NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCE AND TECHNOLOGY

COURSE CODE: DAM 462

COURSE TITLE: INFORMATION TECHNOLOGY

DAM 462: INFORMATION TECHNOLOGY (IT) (4 UNITS)

MODULE 1 – INTRODUCTION TO INFORMATION TECHNOLOGY (IT)

- UNIT 1 – MEANING AND SCOPE OF INFORMATION TECHNOLOGY
- UNIT 2 – APPLICATION OF INFORMATION TECHNOLOGY
- UNIT 3 – INFORMATION TECHNOLOGY IN AGRICULTURE

MODULE 1

UNIT 1 MEANING AND SCOPE OF IT

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1.0 INTRODUCTION

Having read through the course guide, you will have a general understanding of what this unit is about and how it fits into the course as a whole. This unit describes the general fundamentals of information technology.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the term information technology
- Highlight the significance of information technology on education
- Explain the history behind information technology

3.1 INFORMATION TECHNOLOGY

Information Technology (IT) is a term that encompasses all forms of technology used to create, store, exchange and use information in its various forms (business data, voice conversations, still images, motion pictures, multimedia presentations, and other forms, including those not yet conceived). It is a convenient term for including both telephony and computer technology in the same word. It is the technology that is driving what is often called “the information revolution”.

3.2 SIGNIFICANCE OF INFORMATION TECHNOLOGY ON EDUCATION

The pace of change brought about by new technologies has had a significant effect on the way people live, work and play worldwide. New and emerging technologies challenge the traditional process of teaching and learning, and the way education is managed. Information technology, while an important area of study in its own right, is having a major impact across all curriculum areas. Easy worldwide communication provides instant access to a vast array of data, challenging assimilation and assessment skills. Rapid communication, plus increased access to IT in the home, at work, and in educational establishments, could mean that learning becomes a truly lifelong activity – an activity in which the pace of technological change forces constant evaluation of the learning process itself.

Some of the important significances of IT in education are highlighted below:

i. Access to variety of learning resources

In the era of technology, IT aids plenty of resources to enhance the teaching skills and learning ability. With the help of IT, now it is easy to provide audio visual education. The learning resources are being widened. Now with this vivid and vast technique as part of the IT curriculum, learners are encouraged to regard computers as tools to be used in all aspects of their studies. In particular, they need to make use of the new multimedia technologies to communicate ideas, describe projects, and order information in their work.

ii. Immediacy to information

IT has provided immediacy to education. Now in the year of computers and web networks, the pace of imparting knowledge is very fast and one can be educated anywhere at any time. New IT has often been introduced into well-established patterns of working and living without radically altering them. For example, the traditional office, with secretaries working at keyboards and notes being written on paper and manually exchanged, has remained remarkably stable, even if personal computers have replaced typewriters.

iii. Any time learning

Now in the year of computers and web networks, the pace of imparting knowledge is very fast and one can be educated. One can study whenever he wills irrespective of whether it is day or night and irrespective of being in any part of the world because of boom in IT.

iv. Collaborative learning

Now IT has made it easy to study as well as teach in groups or in clusters. With the aid of the internet, we can be united together to do the desired task. Efficient postal systems, the telephone (fixed and mobile), and various recording and playback systems based on computer technology all have a part to play in educational broadcasting in the new millennium.

v. Multimedia approach to education

Audio-visual education, planning, preparation and use of devices and materials that involve sight, sound, or both, for educational purposes. Among the devices used are still and motion pictures, filmstrips, television, transparencies, audiotapes, records, teaching machines, computers, and videodiscs. The growth of audio-visual education has reflected developments in both technology and learning theory.

Studies in the psychology of learning suggests that the use of audio-visuals in education has several advantages. All learning is based on perception, the process by which the senses gain information from the environment. The higher processes of memory and concept formation cannot occur without prior perception. People can attend to only a limited amount of information at a time; their selection and perception of information is influenced by past experiences. Researchers have found that, other conditions being equal, more information is taken in if it is received simultaneously in two modalities (vision and hearing, for example) rather than in a single modality. Furthermore, learning is enhanced when materials is organised and that organisation is evident to the student.

vi. Authentic and up to date information

The information and data which are available on the net is purely correct and up to date. Internet, a collection of computer networks that operate to common standards and enable the computers and the programs they run to communicate directly provides true and correct information.

vii. Online library

The internet supports thousands of different kinds of operational and experimental services one of which is online library. We can get plenty of data on this online library. As part of the IT curriculum, learners are encouraged to regard computers as tools to be used in all aspects of their studies. In particular, they need to make use of the new multimedia technologies to communicate ideas, describe projects, and order information in their work. This requires them to select the medium best suited to conveying their message, to structure information in a hierarchical manner, and to link together information to produce a multidimensional document.

viii. Distance learning

Distance learning, a method of learning at a distance rather than in a classroom. Late 20th century communications technologies, in their most recent phases multimedia and interactive, open up new possibilities, both individual and institutional, for an unprecedented expansion of home-based learning, much of it part-time. The term distance learning was coined within the context of a continuing communications revolution, largely replacing a hitherto confusing mixed nomenclature – home study, independent study, external study, and most common, though restricted in pedagogic means, correspondence study. The convergence of increased demand for access to educational facilities and innovative communications technology has been increasingly exploited in face of criticisms that distant learning is an inadequate substitute for learning alongside others in formal institutions.

Whatever the reasoning, distance learning widens access for students unable for whatever reason (course availability, geographical remoteness, family circumstances, individual disability) to study alongside others. At the same time, it appeals to students who prefer learning at home.

3.3 HISTORY OF INFORMATION TECHNOLOGY

Information technology has been around for a long, long time. Basically as long as people have been around, information technology has been around because there were always ways of communicating through technology available at that point in time. There are four (4) main ages that divide up the history of information technology. Only the latest age (electronic) and some of the electromechanical age really affects us today, but it is important to learn about how we got to the point we are at with technology today.

Ages:

Premechanical:

The premechanical age is the earliest age of information technology. It can be defined as the time between 3000B.C. and 1450A.D. We are talking about a long time ago. When humans first started communicating, they would try to use language or simple picture drawings known as petroglyths which were usually carved in rock. Early alphabets were developed such as the Phoenician alphabet.

Petroglyph:

As alphabets became more popular and more people were writing information down, pens and paper began to be developed. It started off as just marks in wet clay, but later paper was created out of papyrus plant. The most popular kind of paper made was probably by the Chinese who made paper from rags.

Now that people were writing a lot of information down they needed ways to keep it all in permanent storage. This is where the first books and libraries are developed. You've probably heard of Egyptian scrolls which were popular ways of writing down information to save. Some groups of people were actually binding paper together into a book-like form.

Also, during this period were the first numbering systems. Around 100A.D was the first 1-9 system was created by people from India. However, it wasn't until 875A.D. (775 years later) that the number 0 was invented. And yes now that numbers were created, people wanted stuff to do with them so they created calculators. A calculator was the very first sign of an information processor. The popular model of that time was the abacus.

Mechanical:

The mechanical age is when we first start to see connections between our current technology and its ancestors. The mechanical age can be defined as the time between 1450 and 1840. A lot of new technologies are developed in this era as there is a large explosion in interest with this area. Technologies like the slide rule (an analog computer used for multiplying and dividing) were invented. Blaise Pascal invented the Pascaline which was a very popular mechanical computer. Charles Babbage developed the difference engine which tabulated polynomial equations using the method of finite differences.

Difference Engine:

There were lots of different machines created during this era and while we have not yet gotten to a machine that can do more than one type of calculation in one, like our modern-day calculators, we are still learning about how all of our all-in-one machines started. Also, if you look at the size of the machines invented in this time compared to the power behind them it seems absolutely ridiculous to understand why anybody would want to use them, but to the people living in this time, ALL of those inventions were HUGE.

Electromechanical:

Now we are finally getting close to some technologies that resemble our modern-day technology. The electromechanical age can be defined as the time between 1840 and 1940. These are the beginning of telecommunication. The telegraph was created in the early 1800s. Morse code was created by Samuel Morse in 1835. The telephone (one of the most popular forms of communication ever) was created by Alexander Graham Bell in 1876. The first radio developed by Guglielmo Marconi in 1894. All of these were extremely crucial emerging technologies that led to big advances in the information technology field.

The first large-scale automatic digital computer in the United States was the Mark 1 created by Harvard University around 1940. This computer was 8ft high, 50ft long, 2ft wide, and weighed 5 tons – HUGE. It was programmed using punch cards. How does your pc match up to this hunk of metal? It was from huge machines like this that people began to look at downsizing all the parts to first make them usable by businesses and eventually in your own home.

Electronic:

The electronic age is what we currently live in. It can be defined as the time between 1940 and right now. The ENIAC was the first high-speed, digital computer capable of being reprogrammed to solve a full range of computing problems. This computer was designed to be used by the US Army for artillery firing tables. This machine was even bigger than the Mark 1 taking u 680 square feet and weighing 30 tons. It mainly used vacuum tubes to do its calculations.

There are 4 main sections of digital computing. The first era of vacuum tubes and punch cards like the ENIAC and Mark 1. Rotating magnetic drums were used for internal storage. The second generation replaced vacuum tubes with transistors, punch cards were replaced with magnetic tape, and rotating magnetic drums were replaced by magnetic cores for internal storage. Also, during this time, high level programming languages were created such as FORTRAN and COBOL. The third generation replaced transistors with integrated circuits, magnetic core turned into metal oxide semiconductors. An actual operating system sowed up around this time along with the advance programming language BASIC. The fourth and latest generation brought in CPUs (central processing units) which contained memory, logic, and control circuits all on a single chip. The personal computer was developed (Apple II). The graphical user interface (GUI) was developed.

4.0 CONCLUSION

In this unit, you have been introduced to the essentials of Information Technology. You have also learnt the history and the various ways information technology has developed over the years in our various lives.

5.0 SUMMARY

What you have learnt in this unit concerns:

- Information Technology as the acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications.
- The significance of IT in education highlighted as:

    i. Access to variety of learning resources

    ii. Immediacy to information

    iii. Any time learning

    iv. Collaborative learning

    v. Multimedia approach to education

- The history of Information technology

<u>Exercises</u>

1. Define the term Information Technology

2. What significance does information technology bring to a society?

6.0 TUTOR MARKED ASSIGNMENT

- **Discuss the evolution of Information Technology.**

7.0 FURTHER READING AND OTHER RESOURCES

www.wikipedia.com

Langley, Dennis, Shain Michael (1985): Dictionary of Information Technology.

MODULE 1

UNIT 2 APPLICATION OF INFORMATION TECHNOLOGY

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1.0 INTRODUCTION

Having read through the course guide, you will have a general understanding of what this unit is about and how it fits into the course as a whole. This unit describes the various ways information technology applies.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the essentials of information technology
- Identify the necessary areas of application of information technology
- Have good understanding of the term information technology

3.0 MAIN CONTENT

3.1 INFORMATION TECHNOLOGY AND ITS APPLICATION

Information Technology is the acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications. IT is the area of managing technology and spans wide variety of areas that include but are not limited to things such as processes, computer software, information systems, computer hardware, programming languages and data construct. In short, anything that renders data, information or perceived knowledge in any visual format whatsoever, via any multimedia distribution mechanism as considered part of the domain space known as information technology (IT).

IT professionals perform a variety of functions (IT disciplines/competencies) that range from installing applications to designing complex computer networks and information databases. A few of the duties that IT professionals perform may include data management, networking, engineering, computer hardware, database and software design, as well as management and administration of entire system.

Information technology is starting to spread further than the conventional personal computer and network technology, and more integration of other technologies such as the use of cell phones, televisions, automobiles and more which is increasing the demand for such jobs.

In the recent past, the Accreditation Board for Engineering and Technology and the Association for Computing Machinery have collaborated to form accreditation and curriculum standards for degrees in information technology as a distinct field of study as compared to computer science and information systems today. The worldwide IT services revenue totalled $763 billion in 2009.

4.0 CONCLUSION

In this unit, you have been introduced to the fundamental areas of application of information technology (IT) and you have also been introduced to the essentials of IT.

5.0 SUMMARY

What you have learnt in this unit concerns:

- Information Technology as the acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications.

Exercises

1. Highlight 5 fields where application of IT is of utmost significance
2. What accreditation body is involved in the regulation of IT applications?

6.0 TUTOR MARKED ASSIGNMENT

- **Who is an IT personnel and what roles do they perform?**

7.0 FURTHER READING AND OTHER RESOURCES

Langley, Dennis, Shain Michael (1985): Dictionary of Information Technology.

MODULE 1

UNIT 3 INFORMATION TECHNOLOGY IN AGRICULTURE

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1.0 INTRODUCTION

Having read through the course guide, you will have a general understanding of what this unit is about and how it fits into the course as a whole. This unit describes the general introduction of information technology into the agricultural sector.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain and highlights the role of information technology (IT) into the agricultural sector.
- State the different components of IT in agriculture

3.1 ROLE OF INFORMATION TECHNOLOGY IN AGRICULTURE

In the context of agriculture, the potential of information technology (IT) can be assessed broadly under two heads:

1. As a tool for direct contribution to agricultural productivity and

2. As an indirect tool for empowering farmers to take informed and quality decisions which will have positive impact on the way agriculture and allied activities are conducted.

Precision farming, popular in developed countries, extensively uses IT to make direct contribution to agricultural productivity. The techniques of remote sensing using satellite technologies, geographical information systems, agronomy and soil sciences are used to increase the agricultural output. This approach is capital intensive and useful where large tracts of land are involved. Consequently it is more suitable for farming taken up on corporate lines.

The indirect benefits of IT in empowering farmers are significant and remain to be exploited. Farmers urgently require timely and reliable sources of information inputs for taking decisions. At present, the farmer depends on trickling down of decision inputs from conventional sources which are slow and unreliable. The changing environment faced by farmers makes information not merely useful, but necessary to remain competitive.

Information of the required quality always has the potential of improving efficiency in all spheres of agriculture. In addition to facilitating farmers in improving the efficiency and productivity of agriculture and allied activities, the potential of IT lies in bringing about an overall qualitative improvement in life by providing timely and quality information inputs for decision making. The personnel who work for the welfare of farmers, such as extension workers, do not have access to latest information which hinders their ability to serve the farming community effectively, hence the scope for e-powering farmers as well as those who work for their welfare.

3.2 INFORMATION TECHNOLOGY AND ITS COMPONENTS IN AGRICULTURAL DEVELOPMENT

Induction of IT as a strategic tool for agricultural development and welfare of farmers requires that the necessary IT infrastructure is in place. The rapid changes and downward trend in prices in various components of IT makes it feasible to target at a large scale IT penetration into agricultural development. Some of the broad factors to be noted with respect to various components of IT are listed below:

1. **Input devices**:

Radical improvements are witnessed with respect to the means of communication by human beings with computers such as key boards, mouse devices, and scanners. The advent of touch screen monitors that allow users to give *input to computers by touching on the appropriate location of the monitor* has made it possible to develop user-friendly interface for farmers which is easy, intuitive, circumvents language barrier and at the same time provides a relaxed environment to the users. The present day digital cameras make it possible to capture and store good quality graphics and large video clips. The small size and low weight of these digital cameras, which are increasingly becoming affordable, open up the possibilities of providing computer based demonstration clips to educate the farmers. The digital cameras can also be used to upload plant stress related images, movie clips which can facilitate an expert residing at a far of location to quickly recommend a solution.

2. **Output devices:**

Monitor screens, printers & plotters, data projectors support high resolution and good quality output. The quality of these output devices have the potential of generating renewed interest in the farmers in using IT based services. The light weight portable data projectors can be easily carried by the agricultural extension personnel for serving larger audience. Similarly, speakers can also be attached to the computers to incorporate voice based trainings for farmers.

3. **Processors**:

The processing speeds of computers have gone up. At present, Intel P-IV based processors @ 1.5 Ghz are available in the PC range which makes it possible to undertake substantial processing of data at the client side.

4. **Storage Devices**:

40GB and even higher hard disk drives have become common in PC range of computers. This makes it possible to store substantial information at the local level which facilitates faster access. Similarly, high capacity floppy disk drives, CDs make it possible to transfer large volumes of data to locations which can not be connected to networks immediately. These storage devices are also used for backup of crucial data. As a precaution, many corporations store their backups at locations away from the place of work.

5. **Software:**

Various operating systems are available which act as interface between the user and the machine. The graphic user interface (GUI) has become an accepted prerequisite for end users. Microsoft's 'Windows' continues to be a favourite in agricultural development. Application software which can support complex user requirements are available. Of the shelf solutions for office automation packages, groupware applications, complex database solutions, communication products, solutions based on remote sensing & geographical information systems are available. In addition, solutions based on some or all of these are also readily available. The present downward trend in the IT industry provides an opportunity to get customised application for any specific task developed at an affordable price. Rapid Application Development and Deployment (RADD) is a popular model for quick development and deployment of applications. Development environment itself is simplified with tools that quicken the pace of software specialists. Project management and monitoring software are available that facilitate efficient execution of large and complex applications that are required for agricultural development.

6. **Networking devices**:

The capacity of modems, used to convert the data from digital to analog and vice versa, which are popularly employed to use telephone lines have increased. Internal modems are available integrated into the computer so that they are not exposed to outside environment. The capacities of other networking devices such as routers have also gone up which makes it possible to create large networks with smooth data transmission.

7. **Transmission Media**:

The media through which the data transfer takes place has also undergone revolutionary change. Telephone lines are still the popular source in India although the reliability and low bandwidth are still major issues. High capacity cables, optical fibre, radio, wireless local loops, satellite transmission and various solutions based on a combination of these are already being used in many parts of the country.

8. **Other Accessories**:

Uninterrupted Power Supply (UPS) devices are crucial to ensure the longevity of the IT equipment as well as provide backup mechanisms. The potential of solar power packs to provide a feasible solution to shortage of power in the rural areas needs to be exploited.

4.0 CONCLUSION

In this unit, you have been introduced to the fundamentals of application of information technology (IT) in the agricultural sector and you have also been introduced to the fact that rapid changes in the field of information technology makes it possible to develop and disseminate required electronic services in the agricultural sector.

5.0 SUMMARY

What you have learnt in this unit concerns:

- The introduction of Information Technology in the agricultural sector which empowers farmers in the area of trickling down decision inputs from conventional sources which are slow and unreliable.
- The components of Information Technology and its introduction into the agricultural sector.

<u>Exercises</u>

1. Discuss the role of information technology and its application in the agricultural sector

2. List and discuss 5 components of information technology as it applies to the agricultural scene.

6.0 TUTOR MARKED ASSIGNMENT

- It your own words, explain the role of information technology in the Nigerian agricultural sector.

7.0 FURTHER READING AND OTHER RESOURCES

IT Applications in Agriculture: Some Developments and Perspectives by Friedrich Kuhlmann
Institute of Agricultural and Food Systems Management Justus-Liebig-University Giessen/Germany
Senckenbergst., 3, D-35390 Giessen

Role of Information Technology in Agriculture and its scope in India by S.C. Mittal.

MODULE 2

DAM 363: AGRICULTURAL SYSTEM MODELING (3 UNITS)

- UNIT 1 – INTRODUCTION TO SYSTEM MODELING
- UNIT 2 – AGRICULTURAL SYSTEMS
- UNIT 3 – AGRICULTURAL SYSTEMS IDENTIFICATION
- UNIT 4 - AGRICULTURAL MODELING PROCESS
- UNIT 5 - SIMULATION MODEL IN AGRICULTURE

MODULE 2

UNIT 1 INTRODUCTION TO SYSTEM MODELING

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1.0 INTRODUCTION

This unit gives an introduction to system modeling and the identification of the various types. It also describes system modeling and gives an overview of what it entails.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the term system modeling
- Identify the types of system models
- Identify the various agricultural system

3.0 MAIN CONTENT

3.1 INTRODUCTION TO SYSTEM MODELING

System modeling is a technique to express, visualize, analyze and transform the architecture of a system. Here, a system may consist of software components, hardware components, or both and the connections between these components. Systems modeling or systems modeling is the interdisciplinary study of the use of models to conceptualize and construct systems in business and IT development.A system model is then a skeletal model of the system. System modeling is intended to assist in developing and maintaining large systems with emphasis on the construction phase. The idea is to encapsulate complex or changeable aspects of a design inside separate components with well-defined interfaces indicating how each component interacts with its environment. Complete systems are then developed by composing these components. System modeling can increase reliability and reduce development cost by making it easier to build systems, to reuse previous built components within new systems, to change systems to suit changing requirements such as functional enhancement and platform changes, and to understand systems. In this way, a system model can satisfy different requirements such as documenting the system, providing a notation for tools such as consistency checkers and can also be used in the design stage of system development. Thus, system modeling is used to ensure that a developing piece of software evolves in a *consistent* manner and that the task of integrating software components is *simplified*.

3.2 OVERVIEW

In business and IT development the term "systems modeling" has multiple meaning. It can relate to:

- the use of model to conceptualize and construct systems
- the interdisciplinary study of the use of these models
- the systems modeling, analysis, and design efforts
- the systems modeling and simulation, such as system dynamics
- any specific systems modeling language

As a field of study systems modeling has emerged with the development of system theory and systems sciences.

As a type of modeling systems modeling are based on systems thinking and the systems approach. In business and IT systems modeling contrasts other approaches such as:

- agent based modeling
- data modeling and
- mathematical modeling

In "Methodology for Creating Business Knowledge" (1997) Arbnor and Bjerke the systems approach (systems modeling) was considered to be one of the three basic methodological approaches for gaining business knowledge, beside the analytical approach and the actor's approach (agent based modeling).

3.3 HISTORY

The function model originates in the 1950s, after in the first half of the 20th century other types of management diagrams had already been developed. The first known Gantt Chart was developed in 1896 by Karol Adamiecki, who called it a *harmonogram*. Because Adamiecki did not publish his chart until 1931 - and in any case his works were published in either Polish or Russian, languages not popular in the West - the chart now bears the name of Henry Gantt (1861–1919), who designed his chart around the years 1910-1915 and popularized it in the West. One of the first well defined function models, was the Functional Flow Block Diagram (FFBD) developed by the defense-related TRW Incorporated in the 1950s.In the 1960s it was exploited by the NASA to visualize the time sequence of events in a space systems and flight missions.[6] It is further widely used in classical systems engineering to show the order of execution of system functions.

One of the earliest pioneering works in information systems modeling has been done by Young and Kent (1958), who argued:

> *Since we may be called upon to evaluate different computers or to find alternative ways of organizing current systems it is necessary to have some means of precisely stating a data processing problem independently of mechanization.*

They aimed for a precise and abstract way of specifying the informational and time characteristics of a data processing problem, and wanted to create a notation that should enable the analyst to organize the problem around any piece of hardware. Their efforts was not so much focused on independent systems analysis, but on creating abstract specification and invariant basis for designing different alternative implementations using different hardware components.

A next step in IS modeling was taken by CODASYL, an IT industry consortium formed in 1959, who essentially aimed at the same thing as Young and Kent: the development of "a proper structure for machine independent problem definition language, at the system level of data processing".

3.4 TYPES OF SYSTEMS MODELING

In business and IT development systems are modeled with different scoops and scales of complexity, such as:

- Functional modelling
- Business process modeling
- Enterprise modelling

Further more like systems thinking, systems modeling in can be divided into:

- Systems analysis
- Hard systems modelling or operational research modelling
- Soft system modelling

And all other specific types of systems modeling, such as form example complex systems modeling, dynamical systems modeling, and critical systems modeling.

3.5 MODELLING FRAMEWORK AND LANGUAGE

For system modelling, we need a conceptual framework and a system modelling language, textual and/or diagrammatic. Besides textual notations like tables or prose, diagrammatic notations like graphs are common today. Within these diagrams, there are symbols representing the parts of the system, e.g. objects and groups of objects, and other symbols visualising the connections between these parts. The number of symbols for each purpose differs noticeably between notations.

During the past decades four main conceptual frameworks have evolved:

· Design Methods

· Module Interconnection Languages (MILs)

· Software Architectures

· Design Patterns

Design methods focusing on program language modules date back to the early seventies; modelling systems with objects is a technique of the late eighties. The first MIL was presented 1975, and in the following years a lot of different MILs have been developed. In contrast, software architectures and design patterns are more recent techniques and are each only about five years old.

DESIGN METHODS

Design methods consist of a concept, a language, and a design process. The concept defines which parts of the program are to be represented by the components of the system model. The language is used to describe the system model. To carry out the design of the system according to the software lifecycle or a part of it, a step-bystep process is given to be followed by the designer.

When modelling a system with a ***modular design method***, program modules are used as the components of which the system is composed. Modules include related functions of a specific program language and may keep the data used by these functions. Further, a module offers an interface with the functions that may be used from this module.

An interrelationship between two modules is established by a function contained in one module calling a function contained in another. Thus, this modelling method describes systems in terms of function calls and composition of modules containing functions.

A commonly used example is Structured Design (SD) introduced by Constantine and Yourdon at the end of the Seventies; Modular Design (MD) is an extension of SD, subdividing the system to be designed into modules which can be developed independently of each other. ***Object-oriented design methods***, on the other hand, do not focus on the functional aspect. An object component includes data and functions.

These functions constitute an external interface, and represent the only possibility to manipulate and/or access the data within an object. Another type of components are classes, which serve as templates from which objects can be instantiated, i.e. derived.

The connections between the objects of a system model are manifold, e.g. instantiation of an object from a class, composition, and use. Interacting objects often are not viewed as calling each other's functions, but requesting each other via messages to perform a desired action on their data. An object is responsible that its representation is hidden from other objects. Thus, the object-oriented modelling method adds behaviour over a mere structural solution.

A design method on the verge to object-oriented design is MD++, mainly MD with an object-oriented extension. Other methods focus on a particular implementation language, e.g. HOOD (Hierarchical Object- Oriented Design) is used to develop systems with the ADA implementation language. Today's widely used object-oriented methods include the Object Modelling Technique (OMT) by Rumbaugh, the Object-Oriented Design and Analysis (OODA) by Booch, the Object-Oriented Design LanguagE (OODLE) by Shlaer, and Ooram (Object-Oriented role modelling) by Reenskaug.

For both modular and object-oriented design methods there exist textual and diagrammatic notations coming with the specific design methods, with diagrammatic notations becoming common during the last years.

Besides these two main design methods there exist design methods for special purposes like task design, which is focusing on processes and their communications, and real-time systems design.

4.0 CONCLUSION

In this unit, you have been introduced to the essentials of system modelling. You have also learnt the types of the system modelling with modelling framework and language.

5.0 SUMMARY

What you have learnt in this unit concerns:

- Introduction to system modeling
- The types of system modeling
- Modeling framework and language

MODULE 2

UNIT 2 AGRICULTURAL SYSTEMS

Table of Contents

1.0 INTRODUCTION

This unit presents an introduction to agricultural system incuding the diferent types and why it is being modelled.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Describe an agricultural system
- Identify the different types of agricultural system
- State why agricultural system is modelled

3.0 MAIN CONTENT

3.1 AGRICULTURAL SYSTEM

In the agricultural industry, there are many strategies for operating farms of all sizes. The various strategies for managing a farm can generally be categorized into agricultural systems. These agricultural management strategies typically describe whether farmers use pesticides or are organic, whether they are self-contained or interact with the surrounding environment, and whether farmers use strict measurements and plans or follow their intuition to make decisions on their farms.

Examples of natural agricultural systems might include pest control programs that use aphids those ladybugs. It is only a natural system if the ladybugs arrived naturally. If a person purchases ladybugs and introduces them to a farm to control, the ladybugs become part of an artificial system of agriculture, which is any system made by humans or to serve human needs. Social agricultural systems are generally the communities and methods of sharing information that farmers use to acquire information to solve problems.

An *agricultural system* is an assemblage of components which are united by some form of interaction and interdependence and which operate within a prescribed boundary to achieve a specified agricultural objective on behalf of the beneficiaries of the system. This definition is analogous to the general definition of any *artificial* (i.e., man-made) *system* of which all managed agricultural systems (including specifically the farm-level systems).Agricultural systems can also be explicit or implicit, and descriptive or operational. When a farm uses an explicit agricultural system, the farmer weighs or measures exact amounts of nutrients like fertilizer, water, or pesticides. This type of agricultural system is most common in high-production, for-profit farming. Though explicit farming involves careful measurement of agricultural elements and close adherence to planned methods, most farmers use an element of implicit farming when they observe their crops and adjust for unexpected changes. In implicit agricultural systems, farmers use less strict measurement. Farmers who use systems based on implicit agricultural theory often use some explicit elements, like farming books and almanacs, to better meet their agricultural goals.

Agricultural systems also include static or dynamic systems, and open or closed systems. Generally, a dynamic agricultural system is one that is constantly changing to account for changes in the environment, as a static agricultural system tends to stay the same. An agricultural system that is open will contain or interact with parts of the local environment, while a closed agricultural system does not interact with the local environment at all. For example, a greenhouse lettuce farm is a relatively closed environment compared to an outdoor lettuce farm.

3.2 WHY MODEL AGRICULTURAL SYSTEMS

System models provide a simplified description of important system components and their interactions.

Schoemaker (1982) identifies four purposes for systems models:

1) description
2) prediction
3) postdiction
4) Prescription.

Descriptive models are used to characterize the system; their performance, in turn, allows modellers to evaluate whether they have adequately described the important aspects. Predictive models forecast future system behaviour. Descriptive models may serve a predictive purpose, but many predictive models are much simpler than descriptive ones, especially when certain system patterns repeat themselves systematically, obviating the need to describe the underlying mechanisms. For example, seasonal temperature patterns can be predicted fairly reliably from historical data, without describing the revolution of the Earth around the sun and the attendant changes in insolation, ocean currents, and jet stream activity. Postdictive models tend to be human logical constructions that allow us to explain after-the-fact what system constraints or special phenomena caused a given outcome. Prescriptive models are normative ones that offer guidance on how a system should be managed to meet some goal. Many agricultural models serve more than one of these purposes.

A secondary, but often very important, reason for modeling agricultural systems is to improve knowledge of the system. Knowledge of any given agricultural system is often uneven.

Areas where knowledge of the system is sparse or missing tend to become apparent either

1) In the process of designing the model structure, or

2) In the process of finding parameters that can make empirical models operational.

For example, one recent exercise in developing a weed management model revealed that in the past 30 years, North American weed scientists have focused their research so heavily on herbicide performance that little is known about weed biology and ecology; the modeling process helped to instigate a new research effort in this area (Forcella *et al.*, 1992). Model design experiences often lead to revised priorities for future data collection research, based on data gaps defined (Dalton, 1982b; C. Mullon in ORSTOM, 1989). Hence, systems modeling may provide value not just through the end-product model developed, but also through the development process itself.

4.0 CONCLUSION

In this unit, you have been introduced to agricultural system, the types and the reasons why it should be modelled.

5.0 SUMMARY

What you have learnt in this unit concerns:

- what agriculture system entails
- the different types of agricultural system

MODULE 2

UNIT 3 AGRICULTURAL SYSTEMS IDENTIFICATION

Table of Contents

1.0 INTRODUCTION

This unit presents an introduction to agricultural system identification incuding its classification and a hierarchical classification of this system.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Describe an agricultural system
- Identify agricultural systems

3.0 MAIN CONTENT

3.1 AGRICULTURE IN RELATION TO OTHER SYSTEMS

Agriculture is shown as comprising one of a very large number of actual or potential artificial systems at the sub-division level. Others are those relating to mining, transport, public health, education etc. What such systems at this sub-divisional level have in common is that each is artificial: each is based upon or draws elements from higher-level natural and social systems; and each also contains elements which are purposefully created by some human agency in order to meet its needs.

Further sub-classification of systems

Systems within the three broad divisions or their multitudinous subdivisions can be further classified according to system 'type', a loose term but one which might be used to differentiate among agricultural systems according to a number of factors of which only two are shown in the sketch. As outlined below, first, the system might be either an explicit or implicit one; second, its purpose might be either descriptive or operational. Other 'type' designations could be added; e.g., operational systems could be further classified according to whether or not they are amenable to optimization.

- *Explicit systems* are those in which the constituent elements are more or less closely identified and defined, and the relationships among these elements are stated formally in quantitative, usually mathematical, terms. Agricultural scientists and economists who work with farmers are concerned mainly with explicit systems of Order Levels 1 to 10. But farmers themselves will seldom be concerned with explicit systems - only with systems of a simpler kind, or only with selected parts of such systems.

- *Implicit systems* are systems in which only the main or critical elements are acknowledged and only the major or immediately relevant interrelationships are considered. However, these elements and relationships are not formally recorded, analysed or evaluated. Farmers themselves deal primarily with implicit systems. In both traditional and more modem societies particular agricultural systems of Order Levels 1 to 10 are implied in what farmers do, or deliberately do not do. In more 'advanced' societies, farmers might formalize and work with a few explicit systems or parts of systems (farm record books, simple crop budgets, household expenditure accounts) but here also most agro-management systems will exist by implication.

The purpose in here distinguishing between explicit and implicit systems is to discourage the view that, because farmers (especially small traditional farmers) do not deal with explicit formal systems, these farmers are backward, ignorant, unsophisticated and generally inferior as resource managers. If anything, the facts generally point to a contrary conclusion. While bad farmers can be found anywhere, any close study of small traditional farmers and farming villages in the developing world will, with patience, identify implicit systems at agro-technical, enterprise, farm, farm-household and village levels which are far more complex, sophisticated, sustainable and socially efficient than most agricultural systems found in developed countries.

- *Descriptive systems* are usually intended to facilitate an understanding of the organization, structure or operation of a productive process. This might be their sole purpose; e.g., a farmer might construct a simple input-output budget table in order to learn the structural configurations of some potential new crop. Depending on the results of this, he or she might then proceed to construct a more detailed budget (an operational system) to find how best to fit this new crop into his or her farm plan. At higher Order Levels an organogram describing the administrative structure of a ministry of agriculture or of an extension service might be constructed or the flowchart of a commodity from farm to consumer might be drawn - these also are descriptive systems.

- *Operational systems* are constructed (by an analyst or manager or research worker) as a basis for taking or recommending action aimed at improving the performance of the system. Such systems are often elaborate (as exemplified in Chapters 9 and 11). However, increased precision is not infrequently achieved at the cost of decreased practical usefulness. Thus farm managers themselves work primarily with simple operational systems, although the actual physical systems which these represent may be very complex.

As outlined by Dillon (1992), it is also sometimes useful to recognize that, like other systems, agricultural systems may be categorized as:

- *Purposeful* or *non-purposeful,* depending on whether or not they can select goals and the means by which to achieve them.

- *Static* or *dynamic* depending on whether or not they change over time in response to internal or external influences.

- *Open* or *closed* depending on whether or not they interact with their environment.

 Abstract or *concrete* depending on whether or not they are conceptual or physical in nature.

 Deterministic or *stochastic* depending on whether or not their behaviour exhibits randomness over time, i.e., their future behaviour is uncertain.

3.2 THE AGRICULTURAL SYSTEM IDENTIFICATION

Agricultural and particularly farming systems exhibit great diversity as shown by, e.g., Duckham and Masefield (1970), Grigg (1974), Kostrowicki (1974) and Ruthenberg (1980). They have been classified in various ways as reviewed by Fresco and Westphal (1988) who also present an ecologically-based classification and typology of farm systems. The hierarchical classification of farm systems presented here is distinctly different. It is specifically oriented

(i) To a farm management and farm-household perspective and
(ii) To use as a framework for analysis of what are proposed as the six basic types of farms found in Asia and elsewhere in the developing world.

3.3 THE HIERARCHY OF AGRICULTURAL SYSTEMS

Systems of Order Levels 1 to 12 comprise the field of farm management but systems of Order Level 1 and 2 are also, indeed primarily, the domain of the applied agricultural sciences. A further proviso is that the 'household' components of farm-household systems of Order Level 12 remain as yet not very well understood. This component is primarily the province of workers in such fields as household economics, rural sociology and social anthropology. While these various farm family-related fields are fairly well established, they have yet to be brought together in a comprehensive and cohesive way at farm-family level to provide verified models of how rural families in the developing world think about, plan and operate the 'farm' component of their farm-household systems (Clayton 1983). This depicts the direction of hierarchical status as proceeding downward from sector to industry to village to farm to crop etc. But whether this direction of subordination is valid will depend on circumstances and analytical purpose. Agricultural scientists would probably reverse the order-ranking shown for the systems on the grounds that, unless the basic agro-technical processes (Order Level 1 and 2 systems) are well developed, the production of individual crops will be inefficient, total farm production will be low and the agricultural sector itself will in consequence be an impoverished one. Similarly extension workers might be inclined to place household systems at the top of the systems hierarchy on the basis that good farming practices (Order Level 1 and 2 systems) will not be adopted unless the household systems are working well, nor consequently will the 'higher'-order systems at industry and sector level operate at their full potential.

3.4 AGRICULTURE SYSTEMS CLASSIFICATION

The nature of each farm-level system (i.e., Order Levels 1 to 12) of the hierarchy presented may be specified from a management point of view as follows:

- *Order Level 1: Uni-dimensional process systems.* Systems of this lowest order are of an agro-technical nature. They involve an issue or problem which for purposes of analysis or management is abstracted from the context in which it naturally or normally occurs. One example is the application of a single fertilizer element, say nitrogen (*N*), to a crop and consequent plant response to *N* in terms of crop yield *Y*. As noted previously, systems of this order are primarily the domain of physical scientists, but those systems which have practical relevance for farmers thereby also have an economic dimension and so fall within the scope of farm economics. Such simple single-dimensional systems are later examined as processes and as input-output response relationships.

- *Order Level 2: Multi-dimensional process systems.* Systems of this second order are also concerned with limited agro-technical relationships and again they are primarily the domain of physical scientists. They differ from Order Level 1 systems in that they take - or are defined to take - a wider and more realistic view of a subject or problem. To use the same example of fertilizer response: at Order Level 2 an agro-technical system might involve the response of plant growth or yield *Y* to not one but to several or a large number of input factors such as nitrogen, phosphorous, irrigation water, crop hygiene, soil tilth etc

- *Order Level 3: Enabling-activity systems.* Systems of this order are certain enabling activities which generate an intermediate product intended for use as an input/resource by enterprises which do produce a final product. An example is offered by a legume crop turned under to provide fertility for a following (final product-generating) paddy crop. There will often be alternative ways of obtaining this resource: e.g., stripping leaves off leguminous trees, keeping cattle for their manure, or buying a bag of fertilizer. These are all enabling, resource-generating activities but only some of them, the complex ones, warrant designation as systems. They are intended to supply resources to systems of Order Levels 4 and 6.

- *Order Level 4: Crop systems.* Systems of this order relate to the production of individual crops; but if these are primarily intended to produce inputs for other crops or livestock, they are regarded as systems of Order Level 3. On many small farms, crop and livestock enterprises produce both final products.

- *Order Level 5: All crop systems.* Systems of this order, known also as *cropping systems,* refer to the combined system of all the individual crops on a farm. On a farm with a single mono-crop, this Order Level 5 system will obviously be equivalent to an Order Level 3 system; but on small mixed farms there will usually be four, five, six or more different crops (of Order Levels 3 and 4) grown in some degree of combination and as many as 20 or more on the highly diversified forest-garden farms of South Asia.

- *Order Level 6: Animal systems.* These systems relate to single-species animal enterprises or activities - e.g., dairy cows, camels, fish, ducks. They are the animal equivalent of Order Level 4 (i.e., individual crop) systems.

- *Order Level 7: All animal systems.* These systems are the aggregation of all Order Level 6 subsystems on a farm. Known as *livestock systems*, they are the animal equivalent of Order Level 5 (i.e., all crop) systems.

- *Order Level 8: Resource pool.* This subsystem is a conceptual device for farm-system planning in which resources and fixed-capital services required by other subsystems are 'stored' in a 'resource pool' from which they are allocated to the other subsystems (of Order Levels 1, 2, 3, 4 and 6). The resource pool is central to operation of the whole farm-household system.

- *Order Level 9: Farm service matrix.* A system of this Order Level consists of all the fixed capital resources of a farm which are pertinent to the operation of the farm as a whole but are not assigned to the exclusive use of any particular enterprise or activity: land, fences, barns, irrigation channels and work oxen are common examples. Some of these capital items are true subsystems, having interdependence among their component parts (as in an irrigation storage/delivery/distribution network, a grain drying facility, an integrated network of soil conservation structures etc.). Some are only things (e.g., fences, a plough, a barn). But, in its totality, such capital is managed and manipulated as a system for the purpose of providing general services which, while not specific to them, enable the functioning of lower Order Level systems of the farm.

- *Order Level 10: Whole-farm systems.* Systems of this Order Level consist of all the lower Order Level subsystems which go to make up a farm. They consolidate in a single entity all the farm fixed capital, all the operating capital, all the final-product enterprises, all the activities and all the agro-technical processes which underlie such enterprises and activities. Structuring and managing systems of this Order Level are the main tasks or focus of farm management as carried out, on the one hand, by farmers and as investigated, on the other hand, by farm management economists in their professional capacity of providing advice to farm managers, development agencies and governments.

The terms farm *system* and *farming system* are often used interchangeably. Here the practice is to use farm system to refer to the structure of an individual farm, and farming system to refer to broadly similar farm types in specific geographical areas or recommendation domains, e.g., the wet paddy farming system of West Java or the grain-livestock fanning systems of Sind.

- *Order Level 11: Household systems.* On small farms the household itself is the most dynamic and complex of all farm-level systems, although it is a social system not an agricultural one. It dominates the agricultural systems which comprise the farm component. It has two functions: as *household* it provides purpose and management to the farm component, and as major system *beneficiary* it receives and allocates system outputs to itself and other beneficiaries.

- *Order Level 12: Farm-household systems.* These consist of two components or (sub) systems of Order Levels 10 and 11, i.e., the whole-farm system and its associated household system, respectively. The term is a very useful if not mandatory one when used to refer to the small farms of Asia. It carries an insistence that the technical analysis discussed in following chapters will amount to nothing at all unless it is applied to achieving the real needs and aspirations of the household - which, as discussed in Chapter 6, might be quite a different thing from evaluating the performance of a farm system according to the subjective or preconceived ideas of agricultural technicians and economists (Chambers and Ghildyal 1985; Rhoades and Booth 1982). As the peak farm-level system, the farm-household system may be described in system terms as a goal-setting (i.e., purposeful) open stochastic dynamic system with a major aim of production from agricultural resources. These attributes are sufficient to make it also a complex system. The purposefulness of a farm-household system is ensured by its human and social involvement which enables the system to vary its goals and their means of achievement under a given environment. The openness of the farm-household system is obvious from its physical, economic and social interaction with its environment. The non-deterministic or stochastic nature of the farm-household system is guaranteed both by the free-choice capacity of its human (and, if present, animal) elements and by the stochastic nature of the environment with which it (and all its subsystems) interacts. Necessarily, a farm-household system is also dynamic by virtue of its purposefulness, openness and stochasticity which ensure that the system changes over time. Too, any farm-household system is a mixture of abstract and concrete elements or subsystems. The concrete elements are associated with the physical activities and processes that occur in the system.

4.0 CONCLUSION

In this unit, you have been introduced to agricultural system identification.

5.0 SUMMARY

What you have learnt in this unit concerns:

- Agriculture system identification
- Agriculture system classification

6.0 TUTOR MARKED ASSIGNMENT

- Explain the term System Modeling
- Write a short note on Agricultural Systems.

7.0 FURTHER READING AND OTHER RESOURCES

Wikipedia.Org.

Renaissance esprit project 2010.

Scott M. Swinton and J. Roy Black.(2000) Modelling of agricultural systems.

H. Bliss (2011) What are the different types of agricultural systems.

MODULE 2

UNIT 4 AGRICULTURAL MODELLING PROCESS

Table of Contents

1.0 INTRODUCTION

This chapter explores the purposes, types and applications of agricultural systems models. It begins by addressing the questions: "Why model agricultural systems?" and "For whom are these models developed?"

The chapter next defines agricultural systems and develops interlocking typologies of models to address the question, "How are agricultural systems modeled?" It then explores a range of subject matter applications of agricultural systems models, closing with a review of current trends and future directions in this rapidly evolving field.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the term modelling process

- Describe the types of system model
- Identify the challenges of modelling in agriculture

3.0 MAIN CONTENT

3.1 MODELLING PROCESS

3.2 TYPES OF SYSTEM MODELS

In turning from systems to their representation via models, we face not only the diverse system typologies listed above, but also diverse ways to characterize the model designs themselves. In this section, we will examine system models beginning with a general typology of model communication, and moving on to a sub classification of mathematical system models.

3.2.1 Communicating systems models: Iconic, analogue and symbolic approaches

System models can be communicated by three general means: iconic, analogue, and symbolic.

Iconic models represent the system in a visual form. This can range from a miniature version of the real physical system of interest (e.g., an experimental agronomic field plot) to a pictorial representation, such as a flow chart.

Analogue models are expressed in words by analogy. For example, one might describe the xylem cells in a plant as functioning like sections of plumbing pipe. Symbolic models are primarily mathematical ones; they will be discussed at length below.

Iconic and symbolic models are the ones most commonly used to represent agricultural systems. Iconic models have been used to convey visually the broad interactions within systems of many hierarchical levels and overlapping system boundaries.

3.2.2 Mathematical symbolic models

Mathematical symbolic models of agricultural systems have become dramatically more important over the past forty years with the revolution in computer technology. Computing advances have allowed modelers to take advantage of three great strengths of mathematical models

1) To mimic system complexity and dynamics through detailed equations

2) To mimic random (stochastic) processes

3) To do these things with precision and replicability.

Mathematical models of agricultural systems use three general techniques: simulation, optimization, and statistics. Proper stochastic simulation requires careful modeling of the random processes of interest; a well-designed model can easily generate many simulated system outcomes allowing study of their probability distributions and dynamic properties.

While many early optimization models were static and deterministic, optimization modeling has developed to embrace stepwise decision making over time and decisions in risky settings. Such models include polyperiod linear programming models. These models also include dynamic programming models, which use an optimization technique for identifying optimal time paths for discrete-valued control variables. Applications have included long-term weed control; machinery selection, crop choice for erosion control, and agricultural policy impact analysis has been used in *ex ante* analysis of agricultural technology adoption and agricultural policy impacts. Optimization models can support the decision-making objectives of agricultural managers, such as minimizing the cost of animal weight gain, enhancing weed control, or boosting farm profits.

3.3 MODEL APPLICATIONS AT DIFFERENT SCALES

Like the agricultural systems they describe, models of systems can be classified according to space, time, and hierarchical organization. In fact, many conventional subject matter categories (such as biophysical-ecological, sociological-cultural, and economic) correspond to physical scale or organizational level. A useful way to organize agricultural systems models is to modify the Stomph *et al.* hierarchical classification into

1) The sub organism,

2) The organism

3) Communities of organisms

4) Aggregates of communities.

At the sub-organismal scale, most agricultural systems models are biophysical. These include sub-cellular models (or even smaller), attempting to describe such phenomena as how food is converted into mechanical energy by mitochondria or how root hairs differentially absorb plant nutrients.

A much larger number of agricultural systems models have been developed at the organismal level. One major grouping is the growth models. These are almost exclusively discrete-event dynamic simulators. An important group describes crop and livestock growth in response to key inputs (e.g., Hanks & Ritchie, 1991; Meynard, 1998; Peart & Curry, 1998; Tsuji *et al.*, 1994; Rotz *et al.*, 1989).

Many of these are employed to test new technology or policy scenarios, since they can predict crop and livestock yield results due to changes in management, including generating probability distributions of outcomes that result from random weather.

In agricultural economic systems, the individual productive enterprise is analogous to the organism. It represents a formal conceptual way of viewing an economic subsystem in terms of financial costs and benefits.

Subsector models are typically analogue or iconic in structure.

Farmer decision-support computer models constitute yet another enterprise-level class of agricultural systems models. Papy (this volume) suggests that such models can provide a foundation for management consultations between experts and farmers. A variety of such mathematical models have been developed in the United States and Europe to support such decisions as whether to control crop or livestock pests (e.g., Swinton & King, 1994; Wilkerson *et al.*, 1991; Kells & Black, 1991; Renner & Black, 1991), whether to invest in new farm machinery (Cerf *et al.*, 1995), or whether to participate in government commodity price support programs (Gardner *et al.*, 1992).

Moving up to aggregates of individual organisms and their interrelationships, we encounter models of agricultural ecology and economics. The ecological models describe relationships among species in specific habitats or farming systems. In agriculture, many of these are mathematical models that come out of the pest sciences (entomology, plant pathology, and weed science) or efforts to model environmental fate and transport of hazardous substances. At the field scale, models include: for soil erosion, RUSLE and EPIC (Williams *et al.*, 1989); for chemical fate, EPIC-PST; for surface runoff, CREAMS; for nitrate leaching, NLEAP (Shaffer *et al.*, 1991). Other iconic models of aggregates come from technology development research in developing countries under the farming systems research or action-research methodologies in specific agro-climatic zones (e.g., McIntire *et al.*, 1992).

If enterprises represent the organisms in agricultural production economics, then farms represent the fundamental aggregates of these organisms. Due to the well-developed neoclassical economic theory of the firm, household-level agricultural economic models are more common than intra-household or village-level models (Fleming & Hardaker, 1993). The simplest of these household models are whole-farm budgets, which integrate a set of enterprise budgets in the context of limited farm resources. There exist several computerized accounting models for developing consistent whole-farm budgets either for evaluating farm plans (Hawkins *et al.*, 1995, 1993) or for *ex ante* policy analysis at the farm level (Richardson & Nixon, 1986). These models are best classified as simulation models.

The declining cost of and increasing capacity to do computer calculations is encouraging more computationally-intensive agricultural models. This is particularly true in optimization models. Optimization models with nonlinear objective functions and constraints are increasingly easy to develop using commercial software. Techniques like CGE are proliferating as a result. Dynamic programming models, while not automated, have become more numerous in part due to increasing computing power that helps to overcome their extravagant computer memory requirements.

Expansion of computer power has also led to increasing integration of related agricultural models. For example, twelve crop growth discrete-event simulation models sharing a daily time step and a single-season simulation period have been assembled into the "Decision Support System for Agro-technology Transfer" model (DSSAT, Tsuji *et al.*, 1994). The group of models share similar input data requirements and can be used to simulate crop rotations under alternative management scenarios. Similarly, the SWAT (Soil and Water Assessment Tool) model is the offspring of EPIC-PST, a field-level dynamic erosion and pesticide fate soil and yield impact predictor, and a surface water movement model at the sub watershed level (Arnold & Allen, 1992).

3.4 MODELING INTERACTIONS AMONG SYSTEMS

Agricultural systems models will also be needed to improve our understanding of how production system components interact if the systems are to be optimized. Three issues motivate the need for better information to optimize agricultural systems: environmental quality, product quality control, and ecosystem management.

In most regions of the world, the environmental quality issue is now clear: The side effects of certain farming practices impose costs on others that must be reckoned with if sustainable systems are to be developed.

Examples include water pollution due to manure runoff from intensive livestock production, threats to animal welfare, soil erosion that fills waterways with silt and reduces crop yields, salinization from irrigation systems, and pesticide misuses.

The second motivation for better modeling interactions is to enhance product quality control. As agriculture in many industrialized countries progresses toward closer integration of production with marketing and retailing, it becomes essential to be able to link end-product quality to detailed knowledge of production system components and how they interact. For more and more products (e.g., fresh fruits and vegetables, branded meats), the range of permissible tolerances for quality deviation is narrowing. With the emerging use of ecolabels that describe environmental characteristics of production conditions (Van Ravenswaay & Blend, 1999), modeling will become important to determine the risks of producing in more environmentally benign ways that may attract premium product prices.

The third reason for need for better modeling component interactions is to advance ecosystems management in lieu of the conventional, more industrial approach to production management. Sustainable agriculture is based more on the manipulation of the basic biological system. For example, pest and weed management are based not on application of purchased external chemical inputs, but instead on fostering biological controls that are already part of the agro ecosystem. In order to accomplish this more effectively, two advances are needed.

First, we need a better understanding of interactions among system components. Second, we need more efficient experiential learning methods, since annual experiments with uncontrolled weather make for slow learning.

Improved modeling of interactions within and among agricultural systems can help address all three of these needs—better environmental quality, better product quality control, and better ecosystem management.

3.5 MODELLING CHALLENGES

The rapid expansion of information technology in agriculture will call for more, better computerized models of agricultural systems. The precision agriculture revolution has begun with low-cost data collection (e.g., yield monitors, remote sensing), GIS software, and hardware controllers to allow variable rate input control. The logical next phase will be an explosion in computerized decision support models that can make sound input recommendations site-specifically, interacting with a spatial database of field characteristics. As computer models become more accessible over the Internet, both for downloading and for direct access using languages such as Java, other simulation and decision support uses will also proliferate.

The new demands for computerized agricultural models will bring new challenges. The growing user audience for computerized decision support will require more user-friendliness and data updating than the research community that was the main audience for earlier generations of agricultural models. These will likely call for new ways to share model design and support between public and private sector institutions. Universities and governments may be good at generating new modeling concepts, but they are poorly suited to the continual updating and customer support that are hallmarks of successful private software companies.

Certain aspects of good model development will continue to be as challenging as always. Finding the appropriate trade-off between versatility in model output information and reasonably parsimonious data input requirements is never easy. The best model designs will realistically envision model uses and will be designed to accommodate them flexibly. The trend toward object-oriented computer programming may make it more practical to construct large models from fairly simple building blocks. But up to the present, there has always been a painful trade-off between model robustness, data requirements, and adaptability to new uses. This problem is nowhere more truely than for the adaptation of research models for field decision support purposes (King *et al.,* 1993). Critics of past agricultural decision support models stress that successful models are developed by researchers with close links to

the field and used for the specific purposes intended (Molle & Valette, 1995; Meynard, 1998).

The exponential growth of computerized mathematical symbolic models will not end the need for iconic and analogue models to conceptualize agricultural systems. The new use of iconic and analogue models to describe the economic transformation of the food system supply chain is a case in point. Nonetheless, the easy manipulation and replication of computerized system models will cause them to continue expanding in use for the foreseeable future.

4.0 CONCLUSION

In this unit, you have been introduced to the fundamentals of application of information technology (IT) in the agricultural sector and you have also been introduced to the fact that rapid changes in the field of information technology makes it possible to develop and disseminate required electronic services in the agricultural sector.

5.0 SUMMARY

What you have learnt in this unit concerns:

- The introduction of Information Technology in the agricultural sector which empowers farmers in the area of trickling down decision inputs from conventional sources which are slow and unreliable.
- The components of Information Technology and its introduction into the agricultural sector.

Exercises

1. Discuss the role of information technology and its application in the agricultural sector

2. List and discuss 5 components of information technology as it applies to the agricultural scene.

6.0 TUTOR MARKED ASSIGNMENT

- It your own words, explain the role of information technology in the Nigerian agricultural sector.

7.0 FURTHER READING AND OTHER RESOURCES

IT Applications in Agriculture: Some Developments and Perspectives by Friedrich Kuhlmann

Institute of Agricultural and Food Systems Management Justus-Liebig-University Giessen/Germany Senckenbergst., 3, D-35390 Giessen

Role of Information Technology in Agriculture and its scope in India by S.C. Mittal.

MODULE 2

UNIT 5 SIMULATION MODELS TO STUDY SYSTEM BEHAVIOURS

Table of Contents

1.0 INTRODUCTION

Having read through the course guide, you will have a general understanding of what this unit is about and how it fits into the course as a whole. This unit defines simulation modeling and describes the various types and significances to agriculture.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the Simulation Model
- Understand the classification of simulation model
- Have good understanding of its significances and application to Agriculture
-

3.0 MAIN CONTENT

3.1 MEANING OF SIMULATION MODELING

Simulation model is the term used to include all forms of model which are explicitly aimed at investigating basic phenomenological features of a system or process.

3.2 CLASSIFICATION OF SIMULATION MODEL

This class of model includes two forms.

1. Computer simulation models, whereby an exact and detailed analysis of the system leads to a mathematical formulation of its behavior which can be implemented on analogue or digital computer. Such simulations tend to be extremely complex in nature involving many intricacies which would be omitted from a dynamical model.
2. Scale simulation models, some phenomena are so complex that they defy useful analysis. In order to simulate such processes it is common practice to construct a physical replica of the process under study with appropriate dimensional scaling. Such scale simulations allows a variety of design and operational conditions to be studied in a controlled environment often at a more realistic level than other model forms would permit.

Apart from facilitating scientific inquiry, simulation models can serve valuable predictive and prescriptive functions for farm managers and policy makers. Biophysical simulation models can predict the environmental consequences of agricultural activities, thereby providing valuable insights for policy formulation, technology design, or regulatory enforcement

Simulation models are developed with the intent of accurately describing the evolution of the system at a given scale. They tend to be dynamic models and may describe continuous systems using differential equations or discrete ones using difference equations or Markov chains. Some continuous models admit an analytical solution.

Non-optimizing dynamic simulation models serve roles for both the scientist and the decision maker. For scientific purposes of description and postdiction, they offer the potential to conduct controlled, computerized experiments by replicating natural conditions that could otherwise not be replicated, or could be replicated only at great cost. Experiments that might otherwise be destructive or excessively time-consuming can be conducted safely and quickly in a simulated setting. Moreover, since most complex systems involve random processes that cannot be described by closed-form mathematical expressions admitting an analytical solution, discrete-event simulation can be extended to model stochastic processes explicitly.

3.3 SIGNIFICANCE OF COMPUTER MODELS FOR FARM MANAGEMENT

As information processing and acquisition costs decline, the use of computer models for farm management decision support is expanding rapidly in North America. The models are designed for two purposes:

1) Record keeping

2) Decision support.

Farmers keep records both voluntarily (for comparative and trend analysis of farm performance in production, marketing, and financial management) and because they are required to. In the United States, farmers are required to keep detailed records on pesticide use, employees, and taxable income, among others. The emerging nutrient accounting systems for livestock and crop farms in parts of Europe—notably the Netherlands (Breembroek *et al.*, 1996)—are analogous to financial accounting in the sense that they can be audited to insure that nutrient losses to water and air fall within legal bounds.

Decision support models are increasingly popular because farming is becoming more competitive and because data collection is becoming cheaper or mandatory. In the United States, the national association of soybean growers is supporting research to adapt a soybean crop growth model to use for in-season soybean management decisions such as when to irrigate or how much fertilizer to apply given growing conditions up to the present. Electronic sensors can now monitor yields of many crops at harvest, just as they can identify individual cows at milking time. Remote sensors can monitor crop conditions during the growing season from satellites or airplanes. So in addition to more traditional uses, farm-level decision support models are now being developed to make "real time" recommendations such as to administer variable fertilizer rates as applicators move across a farm field (Pierce & Sadler 1997). Other applications include recent work in managing animal nutrition and physiology to meet acceptable manure nutrient output levels while achieving farm profitability.

4.0 CONCLUSION

In this unit, you have been introduced to the fundamentals of simulation model in the agricultural sector and you have also been introduced to the fact that rapid changes in the field of agriculture with the use of model to implement and simulate real life scenario before carrying them out thereby improving the results.

5.0 SUMMARY

What you have learnt in this unit concerns:

- The meaning of simulation model in the agriculture which empowers farmers in the area of trickling down decision inputs from conventional sources by the use of computer aided application or series of software to simulate real life scenarios which experienced on the farm and thereby improving the result when it is eventually carried out.
- The significance of simulation model to the agricultural sector.

<u>Exercises</u>

1. Discuss the simulation model and its application in the agricultural sector

2. List and discuss 5 significance of simulation model to agriculture.

6.0 TUTOR MARKED ASSIGNMENT

- It your own words, explain the meaning and role of simulation model in the Nigerian agricultural sector.

7.0 FURTHER READING AND OTHER RESOURCES

IT Applications in Agriculture: Some Developments and Perspectives by Friedrich Kuhlmann
Institute of Agricultural and Food Systems Management
Justus-Liebig-University Giessen/Germany Senckenbergst., 3, D-35390 Giessen

Role of Information Technology in Agriculture and its scope in India by S.C. Mittal.

MODULE 3 – AGRICULTURAL SYSTEM

- UNIT 1 – DECISION SUPPORT SYSTEM IN AGRICULTURE
- UNIT 2 – AGRICULTURAL EXPERT SYSTEM
- UNIT 3 – DATABASE DEVELOPMENT AND MANAGEMENT IN THE AREA OF AGRICULTURE
- UNIT 4 – METHOD FOR DISSEMINATION OF INFORMATION IN AGRICULTURAL EXTENSION

MODULE 3

UNIT 1 DECISION SUPPORT SYSTEM IN AGRICULTURE

Table of Contents

1.0 INTRODUCTION

Having read through the course guide, you will have a general understanding of what this unit is about and how it fits into the course as a whole. It describes the agricultural decision support system.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the term modelling process
- Describe the types of system model
- Identify the challenges of modelling in agriculture

3.0 MAIN CONTENT

3.1 THE MEANING AND SCOPE OF DECISION SUPPORT SYSTEM

A Decision Support System (DSS) is a collection of integrated software applications and hardware that form the backbone of an organization's decision making process. Companies across all industries rely on decision support tools, techniques, and models to help them assess and resolve everyday business questions. The decision support system is data-driven, as the entire process feeds off of the collection and availability of data to analyze. Business Intelligence (BI) reporting tools, processes, and methodologies are key components to any decision support system and provide end users with rich reporting, monitoring, and data analysis.

Decision support systems are a class of computer-based information systems including knowledge based systems that support decision making activities. DSS is a computerized system for helping make decisions. A decision is a choice between alternatives based on estimates of the values of those alternatives. Supporting a decision means helping people working alone or in a group gathers intelligence, generate alternatives and make choices. Supporting the choice making process involves supporting the estimation, the evaluation and/or the comparison of alternatives. In practice, references to DSS are usually references to computer applications that perform such a supporting role. DSS are "interactive computer-based systems that help decision makers utilize data and models to solve unstructured problems"

High-level Decision Support System Requirements:

- Data collection from multiple sources (sales data, inventory data, supplier data, market research data. etc.)
- Data formatting and collation
- A suitable database location and format built for decision support -based reporting and analysis
- Robust tools and applications to report, monitor, and analyze the data

Decision support systems have become critical and ubiquitous across all types of business. In today's global marketplace, it is imperative that companies respond quickly to market changes.

Companies with comprehensive decision support systems have a significant competitive advantage.

3.2 HISTORY OF DECISION SUPPORT SYSTEM

According to Keen (1978), the concept of decision support has evolved from two main areas of research: The theoretical studies of organizational decision making done at the Carnegie Institute of Technology during the late 1950s and early 1960s, and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s. It is considered that the concept of DSS became an area of research of its own in the middle of the 1970s, before gaining in intensity during the 1980s. In the middle and late 1980s, executive information systems (EIS), group decision support systems (GDSS), and organizational decision support systems (ODSS) evolved from the single user and model-oriented DSS.

According to Sol (1987) the definition and scope of DSS has been migrating over the years. In the 1970s DSS was described as "a computer based system to aid decision making". Late 1970s the DSS movement started focusing on "interactive computer-based systems which help decision-makers utilize data bases and models to solve ill-structured problems". In the 1980s DSS should provide systems "using suitable and available technology to improve effectiveness of managerial and professional activities", and end 1980s DSS faced a new challenge towards the design of intelligent workstations.

In 1987 Texas Instruments completed development of the Gate Assignment Display System (GADS) for United Airlines. This decision support system is credited with significantly reducing travel delays by aiding the management of ground operations at various airports, beginning with O’ Hare international Airport in Chicago and Stapleton Airport in Denver Colorado.

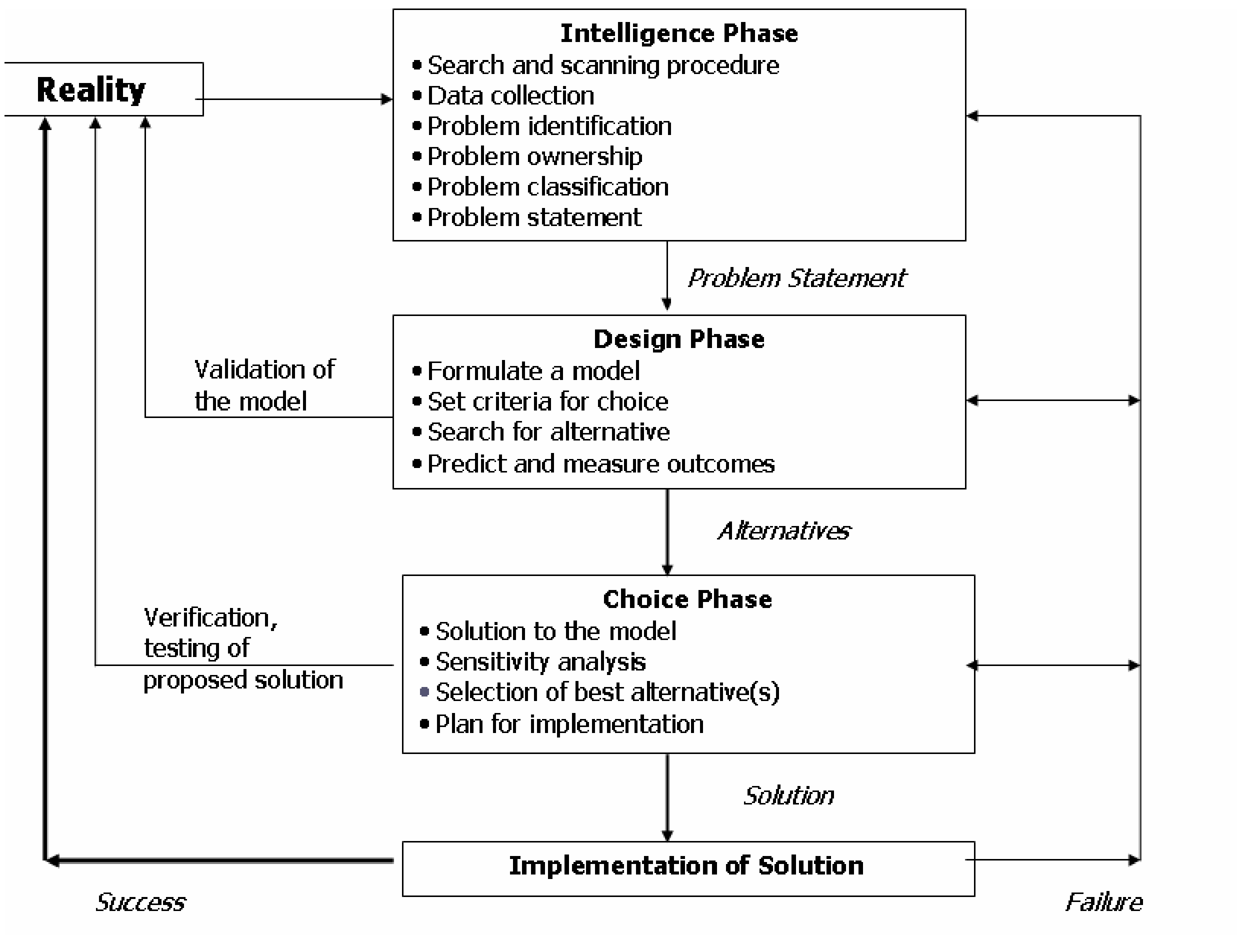
Beginning in about 1990, data warehousing and on-line analytical processing (OLAP) began broadening the realm of DSS. As the turn of the millennium approached, new Web-based analytical applications were introduced.

The advent of better and better reporting technologies has seen DSS start to emerge as a critical component of management design. Examples of this can be seen in the intense amount of discussion of DSS in the education environment.

DSS also have a weak connection to the user interface paradigm of hypertext. Both the University of Vermont PROMIS system (for medical decision making) and the Carnegie Mellon ZOG/KMS system (for military and business decision making) were decision support systems which also were major breakthroughs in user interface research. Furthermore, although hypertext researchers have generally been concerned with information overload, certain researchers, notably Douglas Engelbart, have been focused on decision makers in particular.

3.4 PHASES AND APPLICATION OF DECISION SUPPORT SYSTEM

The decision process may be divided into three phases: intelligence, choice and design as shown in the figure below.



The additional advantages that will accrue are:

- Low cost of operation.
- Quick access to all relevant information.
- Direct and personalized.
- Integrated.

The platform for the farmers to make the use of internet technology to take farm management decisions. The farmers can access online interactive and flexible information for their farm management.

Fig. 1 Phases of decision support system

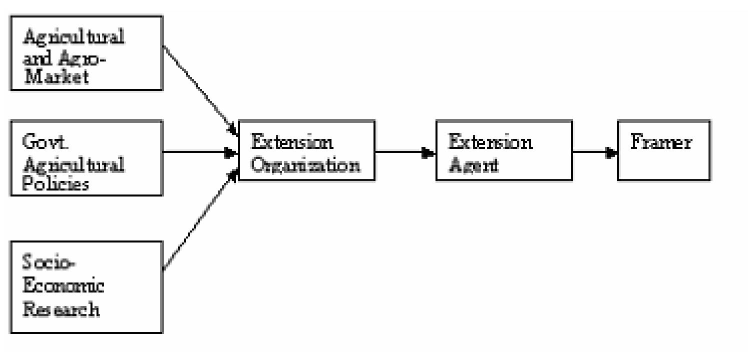


Fig. 2 Proposed Flow System

The proposed flow system for farm management is shown in Fig. 2. The farmers will be able to access the necessary information regarding the various government policies for agriculture, the ongoing socio-economic research and the different benefits for the entrepreneur for investing in particular area of farm management. The Farmers can acquire this information from:

- Farmer's organizations
- Researchers
- Other Farmers
- Farm journals, radio, television, Government Departments and agencies.

The primary and the basic fundamental of any project involving the database is the collection of data and information. This project also requires the collection of information from various sources. The main source of the data is the service published by the state or centre Government.

The present model will help the farmers to take interactive, flexible and quick decisions. This will also help them in increasing their productivity by raising yield per hectare in food grain, thus leading to their economic growth. It will keep track of farmer's all type of information related to crops.

The additional advantages that will accrue are:

- Low cost of operation.
- Quick access to all relevant information.
- Direct and personalized.
- Integrated.

DSS with all the ready information, help the farmers in a very useful manner. The farmers can get all the information at just at click of the mouse, and they need not to travel to Agricultural Universities for that.

A. Sitemap

Sitemap gives us the complete description of how the control flows through the site. The main page that links to all the pages is called the Home Page. This page shows the introduction about the Farm Entrepreneur System, the objective of the system and the principles of activity.

B. Information Retrieval System

The main advantage of this model to the farmer is that they can retrieve the dynamic information for their farm management decisions. DSS Framework being an agent for the driving force behind the changes in highland resource uses, the farm or household is considered to be the center of this analysis. The decisions on agricultural land and water uses are made in response to resource endowments, economic conditions and socio-cultural norms of the household or communities.

C. Resource Management Unit

Farms or households are classified into different types, called resource management units or RMU.

D. Modeling at the Node Level

The term node is defined, conceptually, as ‘water balance unit’. Its implication depends much on the aspect from which a node is looked at. From hydrological view point, a node represents a village and a network of nodes. Hence each node has a physical domain, which has to conform to that of the village it represents. Within this physical domain exist other biophysical attributes such as soil type, climate type etc. These biophysical attributes constitute a process, which determines the amount of water that flows in and out of the node.

From a socio-economic viewpoint, the characteristics of farm households, alternative land use options and farmers’ priorities and constraints characterized by RMU types may differ from node to node. The different set of socio-economic conditions would influence the decisions on how they should manage their available resources to their optimal level of production [4].

From a modelling viewpoint, a node plays a major role in the whole Decision Support System. A node is the level at which all modelling Engines are activated and linked together.

The main outputs from modelling process, although initialized at farm or plot level, are reflecting interaction between human and resource availability at the node level.

E. Outputs and Implications

The simulation system provides the output on land and water allocation that can maximize gross margin to the communities and Farm Entrepreneur within the node by taking into account the biophysical and socio economic constraints specific to the area. The effects of a partial change in the land uses, prices, investment and other developments plans on farm gross margin, labor and capital requirements can be easily accessed and the results can be presented both at the non-aggregated RMU (household) level and the aggregated level (node or village).

The economic and environmental tradeoffs of various plans can be determined for improving welfare. Since water is basically a very important shared resource with lack of true ownership, the Decision Support System, can aid assessing management options to help resolving or avoiding land and water use conflicts. Although the output is quantitative in its nature, this DSS is aiming towards providing the trend of resource use options rather than quantifying the amount of resources being used. The workflow overview of the DSS is shown in Fig. 3.

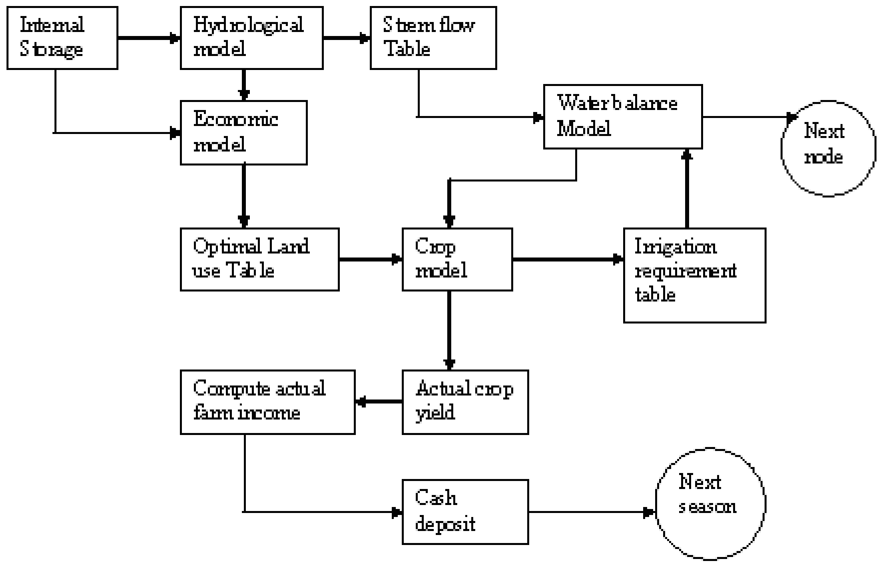


Fig. 3 Workflow of DSS

With growing population and demands for improved watershed management, there is an obvious need to implement sustainable resource use that best serves the communities and the nation. To satisfy this need, the DSS is developed to aid decision – makers and various stakeholders in identifying and assessing options for resource uses. The DSS applies an integrative approach, combining biophysical data, perceptions and socioeconomic conditions of the farmers in the given area.

The DSS attempts to stimulate the farmer's behavior in selecting farming systems given relevant constraints and then aggregating up to the node.

A large number of database queries can be generated according to Crop, Water Availability and Requirement, Socio-economic constraints and so on. Design and Development of this database is purely based on Relation Database Management System Model, so the large volume of queries can be easily handled.

DSS with all the ready information help the farmers in a very useful manner. The farmers can get all the information at just at click of the mouse, and they need not to travel to Agricultural Universities for that.

4.0 CONCLUSION

In this unit, you have been introduced to the fundamental concepts of Decision Support System. It functionality and impact on the agricultural sector is of great importance, if well harness could be a tool of inestimable value to the development of the agricultural sector.

5.0 SUMMARY

What you have gained in this unit entails

- The introduction of Agricultural Decision Support System
- The history account of decision support system in Agriculture.
- The methodology and application of decision support system in the area of agriculture.

6.0 TUTOR MARKED ASSIGNMENT

- Explain the concept of decision support system.
- Explain the word Expert system.

7.0 FURTHER READING AND RESOURCES

MODULE 3

UNIT 3 AGRICULTURAL EXPERT SYSTEM

Table of Contents

1.0 INTRODUCTION

Having read through the course guide, you will have a general understanding of what this unit is about and how it fits into the course as a whole. It describes the agricultural expert system.

2.0 OBJECTIVE

At the end of this unit, you should be able to:

- Explain the term Agricultural expert system
- The need of expert system
- Suitability and feasibility of expert system
- Explain the history of Agricultural expert system
- The methodologies and Application

3.0 MAIN CONTENT

Expert system can be defined as a tool for information generation from knowledge. Information is either found in various forms or generated from data and/or knowledge. Text, images, video, audio are forms of media on which information can be found, and the role of information technology is to invent, and devise tools to store and retrieve this information. When an expert in a specific area gives an advice to a less experienced person, he/she actual uses his/her knowledge and experience to generate this piece of information. This is a very precious piece of information because it is generated after long time of work and experience, and interaction with other experts and practitioners. Sometimes, this piece of information is not included in any form: text, audio, video, or other. Even if it is included, it is not linked with its scientific origin, especially if it is a combination of different domains, and methods. This piece of information gets more precious if it is the result of solving a problem which different specialists participate in its solution. In this case, it is rarely to find this piece of information in any text. Expert systems technology can play a very important role in generating information from knowledge.

3.1 THE NEED OF EXPERT SYSTEM

The need of expert systems for technical information transfer in agriculture can be identified by recognizing the problems in using the traditional system for technical information transfer, and by proving that expert systems can help to overcome the problems addressed, and are feasible to be developed.

3.1.1 Information Transfer Problems

Static Information: Examining the information stored and available in the agriculture domain revealed that this information is static and may not respond to the growers need. All extension documentations give general recommendations because there are many factors if taken into consideration; so many different recommendations should be included in the document.

Specialties Integration: Most of the extension documents handle problems related to certain specialty: plant pathology, entomology, nutrition, or any other specialty. In real situations the problem may be due to more than one cause, and may need the integration of the knowledge behind the information included in the different extension documents and books.

Information unavailability: Information may not be available in any form of media. It is only available from human experts, extensionists, and/or experienced growers. In addition, the information transfer from specialists & scientists to extensionist and farmers represents a bottle neck for the development of agriculture on the national level. The current era is witnessing a vast development in all fields of agriculture. Therefore there is a need to transfer the information of experts in certain domain to the general public of farmers, especially that the number of experts in new technologies is lesser than their demand.

Combination of more than one information source: Images may need sometimes an expert to combine other factors to reach an accurate diagnosis, and even if a diagnosis is reached, the treatment of the diagnosed disorder should be provided through extension document.

Updating: Changes in chemicals, their doses, and their effect on the environment should be considered. Updating this information in documents and distribute them takes long time. The same arguments can be made for audio tapes that are another form of extension documents but in voice instead of written words. Video tapes are more stable than other media as the information provided through the tape describes usually well established agricultural operations. However, if the tape includes information as what is commonly included in documents and audio tapes, this information should be updated.

3.2 SUITABILITY AND FEASIBILITY OF EXPERT SYSTEMS

The expert system generates the advice based on its knowledge base and its reasoning mechanism that are actually behind all developed extension documents, and more.

Consequently, when a user enters the data of his/her plantation to the system, the appropriate advice is generated. There are no limitations on the number of generated recommendations. Therefore expert system overcomes the problem of static information provided in extension documents.

The knowledge acquisition process for building an expert system facilitates the integration of knowledge and experiences of different specialties. For example, an agricultural diagnostic expert system requires the integration of specialists in nutrition, plant pathology, entomology, breading, and production. Therefore, when a problem occurs, the system can help the user in identifying the cause of the problem in a much more efficient way than consulting a document that handles a specific problem.

Expert systems can be integrated with other information sources such as images bases and/or textual bases to make use of these sources. For example, images can be used for describing symptoms as it is very difficult and very confusing to describe them in words.
Images can also be used for confirming the diagnosis of the cause of a certain disorder. Expert systems can also be integrated with textual data bases that may be the extension documents related to the specialty and/or commodity handled by an expert system. This textual data base can be used for explanation purposes of basic terms and operations. It can also be used to confirm the reached conclusion in some situations.

3.3 HISTORICAL ACCOUNT

Knowledge-based expert system technology has been applied to a variety of agricultural problems. Since the early eighties, the expert system applied to the problems of diagnosing Soybean diseases (Michalski et al., 1983) is one of the earliest expert systems developed in agriculture. A unique feature of the system is that it uses two types of decision rules:

1) The rules representing experts' diagnostic knowledge
2) The rules obtained through inductive learning from several hundred cases of disease.

POMME (Roach et al,, 1985) is an expert system for apple orchid management. POMME advises growers about when and what to spray on their apples to avoid infestations. The system also provides advice regarding treatment of winter injuries, drought control and multiple insect problems.

COMAX (Lemon, 1986) is a crop management expert system for cotton which can predict crop growth and yield in response to external weather variables, soil physical parameters, soil fertility, and pest damage. The expert system is integrated with a computer model, Gossym that simulates the growth of the cotton plant. This was the first integration of an expert system with simulation model for daily use in farm management.

In 1987 expert system technology was identified as an appropriate technology to speed up agricultural desert development in Egypt (Rafea and El-Beltagy, 1987). The paper has discussed the importance of applying expert systems in agricultural desert development in Egypt and suggested an integrated structure of an R&D unit to develop and maintain an efficient use of these systems.

CALEX system (Plant, 1989) has been developed for agriculture management. It is domain independent and can be used with any commodity. CALEX consists of three separate modules: an executive, a scheduler, and an expert system shell. The executive serves as the primary interface to the user, to models, and to the disk. The scheduler generates a sequence of management activities by repeatedly activating the expert system. The expert system makes the actual management decisions.

In the nineties, several expert systems have also been developed. An agroforestry expert system (UNU-AES) was designed to support land-use officials, research scientists, farmers, and other individuals interested in maximizing benefits gained from applying agroforestry management techniques in developing countries (Warkentin et al. 1990). UNU-AES is a first attempt to apply expert systems technology to agroforestry.

3.4 METHODOLOGIES AND APPLICATIONS

In this section, I am not intending to describe in details different expert systems methodologies as this should be covered in someplace else. I will try to analyze the examples given in the previous section from two aspects: the methodological aspect and the domain application aspect. The two main methodologies categories are first generation and second generation expert systems. The first generation expert system methodology is based on using commercial expert system shells after acquiring the knowledge through traditional knowledge acquisition techniques and using rapid prototyping method. The second generation expert systems methodology is mainly based on the principle of knowledge level which means developing a knowledge model at the human level problem solving approach, not at the computational level approach. The domain application aspect will be analyzed taking the agriculture area and the task type to classify the given application.

3.4.1 Methodological Aspects

Most of the expert systems developed in agriculture apply the first generation expert system methodology. Examples of this methodology can be found in (Warkentin et al. 1990), (Rafea et al., 1991) and (Mohan and Arumugam, 1995). The first two applications use EXSYS shell and a documentation of this methodology based on a modified Waterfall method is described in (Rafea et al. 1993). The third example application uses the CLIPS shell while the fourth example uses the VP-Expert shell.

Another approach that can be considered as an intermediate between the first and second generation expert systems is the usage of expert system shells in the implementation of a higher level of reasoning. An example of this approach can be found in (Gerevini et al., 1992). in this application the shell KEE is used but the system is explicitly divided into two parts. The first part is concerned with helping the user in classifying the findings, whereas the second part is an interactive abductive module that suggests explanation of those findings. Few applications have been developed following the second generation expert system approach. The two methodologies used are the KADS methodology and the generic task methodology. The KADS methodology was used for developing expert systems for cucumber and citrus management (Rafea et al., 1994) and (Rafea et al., 1995), where as the generic task methodology was used for developing expert system for wheat management (Schroeder et al., 1994) and (Schulthess et al., 1996).

3.4.2 Domain Application Aspects

The agriculture domain can be classified into sub-domains namely: plant production, animal production and management of natural resources related to the agricultural operations such as soil and water. I did find that expert systems have been applied in the three sub-domains.

However, I will concentrate here on the plant production part as most of the expert systems in agriculture have been developed in this sub-domain. Expert systems for field crops are implemented for: diagnosis of Soybean diseases (Michalski et al., 1983), crop management for cotton (Lemon, 1986) and (Plant, 1989) and weed identification for wheat (Schulthess et.al., 1996). Expert systems were also implemented for horticulture crops: apple orchid management (Roach et al,, 1985) and (Gerevini et al., 1992), cucumber production management (Rafea et al., 1995).

Agroforestry is another area in plant production where expert systems have been developed (Warkentin et al. 1990). Some other applications cannot be categorized commodity wise such as the expert system developed for selecting evapotranspiration estimation methods (Mohan and Arumugam, 1995).

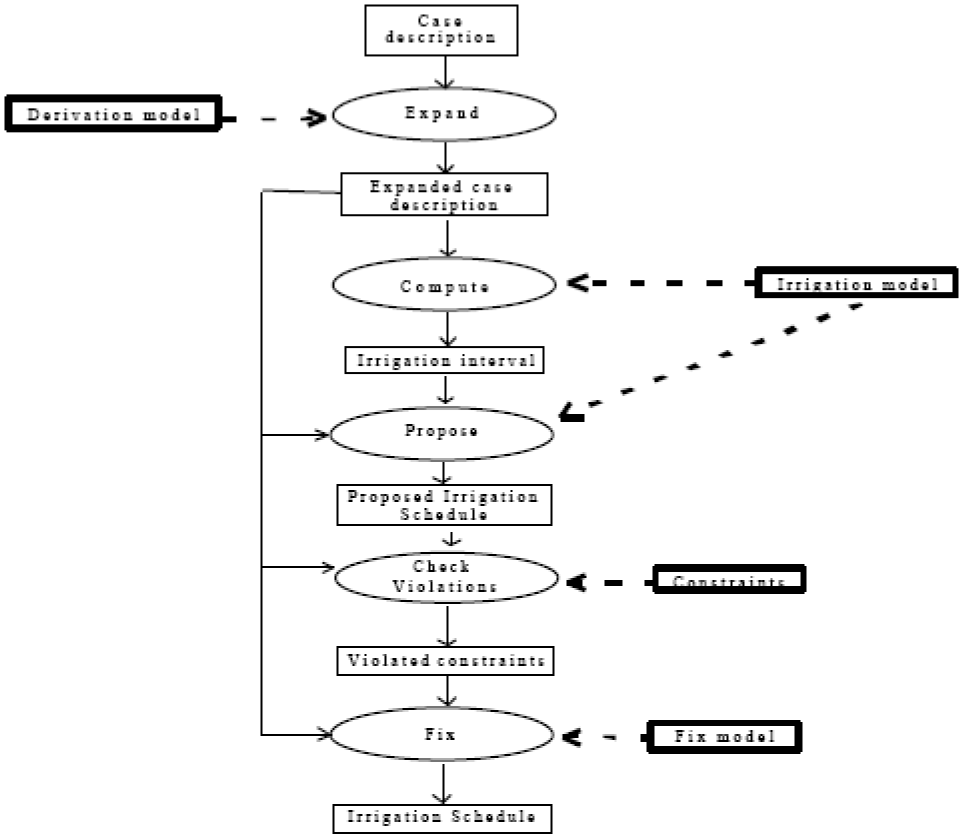
Another way for classifying agricultural expert systems is the domain specific task that this system performs such as: irrigation, fertilization, pest management, diagnosis of plant diseases, and others. There are mapping between the domain specific tasks and the generic tasks. For example irrigation application is mainly a special case of scheduling whereas diagnosis is a special case of classification.

3.3.3 A PROPOSED DOMAIN SPECIFIC METHODOLOGY

The methodology proposed here is based on our experience during the last 7 years in developing expert systems in agriculture. Generally we can classify agricultural operations into pre-cultivation operations and during cultivation operations. Pre-cultivation operations are interested in preparing the field for growing a particular crop. During cultivation operations can be further classified into diagnosis operations which concern finding a reasonable explanation for undesired phenomenon, and scheduling operations that include Irrigation, Fertilization, and Treatment operations. We will concentrate in this section on the scheduling in the agriculture domain as an example.

Our methodology is based on two principles that have emerged during the last decade of AI research:

Knowledge-level Modeling: Knowledge should be modelled on a higher level than that of exploited knowledge representation formalisms, to avoid premature design decisions and to facilitate communication with domain experts. Reusability of Task and Domain Knowledge: The second principle implies that the complexity of KBS development can be relieved by the construction of reusable components libraries, just as any other engineering activity



IRRIGATION INFERENCE STRUCTURE

The main goal of this task is to design an irrigation schedule for a particular crop in a particular farm. The output schedule is simply a plan of water quantities to be applied and the time of application, according to the requirements of the plant, and the affecting factors like soil type, climate, and source of water, etc.

Fig. 1 shows the constructed generic inference structure for the irrigation task. As illustrated in Fig.1, the irrigation task starts with acquiring case description: This includes parameters that affect the irrigation process, such as soil, water and climate data. The expand inference step uses these initial parameters to derive other parameters that are needed in the subsequent inference steps. The knowledge required for this inference step is the derivation model that can be represented as object hierarchies, rules, facts, and mathematical functions, according to the nature of knowledge. The compute inference step, calculates the irrigation interval using the input, and derived parameters. The knowledge required by this step are represented in the form of mathematical functions. The propose step, generates a preliminary irrigation schedule depending on a set of fixed mathematical functions regardless to any additional environmental constraints, which includes all circumstances that are not covered by the irrigation model. The check violation step evaluates the proposed irrigation schedule with regard to some environmental constraints - such as the existence of certain disorders in the farm- , and reports these violations to be fixed by the fix inference step, to produce the final and acceptable irrigation schedule.

4.0 CONCLUSION

In this unit, you have been introduced to the fundamental concepts of Agricultural Expert system you have also learnt the need of expert system.

5.0 SUMMARY

What you have gained in this unit entails

- The introduction of Agricultural expert system
- The need of expert system in the area of Agriculture
- The history account of expert system in Agriculture.
- The methodology and application of expert system in the area of agriculture.

6.0 TUTOR MARKED ASSIGNMENT

- Write short note on the need of expert system.
- Explain the word Expert system.

7.0 FURTHER READING AND RESOURCES

MODULE 3

UNIT 4 DATABASE DEVELOPMENT AND MANAGEMENT IN THE AREA OF AGRICULTURE

Table of Contents

1.0 INTRODUCTION

The development of agricultural science and technology database can be divided into three stages.

a) The period from the late 1970s to the mid 1980s. During this period, experts began to explore database technology and to build agricultural science and technology databases in Chinese language. The introduction of foreign agricultural science and technology databases also started from this stage.

b) The period from the mid 1980s to the mid 1990s. Up to now, more than half million records have been included in this database.

c) The stage from the mid 1990s and onwards. With the rapid development of the Internet, the penetration of computers and the diffusion of information technologies, the construction of agricultural science and technology databases is developing towards network-based orientations.

2.0 OBJECTIVES

By the end of this unit, you should be able to:

- Explain the term database development the area of agriculture
- Database development and management in the area of agriculture
- Explain the trends and experienced for database development and management in agriculture and uses of database
- Give suggestion and recommendation in promoting management in agriculture and database development

3.0 MAIN CONTENT

3.1 DATABASE DEVELOPMENT IN THE AREA OF AGRICULTURE

A database model is a theory or specification describing how a database is structured and used. Several models have been suggested which comprises of common model such as:

- hierarchical model
- relational model
- entity-relational model
- object-relational model
- object model

A data model is not just a way of structuring data: it also defines a set of operation that can be performed on the data. Example the relational model, it defines operation such as select, project and join. Although these operation may not be explicit in a particular query language, but they provide the foundation on which a query language is built.

3.2 THE CONSTRUCTION OF DATABASE DEVELOPMENT AND MANAGEMENT IN THE AREA OF AGRICULTURE

Selecting a proper construction model is the prerequisite for the success of any database development.

Through extensive review, four models are identified.

a) Non-profit co-op construction model. In this model, funds for database construction come from government grants, data are provided by several organizations, and one of them is responsible for the integration of these data into database system. The resulting database can be freely accessed by the public;

b) Centralized construction model. In this model, all the task of constructing a database is undertaken by one organization having enough information resource, funds and manpower;

c) Market operation model. In this model, key operations in database construction, such as topic or subject material selection and indexing, are under the control of the organizer, activities such as data input and products development are outsourced to reduce the costs. Databases produced this way are treated as commercial products, and users need to pay for the use of such databases;

d) Market co-op model. This model requires co-operation among database producers, and they agree to put their databases into a common system to increase the market share that may not be achieved by their own. In the process of constructing agricultural science and technology databases, the four above mentioned models may be selected at the same time.

Information technology develops rapidly today, and so attention must be paid in this respect when considering database construction. The following points are identified as the major technical areas for selection when planning agricultural science and technology databases.

a) Technologies for full text databases;

b) Technologies for constructing and managing distributed databases;

c) Multimedia technologies for developing multimedia databases;

e) Data warehousing and data mining technologies;

f) Knowledge base and intelligent database system

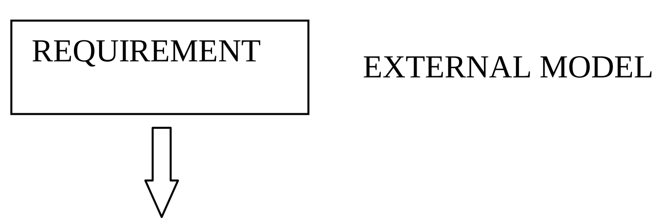
g) Technologies for developing Web-based databases for more efficient dissemination of agricultural science and technology information over the Internet.

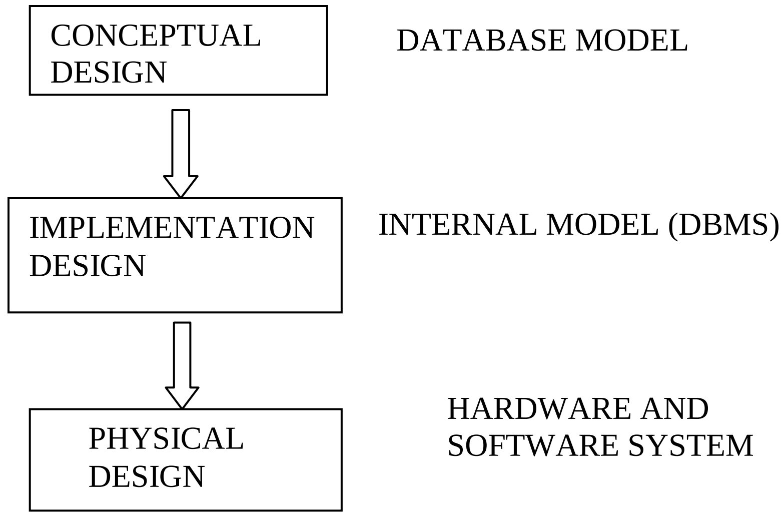
The overall arrangement for the further development of agricultural science and technology database should take the following three aspects into consideration: reference level, full text level and subject matter level. The reference level refers to such databases as bibliographic database, abstract database, etc.

They provide users with the clues to the source information but not the source information itself. Planning and construction of databases at this level should be continually maintained. Full text level includes databases containing the full papers or articles from agricultural scientific journals, books, reports, and so on. They provide the source information to users. At the subject matter level, database includes the following types of data: data from scientific experiments, observation, measurements, etc. Construction of the reference and full text databases is usually done by agricultural libraries and information institutions, while for the construction of subject matter databases, relevant subject research institutes are involved.

For the media carrying the database, a variety of media should be considered including hard disks, CD-ROMs and so on, with the aim of developing the databases accessible over the network. For the types of agricultural science and technology databases to be built in the future, factual, numerical and multimedia type databases should be strengthened in addition to the traditional bibliographic database.

The agricultural science and technology databases series can also be designed according to the activities for which the databases will serve: research management, basic research, applied research and agricultural extension activities. For the databases for research management, the following information should be included: research institutions, personnel and research funds; policy and regulations; current projects and research achievements; and dynamic news. For the databases serving basic and applied research, each subject should be taken as the basic unit and the knowledge related to it should be fully collected. Databases for extension mainly contain data and information on practical techniques and skills.





REQUIREMENT: Identify user's needs (present and future) for data. It also describes data that are needed by the organization, later it proceeds by translating there user requirement **into** a conceptual design.

CONCEPTUAL DESIGN: It is used to synthesis the various users. It views information requirements into a global database design. The conceptual data model describes entities, attributes and relations. It is an information structure of data.

IMPLEMENTATION DESIGN: This is used to map the conceptual data model into a logical scheme that can be processed by a particular DBMS.

PHYSICAL DESIGN: This consists of hardware and software operating system. It concerns with database security, integrity, backup, recovery, storage format, selecting access methods, record blocking. The resulting design must satisfy user needs in terms of completeness, integrity, performance, constraint and other factor.

3.2.1 ELEMENTS OF DATA MODEL

EXISTENCE DEPENDENCE: This is a situation in which an instance of one entity cannot exist without the existence of some other entity e.g. A livestock farm cannot exist without animals.

TIME: The contents of database may or may not be allowed to vary over time. Each data value can be time –stamped or tagged to indicate the data the value was entered (transaction time) becomes valid or stops being valid.

UNIQUENESS: The uniqueness restriction that is mostly encountered in data models is a primary key. The value of a primary key distinguishes an instance of one entity from other instance of that entity.

GENERATION: It defines super type/ sub type relationship. A specific entity may not have the same meaning to all people in the organization.

AGGREGATION: An aggregation is a collection of entities of a given type. The entities that constitute an aggregate are called its constituents and form a subset of the members of the class underlying the aggregation.

3.2.2 DATA MODELS

Organization of the data is represented by a data model. Data model is an intellectual tool used to understand a logical organization of data. A data model is a pattern according to which data are logically organized.

Data models consist of named logical units of data and express the relationships among the data as determined by the interpretation of the model of the world.

Within a model of the world, similar things are usually grouped into classes of objects called objects types. An example of an object type is the classes of object called houses. An object type is described by listing its characteristics such as address, color, style, and price. It is possible for an object to be characteristics of another object type. For example, address is an object type whose characteristics include street, number and street name. Style characteristics of houses have instances such as ranch house, bungalow, and duplex.

A set of characteristics that uniquely identifies a object within its object type is referred to as key. For example, if the address of a house can be used to identify each house uniquely, then the address characteristics is a key of the object type houses.

For example, it is necessary to decide whether an object type will exist independently or only as a characteristics of another object type. Object types that have an independent existence and can be meaningfully considered by themselves are interpreted as sets of entities or entity sets.

For example, the object type house is an entity set. An entity set is meaningfully described in terms of its attributes.

For example, the entity set houses is described by attributes such as address, color and style.

Object type=house

Its characteristics are address, color, sue, style, price.

Key = address

Object type that has its characters as characteristics (address with characteristics number, name).

Objects can be categorized into tangible e.g. persons, cars and intangible e.g. observations, meetings, or desires. Thus, objects can be categorized into classes according to their common properties.

The database is perceived by its user as set of facts about objects. These facts are of three types:

1. Facts stating that an object belongs to a category.
2. Facts stating that there is a relationship between objects.
3. Facts relating objects to date such as members, texts, images, dates, tabulated or analytical functions.

Database is a collection of values or objects. A description of data includes the meaning of data, how it is organized, how it is viewed, how it is accessed and how it is manipulated.it is like a dictionary in which you can search or sort from 1 to n in which you're inserting objects into container, locating objects in the container and you can also delete.

Methodology

Database db = new.........to create database

The variable db.insert (r_o)............we have to call a method to insert to the record. where r_o is the zero record.

Record r = db.locate (k_o)...........to locate in the database

db.delete (k_o)...........you can delete from the database

Database that contains data file

Database ⟶

Attribute ⟶

Private Record 〔 〕base

When you are inserting, its private methods

Insert (Record r)

Locate (key k)

Delete (key k)

You must get the key to access a record get key is to use the key to locate
Record

3.2.3 NULL VALUE, PROBABILISTIC DATABASE.

Uncertainty in Database

- Missing data
- Probability value
- Fuzzy queries – there could be the need to merge different sets of data to form a simple database. This is known as data fusion.

Missing data

- To address this problem of missing data, the use of null values has become necessary important.

Null values – Null values are required when an attribute in a row of a relation is missing.

e.g. the value exists but is unknown

The value does not exist.

Null values can be marked so that each missing item of data has symbol or value.

e.g. Suppose a farmer plants groundnut and yam; but the name of farmer is unknown.

Or

There is a farmer called bamidele, but it is unknown what he farms.

This can be represented by the following

farms (   )

farms (   )

farms (   )

Where

This constraint adds to the database the fact that the subject Bamidele's plant is not sweet potatoes.

A null employee may have been appointed but not assigned a task. A null value in the field for office could represent "not yet assigned". Eventually, the new employee will be assigned a task, as we this null value will be updated.

FOR EXAMPLE

If attribute n 1 missing in row number of relation r

THEN attribute n is null value v in row m of relation r*

Where r* is the completed relation r

V is null value, Existing but not known.

CLASSIFICATION

Simple-objects: have only single valued properties that are themselves object.

Composite-object: contain at least one property that is multi-valued but more that are themselves objects.

Compound Objects.

Association –objects: are independent objects that establish a relationship between other objects. They appear as objects properties of the objects they connect. They have keys and non object properties.

Aggregate-objects: are higher-level objects that represent entity group rather than instances.

Notice that in this interpretation of a model of the world, the object type address has been interpreted as characteristics of the object type house; it is therefore an attribute of the entity set houses. Address can also be interpreted as entity set. At any one time, an object can be interpreted as an independent object type or as characteristics of another object type, but not as both.

For each entity set, its attributes have certain values. For example, the color attributes has value such as red, green, and blue. The set of possible values of an attribute is called the domain of the attribute. It is possible for different attributes to share a single domain. For example, the attributes house size and lot number both assume values from the domain called non-negative integers.

A set of attributes that uniquely determine an instance of an entity is called a key. For instance, the attribute address is a key in the entity set houses i.e. given a value for address, a house is uniquely identified.

3.3 TRENDS AND EXPERIENCED FOR DATABASE DEVELOPMENT AND MANAGEMENT IN AGRICULTURE

Through systematic analysis and comparisons of the situations for database construction among countries around the world, several trends/experiences become apparent, and can be summarized as below:

a) Government support is very important to the development of scientific databases, and especially at the initial stage.

b) The proportion of on-line database, full text database and multimedia database has been on the rise, and the database subjects become more diverse.

c) The capacity of individual database continues to increase, new database service keeps emerging and many large-scale databases can now be accessed through the Internet.

d) Introduction and self-construction are combined as the database development strategy in many countries over the world.

e) Attention is given to explore the database market to fully realize its potential in the market. The above points can be used as reference when planning further development of agricultural science and technology databases.

3.3.1 Using the Databases

Several models for using agricultural science and technology databases can be identified. There are two models if considered whether money is needed for using the database, one is free use and the other is paid use. Databases for free use usually include reference or directory database such as bibliographic database. Databases that provide value-added service may charge the users for certain amount for the service, and those databases created by commercial companies may also need to pay for the use of the information from the databases. If considered from the environment in which the database is used, two models can be seen, one is network environment and the other is stand-alone environment. In the future, databases that can be accessed through the network should be encouraged.

3.4 SUGGESTIONS AND RECOMMENDATIONS FOR PROMOTING THE MANAGEMENT OF AGRICULTURE AND DATABASE DEVELOPMENT

Aimed at promoting the management of agricultural science and technology databases and on the basis of the experiences and lessons learned from other countries, suggestions and recommendations are given as follows:

1) Increasing government support for the continued construction of the databases.
2) Taking effective measures to promote the development of database industry.
3) Coordinating the activities among database construction organizations to avoid meaningless duplication of Efforts.
4) Establishing uniform planning for database development.
5) Improving the utilization rate and service efficiency of agricultural science and technology databases.
6) Promoting technical innovation for database development.
7) Adjusting the structure of existing database types.
8) Enlarging database capacity.

9) Coordinating the introduction of foreign databases
10) Enhancing the workforce for database construction and service.
11) Improving the legal protection to agricultural science and technology databases.
12) Strengthening policy advisory and service to the database construction.

4.0 CONCLUSIONS

The development of agricultural science and technology databases has been progressing rapidly in recent years, but there is still a long way to go as compared with internationally known agricultural databases. For the further development, government support continues to be one of the most important factors to achieve sustainable development of the databases.

5.0 SUMMARY

What you have learnt in this unit concerns

- The means of constructing database development and management in agriculture.
- The trends and experience for database development and management in agriculture.
- The suggestion and recommendation in promoting management and database development.

6.0 TUTOR MARKED ASSIGNMENT

- Write a short note on trends and experienced for database development and management in agriculture.
- Write briefly on data model.
- State 5 recommendation in promoting management and database development in the area of agriculture

7.0 FURTHER READING AND OTHER RESOURCES

Scientech Documentation and Information Center, Chinese Academy of Agricultural Sciences

MODULE 3

UNIT 5 METHOD OF DISSEMINATION OF INFORMATION IN AGRICULTURAL EXTENSION

Table of Contents

3.0 Main Content

3.1 The means of disseminating of information in Agricutural Extension

3.2 Roles of disseminating of information and technology

3.3 Challenges related to sharing,exchanging and disseminating knowledge and technologies

3.4 The use ICT in Agriculture

4.0 Conclusion

5.0 Summary

6.0 Tutor Marked Assignment

7.0 Further Reading and Other Resources

1.0 INTROCUCTION

If information is to be used and empowering, it must be disseminated in a manner that best facilitates its reception. However, information is delivered in a multitude of manners and the challenge is to determine which method is most appropriate to the audience attempting to be reached.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Means of disseminating information in Agricultural Extension
- The roles of disseminating of information and technology.
- The challenges in sharing, exchanging and dissemination methods based on Agricultural Extension.

3.0 MAIN CONTENT

3.1 MEANS OF DISSEMINATING INFORMATION IN AGRICULTURAL EXTENSION

The means of disseminating information in agricultural needs to pay adequate attention to because the communication gap lies not so in language or cultural differences as in the methods employed for the dissemination of agriculture information.

Various method, including field trips, guest speaker, group discussions, workshops, on-farm demonstration, small media (e.g. slide set, brochure, leaflet, flip cards, audio-visuals materials ,mass media(e.g. T.V, radio, newspaper, comic book, magazines, cinema), Traditional media(e.g. drama, traditional forms of theatre, songs and dance, puppet shows, story-telling, printed matter, and interactive telecommunications have been advocated by extension practitioners for information dissemination in agriculture

3.1.1 Person-to-person or group discussions

This involves direct, face-to-face contact and allows questions and answers and clarification of meaning. It helps to ensure mutual understanding. Interpersonal communication includes conversation between friends or family, and discussions with health professionals, community health workers, religious and community leaders, traditional health practitioners, women's and youth organisations, school teachers, trade union leaders, development workers, government officials, parents and children, including child-to-child communication.

3.1.2 Traditional media

Traditional media are performance arts that are used to illustrate and convey information in an entertaining way. Live performances can provide special opportunities for interaction between performers and audience. They include drama, traditional forms of theatre, puppet shows, street theatre, storytelling, songs and dance. Traditional media are often artistic methods of communication passed down from generation to generation.

3.1.3 Small media

The small media are often tools used to support larger communication initiatives or to illustrate interpersonal communication. They include posters, cassettes, leaflets, brochures, slide sets, video, flipcharts, flash cards, T-shirts, badges and loudspeakers.

3.1.4 Mass media

The mass media provide indirect, one-way communication and include community, national and international radio and television as well as newspapers, magazines, comic books, cinema or other situations where a large number of people can be reached with information without personal contact.

Pros and cons of means of public information dissemination

Here are some guidelines on the pros and cons of media typically used for public information dissemination.

Mass media

Accessing the mass media is discussed in greater detail below, but here are a few basic principles on using the different components of the mass media.

Broadcasting

If you're going to use radio or TV to disseminate information, remember these general rules:

Keep it short and concise — don't confuse your audience with too much information; Use simple, straightforward language;

- Offer specific, practical advice;
- Organize the information clearly and logically; and
- Repeat the information.

If resources are limited, bear in mind it is much more likely that people will hear a few short spots rather than one 30- or 60-minute discussion programme on important information. You may be able to get airtime for free; if not, consider providing equipment for a local radio or TV station to build their capacity.

There are many possible formats for radio/TV programming for disseminating information. Here are just a few:

Spots: 30 seconds to 2 minutes

Use a dialogue or interview to carry one simple message, tightly packed with a music jingle. Have the announcer reinforce the message at the end.

Mini-dramas: 1 minute to 3 minutes

Have one main message and one secondary one in a scripted sketch for two or three characters. Be entertaining and don't include too much information.

Interviews: 2 to 5minutes

Be clear about the messages you want to convey — there should be a maximum of two or three key messages and the journalist should repeat them at the end.

If you are to be interviewed on TV:

- Look at the camera or interviewer.

- Keep still: don’t wobble about.
- Don’t joke.
- Don’t wear checked clothes, prefer blue shirts.
- Make a 3, 4 or 5-point list of what you want to get over. And make sure you do.

Soap opera: Topical health and social issues can be inserted into soap operas, which can have very wide appeal. Your job is not to write the script but to brief the scriptwriters about the issues and the type of behaviour your programme wishes to promote.

Radio: Radio is not a forgotten medium when it comes to disseminating information, because it reaches a wider audience than any other medium: there are an estimated 94 radios per 1,000 people in the least developed countries — 10 times the number of televisions or copies of daily newspapers available. Communities, some of which are remote, make sure you fully check radio’s reach. Radio builds on oral traditions and programmes are cheap, quick and easy to make. Radio listening is often a group activity, which encourages discussion of educational issues after the broadcast. This is an important stage in the process of behaviour change.

On the other hand, radio is not usually appropriate for teaching practical skills, nor is it appropriate in some cultures for sensitive messages. Some information needs to be discussed and demonstrated. And some more sensitive issues might be best communicated using traditional media. To a large extent, this is a matter of common sense.

But information that is given by visiting expert, lecturers, professors, teachers in the universities, agricultural base industries or in community workshops should be regularly reinforced by local radio, television or other media.

Newspapers/magazines: Newspapers tend to reach more educated, elitist audiences in many developing countries. This may not seem the quickest way, compared with radio or TV, to reach a mass audience. But newspapers and magazines do have the advantages of being more permanent, carrying more information and often being more authoritative than other media. Writing and issuing a straightforward press release remains the most effective and economic tool for mass communication. And the other branches of the mass media tend to feed on what they have read in the press. Newspapers and magazines can also be used to reach key groups for example, by carrying materials which lecturers can use in their lecture hall, or suggestions for discussions by development workers in the field. And don’t forget to look for specialised publications that may easily reach your key audiences, the farmers, educators, government officials, doctors and nurses, military.

The Internet: We should also recognise the Internet as a valuable medium of disseminating information, both for reaching people by email and for broader casting of information from a website. Again, the basic rules of good communication apply be brief, be clear, don't get too complicated, and keep it up to date. A good communication programme will exploit this, not only for your target audiences but also for ongoing education of programme staff and your partner organisations.

"Small media"

The strengths of small media are that they provide accurate, standardized information in a handy and re-usable form that can be used as visual aids in workshops, discussions and teaching. They attract attention and may be distributed to areas where the mass media do not reach. Most commonly, however, small media are used in isolation from other information activities and as a result have little meaning or impact with target audiences. Posters may look good, but you need to be aware that it is the least effective medium of communication for development, particularly among the poor and those who have limited literacy skills. Research clearly shows that posters, brochures and flipcharts have limited use and are seldom cost-effective durable. They are expensive to produce and to distribute, have a short lifespan, and training is necessary for effective design and production. Training is also usually needed in how to use them effectively. Although experience shows that the bulk of small media production remains store rooms and is never distributed, managers are often seduced by the "ease" production and the possibility to control ("plan") the communication. Too often they are used to illustrate that the programme is "doing something".

If you must use them, posters, brochures and flipcharts must have a specific purpose and be carefully integrated into communication activities. They may be designed to support a key message and to provide an ongoing reminder of that message. Or they may be designed to promote easier understanding of messages during interpersonal communication.

As the cost of developing flipcharts and other visual aids can be high, there is tendency to develop a prototype that is used for a number of ethnic groups and situations. These need to be adapted to local situations if they are to be effective.

3.2 ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY

The emergence of Information and Communication Technologies (ICT) in the last decade has opened new avenues in knowledge management that could play important roles in meeting the prevailing challenges related to sharing, exchanging and disseminating knowledge and technologies. ICT allows capitalizing to a greater extent on the wealth of information and knowledge available for Agriculture Knowledge, Science and Technology (AKST). The ultimate objectives of AKST activities are to come up with results that can advance research more in certain areas, and engender technologies that AKST stakeholders can use to increase production, conserve the environment, etc. The following paragraphs will discuss the knowledge management challenges, explain how ICT could play a role in addressing them, and highlight an example of an institution in the Nigeria Agriculture Research Center whose main function is to conduct applied research in ICT in Agriculture.

3.3 Challenges related to sharing, exchanging and disseminating knowledge and technologies

The first challenge is the poor mechanisms and infrastructure for *sharing and exchanging* agriculture knowledge generated from research at national and regional levels. Many research activities are repeated due to the lack of such mechanisms and infrastructure at the national level. Researchers can find research papers published in international journals and conferences more easily than finding research papers published nationally in local journals, conferences, theses and technical reports. The second challenge is the inefficient mechanisms and infrastructure for transferring technologies produced as the result of research to growers either directly or through intermediaries (extension subsystem). Knowledge and technologies fostering agricultural production and environment conservation are examples. Although many extension documents are produced by national agriculture research and extension systems to inform growers about the latest recommendations concerning different agricultural practices, these documents are not disseminated, updated or managed to respond to the needs of extension workers, advisers and farmers. This is also true for technical reports, books and research papers related to production. The third challenge is keeping the indigenous knowledge as a heritage for new generations. It is available through experienced growers and specialists in different commodities. These inherited agricultural practices are rarely documented, but they embody a wealth of knowledge that researchers need to examine thoroughly. The forth challenge is easily accessing and availing economic and social knowledge to different stakeholders at operational, management and decision-making levels, so that those responsible will be able to make appropriate decisions regarding the profit making of certain technologies and their effect on resource-poor farmers.

3.4 Using ICT in Agriculture

Ministry of Agriculture and land reclamation recognized expert systems as an appropriate technology for speeding development in the agricultural sector. To realize this technology, in 1989, the ministry initiated the Expert Systems for Improved Crop Management Project (ESICM) in conjunction with the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP). The project began in mid-1989 and the Central Laboratory for Agricultural Expert Systems (CLAES) joined the Agricultural Research Center (ARC) in 1991. Through the development, implementation and evaluation of knowledge-based decision support systems, to optimize the use of resources and maximize food production. A dozen expert systems have been developed for horticulture and field crop management. In 2000, the Virtual Extension and Research Communication Network (VERCON) project was funded by the FAO Technical Cooperation Program (TCP) to develop a Web-based information system to strengthen the link between research and extension (CLAES, 2002; FAO, 2003). This network has been extended to include other stakeholders, and other services through a project funded by Italian Debt Swap Program and executed by FAO in collaboration with CLAES (CLAES, 2008). Several expert systems have been made available on this network in addition to other modules. In collaboration with ICARDA, CLAES has developed three regional expert systems for wheat (CLAES, 2006c), faba (CLAES, 2006d) and barley (ICARDA, 2006). CLAES also developed the National Agricultural Research Management Information System (NARIMS) through a project funded by FAO/TCP. This system has five modules: Institutes Information System, Researchers Information Systems, Projects Information Systems, Publication Information System, and National Research Program Information System (CLAES, 2007).

4.0 CONCLUSION

In this unit,to we have discuss the means of disseminate information in the area of agriculture.

5.0 SUMMARY

What you have learnt in this unit concerns

- The means of disseminating information in agricultural extension.
- The roles of information and communication in the area of agricultural extension
- The challenges related to sharing, exchanging and disseminating information in agricultural extension.
- The use of ICT in agriculture

6.0 TUTOR MARKED ASSIGNMENT

- Write a short note on challenges on sharing, exchanging and disseminating information in agricultural extension.
- List 5 means of disseminating information in agricultural extension

7.0 FURTHER READING AND OTHER RESOURCES

Wikipedia.org

CLAES. 2002. Egyptian implementation of the virtual extension and research communication network. Available at http://www.vercon.sci.eg . CLAES, Egypt.