials are more prone to inoculum buildup and epidemic disease development.

Managing the large reservoirs of inoculum and high disease pressures that develop in perennial monocultures can be difficult and costly. For example, management of black Sigatoka leaf spot of banana (black leaf streak), caused by *Mycosphae- rella fijiensis*contributes as much as 25% of the final retail cost of export bananas and can fail during periods of high rainfall or less than adequate fungicide applications . In India, 10% of the total costs of coffee production went toward the control of rust. And eradication efforts can be very expensive. Cacao swollen shoot, caused by *Cacao swollen shoot virus*, in West Africa and citrus canker, caused by *Xanthomonas axonopodis* pv. *citri*, in Florida are worst-case examples of where large sums of money were invested in ultimately unsuccessful campaigns.

Due to long-term selection pressure, there are increased opportunities in perennial systems for the development of pesticide-resistant pathogens. Despite an increased awareness of pesticide resistance and the establishment of strategies to avoid the build-up of resistant strains, a rapid erosion of the efficacy of new chemicals is still common.

Long-term exposure to disease-promoting or predisposing factors can increase disease development in perennial hosts. Host nutritional status is an important abiotic factor that can be related to increased disease. Likewise, an excess of water can encourage the development of diseases induced by stramenopiles.

3.Write paragraphs by topic: diseases of tropical vegetable crops

UNIT 4: DISEASES OF TROPICAL FRUIT TREES

1. Vocabulary

Fill in the gaps with given words.

due to ; erode ; waterlogged ; compound ; presence ; friable ; laterite ; penetrate

a. Metals are.............. by acids.

b. Common salt is a .... of sodium and chlorine.

c. The train was delayed ....the bad weather.

d. The dogs were trained to detect the............ of drug.

e. Soil with large particles is ....

f. Almost roads in the countryside are made of..............

g. The heavy rain had ....right through her coat.

h. The area is often .... in rainy season.

1. Pre-reading task.

a. What countries are tropical?

2. Read the passage and answer these questions as quickly as possible.

a. What colour is laterite?

b. What are the three major soil types mentioned in the passage?

TROPICAL SOIL

The soil of hot, tropical areas varies in texture, structure and colour and in their value for agriculture. A group called Tropical Red Earths is a very common soil type in, for example, tropical Africa. The group includes yellow, orange and brown soils as well as red. Their colour is due to the presence of certain minerals, mainly iron and aluminium oxides. They are usually rich in clay but they are quite friable and easily cultivated. A common type of soil in this group is laterite. It is a red-brown soil, which becomes very hard when it is dry. Laterite often forms a very hard crust on or below the surface. Plants are unable to grow through it and water cannot penetrate it. These soils are usually eroded by water running over the surface.

Black or dark-coloured soils are found in lowland areas, which become flooded or waterlogged, and in valleys. They are usually rich soils and valuable for cultivation (rice). The grey and light-coloured soils contain calcium compounds and are often found over limestone rock.

A. Say whether the information in the following sentences is true or false. Correct any false or partly false information.

1. There is only one type of soil in tropical countries.
2. Soils which are rich in iron oxides are common in tropical Africa.
3. These soils are fine-textured and usually solid in structure.
4. Laterite is an example of Tropical Red Earths.
5. Laterite has properties which make it difficult for plants to grow.
6. Laterite is a well-drained soil.
7. Important nutrients are leached out of laterite soils.
8. Black or dark-coloured soils are poorly drained.
9. Black or dark-coloured soils usually have large soil particles.
10. Black or dark-coloured soils retain important plant nutrients.

B. Writing and speaking. Answer the following questions

1. Can you say anything about the pH value of Tropical Red Earths from the information given in the passage?

2. Find out about the properties of soils in your area. *(type of soil, colour, texture and structure of the soil).* Which crops grow on them?

C. The pH value of soil water.

We use the pH scale to describe the acidity or alkalinity of a soil. A soil with a pH value between 1 and 6 is acid, whereas a soil with a pH value of 7 is neutral and a soil with a pH value between 8 and 14 is alkaline. Most soils have a pH value between 8 and 6. Most crops do not grow well in very acid or very alkaline soils.

Writing1. Now make similar sentences about tea, coffee, citrus crops, rice, tomato and

Exercise 3. (pair-work)

Ask and say about the tolerance of the crops in the box as example below.

- *A:* What crops grow well in an acid soil?
- *B:* Blackberry, potato and watermelon grow well in acid soil.
- *A:* What crops do not grow well in an acid soil?
- *B:* The crops do not grow well in an acid soil such as: onion, spinach and cauliflower.
- *A:* In what soil do beans grow well?
- *B:* Beans grow well in slightly acid or neutral soil, but they do not grow well in very

acid soil.

Read the following passage and answer these questions.

a. Which of these would you expect to find in tropical soils? Discuss and explain your answers.

- soil erosion
- nutrient deficiency
- an excessive amount of water
- an insufficient quantity of water
- an excess of nutrients

b. How much kaolinite clay do tropical soils usually contain?

c. What is this section of the reading passage about?

- tropical soils and their management
- the differences between tropical and temperate soils
- the differences between tropical and temperate soil management.

2.Translation and discussion: the management of tropical soils

The management of tropical soils involves different principles from those of temperate soils. This is because both the climate and the soils are different. In the tropics there is a low temperature range and a high average temperature. The rainfall is usually very heavy in the rainy season but inadequate in the dry season, where there is one.

Tropical soils contain a large amount of kaolinite clay and if they are low in iron and aluminium, their structure may be excessively poor and unstable. If, on the other hand, the soil contains adequate amount of iron and aluminium, their oxides and hydroxides will cement the kaolinite particles together in relatively large aggregates and this will improve soil structure.

When managing tropical soils, therefore, two basic principles are involved. The first is to use a method of farming which involves a minimum of clean cultivation since the latter leaves the soil bear and consequently liable to water erosion and loss of nutrients by leaching. The second is to use a method which maintains sufficient organic matter in the surface soil. This helps to keep bases and phosphates available in the soil, is a good source of plant nutrients and maintains good structure in the surface soil.

1. *Writing and speaking.* (pair or group-work) Find the answer to the followings.

a. Give two ways in which tropical climates differ from temperate climates.

b. Name two common bases found in some tropical soils.

c. Name two factors, which improve soil structure and explain their effect.

d. Explain why a soil may contain insufficient phosphates.

e. Give one function of iron oxide in the soil.

f. Give the two advantages of each of the basic principles in managing tropical soils.

3.Write paragraphs by topic: diseases of tropical vegetable crops

UNIT 5: INSECTS

1. Vocabulary

Bee

Bees are known for their role in pollination and for producing honey and beeswax

Wasp

can be quite aggressive and can sting more than once, unlike bees

Fly

They are known for transmitting diseases

Dragonfly

Dragonflies are valuable predators that eat mosquitoes, and other small insects like flies, bees, ants, and very rarely butterflies. They are usually found around lakes, ponds, streams and wetlands

Moth

A moth is an insect closely related to the butterfly. Moths are nocturnal

Butterfly

A butterfly is a mainly day-flying insect whose life cycle consists of four parts: egg, larva, pupa and adult.

Grasshopper

Grasshopper are winged, but their wings are not fit for flight.

Cricket

Crickets are are insects somewhat related to grasshoppers. They tend to be nocturnal

Caterpillar

Caterpillars have been called "eating machines", and eat leaves voraciously

Cockroach

Cockroaches are associated with human habitations

Spider

Spiders are found worldwide on every continent except for Antarctica. a few species of spiders are venomous and are dangerous to humans

Ant

It lives in nests and most varieties are harmless, although some can also bite

Worm

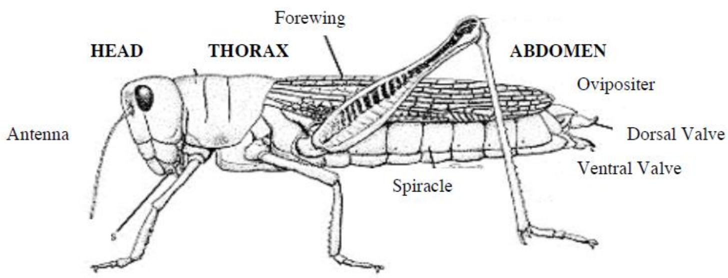
some worms occupy parasitic niches (inside human and animal bodies.) Others live on land, in marine or freshwater environments

2. Translation and discussion

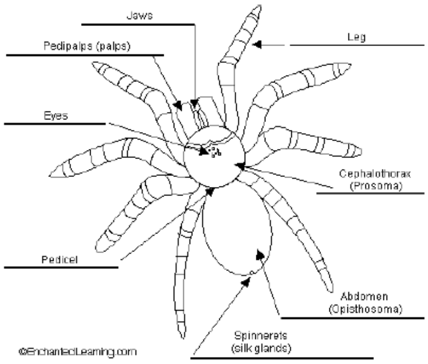
Insects share characteristics that separate them from other animals. All insects are invertebrates. They have an exoskeleton or protective outer skeleton, unlike humans and other animals that have skeletons within the body (vertebrates). The exoskeleton does not grow and must be molted (shed) each time the animal undergoes a period of growth.

Over 1 million species of insect have been discovered and as many as 30 million remain unidentified! In fact, insects account for approximately 75% of all known animal species.

Insects have three body segments; the head, thorax and abdomen. Six jointed legs connected at the thorax and one or two pair of wings.



Spiders are often grouped with insects and indeed they are related. Spiders and insects belong to the Phylum Arthropoda, the group of animals with exoskeletons. Spiders, however, have 8 legs, no antennae or wings and

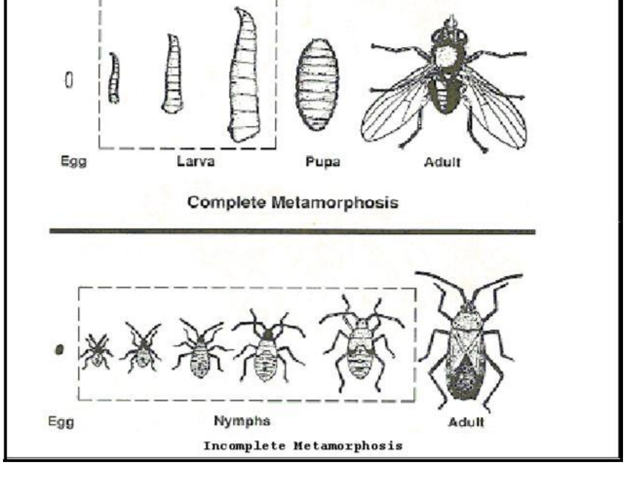


only 2 body segments.

Insects have special features, adaptations, which help them to survive and fill a wide range of niches, or specific roles played in an environment. For example, a leaf insect has the ability to blend in perfectly with leaves on a tree and the coloration and stillness of the preying mantis helps it go unnoticed by its prey.

Insects are masters of camouflage and use it for many purposes. Concealment for purposes of protection and predation,communication, attraction of mates and warning signs are all reasons an insect benefits from this adaptation. Notice how easily the preying mantis at the left could be mistaken for a dead leaf! The benefits of camouflage are, however, only useful if an insect is in the environment in which that adaptation developed. Imagine a brown walking stick on green grass. It would not be difficult, under these conditions, for a predator to spot it. A well-concealed moth would have a difficult time attracting a mate using coloration alone. Many insects have adapted to deal with problems such as these.

Many moths emit an odor, which can be detected up to 1 mile away by its intended mate. The sphinx moth flashes brightly colored eyespots on its underwings to scare away predators. A caterpillar might have false eyes on the end of its body to confuse a would-be predator.



Insects reproduce and develop much differently than other animals do. All insects lay eggs, which will hatch as larva and later become encased as a pupa in insects that undergo complete metamorphosis (like butterflies and ants).

Insects that undergo incomplete or simple metamorphosis (like dragonflies and grasshoppers) hatch as nymphs, which look like miniature adults

Insects are the most abundant and diverse form of animal life on the planet. They are found on every land of the earth, from pole to pole. Physiological, morphological, and behavioral adaptations all contribute to their success as a class. The table below shows just a few of the many adaptations insects can have.

Adaptation	**Function**
Exoskeleton (hard outer covering)	Protects from enemies, keeps it from drying out, mechanical advantage for increased strength
Small size	Avoid predators, need less resources like food and space, lighter exoskeleton facilitates movement and flight
Flight	Escape predators, transportation to new habitats and resources
Antennae	Used to feel and smell
Stingers	Used for protection
Coloring	Used for camouflage, protection, reproduction

High reproduction rate	Lay many eggs that hatch, have a shorter life cycle, allows them to adapt and survive as a species
Social Colonies	Efficient nest building and food processing to assure that young will survive

3.Write paragraphs by topic: insects

UNIT 6: INTEGRATED PEST MANAGEMENT ON FRUIT CROPS AND VEGETABLE

1.Vocabulary

1.1. Find the words in the text which have similar meaning to the following words.

- grain farming
- livestock ranching
- mixed crop and livestock farming
- commercial garden and fruit farming (aka “truck farming”)
- dairy farming (aka “dairying”)
- milkshed
- ridge tillage
- horticulture
- vertical integration
- The Green Revolution
- agricultural density
- Boserup Hypothesis
- Malthusian Theory
- physiological density
- desertification
- CAFOs

2. Translation and discussion

2.1 Agricultural policy

Agricultural policy in the United Kingdom since 1973 has been determined primarily by Common Agricultural Policy (CAP) of the EU, which aims to ensure stable markets, a fair standard of living for producers, and regular supplies of food at reasonable prices for consumers. The costs to EU taxpayers of the CAP, which accounts for more than 50 per cent of the EU’s budget, and the mechanisms of maintaining farm prices through grants and subsidies, and through tariffs on cheaper imports, have come under increasing criticism since the early 1980s by Britain, by developing countries, and by the United States.

Various reforms have been implemented in an attempt to reduce costs, subsidies, and the huge levels of overproduction, which generated „’butter mountain" and „'wine lakes" during the 1970s and 1980s. These have included schemes to encourage farmers to take land out of agricultural production, to adopt more environmentally kind, but less productive methods of farming, to impose production quotas on certain products, like milk, and to reduce subsidies on others.

In Britain agricultural marketing is carried out by private traders, producers' cooperatives, and marketing boards for certain products. The number of marketing boards has been steadily reduced over the past 20 years. In November 1994 one of the largest, the Milk Marketing Board for England and Wales, ceased to exist and was replaced by a producers' cooperative, Milk Marque.

Britain's food industry is one of the world's largest and most successful, with a highly developed retail, supply, and distribution network. Its supermarket chains supply an ever- increasing choice of food products to the British consumer and are among Europe's most profitable companies. The 1997 merger of Guinness and Grand Metropolitan created one of the world's biggest food and drinks conglomerates.

Comprehension check.

1. What are the main points of the policy?
2. What is the aim of the policy?
3. Who gets the most benefits from the policy?
4. Are there any agricultural policies in your country?
5. Do the policies help to develop the agriculture?
6. What is the agriculture of your country?
7. What is the most dominant sector in the agriculture?
8. Where is rice mainly grown?
9. What population does the agriculture employ?
10. What percentage of GDP does the agriculture account for?
11. What do you think about your agriculture now and in he future?
12. Are there any plans for developing your agriculture?
13. According to you can we develop our livestock rising like Holland or USA?
14. As a future agronomist do you have any special plans for the agriculture?
15. What economic sector can be developed best in our agriculture?

16. Write the terms below with their definitions in the table below. Then add any examples, key takeaways, or other notes.

erm	Definition	Examples/Key Takeaways/ Notes
	Agriculture in which most crops are fed to animals which in turn provide manure to improve soil fertility.	1. Most common form of agriculture in U.S. west of Appalachia (Corn Belt (Ohio to the Dakotas where corn and soy are mostly used for animal feed) and in Europe from France to Russia. 2. Almost all land is devoted to growing crops but most of the income is derived from the sale of animal products (e.g. beef, milk, eggs).
	Agriculture in which the primary goal is raising of dairy animals and the sale of dairy products.	1. Most common form of agriculture near big cities in NE U.S. and NW Europe. 2. Dairy increasingly in LDCs. Dairy, once considered luxury product, now sought after as incomes rise.)
	The growing of grains such as wheat, corn, oats, barley, rice and millet for sale to manufacturers of food products or for export. Grain farming is distinguished from mixed crop and livestock farming because the grain grown is intended for consumption by humans.	1. Wheat is leading world export crop by tonnage. (High value per unit weight.) Maize #2, rice #3. 2. Grain grown in areas too dry for mixed crop and livestock. 3. Very few large scale grain producers: U.S., Canada, Argentina, Australia, France, U.K.
	The commercial	This form of agriculture is adapted to

	growing of livestock over an extensive area. Now integrated with meat processing industries, especially CAFOs. Some places (Argentina) cattle is mainly for export.	semiarid and arid climates and is practiced in MDCs where vegetations is too sparse and soils too poor to support crops. Refrigeration expanded markets greatly.
	A specialized type of farming that occurs only in coastal areas with the warm, dry summer/mild winter Mediterranean climate.	1. These areas produce most of world’s wine. Also: olives (Greece), fruits, nuts, vegetables. 2. But: water issues (esp. California!) exist in these mostly arid areas.
	The relatively small-scale production of a wide variety of fruits, vegetables and flowers as cash crops, frequently sold directly to consumers and restaurants. Also called “truck” farms, so named because "truck" was a Middle English word meaning "bartering".	1. Predominate type of agriculture in southeastern U.S. and increasing in northeast U.S. where it is replacing some dairying. But no integrated commodity chain yet. 2. What are main “truck” farm crops in our area?
	A technique where equipment is used to move soil so the crop row is slightly elevated, resulting in improved drainage and exposure to the sun.	
	The ring around a city from which milk can be supplied without spoiling. Refrigeration expanded milksheds greatly.	The further a dairy farm is from an urban area, the more likely it will produce cheese rather than milk. Why?

	The process by which commercial farmers in MDCs are often connected to a global commodity chain which includes food processing, packaging, storing, distributing, marketing, and retailing controlled by large agribusiness corporations such as General Mills and Kraft.	
	The growing of fruits, vegetables, and flowers.	
Key Issue 4: Why Do Farmers Face Economic Difficulties?		
	The ratio of the number of farmers to the amount of arable land.	
	The ratio of the number of people to the amount of arable land.	
	The idea, popularized by British economist Thomas Malthus, that increases in population would outgrow increases in food supply.	
	The idea, popularized by Danish economist Ester Boserup, that the population growth spurs innovations that make it possible to feed an increasing population.	
	The rapid diffusion of new agricultural technology, especially new high-yield hybrid seeds and fertilizers, in the late 20th century, which greatly increased agricultural productivity. This was leveraging energy and technology to improved yields.	
	An early geographic model designed to describe and predict the spatial distribution of various crops surrounding a city based on the value of land, the perishability of the crop, and the cost of land. Explains how transportation tech favors large corporate farms over family farms. (Explain)	Know your Von Thünen's rings (moving out from city): a. Dairy and market gardening b. Forestry c. Grains, other extensive field crops d. Ranching, livestock
	Concentrated Animal Feed Operation: a large industrial feedlot	Problems: ethical? Ground water pollution. Need for anti biotics

	where animals are rapidly fattened before slaughter.	in feed.
	Degradation of land, especially in semiarid areas primarily because of human actions like excessive crop planting animal grazing, and tree cutting.	Causes: overgrazing, deforestation, and excessive crop planting depleting soils, salinization (salty water used for irrigation in areas of rapid evaporation). Major problem in Sahel region.

3.Write paragraphs by topic: integrated pest management on fruit crops and vegetable

FURTHER READING: PLANT TISSUE CULTURE

Background

Plant research often involves growing new plants in a controlled environment. These may be plants that we have genetically altered in some way or may be plants of which we need many copies all exactly alike. These things can be accomplished through tissue culture of small tissue pieces from the plant of interest. These small pieces may come from a single mother plant or they may be the result of genetic transformation of single plant cells which are then encouraged to grow and to ultimately develop into a whole plant. Tissue culture techniques are often used for commercial production of plants as well as for plant research.

Tissue culture involves the use of small pieces of plant tissue (**explants**) which are cultured in a nutrient medium under sterile conditions. Using the appropriate growing conditions for each explant type, plants can be induced to rapidly produce new shoots, and, with the addition of suitable hormones new roots. These plantlets can also be divided, usually at the shoot stage, to produce large numbers of new plantlets. The new plants can then be placed in soil and grown in the normal manner.

Many types of plants are suitable for use in the classroom. Cauliflower, rose cuttings, African violet leaves and carnation stems will all easily produce clones (exact genetic copies) through tissue culture. Cauliflower florets in particular give excellent results since they can be grown into a complete plant in the basic tissue culture media, without the need for additional growth or root hormones. Green shoots are generally observable within three weeks, and roots develop within six weeks.

The most important part of this activity, however, is to maintain as sterile an environment as possible. Even one fungal spore or bacterial cell that comes into contact with the growth media will rapidly reproduce and soon completely overwhelm the small plant piece that you are trying to clone.

Objectives

4. To understand a procedure that is often used to propagate many plants of the same genetic background.

5. To understand the importance of sterile techniques.

Materials

1 Vial of Murashige Skoog (MS) media. (If you wish to make up your own growing medium you could use the recipe for the Murashige medium given at the end of this section.)

1 L sterile distilled water

10 g of agar/L

30 g sucrose/L

1.5 L or 2 L container in which to prepare the growth medium small amounts of 1M NaOH and 1M HCl to adjust the pH of the media 60 flat bottom culture tubes with closures. Glass aquarium or box lined with plastic

Plastic sheet to cover the top of the aquarium

Adhesive tape

10% Bleach in a spray bottle

70% alcohol in a spray bottle

Forceps or tweezers

Gloves

Cutting equipment such as a scalpel blade or razor blade

2 bottles of sterile distilled water *(purchase at the grocery store)*

Pressure cooker

Your chosen plant (cauliflower, rose, African violet or carnation) paper towel for cutting on or sterile petri dishes if available Beaker or jar in which to wash the plant material Detergent-water mixture - 1ml detergent per liter of water

Bleach sterilizing solution - dilute commercial bleach (5-6% sodium hypochlorite) to a final concentration of 1-2% sodium hypochlorite in distilled water in a large beaker or jar.

2 or 3 beakers or jars of sterile water

A well-lit area away from direct sunlight or use full-spectrum gro-lights Hormones such as BAP (benzylaminopurine) and NAA (naphthalene acetic acid) to stimulate growth and root development, respectively. (Commercial rooting hormone solutions and powders are also available from hardware stores.)

Murashige Minimal Organics Medium recipe (MMOM)

Inorganic salts	mg/L
NH_4NO_3	1,650.00
KNO_3	1,900.00
$CaCl_2$ (anhydrous)	332.20
$MgSO_4$ (anhydrous)	180.70
KH_2PO_4	170.00
Na_2EDTA	37.25
$FeSO_4.7H_2O$	27.80
H_3BO_3	6.20
$MnSO_4.H_2O$	16.90
$ZnSO_4.H_2O$	5.37
KI	0.83
$Na_2MoO_4.2H_2O$	0.25
$CuSO_4$ (anhydrous)	0.016
$CoCl_2$ (anhydrous)	0.014
Sucrose	30,000.00
i-Inositol	100.00
Thiamine.HCl	0.40

The pH is adjusted to 5.7 using 0.1 M HCl or NaOH.

Procedure

Preparation and sterilization of growing medium (when not provided pre-poured)

These steps will make 1 L of growth medium which is enough to prepare about 65 growing tubes.

1. Dissolve the MS mixture in about 800 ml of distilled water. Stir the water continuously while adding the salt mixture. Add 30 g sugar and stir to dissolve. Adjust pH to 5.8 using 1M NaOH or 1M HCl as necessary while gently stirring. Add distilled water to make the total volume up to 1 L.

2. Weigh out 10 grams of agar and add it to the MS solution. Heat the solution gently while stirring until all the agar has dissolved.

3. Pour the still warm medium into the polycarbonate tubes to a depth of about 4 cm which will use about 15ml of media per tube.

4. Place the tubes (with lids sitting on the tubes but not tightened) in a pressure cooker and sterilize for 20 minutes. Cool the pressure cooker, then remove the tubes and tighten the lids. Alternatively the tubes can be placed in boiling water for 30 minutes, but make sure that none of the water is able to enter the tubes.

5. **NOTE:** If you wish to use plants other than cauliflower you need to prepare two different media which contain plant hormones necessary to stimulate development of differentiated tissues. The first one should contain a cytokinin such as BAP which promotes shoot formation and the second one a rooting hormone such as NAA or store bought rooting hormone. To do this, prepare the mixture up until the end of step 2. Keeping the mixture warm so that it does not solidify, divide it equally into two pre-warmed containers. Each container can be used to prepare 30 or so tubes as above. The first container should have BAP added at the rate of 2.0mg/l. The second container should have the NAA hormone added at the rate of 0.1 mg/L. To do this it is necessary to make concentrated solutions of both BAP (2.0mg/ml) and NAA (1.0mg/ml) and filter sterilize them. Add 1ml of the concentrated BAP stock or 100µl of the NAA concentrated stock to each 1 liter of media that you prepare. If you use rooting hormone that is purchased from your local hardware or nursery supply store instead of NAA then just follow the directions before adding to your media.

Preparation of a sterile transfer chamber and equipment

A classroom transfer chamber can be made from a clean glass aquarium turned on its side. Scrub the aquarium thoroughly with a 30% bleach solution, making sure that you wear gloves and do not inhale the fumes. Rinse with sterile distilled water, turn upside down on a clean counter or paper towels and allow to dry. Cut holes in a clean plastic sheet to allow arms to reach into the chamber and reinforce the cut edges with tape if necessary. Tape the clean plastic sheet over the open side of the aquarium making sure that the arm holes are located at a convenient height. Plastic sleeves could also be fitted to these holes if you wish to make it easier to prevent the entry of airborne spores into the chamber. The finished aquarium chamber can be sterilized by spraying with 10% chlorox bleach just prior to each use and drying with sterile paper towel.

Wrap the forceps, scalpels, razor blades, paper towel and gloves (rubber or surgical) in aluminum foil, seal with tape and sterilize by processing them in a pressure cooker for twenty minutes. These items can also be sterilized by placing in an oven at 350^{o}F for 15 minutes. You can wrap each item separately or put together a "kit" so that each student will have their own sterile equipment to use.

Alternatively the forceps and blades can be sterilized by dipping in 10% bleach and then rinsing in sterile water, or dipping in alcohol and then placing in a flame, although this is not recommended for use in crowded classrooms. If you choose to dip in bleach and rinse in sterile water, it is best if fresh solutions are available for each 3-4 students since the water can easily be contaminated if care is not used. These liquid containers should only be opened once they are inside of the sterile chamber.

Plant preparation

Your plant material must first be surface sterilized to remove any bacteria or fungal spores that are present. We aim to kill all microorganisms, but at the same time not cause any adverse damage to the plant material.

1. Cauliflower should be cut into small sections of florets about 1 cm across. If using a rose or other cuttings, cut the shoots into about 5 to 7 cm lengths. Whole African violet leaves can also be used.

2. Wash the prepared plant material in a detergent-water mixture for about 20 minutes. If trying hairy plant material scrub with a soft brush (toothbrush). This will help remove fungi etc., and the detergent will help wet the material and remove air bubbles that may be trapped between tiny hairs on a plant.

3. Transfer the washed plant material to the sterilizing chlorox

solution. Shake the mixture for 1 minute and then leave to soak for 10-20 minutes. Carefully pour off the bleach solution using the lid to keep the plant tissue from coming out and then carefully cap the container.

Note 1: At this point, the tissue is considered sterile. All subsequent rinses should be done with sterile water, and all manipulations of the tissue performed with sterile instruments and supplies. Open one container at a time and never leave the lid off of any container longer than necessary.

Note 2: Many students will not fully appreciate the importance of carefully sterilizing explants and so there will be some cultures that become infected with bacterial or fungal growth. If you do not wish to emphasize this aspect of the laboratory students can be provided with plant materials that the instructor has already sterilized prior to use by the class.

Transfer of plant material to tissue culture medium

Use the sterile gloves and equipment for all of these steps.

1. Place the plant material still in the chlorox bleach sterilizing container, the containers of sterile water, the sterilized forceps and blades, some sterile paper towel to use as a cutting surface and enough tubes containing sterile medium into the sterile aquarium. The outside surfaces of the containers, the capped tubes and the aluminum wrapped supplies should be briefly sprayed with 70% alcohol before moving them into the chamber.

2. The gloves can be sprayed with a 70% alcohol solution and hands rubbed together to spread the alcohol just prior to placing hands into the chamber. Once students have gloves on and sprayed they must not touch anything that is outside of the sterile chamber.

3. Carefully open the container with the plant material and pour in enough sterile water to half fill the container. Replace the lid

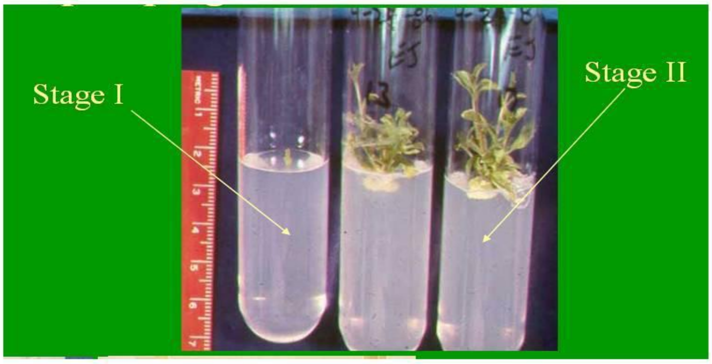
and gently shake the container to wash tissue pieces (explants) thoroughly for 2-3 minutes to remove the bleach. Pour off the water and repeat the washing process 3 more times.

4. Remove the sterilized plant material from the sterile water, place on the paper towel or sterile petri dish. Cut the cauliflower into smaller pieces about 2 to 3 mm across. If using rose cut a piece of stem about 10 mm in length with an attached bud. The African violet leaf can be cut into small squares about 1-1.5 cm across. Be sure to avoid any tissue that has been damaged by the bleach, which is apparent by its' pale color.

5. Take a prepared section of plant material in sterile forceps and place into the medium in the polycarbonate tube. Cauliflower pieces should be partly submerged in the medium, flower bud facing up. Rose or other cuttings should be placed so that the shoots are level with the medium surface. The African violet leaf pieces should be laid directly onto the medium surface.

6. Replace the cap tightly on the tube.

Figure 1: The small explant develops callus which then produces shoots a few weeks after being placed into tissue culture media



Growing the plants

1. The tubes containing plant sections may be placed in a well-lit area of the classroom although not in direct sunlight. The shoots will probably grow more quickly if the explants are placed under fluorescent or grow-lights to provide at least 12 hours of light per day. The aquarium can be used as a growth chamber with the lighting about 8-10" overhead. This will also help maintain a more regular and warm temperature. Ensure that the temperature does not go over

28°C. New shoots should develop within 2 weeks, and should be well advanced in 3 to 4 weeks. Check the tubes daily and discard any that show signs of infection (before discarding first sterilize in the pressure cooker or add bleach into the tube).

2. Roots can appear within 6 weeks on cauliflowers. The roses, African violet and other cuttings will need to be moved into rooting media for roots to properly develop. This transfer to the second, rooting media must be conducted under the same sterile conditions as at the initiation of the culture. All necessary equipment and the aquarium should be set up as before and properly sterilized.

3. Working inside the sterile aquarium chamber, remove the cap from the culture tube. There will usually be several shoots that have arisen from each explant. These shoots should be carefully separated by gently removing the whole explant from the media with sterile forceps and then separating the shoots by gently pulling them apart using two pairs of forceps. Each shoot should then be placed into a tube of rooting media and the bottom of the shoot pushed into the media so that good contact is made. The cap is replaced and the shoots are then allowed to grow as in step 1 until roots are formed, usually within 2-3 weeks.

Potting the clones

Once roots are well formed the plants are ready to be transferred into soil.

Figure 2: Roots are fully developed prior to moving plants to pots of soil

1. Each plant should be carefully removed from its tube of media and planted into a small pot containing a clean light potting mix. Gently wash off all the agar medium prior to planting. The

plants will still need to be protected at this stage since they are not accustomed to the drier air of the classroom when compared to the moist environment of the tube of media.

2. Place all of the pots onto a tray and cover lightly with a plastic dome or tent. Place the plants in an area with 12-16 hours of light (either natural or artificial) but not direct sunlight.

3. After a week the cover can be gradually removed and the plants acclimated to stronger light and drier atmospheric conditions.

4. You now have a collection of plants in your classroom that are genetically exactly the same. You could use these plants to carry out other experimental tests knowing that one of the main variables in the experiment has been eliminated. Some of these tests could include looking at plant responses to low light levels, to drought or to saline soil conditions. (see activity 7)

Student Activity

1. Tissue culture uses a small piece of tissue from a mother plant to grow many new copies of the original plant. What is the term used to refer to this small piece of tissue?

2. What are some of the plants that we might use for tissue culture?

3. Why is tissue culture used for propagation of some plants rather than just planting seeds?

4. What is a sterile environment?

5. Why is a sterile environment important in tissue culture?

6. How did you or your teacher sterilize the instruments that were used in this tissue culture activity?

7. Could we sterilize the plant tissue in the same manner? Why or why not?

8. What happens if you open your sterile plant container when it is not inside a sterile environment?

FURTHER READING: PESTICIDES

BACKGROUND

What Are Pesticides?

Pesticides are natural or synthetic agents that are used to kill unwanted plant or animal pests. While the term *pesticide* is now often associated with synthetic chemical compounds, it was not until relatively recently that synthetic pesti-cides came into use. Naturally occurring compounds or natural extracts have been used as pesticides since ancient times. The earliest pesticides were most likely salt, sulfurous rock, and extracts of tobacco, red pepper, and the like. It is rumored that the Napoleonic army used crushed chrysanthemums to control lice, with limited effectiveness. Petroleum oils, heavy metals, and arsenic were used liberally to control unwanted pests and weeds until the 1940s, when they were largely replaced for many uses by organic synthetic pesticides, the most famous of which is DDT.

Because the broad term *pesticide* encompasses a diverse collection of sub-stances, an explanation of pesticide taxonomy and nomenclature is warranted. Pesticides can be classified either by target pest or by chemical identity.[1] Clas-sification by target pest is perhaps the most familiar. For example, insecticides are pesticides that target insects, and herbicides target plants. There are many more examples (acaricides target ticks, nematocides target nematodes, etc.), but it is important for the purposes of this report to note that 11 of the 12 pesti-cides of concern identified by OSAGWI are insecticides and/or acaricides. The twelfth, DEET, is also directed against insects and ticks, but it is unique in that it is considered a repellent rather than an insecticide. To avoid confusion, the term pesticide is used in lieu of subclassification alternatives in this report.

Pesticides can also be organized by their chemical class. A pesticide class is a group of pesticidal compounds that share a common chemistry. For example, all pesticides in the class organophosphate (OP) are derivatives of phosphoric acid, and all pesticides in the class organochlorine are composed of carbon, hy-drogen, and chlorine. There are also chemical subclasses of pesticides, but these are beyond the scope of this discussion. This report considers four chemical classes of insecticides, as well as the repellent DEET, which is more conveniently identified by its mode of use.

When discussing a pesticide, it is possible to refer to the pesticidal compound itself or to the pesticide product or formulation. The compound itself is also known as the active ingredient—the chemical responsible for killing the target pest. The formulation is the manner in which the active ingredient is delivered. Typical formulations include liquids, dusts, wettable powders, and emulsifiable concentrates. The pesticide formulation includes the active ingredient as well as other ingredients. These other ingredients may be inert, such as talcum powder, or they can act to enhance the pesticidal properties of the active ingre-dient. For example, some pesticide formulations include a synergist that enhances the toxic activity of the active ingredient. Other ingredients in many pesticide formulations are solvents. When considering the potential health ef-fects of pesticides, it is important to consider the toxicity of the active ingredi-ent as well as the other ingredients in the formulation. This is often a daunting task. Clinical reports of pesticide poisoning provide clues about the toxicity of the pesticide formulation or product, while controlled experiments involving laboratory animals may include the formulation or just the active ingredient alone.

Pesticide Regulation

The EPA regulates both active ingredients and pesticide formulations under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).[2] FIFRA gives the EPA the authority to regulate pesticides to ensure that their use does not have unreasonable adverse effects on humans and the environment. The registrant of a pesticide must submit specific data to the EPA to support the conclusion that the product meets this standard before the EPA will grant a registration that allows the pesticide to be marketed and sold. This can be a lengthy and ex-pensive process. It includes approval of a pesticide label that provides informa-tion on the use and safety precautions related to the product. Under FIFRA, this label is legally binding. For example, it would be illegal to use a pesticide prod-uct in a food service establishment if the product is not specifically labeled for that use. Following approval by the Armed Forces Pest Management Board (AFPMB), the U.S. military can procure pesticide products registered by the EPA and must follow the label instructions.

As part of the registration process, the EPA differentiates between general-use and restricted-use pesticides (GUPs and RUPs), primarily on the basis of EPA toxicity class. GUPs can be sold to the public for unrestricted use, while RUPs can be sold to and used only by certified applicators.[3] The distinction between GUPs and RUPs can be somewhat confusing, because the classification can refer to either the active ingredient or the formulation. For example, the inclusion of some active ingredients makes any pesticide product an RUP, while in other cases, the distinction between GUP and RUP is made by pesticide formulation. Consider two pesticide products containing the same active ingredient but different formulations.

If the EPA does not consider all products with this active ingredient to be RUPs, one of those products can be for general use and the other restricted, because their formulations might be considered to present different risks to humans or the environment.

Related to the distinction between GUP and RUP on a pesticide label is the EPA toxicity class. This classification is based on acute human toxicity, hazard to applicators, and ecological effects. The acute human toxicity is assessed via animal tests, and ecological effects include the potential for groundwater con-tamination. Each toxicity class is associated with a signal word, which must ap-pear on the pesticide label. The toxicity classes are shown in Table 2.1.

PESTICIDE IDENTITY AND PROPERTIES

Tables in Chapters Four through Seven present the identity and chemical and physical properties of each pesticide of concern. This information is intended to enable cross-referencing regarding the chemical identity of the pesticides as well to provide data that may be useful in characterizing their environmental behavior and potential health effects.

Table 2.1

EPA Pesticide Toxicity Classes

Toxicity Class	Toxicity Rating	Signal Word on Label
I	Highly toxic	DANGER-POISON
II	Moderately toxic	WARNING
III	Slightly toxic	CAUTION
IV	Practically non-toxic	CAUTION

References for these tables include the Merck Index (10th ed., 1983), the EPA Integrated Risk Information Service (IRIS) database (http://www.epa.gov/iris), the EPA Pesticide Product Information System Databases (http://www.epa.gov/opppmsd1/PPISdata/index.html), the EXTOXNET database,[4] and pesticide labels graciously provided by the Entomo-logical Sciences Division of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). Original references were obtained for veri-fication. Occupational exposure values (standards and recommendations) were obtained from the American Conference of Governmental Industrial Hy-gienists (ACGIH, 1999);[5] reference doses and concentrations (RfD and RfC) were obtained from the IRIS database. In addition, Cheremisinoff and King (1994), Hornsby et al. (1996), and Kamrin (1997) provided references and direc-tions to original sources.

The characteristics summarized in the physical and chemical properties tables for each pesticide of concern are described below.

Molecular Weight, Color, Form, and Odor. These entries are self-explanatory and are presented as the range of values reported in the referenced sources, where appropriate. The color, form, and odor of pesticides are generally restricted to the active ingredients and are given here because they may assist recall efforts of veterans being surveyed about their potential exposure to pesticides. It should be noted, however, that these values could be substantially different for pesticide formulations used during ODS/DS.

Water Solubility. The water-solubility value is given for the active ingredient at room temperature, either 20°C or 25°C. Values are presented as milligrams of solute per liter of water (mg/L); in most cases, mg/L can also be reported as parts per million (ppm), even for very soluble compounds (Hornsby et al., 1996). Generally, the higher the value, the more readily the compound dis-solves in water.

Partition Coefficient (K_{ow}). The octanol-water partition coefficient indicates how a chemical is distributed at equilibrium between organic (octanol) and aqueous (water) phases. This coefficient is primarily used in predicting the en-vironmental fate of organic chemicals such as pesticides. The higher the coefficient, the greater the propensity for the chemical to be partitioned to organic phases. This generally means that the chemical will tend to adhere to organic matter in the soil (e.g., organocolloids), but it may also indicate a tendency to accumulate in fat, although this behavior depends on other biological factors in the body. The partition coefficient is included in this report primarily because it is often used to estimate other chemical and physical properties.

Soil Sorption Coefficient (K_{oc}). This coefficient is sometimes called an adsorp-tion coefficient. The distinction between adsorption and absorption is that the latter requires the movement of a chemical across a barrier such as tissue or a cell membrane. The soil sorption coefficient more accurately measures the chemical’s propensity to “attach,” or adsorb, to soil particles. The term *soil sorption* *coefficient* is used to avoid confusion. The utility of this measurement is that it assists in predicting whether a pesticide will remain dissolved in solu-tion or will become adsorbed to soil particles after its application (or following a spill). If a pesticide is adsorbed to soil particles, it may be less available for biodegradation or for runoff or leaching. This assessment could be useful in estimating the potential for pesticide exposure. Generally, K_{oc} values below 500 indicate little or no adsorption of the pesticide to soil (indicating a high possi-bility of runoff or leaching).

Vapor Pressure. This value is given in millimeters of mercury (mm Hg), the unit of measure most often used. To convert to millipascals (mPa), one divides this value in mm Hg by 7.52×10^{-6} (Hornsby et al., 1996). Vapor pressure is a mea-sure of the tendency of a pesticide to volatilize, a phase change that can affect estimations of exposure. Generally, the lower the vapor pressure, the lower the volatilization tendency of the chemical. Vapor pressure values are given for ac-tive ingredients of pesticides in this report.

EPA Toxicity Classification. The EPA toxicity classifications presented in this report were discussed above (Table 2.1).

ACGIH Threshold Limit Values–Time-Weighted Average (TLV–TWA). These values are developed by ACGIH as guidelines to assist in the control of health hazards and are not legal standards. TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health ef-fects.[7] TLV–TWA represents these concentrations as the time-weighted average concentration for a conventional eight-hour workday and a 40-hour workweek. Substances listed with the designation “skin” refer to the potential significant contribution to overall exposure by the cutaneous route. TLVs are based on available information from industrial experience and from experimental animal and human studies, and, when possible, from a combination of the three.

NIOSH Recommended Exposure Limits (REL–TWA, REL–STEL, and IDLH).

These values are recommended by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC). Acting under the authority of the Occupational Safety and Health Act (OSHAct) of 1970 (29 USC Chapter 15) and the Federal Mine Safety and Health Act of 1977 (30

USC Chapter 22), NIOSH develops recommended exposure limits (REL) for hazardous substances or conditions in the workplace. The REL–TWA values are time-weighted average airborne concentrations for up to a 10-hour workday during a 40-hour workweek. Short-term exposure limits (REL–STEL) are 15-minute TWA exposures that should not be exceeded at any time during the workday. For most substances with a TLV–TWA, there is currently not enough toxicological information available to warrant a STEL, as evidenced by the lim-ited availability of STELs reported here. IDLH values are concentrations that are immediately dangerous to life or health.

OSHA Permissible Exposure Limits (PEL–TWA). These regulatory limits are es-tablished by the Occupational Safety and Health Administration (OSHA) and have the force of law in occupational environments where OSHAct is applica-ble. PELs are also time-weighted averages and assume exposures of eight hours a day for a 40-hour workweek. PELs are based on human and animal studies, allowing for scientific uncertainty.

EPA Oral Reference Doses (RfD) and Inhalation Reference Concentrations (RfC). The RfD and RfC can be used to estimate a level of environmental expo-sure at or below which no adverse effect is expected to occur. The RfD or RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure that is likely to be without appreciable risk of deleterious effects to humans, including sensitive subgroups, over a lifetime. These values are based on lifetime exposure.

Carcinogenicity. Carcinogenicity classifications are provided as reported by the ACGIH, the EPA, and the International Agency for Research on Cancer (IARC). These classifications are summarized in Table 2.2. They are generally

Table 2.2

Carcinogenicity Classifications

Agency/Categories	Classification
ACGIH	
A1	Confirmed human carcinogen
A2	Suspected human carcinogen

A3	Confirmed animal carcinogen with unknown relevance to humans
A4	Not classifiable as a human carcinogen
A5	Not suspected as a human carcinogen[a]
EPA – 1986[b]	
A	Human carcinogen
B	Probable human carcinogen
B1 subgroup	Limited evidence from epidemiological studies
B2 subgroup	Sufficient evidence from animal studies; inadequate or no evidence from epidemiological studies
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans
EPA – 1996	
K	Known human carcinogen
L	Likely to produce cancer in humans
CBD	Cannot be determined
NL	Not likely to be carcinogenic in humans
IARC	
1	Carcinogenic to humans
2A	Probably carcinogenic to humans
2B	Possibly carcinogenic to humans
3	Unclassifiable as to carcinogenicity in humans
4	Probably not carcinogenic to humans

[a]The categories A4 and A5 can be confusing. The basic difference is that A4 substances cause con-cern that they could be carcinogenic for humans but cannot be assessed conclusively because of a lack of data; A5 substances are not

suspected to be human carcinogens, based on human epidemio-logic studies, or because the evidence suggesting a lack of carcinogenicity in experimental animals is supported by mechanistic data.

[b]As found in the 1986 *Risk Assessment Guidelines* (EPA/600/8-87/045). New guidelines for carcino-gen risk assessment were proposed in 1996 (1996 *Proposed Guidelines for Carcinogen Risk Assess-ment*, Federal Register: 61[79]:17960-18011). These new guidelines were proposed due to advances in toxicological science. One significant limitation of the old guidelines is that a compound was considered carcinogenic if there was evidence of carcinogenicity from one exposure pathway, even in the absence of such evidence from other pathways. None of the pesticides of concern have been classified under the 1996 system; the old classifications are presented here for future comparisons.

based on the availability and weight of evidence of carcinogenicity from prop-erly designed animal and human studies.

PESTICIDE USE IN ODS/DS

In every war and military conflict, combat effectiveness has been significantly reduced by disease, and a large number of diseases can be directly linked to disease-carrying organisms such as arthropods and rodents.[9] Not only can these organisms transmit disease, their bites can result in distracting and de-moralizing conditions and can cause serious secondary infections and allergic reactions. For these reasons, pest control is of significant military importance, affecting not only troop morale and welfare but also overall unit combat effec-tiveness and strength.

During ODS/DS, insects and rodents were of particular concern as potential disease vectors. The primary focus for pest management was on ground troops.[10] With roughly one-half million personnel deployed to the region in a very short time, under widely varying living, working, and threat conditions, this logistical challenge was large.

Pests of concern in the Persian Gulf region included arthropods such as sand flies, “filth flies,” black flies, mosquitoes, cockroaches, lice, ticks, scorpions, spi-ders, and centipedes. These vermin are capable of transmitting major diseases such as viral encephalitis, malaria, sand fly fever, and leishmaniasis, as well as being an extreme nuisance because of their overabundance.[11] Rodents such as rats, mice, and voles were also of concern as disease vectors and contaminants of food supplies.

During ODS/DS, military authorities recommended various pesticides to con-trol a variety of pests. The pesticides recommended for use by U.S. forces were listed by the AFPMB and approved for use by the EPA. Table 2.3 lists the pesti-cides used or potentially used by U.S. military units during ODS/DS. As de-tailed in Chapter One, OSAGWI has identified 12 pesticides that it considers to be of particular concern either because of toxicity or expected exposure; these pesticides are identified in bold type in Table 2.3.

More than 35 types of pesticides and pesticide products were used by military personnel during ODS/DS. None of the pesticides used was unique to the military; all are, or were at the time, legally available for civilian uses in the United States or other countries. When the provided quantities of pest-control products ran very low, purchases were made from the local economy in Saudi Arabia. For example, insecticide bait containing the active ingredient azame-thiphos was reportedly purchased in Saudi Arabia and used by U.S. units.

Table 2.3

Pesticides Used or Potentially Used During ODS/DS

Active Ingredient Product	Synonyms, Trade Names	Target Pests
Allethrin	d-trans-Allethrin	Insects
Aluminum phosphide	Phostoxin, Fumitoxin, AlP	Stored product pests
Amidinohydrazo ne	Combat	Insects
Azamethiphos	Snip Flykiller, Alfacron	Flies
Bacillus thurengiensis	Teknar	Mosquito larvae
Bendiocarb	Ficam W	Roaches, fleas, ticks, mos-
		quitoes, other arthropods
Boric acid	Whitmire (PT 240) Perma-dust	Insects

Brodifacoum	Talon G	Rodents
Bromadiolone	Maki	Rodents
Carbaryl	Sevin	Ants, fleas, other insects
Chlorophacinone	Rozol	Rodents
Chlorpyrifos	Dursban	Mosquitoes, other insects, ticks,
		mites
Cypermethrin	Demon	Insects
Deltamethrin		Insects
Diazinon		Insects
Dichlorvos	DDVP,	Insects
Diethyl-*m*-toluamide	DEET, 3M Insect/Arthropod and	Sand flies, other insects, ticks
	Cutter Insect Repellents	
Diphacinone	P.C.Q., Rodent Cake, Di-Blox	Rodents
Ethyl hexanediol		Insects
Lindane		Lice
Malathion		Insects
Methomyl	Flytek	Flies
Pentachlorophenol		Fungi
Permethrin	Permanone	Insects
Pet flea and tick collars	Amitraz, carbaryl, chlorpyrifos,	Insects, ticks
	methoprene, permethrin,	
	phosmet, propoxur,	

	tetra-	
	chorvinphos	
d-phenothrin		Insects
Pindone		Rodents
Propoxur	Baygon	Flies, roaches, other insects
Pyrethrum/pyrethrins	Pyrenone	Mosquitoes, flies
Resmethrin		Insects
Sulfur	Chigg-Away	Chiggers (mites)
Valone		
Warfarin	O-R-500, Rodex, Final, Erase	Rodents

This product, manufactured by Ciba Geigy, is not available in the United States.[12] Local firms provided pest control services in selected areas, and around some industrial camps they applied pyrethroid insecticides and malathion on portable latrines. The actual total usage of pesticides by U.S. forces during ODS/DS is unknown, but estimates for pesticides acquired within the military supply system have been made from records indicating the amounts sent to the Gulf region minus the amounts returned (see Fricker et al., 2000). Total usage does not include any pesticides in the possession of units at the outset of ODS/DS or pesticides acquired outside the military supply system. Thus, it does not include any pesticides acquired from the local economy or any that personnel obtained on their own—factors that could lead to underestimates of pesticide use. There is anecdotal information that some troops obtained pest-control products such as citronella candles from private sources. And some service members brought or had mailed to them unauthorized pesticides such as pet flea and tick collars that were designed to protect pets. During ODS/DS, a popular actor who visited the area advised the viewing audience of a televi-sion show to send these pet collars to U.S. service personnel.[13] Other practices could have led to overestimates of pesticide use. These practices include units keeping pesticides received during ODS/DS and returning them to their units' supply stocks rather than the supply system, and giving pesticides to coalition partners. Both practices would result in overestimations of pesticide use when the “supplies in minus supplies out” method of estimating is employed.

FURTHER READING: GENETICALLY MODIFIED FOODS: HARMFUL OR HELPFUL?

Genetically-modified foods (GM foods) have made a big splash in the news lately. Euro-pean environmental organizations and public interest groups have been actively protest-ing against GM foods for months, and recent controversial studies about the effects of genetically-modified corn pollen on monarch butterfly caterpillars[1,2] have brought the issue of genetic engineering to the forefront of the public consciousness in the U.S. In response to the up swelling of public concern, the U.S. Food and Drug Administration (FDA) held three open meetings in Chicago, Washington, D.C., and Oakland, California to solicit public opinions and begin the process of establishing a new regulatory proce-dure for government approval of GM foods.[3] I attended the FDA meeting held in Novem-ber 1999 in Washington, D.C., and here I will attempt to summarize the issues involved and explain the U.S. government's present role in regulating GM food.

What are genetically-modified foods?

The term GM foods or GMOs (genetically- modified organisms) is most commonly used to refer to crop plants created for human or animal consumption using the latest molecu-lar biology techniques. These plants have been modified in the laboratory to enhance de-sired traits such as increased resistance to herbicides or improved nutritional content. The enhancement of desired traits has traditionally been undertaken through breeding, but conventional plant breeding methods can be very time consuming and are often not very accurate. Genetic engineering, on the other hand, can create plants with the exact desired trait very rapidly and with great accuracy. For example, plant geneticists can isolate a gene responsible for drought tolerance and insert that gene into a different plant. The new genetically -modified plant will gain drought tolerance as well. Not only can genes be transferred from one plant to another, but genes from non-plant organisms also can be used. The best known example of this is the use of B.t. genes in corn and other crops. B.t., or *Bacillus thuringiensis*, is a naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae. B.t. crystal protein genes have been transferred into corn, enabling the corn to produce its own pesticides against insects such as the

European corn borer. For two informative overviews of some of the techniques involved in creating GM foods, visit Biotech Basics (sponsored by Monsanto) http://www.biotechknowledge.monsanto.com/biotech/bbasics.nsf/index or Techniques of Plant Biotechnology from the National Center for Biotechnology Education http://www.ncbe.reading.ac.uk/NCBE/GMFOOD/techniques.

What are some of the advantages of GM foods?

The world population has topped 6 billion people and is predicted to double in the next 50 years. Ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. GM foods promise to meet this need in a number of ways:

6. Pest resistance Crop losses from insect pests can be staggering, resulting in devastat-ing financial loss for farmers and starvation in developing countries. Farmers typi-cally use many tons of chemical pesticides annually. Consumers do not wish to eat food that has been treated with pesticides because of potential health hazards, and run-off of agricultural wastes from excessive use of pesticides and fertilizers can poi-son the water supply and cause harm to the environment. Growing GM foods such as B.t. corn can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market.[4,5]

7. Herbicide tolerance For some crops, it is not cost-effective to remove weeds by physi-cal means such as tilling, so farmers will often spray large quantities of different her-bicides (weed-killer) to destroy weeds, a time-consuming and expensive process, that requires care so that the herbicide doesn't harm the crop plant or the environment. Crop plants genetically-engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed. For example, Monsanto has created a strain of soybeans genetically modified to be not affected by their herbicide product Roundup ®.[6] A farmer grows these soy-beans which then only require one application of weed-killer instead of multiple ap-plications, reducing production cost and limiting the dangers of agricultural waste run-off.

8. Disease resistance There are many viruses, fungi and bacteria that cause plant dis-eases. Plant biologists are working to create plants with genetically-engineered resis-tance to these diseases.

9. Cold tolerance Unexpected frost can destroy sensitive seedlings. An antifreeze gene from cold water fish has been introduced into plants such as tobacco and potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings.[10] (Note: I have not been able to find any journal ar-ticles or patents that involve fish antifreeze proteins in strawberries, although I have seen such reports in newspapers. I can only conclude that nothing on this application has yet been published or patented.)

6. Drought tolerance/salinity tolerance As the world population grows and more land is utilized for housing instead of food production, farmers will need to grow crops in lo-cations previously unsuited for plant cultivation. Creating plants that can withstand long periods of drought or high salt content in soil and groundwater will help people to grow crops in formerly inhospitable places.

7. Nutrition Malnutrition is common in third world countries where impoverished peo-ples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutrient deficiencies could be alleviated. For example, blindness due to vitamin A de-ficiency is a common problem in third world countries. Researchers at the Swiss Fed-eral Institute of Technology Institute for Plant Sciences have created a strain of "golden" rice containing an unusually high content of beta-carotene (vitamin A).[13] Since this rice was funded by the Rockefeller Foundation,[14] a non-profit organization, the Institute hopes to offer the golden rice seed free to any third world country that requests it. Plans were underway to develop a golden rice that also has increased iron content. However, the grant that funded the creation of these two rice strains was not renewed, perhaps because of the vigorous anti-GM food protesting in Europe, and so this nutritionally-enhanced rice may not come to market at all.

8. Pharmaceuticals Medicines and vaccines often are costly to produce and sometimes require special storage conditions not readily available in third world countries. Re-searchers are working to develop edible vaccines in tomatoes and potatoes.[16,17] These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

5. Phytoremediation Not all GM plants are grown as crops. Soil and groundwater pollu-tion continues to be a problem in all parts of

the world. Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contami-nated soil.[18]

How prevalent are GM crops? What plants are involved?

According to the FDA and the United States Department of Agriculture (USDA), there are over 40 plant varieties that have completed all of the federal requirements for com-mercialization (http://vm.cfsan.fda.gov/%7Elrd/biocon). Some examples of these plants include tomatoes and cantaloupes that have modified ripening characteristics, soybeans and sugarbeets that are resistant to herbicides, and corn and cotton plants with increased resistance to insect pests. Not all these products are available in supermarkets yet; how-ever, the prevalence of GM foods in U.S. grocery stores is more widespread than is commonly thought. While there are very, very few genetically-modified whole fruits and vegetables available on produce stands, highly processed foods, such as vegetable oils or breakfast cereals, most likely contain some tiny percentage of genetically- modified in-gredients because the raw ingredients have been pooled into one processing stream from many different sources. Also, the ubiquity of soybean derivatives as food additives in the modern American diet virtually ensures that all U.S. consumers have been exposed to GM food products.

The U.S. statistics that follow are derived from data presented on the USDA web site at http://www.ers.usda.gov/briefing/biotechnology/. The global statistics are derived from a brief published by the International Service for the Acquisition of Agri-biotech Applica-tions (ISAAA) at http://www.isaaa.org/publications/briefs/Brief_21.htm and from the Biotechnology Industry Organization at http://www.bio.org/food&ag/1999Acreage.

Thirteen countries grew genetically-engineered crops commercially in 2000, and of these, the U.S. produced the majority. In 2000, 68% of all GM crops were grown by U.S. farm-ers. In comparison, Argentina, Canada and China produced only 23%, 7% and 1%, re-spectively. Other countries that grew commercial GM crops in 2000 are Australia, Bul-garia, France, Germany, Mexico, Romania, South Africa, Spain, and Uruguay.

Soybeans and corn are the top two most widely grown crops (82% of all GM crops har-vested in 2000), with cotton, rapeseed (or canola) and potatoes trailing behind. 74% of these GM crops were modified for herbicide tolerance, 19% were modified for insect pest resistance, and 7%

were modified for both herbicide tolerance and pest tolerance. Glob-ally, acreage of GM crops has increased 25-fold in just 5 years, from approximately 4.3 million acres in 1996 to 109 million acres in 2000 - almost twice the area of the United Kingdom. Approximately 99 million acres were devoted to GM crops in the U.S. and Ar-gentina alone.

In the U.S., approximately 54% of all soybeans cultivated in 2000 were genetically -modi-fied, up from 42% in 1998 and only 7% in 1996. In 2000, genetically-modified cotton varieties accounted for 61% of the total cotton crop, up from 42% in 1998, and 15% in 1996. GM corn and also experienced a similar but less dramatic increase. Corn produc-tion increased to 25% of all corn grown in 2000, about the same as 1998 (26%), but up from 1.5% in 1996. As anticipated, pesticide and herbicide use on these GM varieties was slashed and, for the most part, yields were increased (for details, see the UDSA publica-tion at http://www.ers.usda.gov/publications/aer786/).

What are some of the criticisms against GM foods?

Environmental activists, religious organizations, public interest groups, professional as-sociations and other scientists and government officials have all raised concerns about GM foods, and criticized agribusiness for pursuing profit without concern for potential hazards, and the government for failing to exercise adequate regulatory oversight. It seems that everyone has a strong opinion about GM foods. Even the Vatican[19] and the Prince of Wales[20] have expressed their opinions. Most concerns about GM foods fall into three categories: environmental hazards, human health risks, and economic concerns. Environmental hazards

• Unintended harm to other organisms Last year a laboratory study was published in *Nature*[21] showing that pollen from B.t. corn caused high mortality rates in monarch butterfly caterpillars. Monarch caterpillars consume milkweed plants, not corn, but the fear is that if pollen from B.t. corn is blown by the wind onto milkweed plants in neighboring fields, the caterpillars could eat the pollen and perish. Although the Na-ture study was not conducted under natural field conditions, the results seemed to support this viewpoint. Unfortunately, B.t. toxins kill many species of insect larvae indiscriminately; it is not possible to design a B.t. toxin that would only kill crop-damaging pests and remain harmless to all other insects. This study is being reexam-ined by the USDA, the U.S. Environmental Protection Agency (EPA) and other non-government research groups, and preliminary data from new studies suggests that the original study may have been flawed.[22,23] This topic is the subject of acrimonious de-bate, and both sides of the argument are defending their data vigorously. Currently, there is no agreement about the results of these studies, and the potential risk of harm to non-target organisms will need to be evaluated further.

- Reduced effectiveness of pesticides Just as some populations of mosquitoes devel-oped resistance to the now-banned pesticide DDT, many people are concerned that insects will become resistant to B.t. or other crops that have been genetically-modified to produce their own pesticides.

- Gene transfer to non-target species Another concern is that crop plants engineered for herbicide tolerance and weeds will cross-breed, resulting in the transfer of the herbi-cide resistance genes from the crops into the weeds. These "superweeds" would then be herbicide tolerant as well. Other introduced genes may cross over into non-modified crops planted next to GM crops. The possibility of interbreeding is shown by the defense of farmers against lawsuits filed by Monsanto. The company has filed patent infringement lawsuits against farmers who may have harvested GM crops. Monsanto claims that the farmers obtained Monsanto-licensed GM seeds from an un-known source and did not pay royalties to Monsanto. The farmers claim that their unmodified crops were cross-pollinated from someone else's GM crops planted a field or two away. More investigation is needed to resolve this issue.

There are several possible solutions to the three problems mentioned above. Genes are exchanged between plants via pollen. Two ways to ensure that non-target species will not receive introduced genes from GM plants are to create GM plants that are male sterile (do not produce pollen) or to modify the GM plant so that the pollen does not contain the in-troduced gene.[24,25,26] Cross-pollination would not occur, and if harmless insects such as monarch caterpillars were to eat pollen from GM plants, the caterpillars would survive.

Another possible solution is to create buffer zones around fields of GM crops.[27,28,29] For example, non -GM corn would be planted to surround a field of B.t. GM corn, and the non-GM corn would not be harvested. Beneficial or harmless insects would have a refuge in the non -GM corn, and insect pests could be allowed to destroy the non-GM corn and would not develop resistance to B.t. pesticides. Gene transfer to weeds and other crops would not occur because the wind-blown pollen would not travel beyond the buffer zone. Estimates of the necessary width of buffer zones range from 6 meters to 30 meters or more.[30] This planting method may not be feasible if too much acreage is required for the buffer zones.

Human health risks

- Allergenicity Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible indi-viduals. A proposal to incorporate a gene from Brazil nuts into soybeans was aban-doned because of the fear of causing unexpected allergic reactions.[31] Extensive test-ing of GM foods may be required to avoid the possibility of harm to consumers with food allergies. Labeling of GM foods and food products will acquire new importance, which I shall discuss later.
- Unknown effects on human health There is a growing concern that introducing for-eign genes into food plants may have an unexpected and negative impact on human health. A recent article published in Lancet examined the effects of GM potatoes on the digestive tract in rats.[32,33] This study claimed that there were appreciable differ-ences in the intestines of rats fed GM potatoes and rats fed unmodified potatoes. Yet critics say that this paper, like the monarch butterfly data, is flawed and does not hold up to scientific scrutiny.[34] Moreover, the gene introduced into the potatoes was a snowdrop flower lectin, a substance known to be toxic to mammals. The scientists who created this variety of potato chose to use the lectin gene simply to test the meth-odology, and these potatoes were never intended for human or animal consumption.

On the whole, with the exception of possible allergenicity, scientists believe that GM foods do not present a risk to human health.

Economic concerns

Bringing a GM food to market is a lengthy and costly process, and of course agri-biotech companies wish to ensure a profitable return on their investment. Many new plant genetic engineering technologies and GM plants have been patented, and patent infringement is a big concern of agribusiness. Yet consumer advocates are worried that patenting these new plant varieties will raise the price of seeds so high that small farmers and third world countries will not be able to afford seeds for GM crops, thus widening the gap between the wealthy and the poor. It is hoped that in a humanitarian gesture, more companies and non-profits will follow the lead of the Rockefeller Foundation and offer their products at reduced cost to impoverished nations.

Patent enforcement may also be difficult, as the contention of the farmers that they invol-untarily grew Monsanto-engineered strains when their crops were cross-pollinated shows. One way to combat possible patent infringement is to introduce a "suicide gene" into GM plants. These plants would be viable for only one growing season and would produce sterile seeds that do not germinate. Farmers would need to buy a fresh supply of seeds each year. However, this would be financially disastrous for farmers in third world coun-tries who cannot afford to buy seed each year and traditionally set aside a portion of their harvest to plant in the next growing season. In an open letter to the public, Monsanto has pledged to abandon all research using this suicide gene technology.

How are GM foods regulated and what is the government's role in this process?

Governments around the world are hard at work to establish a regulatory process to moni-tor the effects of and approve new varieties of GM plants. Yet depending on the political, social and economic climate within a region or country, different governments are re-sponding in different ways.

In Japan, the Ministry of Health and Welfare has announced that health testing of GM foods will be mandatory as of April 2001.[36,37] Currently, testing of GM foods is voluntary. Japanese supermarkets are offering both GM foods and unmodified foods, and cus-tomers are beginning to show a strong preference for unmodified fruits and vegetables.

India's government has not yet announced a policy on GM foods because no GM crops are grown in India and no products are commercially available in supermarkets yet.[38] In-dia is, however, very supportive of transgenic plant research. It is highly likely that India will decide that the benefits of GM foods outweigh the risks because Indian agriculture will need to adopt drastic new measures to counteract the country's endemic poverty and feed its exploding population.

Some states in Brazil have banned GM crops entirely, and the Brazilian Institute for the Defense of Consumers, in collaboration with Greenpeace, has filed suit to prevent the importation of GM crops.[39] Brazilian farmers, however, have resorted to smuggling GM soybean seeds into the country because they fear economic harm if they are unable to compete in the global marketplace with other grain-exporting countries.

In Europe, anti-GM food protestors have been especially active. In the last few years Europe has experienced two major foods scares: bovine spongiform encephalopathy (mad cow disease) in Great Britain and dioxin-tainted foods originating from Belgium. These food scares have undermined consumer confidence about the European food supply, and citizens are disinclined to trust government information about GM foods. In response to the public outcry, Europe now requires mandatory food labeling of GM foods in stores, and the European Commission (EC) has established a 1% threshold for contamination of unmodified foods with GM food products.[40]

In the United States, the regulatory process is confused because there are three different government agencies that have jurisdiction over GM foods. To put it very simply, the EPA evaluates GM plants for environmental safety, the USDA evaluates whether the plant is safe to grow, and the FDA evaluates whether the plant is safe to eat. The EPA is responsible for regulating substances such as pesticides or toxins that may cause harm to the environment. GM crops such as B.t. pesticide-laced corn or herbicide-tolerant crops but not foods modified for their nutritional value fall under the purview of the EPA. The USDA is responsible for GM crops that do not fall under the umbrella of the EPA such as drought-tolerant or disease-tolerant crops, crops grown for animal feeds, or whole fruits, vegetables and grains for human consumption. The FDA historically has been concerned with pharmaceuticals, cosmetics and food products and additives, not whole foods. Under current guidelines, a genetically-modified ear of corn sold at a produce stand is not regu-lated by the FDA because it is a whole food, but a box of cornflakes is regulated because it is a food product. The FDA's stance is that GM foods are substantially equivalent to unmodified, "natural" foods, and therefore not subject to FDA regulation.

The EPA conducts risk assessment studies on pesticides that could potentially cause harm to human health and the environment, and establishes tolerance and residue levels for pesticides. There are strict limits on the amount of pesticides that may be applied to crops during growth and production, as well as the amount that remains in the food after proc-essing. Growers using pesticides must have a license for each pesticide and must follow the directions on the label to accord with the EPA's safety standards. Government inspec-tors may periodically visit farms and conduct investigations to ensure compliance. Viola-tion of government regulations may result in steep fines, loss of license and even jail sen-tences.

As an example the EPA regulatory approach, consider B.t. corn. The EPA has not estab-lished limits on residue levels in B.t corn because the B.t. in the corn is not sprayed as a chemical pesticide but is a gene that is integrated into the genetic material of the corn it-self. Growers must have a license from the EPA for B.t corn, and the EPA has issued a letter for the 2000 growing season requiring farmers to plant 20% unmodified corn, and up to 50% unmodified corn in regions where cotton is also cultivated.[41] This planting strategy may help prevent insects from developing resistance to the B.t. pesticides as well as provide a refuge for non-target insects such as Monarch butterflies.

The USDA has many internal divisions that share responsibility for assessing GM foods. Among these divisions are APHIS, the Animal Health and Plant Inspection Service, which conducts field tests and issues permits to grow GM crops, the Agricultural Re-search Service which performs in-house GM food research, and the Cooperative State Research, Education and Extension Service which oversees the USDA risk assessment program. The USDA is concerned with potential hazards of the plant itself. Does it har-bor insect pests? Is it a noxious weed? Will it cause harm to indigenous species if it es-capes from farmer's fields? The USDA has the power to impose quarantines on problem regions to prevent movement of suspected plants, restrict import or export of suspected plants, and can even destroy plants cultivated in violation of USDA regulations. Many GM plants do not require USDA permits from APHIS. A GM plant does not require a permit if it meets these 6 criteria: 1) the plant is not a noxious weed; 2) the genetic mate-rial introduced into the GM plant is stably integrated into the plant's own genome; 3) the function of the introduced gene is known and does not cause plant disease; 4) the GM plant is not toxic to non-target organisms; 5) the introduced gene will not cause the crea-tion of new plant viruses; and 6) the GM plant cannot contain genetic material from ani-mal or human pathogens (see http://www.aphis.usda.gov:80/bbep/bp/7cfr340).

The current FDA policy was developed in 1992 (Federal Register Docket No. 92N-0139) and states that agri- biotech companies may voluntarily ask the FDA for a consultation. Companies working to create new GM foods are not required to consult the FDA, nor are they required to follow the FDA's recommendations after the consultation. Consumer interest groups wish this process to be mandatory, so that all GM food products, whole foods or otherwise, must be approved by the FDA before being released for commerciali-zation. The FDA counters that the agency currently does not have the time, money, or resources to carry out exhaustive health and safety studies of every proposed GM food product. Moreover, the FDA policy as it exists today does not allow for this type of inter-vention.

How are GM foods labeled?

Labeling of GM foods and food products is also a contentious issue. On the whole, agri-business industries believe that labeling should be voluntary and influenced by the demands of the free market. If consumers show preference for labeled foods over non-labeled foods, then industry will have the incentive to regulate itself or risk alienating the customer. Consumer interest groups, on the other hand, are demanding mandatory label-ing. People have the right to know what they are eating, argue the interest groups, and historically industry has proven itself to be unreliable at self-compliance with existing safety regulations. The FDA's current position on food labeling is governed by the Food, Drug and Cosmetic Act which is only concerned with food additives, not whole foods or food products that are considered "GRAS" - generally recognized as safe. The FDA con-tends that GM foods are substantially equivalent to non-GM foods, and therefore not subject to more stringent labeling. If all GM foods and food products are to be labeled, Con-gress must enact sweeping changes in the existing food labeling policy.

There are many questions that must be answered if labeling of GM foods becomes man-datory. First, are consumers willing to absorb the cost of such an initiative? If the food production industry is required to label GM foods, factories will need to construct two separate processing streams and monitor the production lines accordingly. Farmers must be able to keep GM crops and non-GM crops from mixing during planting, harvesting and shipping. It is almost assured that industry will pass along these additional costs to consumers in the form of higher prices.

Secondly, what are the acceptable limits of GM contamination in non-GM products? The EC has determined that 1% is an acceptable limit of cross-contamination, yet many con-sumer interest groups argue that only 0% is acceptable. Some companies such as Gerber baby foods[42] and Frito -Lay[43] have pledged to avoid use of GM foods in any of their prod-ucts. But who is going to monitor these companies for compliance and what is the penalty if they fail? Once again, the FDA does not have the resources to carry out testing to en-sure compliance.

What is the level of detectability of GM food cross-contamination? Scientists agree that current technology is unable to detect minute quantities of contamination, so ensuring 0% contamination using existing methodologies is not guaranteed. Yet researchers disagree on what level of contamination really is detectable, especially in highly processed food products such as vegetable oils or breakfast cereals where the vegetables used to make these products have been pooled from many different sources. A 1% threshold may al-ready be below current levels of detectability.

Finally, who is to be responsible for educating the public about GM food labels and how costly will that education be? Food labels must be designed to clearly convey accurate information about the product in simple language that everyone can understand. This may be the greatest challenge faced be a new food labeling policy: how to educate and inform the public without damaging the public trust and causing alarm or fear of GM food products.

In January 2000, an international trade agreement for labeling GM foods was estab-lished.[44],[45] More than 130 countries, including the US, the world's largest producer of GM foods, signed the agreement. The policy states that exporters must be required to la-bel all GM foods and that importing countries have the right to judge for themselves the potential risks and reject GM foods, if they so choose. This new agreement may spur the U.S. government to resolve the domestic food labeling dilemma more rapidly.

Conclusion

Genetically-modified foods have the potential to solve many of the world's hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution to avoid caus-ing unintended harm to human health and the environment as a result of our enthusiasm for this powerful technology.

TÀI LIỆU THAM KHẢO

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