NETWORKING AND BIOLOGICAL DATA ANALYSIS

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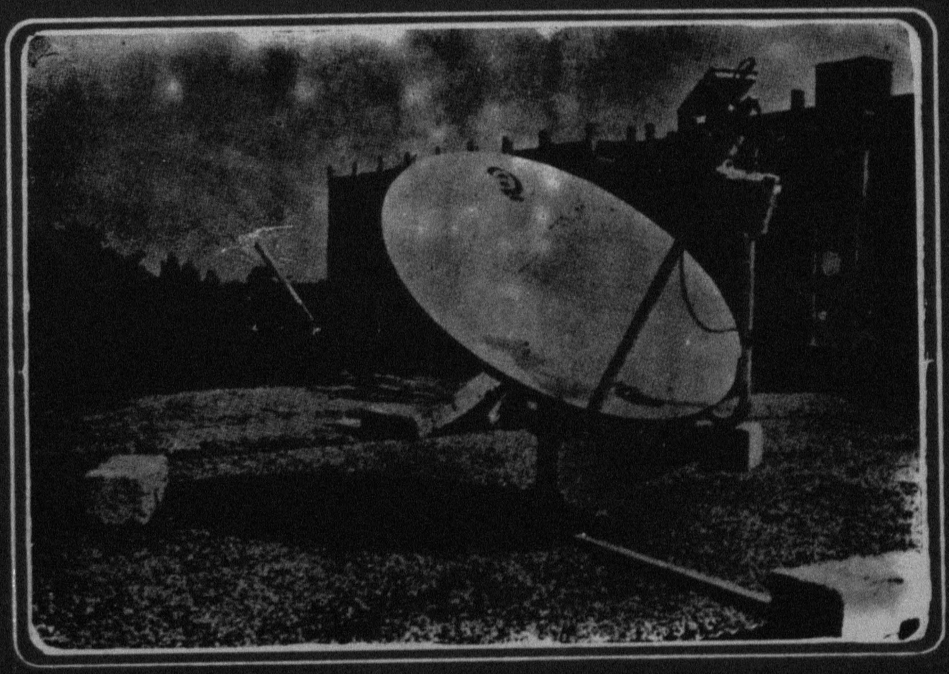
CENTRAL INSTITUTE OF FRESHWATER AQUACULTURE
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Workshop held during February 4-6, 1997



Central Institute of Freshwater Aquaculture
(Indian Council of Agricultural Research)
Kausalyaganga, Bhubaneswar 751002 (Orissa)

WORKSHOP

ON

NETWORKING

AND

BIOLOGICAL DATA ANALYSIS

(Sponsored by Department of Biotechnology)

February 4-6, 1997

Bioinformatics Centre
Central Institute of Freshwater Aquaculture
(Indian Council of Agricultural Research)
Kausalyaganga, Bhubaneswar 751002 (Orissa)

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Cover photo : VSAT installed at CIFA

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C O N T E N T S

E. AQUACULTURE

DATA ANALYSIS

G. COMPUTER GRAPHICS

LOCAL AREA NETWORKS

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INTRODUCTION

A large number of mainframe and minicomputers were installed and operated as stand alone system only a decade back. As the demands grew both in terms of volume and complexity, an increasing need for computing power was felt necessary. Then the concept of centralising to control of all EDP (Electronic Data Processing) operations and the end users to interact with systems slowly took some shape. The falling price and the increasing powerful micro computers with standardised hardware and software made this an extremely viable solution. These micro computers provided a user friendly menu driven environment where end users could interact directly with the computer.

With the increasing use of microcomputers, it was felt that although users were provided computation power at their desk, these could not suffice all their needs because applications often demanded exchange of data between several such users. The need for communication between these microcomputers to share the common resources was felt and local area networks (LAN) offered as a viable and attractive solution for solving these problems.

. LAN provides (i) total computing facility to each user (ii) communication facilities amongst several users (iii) access to mass storage systems, high speed printer and other service computers.

THE IMPORTANCE OF NETWORKING :

A computer network is a collection of computers and peripheral devices connected by communication links that allow the network components to work together. The network components may be located at many remote locations or within the same office. It serves five important purposes.

Each user/department/division/section shares the hardware facilities. High-speed laser printer is an unaffordable luxury which can be shared.

2. Files which are needed very often by different users, may be kept in the central computer and constantly updated to select latest information.

3. Each user of the electronic mail system has a "mailbox" located in the memory of his or her own computer. The electronic mail system distributes messages by storing them in the appropriate mail box which can be collected by respective user.

4. It allows for decentralisation of various data processing functions.

5. This allows for sharing of data and software for rapid communication among various network members.

TYPES OF NETWORKS

Value added networks :

This is established data communication network that owns or leases communication facility through computer. Microwave antenna and communication satellites are the facilities which are rented to many subscribers who link their equipment to the facilities. This type of network saves organisations the time and cost of designing and maintaining their own networks.

Communication networks :

Data and voice can be transmitted through this network. The telephone companies are the largest carriers but others who own transmission networks or purchase bulk service for resale in smaller segments.

Private networks :

Some networks are designed specifically by an individual organisation and used completely by them.

Local Area Networks :

Some networks may connect computers separated by hundreds of miles away but computers within a limited distance or one another, perhaps within the same building or within the same office when connected, the network is known as local area network. The cables connecting the computers and electronic components installed into the computers are used to talk each other over the cables.

Switched networks :

Switched networks are those in which a specific route is temporarily established for the duration of each individual transmission out of numerous transmission links. Such circuits provide direct connection which are interactive and permit twoway communication

Message-switching networks :

The transmission is intercepted at a switching point and stored in a computer. The message is transmitted to next switching point as soon as a link is available otherwise the message remains stored until the recipient established connection with the computer.

Packet-switching networks :

The computer at the switching centre breaks up the data it receives into groups of characters or packet. Each computerised switching centre is connected to atleast two similar centres. Once a packet is assembled, the computer system searches for the shortest available network path to the destination and inserts the packets in the first gap on that path. The data is diverted more on to the ultimate recipient, usually a user's computer or terminal.

WHAT IS A LOCAL AREA NETWORK ?

A personal computer works in standalone state with its own CPU (Central Processing Unit). To share the data stored on one or more personal computers, the organisations felt the need of multiuser environment to share the exepensive resources like printers and storage space etc. It provides modularity, connectivity, superior performance, security and reliability in its operation.

A local area network is a system of interlinking personal computers, sharing common resources like disks, printers etc. Processing on a local area network is performed at the individual workstation. Novell Netware is an example of a file server based network. In LANS, data transmission rate is above 10 megabits per second (Mbps) through bus speed. The typical communication rates per telephone modems are 300 or 1200 bps. 2400 modems are also becoming popular. When bits are moved between components within the computer, this typically travel at 10 Mbps.

FEATURE OF LOCAL AREA NETWORKS :

A LAN is characterised by the following a common communication medium over which all user devices can share information, programmes, and equipment without regard to the physical location of the user or the resource.

A high transmission rate intended to accommodate the needs of both people and equipment. The system normally is able to support transmission between workstation at the maximum speed at which these can accommodate.

Less than 10 miles or 16 kilometers is considered as limited geographic range in which LANs stand between to traditional computer networks.

Resource sharing :

LAN eliminates the possibility of overspending by allowing workstations to share peripherals like printers, plotters, digitisers, tape drives, and hard disks. This lowers the overall cost of data processing. Electronic mail system reduces the cost of documentation across departments and provides for efficient and flexible communication.

Productivity :-

As a productive tool, a LAN can :

- Enable wider distribution of information and technologies needed to deal with it
- Improve information retrieval, processing, storage and dissemination through a distributed database
- Minimise or even possibly eliminate redundant and repetitive tasks

- Provide graphic capabilities and other specified applications that are not cost effective on standalone micros.

Communication :

Communication is a major important area of activity in an organisation. Researchers constantly need information to write orders, type letters, memos, discuss projects, listen to latest developments etc. The services provided by a local area network are designed to expedite the communication among research workers. It provides inhouse, computer-to-computer communication at high speed without the cable required in a system of directly connected the machine. A method of accessing remote resources thereby facilitating communication with the world outside is possible through the system.

Management :

As a management tool, the LAN can increase the system performance through the distribution of tasks and equipments and improve the availability of computer resources i.e if one is occupied with different tasks, the second can perform the work. It increases the system reliability and minimises the adverse effects of loss of any one system. It helps to regain the administrative control of equipments especially the large number of microcomputers.

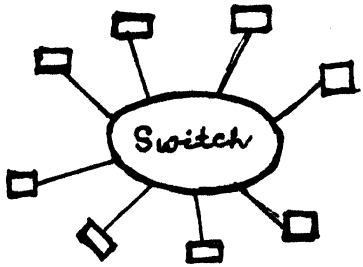
Network Topologies :

Topology or structure is the layout of the connections formed between computers. The reliability and efficiency of a network is determined by its structure. A single computer is designated as the control computer or server. The server directs traffic and maintains order in the network. There are different ways in which network can be connected. The ways in which network can be connected. The most commonly used topologies are.

a. Star
b. Ring
c. Bus

Star topology :-

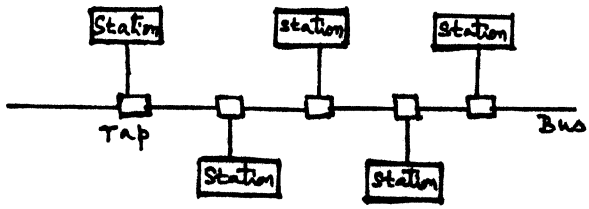
It has central controlling device and each node is directly connected to it. A star network has a server at its centre. All messages must go through the server. When a message is sent to another computer, it goes first to sever and server retransmits the message to its destination. Priority status can



be given to selected nodes. A central point can be developed for performing network maintenance and testing. Its major disadvantage is that the central device must be extremely reliable. Malfunctioning of this controlling device can bring the network down.

Bus topology :

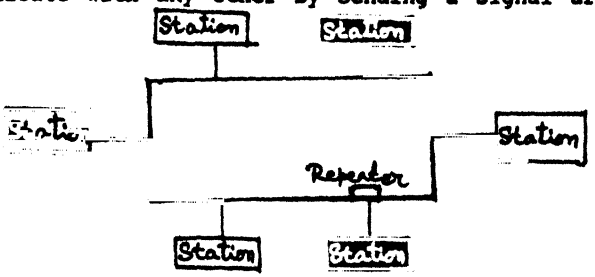
In a bus network, the computers are connected by a cable called bus. Messages are sent along the bus. The connected computers can bear the message and determine whether it is for them. In a bus network, the failure of a single computer does not affect the performance of the rest of the network. Computers may be easily added or removed from the network.



Decentralised control to access the transmission medium results in higher efficiency of the network. Its disadvantages are (i) taps used to control node to the trunk cable can cause signal interference (ii) segmenting the press for network maintenance is difficult.

Ring topology :

In a ring networks, the computers and peripheral devices are arranged so that communication links connect the components in a ring. In this structure, any computer can communicate with any other by sending a signal around the ring.



Each message is tagged with its destination. As the message proceeds around the ring, each computer determines whether it is recipient of the message. If not, the message is sent to the next computer. Ring networks are highly vulnerable. If a single computer fails, at least a portion of the network will not work. It is difficult to change its structure when it fails. Extensive rewiring must be done to maintain the ring structure when computers are added or removed.

COMPONENTS OF A LAN :-

There are five fundamental components in a LAN. These are (a) cables (b) Network interface cards (c) Network file server (d) work stations (e) Network operating system.

Cables : The computers in a network are physically connected by cables. The cables form the medium through which information pass from one computer to another. Three types of cables are used in LAN. They are (a) shielded twisted pair (b) coaxial (c) fibre optic.

Shielded twisted pair :

This type of cable consists of two copper conductors, each covered with insulation (usually PVC). These two wire twisted around one another and enclosed in an overall PVC jacket. This type of cable can carry signals at maximum speed of 10 Mbps. Shielded twisted pair cable offers the following advantages :

a) Low cost of cable leading to low cost of installation

b) Shielding increases immunity to outside interference signals

c) Easy to cut, strip and terminate and can fit easily into office furniture and cable paths, resulting in quicker installations. It suffers from the disadvantage of higher cable capacitance which reduces the data transfer speed.

Coaxial :

Coaxial cable consists of copper conductor surrounded by insulation which is in turn covered with table-shaped copper brand. The outer tube is also surrounded with PVC insulation. The outer copper tube and the inner conductor have the same axis of curvature, hence the term "coaxial". Coaxial cable have the ability to transfer low-frequency voltage levels particularly important for DC voltages encountered in Ethernet cabling. These cables can encountered in Ethernet cabling. These cables can transfer data at speeds upto 350 Mbps.

Coaxial cable has the following advantages :

a. Higher transmission speeds useful to Ethernet LANs..

b. High immunity to electrical interferences.

c. Supports baseband as well as broadband transmission.

d. Supports a higher band width than twisted pair.

Fibre optic :

Fibre-optic cable consists of a very fine fibre made of two types of glass, one for inner core, the other for the outer layer. The two glasses have different indexes for refraction.

A beam of light is carried through the glass fibre and is modulated by the network to shape the signal. Pulses of light rather than bursts of electricity, carry the signals. Since light beams transmit the signals, this cable is totally immune to electrical interferences. Since they can not carry DC signals, they can not be used for ethernet cabling. They can transmit signals at very high speeds, upto 1 trillion bits per second. The supporting hardware must have the capability to communicate with light signals rather than electrical signals.

Advantages offered by fibre optic are :

a. very high speed of transmission, useful for online systems.

b. Data can not be tapped from the cable and hence security is extremely high.

c. Totally immune to electrical interferences.

NETWORK INTERFACE CARDS :

The network interface card facilitates communication. It is plugged into one of the expansion slots of each of the workstations and the file server. The transmission cable is attached to the connector on the NIC.

Two parameters should be considered while selecting NIC

a. Access scheme.

b. Transmission speed.

Access scheme is the method by which the services on the network communicate to other devices through NIC. Different access schemes are token passing, polling and CSMA/CD. The data transmission rate refers to the maximum speed at which a unit of data (referred to as a packet) can travel on a clear length of network cable.

The commonly used Network Interface Cards are :

a) Arcnet b) Ethernet c) Tone Ring

Arcnet (Attached Resource Computer Network) cards offer speeds as high as 25 Mbps. Ethernet cards can transmit data at 10 Mbps. IBM's Tone Ring Cards are used for large Lans.

File Server : - The File Server is a powerful PC which control and manage the Network resources. It normally performs the following Network management functions.

a. Control of the traffic of requests and messages

b. Security requirements

c. Centralised/shared hard disk storage

d. Control of peripherals like printers etc.

In a LAN, processing takes place at the individual PC workstation, but network and peripheral management functions are centralised and extended at the server.

The performance of a file server depends on

a) the power of the processor used

b) the type and capability of Hard Disk Storage used. Both higher speed and capacity hard disk is performed.

c) More RAM means faster processing at server, as network operating system uses RAM to store the location of files and directories present on the hard disk.

WORKSTATIONS :

The workstations are the nodal computers on which users do their works. These can be developed through diskless PCs to any higher end PCs. The user uses the workstation to 1) execute their own application programs locally 2) send a request to the file server for any of the Network functions and receive the response from the file server.

NETWORK OPERATING SYSTEM :

The Network Operating System (NOS) consists of two distinct positions. The first portion is loaded on to the memory of the workstation and resides as a shell above the workstations own operating system. The "shell" intercepts all request from the workstation and determines whether it is a Network request or not. The shell directs local commands to the workstations own operating system and redirects Network commands to the File Server for execution.

NOS resides in the File Server and it governs the following critical areas :

a. Commands and utilities required to enable users to share the networks resources like the Hard Disk or network Printer.

b. Security manages functions for network access control

c. Safeguarding the data on the hard disk through processes which make the system fault tolerant.

The popular Network Operating Systems in use are Netware Series from Novell, IBM's, PCLan, etc. But for an overall performance in the LAN area, Novell Netware has become the most popular networking operating system.

FACTS AND FIGURES OF INTERNET

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INTRODUCTION

In the simplest form Internet is the network of networks. Internet (knownm as Net) is the world's largest computer network. A computer network is generally a bunch of computers hooked together somehow for exchanging information freely. It is a new communication technology that is affecting our lives on a scale as significant as the telephone and television. It's capabilities are very expensive. It is a worldwide computer network connecting nearly 5 million computers around the world. It offers various devices to its users. There is no censorship. Probably that is one of the reasons of its popularity, growing exponentially. Someone commented that Internet is giving shape to a global university in a global village.

HISTORY OF INTERNET :

ARPANET (ARPA - Advanced Research Project Administration of Dept. of Defence, USA initiated in 1969) is the real ancestor of internet. The purpose of ARPENET was networking and linking DOD and military research contracts including large number of universities doing military funded research. The ARPANET initially started connecting three computers in California but quickly spread to cover the continent. With 3 computers and few hundred users just over 25 years ago, the internet now links over 25 million users on 5 million computers in more than 150 countries. From ARPANET came NSFNET (National Science Foundation). NSFNET worked like wonder. By 1990, most of business had moved from the ARPANET to the NSFNET resulting in the shut down of ARPANET. Ultimately NSFNET became so entranched in the internet that it lived on without its original purpose. By 1994, several large, commercial internet networks had grown up within the internet when NSFNET had been wound up with its traffic taken over by commercial networks (IMB, sprint etc.) The term Internet first appeared in 1982 when DARPA"s (Defence Advanced Research Projects Agency, the funding agency for the original ARPANET, the precurser of today's internet) launched the Internet Protocol (IP).

COMPUTER NETOWRK

Computer networking refers to a method is which the computer systems are connected together is such a way that they can excahnge information among themselves. They can be connected by wires, phone lines, sattelite links or any combination of these. Each computer network has a host computer, known as server, which controls the complete network. If networking is done in the same building or in small area, it is known as Local Area Network (LAN), if the computers are spread over the metropolitan Area then it is known as Metropolitan Area Network (MAN). When the computers are spread over larger area, the network is called Wide Area Network (WAN). Networking is done for sharing resources like printers, hard disc drive and software. If one on the network updates data, it is instantly available to every one. Brief description of some Indian Networks in operation are presented below.

EXISTING INDIAN NETWORKS

NICNET : National Informatics Centre (NIC) was set up in 1975. Host computer alongwith mother earth station is located at Delhi. The network has terminals at state capitals and district headquarters. NIC provides services to user departments through a number of application division organised around sectors like finance, agriculture, water, human resource, industry, commerce, etc.

ERNET : The dpet. of electronics, Government of India, along with with severn other institutes set up a project entitled "Education and Research in Computer Networking " (ERNET) in 1986 for establishing communication facilities. The project aimed at setting up of LAN in the institute campuses and interconnecting them through a satellite link to form a WAN.

INDONET : It makes use of reliable, dedicated data channels giving electronic links for instantneous communication and data transfer. It provides access to international data network and databases to the user through the Gateway Packet Switching System of VSNL (Videsh Sanchar Nigam Ltd).

METNET : METNET is termed to be the world's most comprehensive information network as observed by the World Meteorological Organisation (WMO) from its headquarters, Geneva. Global Telecommunication System (GTS) to which India is linked from New Delhi covers some countries and spreads across, worldwide.

PRESS NETWORK : Now newspapers are going in for their own network to connect their H.Q. with regional offices. Many computers have been networked with few servers installed in big cities form uninterrupted online transmission of news.

OILCOMNET : It is a communication network to serve the oil industry. Oil co-ordination committee (OCC) was set up in 1986 to develop this network.

SIRNET : The Scientific and Industrial Research Network (SIRNET) is created to provide data communication facilities to all CSIR laboratories. It is based on indigenous software and hardware.

AIRLINE NETWORK : Indian Airlines installed the largest Commercial Private network in early 1980 to facilitate real time Passenger Reservation System and inhosue data processing and dissemination of messages. It has a gateway connection to other airlines computers of the world.

INFLIBNET : It is a cooperative network. It aims to contribute to pooling, sharing and optimisation of resources, facilities and services of libraries, information centres of university and R&D complexes. It is a multiple function service network. It offers catalogue based services, data base services, document supply services, collection, development and communication based services.

WHO MAINTAINS THE INTERNET ?

It is curious that while there are several groups to help guide the Internet (The Internet Society, Electronic Frontier Foundation, Internet Architect Board, Society for Electronic Access, Internet Engineering task froce) no one owns it, yet everyone owns it. Above mentioned societies/groups are voluntary and their goal is to promote global information exchange through the internet. It is a computer age cooperative maintained and operated by the multitude of networks, universities, non-profit organisations, government agencies, large corporations and more of which it is comprised.

WHO USES INTERNET ?

The answer was given by experts replying like who does not use it ? Once closely guarded by scientists and technonards, today the Internet is open to researchers, students, parents, police, businessmen, world leaders, executives, sport fans, shoppers and terrorists. Internet is the largest and most complete learning tool for groups of people with varied educational backgrounds and interests. Professors, students others can share ideas instantly across vast instances.

SUBJECT COVERED BY INTERNET

Internet covers almost all the subjects imaginable. Some of which are Arts and Culture, Books and literaturel, Business and Career, Computers and Software, Education and Teaching tools, Environment and Nature, Food and Cooking, Games and Sports, Government and Politics, Health and Nutrition, History, Household and Consumer finance, Humor, International affair, Language and Liguistics, Law, Movies and video tapes, Music, Religon and new age, Science and Technology, Space and Astronomy, Shopping, Sports, Recreation and Hobbies, Television, Travel and Geography and many more.

VOLUME OF INTERNET :

The information available on the internet has been indexed. If one read only index pages at the rate of 100 pages daily, it will take 4 years to read the complete index which is equivalent to 1,46,000 page. As per the latest report available, there are 2.2 million current users of internet and every month 1,50,000 new users are joining it. The internet has 40,000 host computers also known as web sites.

It is estimated that by 2000, there will be 100 million users and 1 million hosts on the internet.

INTERNET ADDRESS :

Like postal system in a computer network on Internet, one has to mention the address of the recipient along with the messages so that computer knows who to send it with. The Internet addresses are cunstructed by using Domain Name System (DNS) which goes from left to right and from the narrow to the broader scope. A name consists of several elements or labels, each separated by a delimiter (@). Internet mail address have two parts, separated by @ (the AT sign). The part before @ is mail box, which is one's personal name. This name is assigned by the provider to one's account. The part after that is domain usually the name of your internet provider. Let us clarify with e-mail address of CIFA which is assigned as cifa@x400.nicgw.nic.in. The last word 'in' means India, which is the name of geographical domain. Next word 'nic' means National Informatics Centre having its WAN named 'nicgw' which provides e-mail facilities which confirm to the x.400 standards (x.400 is the largest global message handling system). The part of the address before the sysmbol @ is known as 'user id', in this case cifa. Using this addressing technique e-mail and other files are transmitted to the intended recipient on the internet. Some

domains used in internet address are net - network operations/service centres, gov - government organisations, edu - eudcational institutions, com - commercial, org- organisations (users).

HOW TO GET INTERNET CONNECTION ?

The minimum requirement to get the Internet connection is one Personal Computer (PC), a Modem (known as Modulator and Demodulator with communication software) and a telephone connection and service provider. Through modem two computers can communicate over a standard telephone line. This is done by modulating the computer's digital signal to analog signals, send it over the telephone line and upon receipt demodulating the signals back to the digital form, which the computer understand. On 15th August, 1995, Videsh Sanchar Nigam Limited (VSNL) announced the launching of long awaited Internet Service in India. At present, in India VSNL is the only Internet Service provider. VSNL offers 'Shell' or 'Terminal Dial up' and TCP/IP (Transmission Control Protocol/Internet Protocol) types of connections (known as accounts), charges from 'shell' type of accounts will be Rs.5000/year or 500 hours whichever is earlier for all categories of dial up users. This type of account cannot download graphics. The TCP/IP accounts are more efficient and useful and are expensive amounting Rs.15,000 for 500 hours. Initially an amount of Rs.500 will be charged as registration free by VSNL. Students are likely to get connection at concessional rate in near future to the amazing world of cyberspace.

FACILITIES AND NAVIGATIONAL TOOLS OF INTERNET :

We must familiarise ourself with some of the tools one will be using to take advantage of the Internet has to offer. These are briefly described below :

E-mail : E-mail (electronic mail) is the basic foundation tool for communicating in the Internet. Any on-line service that offers even the barest of connections to the Internet offers E-mail.

FTP : File Transfer Protocol (FTP) is a program one use to copy files stored in computer around the globe. Software upgrades, games, pictures and documents can be downloaded by using FTP at ease.

Telnet : One use Telnet to 'learn' or 'login' to other computers on the net located anywhere in the world and control them as though they are in front of one's desk.

Gopher : Gopher is one of the easiest Internet tools one can use to search for view, download documents, files and other freebies. It is a menu driven and very simple, therefore it is the most popular way to browse through cyberspace. Very often, the Gopher site one is accessing is connected to many other Gopher sites and utilities (such as FTP and Telenet) that one can easily access.

World Wide Web (Mosaic) : The WWW (Mosaic) is a collection of documents, graphics, video and other files scattered throughout the Internet and linked together into hypertext documents on every conceivable subject and many those are inconcieable for one to browse though.

Finger : Finger command is used mainly to find out information about other users and computers. One can also modify what information is displayed about one when someone uses the Finger command with one's user ID.

Usenet : Usenet is a collection of literally thousands of special interest newsgroups that one can access to read and discuss thousands of different topics.

Mailing Lists (Listservers) : Mailing lists are almost like newsgroups except instead of one going to them, they come to the client. If one subscribe to a mailing list, messages are sent to one's Internet address as soon as they are posted. In this way one is constantly sent the latest information about whatever topic the mailing list covers.

Viewers : Graphic Interchange Format (GIF) and Joint Photographic Expert Group (JPEG) files are photographs, drawings, and other types of pictures that have been converted to electronic files. One can download these files just like any other file.

Archives : Some files available for downloading from the Internet have been compressed so that they take up less space when stored on disk. Taking up less storage space also means that such files will take less time to download. Benefit of compression scheme is that multiple files can be combined into a single compressed 'archieve' file that is smaller in size than the total size of the component files in the archieve. Archie is both a program and a system server.

Encoding : Many newsgroups are more than libraries for collection of pictures on a particular subject such as fine arts, cartoons or even erotica. As Newsgroups can only be used to store and transmit text files, and since most pictures are binary, UUENCODE was developed to convert binary files to text files which can be sent through E-mail.

Lynx : A World Wide Web client program that works with plain old terminals, which means that it is generally available on shell provider accounts.

Internet Relay Chat (IRC) : Used to have an on-line interactive discussion. It enables group discussions also.

WAIS : Wide Area Information Servers. It is used to navigate and find information on Net through its archives.

VERONICA : A program that helps find things in Gopher space; a friend of Archie's.

BULLETIN BOARD SYSTEM (BBS) : A system that lets people read each other's messages and post new ones. The usenet system of newsgroups is in effect the world's largest distributed BBS.

FREE NETS : Free-Nets are a type of BBS, but are broad in appeal to the community. Freenet connects community members with professionals in the community (doctors, lawyers, travel agents, etc.) as well as provide information about communicty information, available jobs etc.

MULTIPURPOSE APPLICATION :

Internet has given access to an enormous amount of information. This information can be accessed and used from any corner of the world and knowledge of access tools is necessary to make maximum use of interent. In India and all over the world the Internet is being used for wide variety of purposes, only few are mentioned below.

ELECTRONIC PAPERS/JOURNALS/NEWSLETTER :

Newspapers and magazines are available on the Internet. People with Internet connection need not buy newspapers and magazines to read them, rather they can browse it on the interent. Recently Economics Times has been introduced on the Interent. The Express Computer - a computer weekly is also in the Internet. Global Network Navigator (GNN) is an on-line Web magazine. Besides there are lots of on-line newsletters like 'The Scout Report', 'Yahoo Picks', WEBster, I Watch Digest, Online Business Today, Net Happenings, Matrix News, Internet Business Report, Internet Business Journals, Inside the Internet, The Cook Report and Wired. Slowly Internet may replace television and Newspaper and printing media may be obsolete.

MATRIMONIAL APPLIANCES :

Matrimonial alliances are being done through Internet for which some companies have started matrimonial service site.

PATIENT CARE SUPPORT :

Internet is a continuously updated database for providing patient care support and serves on a distant learning facility for student physicians. On-line medical journals, through which the latest research and development in the field is known.

INTERNET PHONE :

One can now-a-days place calls over the Internet to standard phones or PC's running Vocal Tee Internet Software alongwith placing calls via the internet. Users can place calls from within WWW pages or to other PC's or to standard phone. It gives Internet users a vocal two-way communication facility. This Internet phoning is now as simple as E-mailing or traditional phoning. The rate is lower than STD/ISD calls.

NET VARSITY :

Another Interesting thing is that recently NIIT has established an on-line learning facility on the Interent by the name of 'Net Varsity' based on the conventional model of a university. According to NIIT, the NIIT varsity has all the features of an institution of higher learning including registration procedure, testing and certification. Often features include a library where the vast resources of the internet have been summarised, a student querying service to offer tutor support to students, a student advirosy service to provide counselling on learning opportunities and a placement assistance service. The students will be eligible for certification for the education they get at the 'Net Varsity'.

POSITIVE USE IN INDIA :

Government organisations like CSIR, ICAR have set up Website on the Internet which gives information about their objectives, activities and also about various laboratories. Department of Science and Technology Website informs about National Resources available for Science and Technology. NIC has a wealth of information on its Website.

DARKER SIDE OF INTERNET :

Due to the scope of unhindered use on uncensored subjects, it is being misused also in areas like pornography, nefarious and salversive activities by unscrupulus criminals breaking the database of banks, confidential records of defence establishments

and secrets commercial rivals. These are darker sides of internet which can not be ignored.

CONCLUSION :

Computer networking is perhaps one of the most important milestones in the innovative creations using Information Technology (IT) and an even bigger phenomenon is the Internet. Internet has brought computer networking to an unprecedented frontier and then be described as the biggest IT event in computer and communication technology. In scientific and research community, internet is an essential and indispensable tool. Through internet, scientists can gain instant access to the world's most advanced research facilities and discuss their research problems with others working in the same field. They may be benefitted most through proper use of Internet facilities after gaining basic ideas about the Internet, its navigational tools and services available as discussed above.

ELECTRONIC MAIL

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INTRODUCTION

An electronic mail system is a method of electronically sending messages, mails or documents from one place to another using electronic means for capture, transmission and delivery of information. This method has received impetus because of the inadequacy of existing services and the associated high costs. As such, electronic mail services work like the post office - except that message are stored electronically in a central computer. When it is dialed up to the account which is stored at main computer in the mailbox, it immediately shows how many messages are waiting for you, get the option of reading them and downloading them to collect hard copies.

ELECTRONIC MAIL :

E-mail refers to a service that includes the following facilities :

- Store-and-forward. Messages are held until they are requested by the recipient.
- Distribution list. Copies can be sent automatically to names on a distribution list including 'blind copies'.
- Advise delivery. The send can be told when the recipient has read the message. An immediate reply can be demanded.
- Off-line working. Text can be prepared in advance of transmission and incoming messages can be saved for later consideration or for use within word-processed documents.
- Gateways. Most electronic mail services include access to other facilities.
- Closed user group. These are areas of the e-mail service with restricted access. Other closed user groups will be specific to members of a particular profession.

The mail or messages may be entered using a PC terminal, workstation, a facsimile scanner. In addition to these basic functions of electronic delivery systems, most systems provide features related to other aspects of office work. These features include :

- composing messages
- text editing
- message filing and retrieval
- authentication of message authorship
- specified addresses
- content processing of messages
- message switching
- accounting and billing
- security.

The software is user friendly and helps the user in easily preparing and distributing mail with his name, date and time stamped to the message. The receiver is notified of the pending mail as soon as he logs in and mail is displayed on his terminal with sender's name, date and time of origination of the message. Registered message or urgent mail is automatically acknowledged to the sender.

E-mail services also offer the following :

- Radiopaging. The pager will bleep when an urgent message is received in the mailbox.
- Telemessages. This replacement for the old-style can be sent from some e-mail services rather than calling to the post office yourself. The telemessage service can include "special occasion" formats for birthdays, anniversaries etc.
- Message translation. Messages sent or received can be translated by the e-mail service into the recipient's native language.
- Courier service. A message placed by you on e-mail service can be copied and delivered by hand or mailed.

The basic functions involved in an E-mail system are the message creation, message transfer and post delivery processing. These are provided by the User Agent (UA) and a Message Transfer Agent (MTA).

ADVANTAGES

- Messages can be sent at whatever time of day suits the user.
- Messages will be in the recipient's mailbox within minutes.
- No need to speak to the recipient in person.
- Deliver of messages can be confirmed.
- Messages can be marked as urgent.
- A reply can usually be demanded.
- Copies can be sent automatically to every person on a distribution list appended or previously defined.
- Messages can be read at the user's convenience.
- Incoming messages can be saved.
- Electronic mail reduces the volume of paper that is to be processed.
- On-line information services may also be available.

DRAWBACKS

- Recipient must also be an electronic mail user.
- The user must have access to a modem, phoneline and a computer.
- Text formatting in restricted.
- Charges can be complicated.
- Telephone links vary in quality.
- There is occasional accumulation of junk mail.

ELECTRONIC MAIL COMMANDS

The computer based message systems use simple commands to aid mail function, in addition to incorporating word processing, filing, etc. Some of the commands perform the following functions.

- review the contents of the mailbox

- read the contents of the mailbox
- create a message
- send a message
- file a message
- search the file

A password that identifies you as a legitimate user. In most cases, individual subscribers can choose their own password. A mailbox address to which incoming mail is sent. This may be used for billing purposes by the system.

CONCLUSION

Despite the disadvantages, electronic mail can be a cost-effective solution where simple despatch and guaranted delivery are required. It is quite cheap, not difficult to use, and despatch is fast - faster than facsimile transmission. An organization may be able to hire mailboxes for electronic mail service from public time sharing networks. The intelligent terminals with local editing capabilities help simplify message preparation, and can interface with corporate databases on capital computers. The computer systems acting as nodes in the network, central the transmission of messages and provide the message handling features. In India, NIC has set up a satellite based nationwide computer communication network with 650 nodes connecting the national capitals, the state capitals, district headquarters and R&D organisations all over the coutnry.

BIOINFORMATICS

BIOINFORMATICS

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Scientific information deposited in "electronic libraries" can be processed by high speed computers, using the techniques developed in information technology. Such methods transcend these information barriers and provide efficient, reliable and instant access to current data. The amalgam of Biotechnology with Information Technology is now labelled Bio-informatics.

Till recently, biotechnologists regarded "computer" as wonderful machines, located elsewhere in the Institute or unit and to be used normally with the help of a colleague. Today however, computers are basic tools of biology laboratories and their prefernce has become obvious and essential.

THE NEED FOR INFORMATION :

Current information is crucial to research in order to:

- learn about the latest advances in the field
- collaborate with other scientists
- educate students with state-of-art methodologies
- apply current experimental techniques
- upgrade references for publication purposes
- support a multi-user multi-task environment

FUNCTIONS OF BIOINFORMATICS CENTRE :

The services and functions of a Biotechnology Information Centre include :

* Bibliographic and non-bibliographic database search
* Computational facilities for solving molecular structure and dynamics problems in Biotechnology

* Current Awareness Service
* Developing specialised databases
* Electronic mail
* Fascimile transmission for information interchange
* Inter-institution information transfer/loan
* News clipping service
* Referrals
* Repographics
* Selective Dissemination of Information
* Sequence Analysis
* Training

THURST AREAS IN BIOINFORMATICS :

Bioinformatics will make use of the following important aspects in the field of Information Technology and other supporting tools for R&D intensive work.

GENETIC INFORMATION :

GENES - perhaps the most important scientific finding in the century. Physicists and chemists were permitted entry into the exclusive preserve of biologists, thus paving the way for the development of new disciplines such as molecular biology, biophysics, and bio-chemistry. Since then, the science of biology was more concerned with information on our cells use, store and pass on to subsequent generations.

Genetic information has revolutionised the biological sciences with the ability to manipulate and restructure the very molecules that program living cells. A knowledge of gene and protein sequences has led to the elucidation of molecular structure, biochemical function and finally biological behaviour. Application of advances to genetic engineering, and enzyme engineering is responsible for the emergence of new, efficient and suitable products in the such diverse areas as health care, agriculture, environmental protection and waste disposal.

Such as multi-disciplinary endeavour generates voluminous data as well as drowy information from new and diverse

sources. Natural hierarchy of cells, genes and proteins shows the richness of biological information available to a researcher.

Recent initiatives to map and sequence of a number of genomes lead to the generation of more and more data for creation of GENBANK.

Advances in biological research and biotechnology are becoming increasingly dependent on the effective management of this enormous quality of information. The vastness of the information and its variety necessitate the use of efficent storage and retrieval facilities, using computers and information technology.

COMPUTER MODELING :

This involves mathematical models of structure, function and dynamics, incorporating sophisticated computer graphics for constructure, editing, display and manipulation of molecular systems with biological activity. The recent developments in computer hardware such as parallel processors and high speed interactive graphic workstations have led to tremendous progress in the computational aspects of biological problems.

COMMUNICATIONS AND NETWORKS :

The electronic networks now offer cheapest and fastest communication media for dispersed groups of sicentists who wish to exchange of data, access software and correspond with each other. The networks now offer subject oriented scientific grids across various displines of science. One such grid on biotechnology has been established over NICNET. Communication channels such as telephone, fascimile, E-mail via telephone as well as satellite links and internet access through NICNET have revolutionised the Networking System and would provide the benefit of scientific development made elsewhere in the developed countries.

DATA CAPTURE TECHNOLOGIES :

Data generated in routine biotechnology experiments e.g X-ray crystallography, NMR, laser flow cytometry, image analysis from electron microscopy, can be recorded and analyzed with the developed of suitable computer software.

EDUCATIONAL AND TRAINING TOOLS :

The biotechnology network will take advantage of developing distance ducation programmes in biotechnology through multi-media workstations. The programmes could be transmitted over the existing network and will be very useful tools for understanding some of the fundamental concepts, training of biotechnology scientists, etc. The multi-media workstations technology will comprise an integration of audio, video and communication technologies.

The existing developments in hardware, software and understanding better algorithm will go a long way in making the existing biotechnology network to provide a lead in the country as far as bioinformatics is concerned.

INTERNATIONAL NETWORKS :

The centres established under BTIS provide linkages to some of the international netwroks. It allows access to other international networks e.g. Internet for world wide electronic mail, remote login, file transfer, and electronic bulletin board services. It helps on-line access to the major sequence databases, sharing of new software developed by scientists and time sharing use of computers for Silicon Graphics, Genbank, etc.

Since NICNET forms the backbone of the BTISNET, all the Bioinformatics Centres are connected to NICNET and receive the benefit of the value added network service offered by NICNET.

CONCLUSION :

New innovations for information handling and development of new techniques will be adopted for efficient delivery of required information on current developments in biotechnology. Centres established at different locations in the country are responsible for developing programme specific databases in several thrust areas of biotechnology. Full text databases in biotechnology on CD-ROM would be acquired to make the availability of published material to a large section of the scientific community working in several areas of life sciences and Biotechnology. With the national infrastructure on BTIS already established, the programme will take initiative on extending its linkages with other countries under Biotechnology Network.

DATABASES

DATABASES AND INFORMATION MANAGEMENT

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INTRODUCTION :

Decision making whether for business, government or an individual is based on a central element - information. Infomration forms the basic input for successful analysis of the current situation, evaluate the possible options and select the action to be taken. Much of the elements arise out of information or data, often flow out of the institutions of the government. Information and data released on formats and templates are less adequate to suit ready references. This is a lacuna in almost all countries whether developed or developing in a different degree. At this juncture that a database organization could step in and make available information suitably packaged and presented.

VALUE OF INFORMATION :

Information is now a broad based term to include news, statisitics and datum. A country relies more on statistics, an academician on data and a news caster on just news. Each of them have value at different levels. Policy makers look at broad indicators in making decisions on allocation of government budgets and priorities. Some kinds of information are dealt in such abstract terms, like derived incomes of individuals or opinions towards governmental policy that they need to be addressed with a lot of leverage.

Over the last decade, development of databases to capture all frontiers of information have sprung up. In the past few years, especially in the under developoed world, the discussion on information management has become relevant. We must be able ultimately to identify good information from various source and reduce duplicity in such an effort. There is an urgent need to seek faster and economic dissemination of such data.

INFORMATION AGE :

The acquisition, efficient management and effective dissemination of information is achieved through the application of information technology. It is bioinformatics, a newly

emerging displines, that provides the vital link between the biosciences and information technology.

The growth of technology especially that of electronics and telecommunication has opened up the world and ushered in the second most important revolution scince the industrial revolution. It is indisputable that people are exposed to more information than ever before. There is an urgent need to separate the information from non-information. Informatin really facilitates decision makaing, while noninformation remains a mass numbers or a set of figures.

COMPUTERISED DATABASE :

Databases play an important role in the development of information market and its products. A large number of databases are available online from foreign vendors which are finding an increasing market in the country. Over the past few years, India is gradually building up capability in the databse field and initiatives are taken by domestic vendors and institutions to commercialise databases and related services in a number of fields. The vast expertise and capabilities in computer software that are available in the country, provide excellent opportunities for the establishment and development of a strong commercial base for database in the country.

Although traditionally books and journals have served as the prime repositories for scientific data, published literature is insufficient for the efficient sharing and scanning of information. For the storage and handling of the vast accumulation of scientific information in multimedia form comprising textual, numerical, graphical and even audio material, a computerised database set up is essential.

Computerised databses possess the following advantages.

1. Capacity to store and recall large volumes of information

2. Flexibility to add, modify or delete entries in the database

3. Quickness of information access, retrieval and search.

4. Ability to synthesize information from isolated sources.

5. Uniqueness of entries : duplication of information is avoided

6. User friendly query support : essential for database searching.

7. Convertibility to different formats

8. Multimedia options : text, graphic and audio support.

9. Amenable to multiuser or networked environment.

DATABSES AVAILABLE :

There are three types of databses currently available :

1. BIBLIOGRAPHIC : FULL TEXT

2. BIBLIOGRAPHIC : ABSTRACT

3. NON-BIBLIOGRAPHIC

1. Bibliographic full-text databse :

In these databses, the complete text including figures and even colour graphics, of each issue of every journal in the data base is available on the terminal screen, page by page. It is possible to browse, search and print articles or pages from the screen, using a printer. Such databses were available till recently only through on-line databanks such as DIALOG. They have recently become available on compact discs (CD-ROM).

2. Bibliographic abstract databse :

These contain references to publications, books reviews and reports. Currently most abstracts such as Biological Abstracts, Chemical Abstracts and Index Medicus are available as databases both as on-line and CD-ROM discs.

The different catagories of bibliographic databases available can be classified as :

a. Abstracts : contains the abstracts of referred publications. These are routinely referred to by researchers prior to embarking on a project, during their research to update themselves with new developments in the field and seek collaborations with research groups having similar interests.

b. Patents : These provide vital information on processes and techniques that have been patented. This information is of immense value in application oriented research and in industry.

c. Products : Laboratory equipment, software and even laboratory furniture and fittings for special set up are catalogued in product databases. The addresses of equipment manufactures are also available. These

databases are useful when venturing into a new area of research or while setting up a new experimental area.

d. Specialists/Experts : The list of specialists or experts available in each field along with details of the specific area of expertise, research interests and publications are contained in these databases.

e. Chemicals/Reagents : The variety of chemicals and laboratory reagents currently in the market is so vast that browsing through catalogues is not very practical. Computerised databases on chemicals and reagents cover the names and addresses of companies on a global basis. They can be quickly accessed and searched according to the requirements of the researcher.

3. Non-bibliographic database :

When the database contains secondary information i.e data for processing or computing, it is classified a non-bibliographic database. Biotechnology and biosciences are databanks with the following information :

a. Sequence Databanks : These contain nucleic acid and protein sequence information, basing on published experimental results. The primary sequence information of genes and proteins can be found in : GENBANK (USA), EMBL (GERMANY), DDBJ (JAPAN) for JIPID (JAPAN) for proteins.

b. Structural Databanks : There are databases that contain the complete spatial information in terms of the three dimensional coordinates of the molecular assembly. Such databases are labelled structural databases.

   1. PDB - Protein Databank - USA

   2. CSD - Cambridge Structural Databank (UK)

c. Molecular Biology Database : There exist several non-sequence databases of special interest to biotechnologists and molecular biologists. They contain pertinent information on specialised sub-topics. Some of them are

   (i) Listing of Molecular Biology Databse (Limb)
   (ii) Enzyme Nomenclature Database (ENZYME)
   (iii) Eukartolic Promoter Database (EPD)
   (iv) Normalised Gene Designation Database (NGPD)
   (v) Patterns and sites in proteins (PROSITE)
   (vi) Restriction Enzyme Database (REBASE)
   (vii) References (SEQANALREF)

PROTECTION OF DATABASES :

The key questions that are raised in the protection of databases are : How best the intellectual property in databases is to be protected ? Whether or not the efforts put in establishing a database qualify the basic conditions for being protectable under the copyright laws ? Is it essential to seek stricter control measure for the protection of databases or somewhat lesser central measures are better ? Although protection of database under copyright is the most sought after rearrangement get there are alternative opinions preferring lesser control in the databse area in the interest of creating a strong database industry.

Generally, three broad approaches are followed in the protection of databases. These are

(i) Firstly, steps have been taken to incorporate database protection in the copyright laws.

(ii) Secondly, in addition to copyright protection, additional restriction are put on the use of databases through 'contracts'.

(iii) Thirdly, legislative measure should be enacted for a *sui generis* system of protection of databses.

PROTECTION OF DATABASES UNDER COPYRIGHT LAWS :

Most national systems have gradually moved in the direction of providing protection to computer software and databses under copyright law. In principle it is the skill, labour and judgement of the author that is protected irrespective of the form in which the product appears e.g. whether one types a book on old fashioned type writer or transforms it in a digitized form or in hand written form. Any reproduction of the work including translations is considered a reproduction of the original. If a work is created on a word processor so that it is projected briefly on screen or captured only momentarily in the memory of a computer that work is not fixed and can not be protected by copyright.

Computer databases, which are electronic files of information "formed by the collection, assembly and arrangement of pre-existing materials or data" are thus considered protected, provided the resulting work as a whole constitutes original authorship. A work is copyrightable if it is in a tangible medium of expression communicated for a period of more than transitory duration.

The Indina Copyright Act, 1957 was amended in 1994 to extend more effective protection to owners of copyright by making

provision for the special nature of computer programmes as literary works such as computer programmes, table sand contilations including computer databses and for the protection of computer generated works.

SERVICES BASED ON DATABASE :

1. Current Awareness : This is a general update on recent developments/publications in various fields.

2. Selective Dissemination of Information (SDI Service): Search against user's profile with automatic update at a predetermined periodicity informs the researcher of developments in a specialised area of interest.

3. Bibliography Services : Involve the compilation of references pertaining to a specific field of research.

4. Literature Search

5. Analysis of hard data can be performed.

6. Development of specialised micro databases using the available commercial databases, micro databases can be compiled based on organisms, technique, application, funding source, geographical distribution and location, etc.

APPLICATION OF CD-ROM TO LIBRARY AND INFORMATION SERVICES

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INTRODUCTION

CD-ROM is growing and advancing technology that hold great promise for libraries and information centres and as an alternative for both online database and printed sources. It permits low-cost for information provision, that is to distribute information in bulk and at a comparatively low cost. CD-ROM excels other media like magnetic storage, paper and micro forms in storage, distribution, search and capabilities.

WHAT IS CD-ROM

CD-ROM is one of a series of devices which makes use of optical rather than magnetic storage techniques developed by a joint ventre of Philips and Sony. It is a type of laser disc which is 4.72 inches in diameter with a storage capacity of 650 megabytes (mb) of data-text and graphics which is equal to 2,20,000 pages of A4 size or 1,500 floppy discs (5.25").

The Information Technology Handbook describes CD-ROM as follows "CD-ROM, short for compact disk read only memory, refers to use of the audio compact discs for computer storage. Like a laser vision discs, the information is stored in digital form.

CD-ROM APPLICATIONS TO LIBRARY & INFORMATION SERVICE

Revolutionary changes brought forth by new technologies are helping libraries to realise their goals of modernization. Library application are only part of the gamut of application of CD-ROM technology. As a matter of fact, till date, the large number of CD-ROM products in the market are for at the library and information centres. The information stored on the disc can be retrieved, displayed, and printed in many ways, but the user presently cannot alter the information on the disc. This newly technology is very much suitable for data storages of bibliographic databases, it is having flexible retrieval capacity.

CD-ROM database has become a boon to the libraries and information centres, especially in developing countries like India. CD-ROM can play major role for the modernization of services of library and information centres. We can modernize following services of library and information centres with the help of CD-ROM.

NETWORKING, COOPERATION AND RESOURCE SHARING

Netwrorking is a method of connecting two or more computers together in order to allow them to share resources such as printer, application software or CD-ROM drives. The terms Local Area Network (LAN), Metropolitan Area Network (MAN) and Wide Area Network (WAN) are becoming difficult to define with advances in technology. Generally LAN refers to linking workstations within single building, MAN refers to the whole city and WAN links workstations.

The related area of networking of libraries as well as cooperation and resource sharing among libraries have been indirectly promoted by CD-ROM. The application of CD-ROM on resource sharing is quiet complex and multifaceted, yet very few libraries have considered this aspect of CD-ROM usage. CD-ROM services of one library is a group of cooperating libraries can be more effectively and efficiently shared with other member libraries through FAX and E-mail.

LOCAL DATABASES

CD-ROM databases with provision to download selected records and process and upload to other databases give ample scope for small libraries to develop their own local databases. As most of the databses follow standard formats and there are software which can easily process and improt data from CD-ROM databases, the task of developing specialized databases is made simple, cheap and easy.

TOOLS FOR LIBRARY AUTOMATION

One of the indirect application of CD-ROM is helping library automation. The number of commercial cataloguing tools are available on CD-ROM in the market which are useful for both retrospective and new cataloguing. CD-ROM as a cheap mass storage alternative, today provide many national bibliographics, and catalogues on it to economically download the require data for library automation and cataloguing.

CDMARC bibliography produce by LC, MINIMARC produced by library system and services, and CAT CD-450 produced by OCLC, etc. are the machine readable bibliographic records as CD-ROM. These CD-ROM produces have greatly helped the user and libraries with excellent search software, exhaustive and accurate coverage and improved catalogues. Libraries are benefitted in terms of data, cataloguing and indexing activities, maintaining uniformity in class number and description.

BIBLIOGRAPHIC INSTRUCTIONS TO USERS

Bibliographic instruction as part of user education, aims at instructing, training users to make optimal use of information resources and some time in their literature search within specific subject disciplines. It may be noted that instruction and training about CD-ROM systems is needed as part of user education in addition to using CD-ROM as an aid for bibliographic instruction. The aim of the whole training is to make end user searching as easy and as comfortable as possible, minimise waiting at the workstations and avoid resorting to time consuming trial and error made. Some of the new technologies are less easy to use, but few can be efficiently used without training.

EXCHANGE OF BIBLIOGRAPHICAL DATA

The potential of CD-ROM databases for exchange of bibliographic data is enormous and such standardised exchange of bibliographic data goes long way in helping libraries. Creation and production of authoritive bibliographic records of a nation and national bibliography for international exchange, for cooperative systems, for use in individual libaries, for abstracting and indexing services, for use in online information-retrieval systems, for use in book trade, etc. has been an issue both for information professional for quiet some time. CD-ROM is considered to be a likely medium for the distribution of national bibliographies.

CD-ROM has been the most exciting and far reaching technological innovation of recent time for the development of standard producers for transfer of information between computer system with diverse hardware and software.

REFERENCE SERVICES

Once a reference material is available on CD-ROM, full integrated system can be developed. It offers much more flexibility than print does, because of more access points, user friendly software, etc. There are some number of reference tools are now available in CD-ROM form with sophisticated search and

retrieval softwares and multimedia information. The development of full text databases is slower than bibliographic databases due to the complexity of full text retrieval software. Many reference tools are very costly, often under used, bulky to store and involve lot of time and efforts to search by end-users as well as library staff.

CD-ROM has enormous potential to become an integral part of reference service in libraries. Because of ease of use and affordability, West has already made heavy use of this technology for reference service. The placement of CD-ROM system, reference table will become easier than before not only for refernce service but also to assist and train users in use of CD-ROM and for bibliographical instructions.

CURRENT AWARENESS SERVICE (CAS) AND RETROSPECTIVE SEARCHING

Replacement of online searching and subscription to secondary journals by CD-ROM databases with more versatile search software is one of the significant applications of CD-ROM bibliographical databases and logical outgrowth of secondary journals subscribed for last several decades. It is widely held that most of the secondary journals are either under-used or unused by library users. These abstracting and indexing journals with their quarterly, semiannual, yearly and some times even five yearly circulations and varieties of indexes cost heavily in term of subscription price, filling charges and storing space. On the other hand budget crunch faced by most of libraries is forcing them even to cancel subscription to some of secondary journals now due to the CD-ROM databases which are giving a good break in view that every library should choose CD-ROMs applications for CAS and retrospective search.

EXPANDED SERVICES TO USER

Keeping CD-ROM databases as bases, libraries can develop many interesting and useful services for their customers. Specialized current awareness bulletins SDI service, CD-ROM databases have made it as simple as developing a profile in the form of a search query and storing the query in the PC for execution with every update of CD-ROM databases received.

CONCLUSION

CD-ROM will grow as a means of disseminating information, especially to developing countries and anywhere else where online is expensive or unreliable, it will be boon because of its storage and retrieval capacity especially for those developing countries where importing the materials in hard copy format from developed countries has always been a problem. Apart from its application for the betterment of library services,

multimedia technology must make CD-ROM a better alternative in terms of affordable cost and ease of use and not a luxury but an essential new resources in the libraries of developing libraries. It is necessary to remove the obstacles for the libraries as well as to guarantee the information provided at return on their investment.

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IDAMS -
Internationally Developed Data Analysis and Management Software

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INTRODUCTION

In the last decade, revolutionary advances have been contrinually made in the field of information technology. Basic human instinct drives researchers to seek avenues to disseminate the results of their work. Till recent years, the distribution of information was constrained by lack of large scale communication techniques, with the exception of print media. The coming of age of information technology has revolutionised the storage and dissemination of massive volumes of information.

A database is a collection of interrelated data of different types. The data is stored in a manner which enables efficient storage and retrieval. The difference between a database and a file is analogous to the difference between a thoroughly cross-referenced set of files in cabinets in a library or in an office and a single file in one cabinet that is not cross-references with any other file. The important difference between a computerised database and thoroughly cross-referenced set of files is that the database must be stored on a direct access storage device in order for the Central Processing Unit (CPU) to be able to utilise the cross-references.

EVOLUTION OF DBMS :

During the past decade, a new type of system software - the DBMS has become popular for its capacity to handle large files of non-numeric data, including bibliographic information. It allows multiple independent users to have concurrent access to a central repository of information. The information technology has developed to such an extent that the whole documents can be stored in a data-strip which has a capacity to store about 1 to 2 billion bits or the equivalent of about 200 reels/tapes. In otherwords, a DBMS permits access to the entire record through any of its fields. It provides ability to modify and even restructure the database without affecting existing programmes or creating new file structures. CDS/ISIS is a software package supported by UNESCO through NISSAT. It has a special advantage for IR activities as this package can run on micros.

CDS/ISIS not only takes care of the management of databases but can also be used for the production of union catalogues, running current awareness services, compilation of subject bibliographics. It has a generalised Information Storate and Retrival Systems (ISRS) designed specifically for the computerised management structured non-numercial databases.

IDAMS DATABASE :

Idams has been developed by outstanding computer statisticians from various countries and the professionals of UNESCO with a view to providing a reasonably comprehensive numercial data management and statistical analysis software package. It is also linked with CDS/ISIS package. The package is extremely useful for entering, storing, retrieving and analysing numerical data gathered for administrative or scientific purposes by any agency and institution. The ultimate objective is to assist UNESCO Member States to progress in the rationalisation of the management of their various sectors of activity, a target which is crucial both to establish sound plans of development and for the monitoring of their execution.

IDAMS is a collection of computer programs for the validation, manipulation and analysis of any data that is in the form of values for the same set of items. Many different packages and programs exist for aid in the statistical analysis of such data. One of special feature of IDAMS is that it provides facilities for extensive data validation before embarking on analysis.

IDAMS provides programs for classical techniques such as table building, regression analysis, discriminant analysis, and also some more advanced techniques such as factorial analysis of correspondences, partial order scoring, rank ordering and iterative typology.

There are twenty seven programs in IDAMS, and they are capable of performing several distinctly separate functions for the user. Some of the major capabilities are :

* data display
* data edit and correction
* data copying and subsetting
* transformation of data volumes, through arithmetic and logical operation both within and across records
* univariate and bivariate frequency distributions and related statistics
* scatter plots
* correlation analysis
* multiple regression analysis
* analysis of variance
* multivariate analysis
* factorial analyses including analysis of correspondences

* multidimensional scaling
* discriminant analysis
* partial order scoring
* rank-ordering of alternatives
* iterative typology.

MICRO IDAMS STEPS FOR USE :

1. Prepare and store an IDAMS dictionary describing the variables in the data

2. Enter the data

3. Prepare and store a "set-up" o fcontrol commands specifying what is to be done, what is to be done with the data

4. Execute the IDAMS program (s) as given in the set-up.

5. Review the results

6. Modify the setup if necessary and repeat

7. Print the results.

DATA MODIFICATION :

IDAMS contains an extensive set of facilities for genrating indices, derived measures, aggregations and other transformations of the data including alphabetic recording. The most frequently used capabilities are provided by the facility which can perform temporary operations in all analysis programs that input an IDAMS data set. Results of recording can be saved as permanent variable using the TRANS program.

ANALYSIS OF DATA :

The major use of the program is to obtain univariate or bivariate frequency tables with optional row, column and corner percentages. Program computes Pearsons product-moment correlation coefficients for all pairs of variables, provides multiple regression capability designed for standard or stepwise linear regression analysis which can perform analyses with up to 99 dependent variables and 99 control variables. It covers Multiple Classification Analysis program which examines the relationships between several predictor variable and a single dependent variable. Discriminant analysis looks for the best linear discriminant function(s). The program uses a stepwise procedure. Nonmetric Multidimensional scaling is a versatile, nonmetric, multidimensional scaling program designed for analysis

of similarities. Factorial Analyses covers a set of principal components factor analyses and factor analysis of correspondences having common specifications. A separate module, Graphid is available in micro IDAMS for exploring data through graphic displays.

MULTIMEDIA AND S[illegible]TICAL COMPU[illegible]

FRACTAL IMAGE COMPRESSION : THE ULTIMATE IMAGE COMPRESSION STANDARD

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INTRODUCTION

Multimedia computing has been a recent & most discussed concept in computer science. Image processing is the vital part of multimedia. But the large size of the image files required for various images result in impractical storage and communication requirements. A single 800-by 600-pixel true-colour image requires 1.44 MB of disk space. Clearly, compression is necessary, i.e., there is a need to represent the image using less amount of data by removing redundant data.

Compression technologies can be divided into lossless and lossy methods. A lossless method always produces a decompressed image that is identical, pixel for-pixel, to the original image. The problem with lossless methods, such as the one used in PKZip, is that the attainable compression ratios on images are very small, typically 2 to 1. Lossy compression methods designed for image data can achieve much higher compression ratios. The loss in terms of minute changes in colour or intensity is imperceptible to the human eye.

JPEG COMPRESSION

The JPEG standard is from the Joint Photographic Experts Group. The version of the DCT (Discrete Cosine Transforms) algorithm used in JPEG is based upon independent, nontemporal

(intraframe) data. An image is divided into 8x8 pixel blocks, and the resulting 64 pixels (called a search range) are mathematically described relative to the characteristic of the pixel in the top-left corner. The binary description of this relationship requires far less than 64 pixels, so more information can be transmitted in less time.

JPEG is primarily used to encode still images, and compresses about 20:1 before visible image degradation occurs. JPEG compresses slowly-about one to three seconds for a 1MB image depending upon computer speed.

But for a higher compression ratio as large as 100:1, JPEG/DCT compressed image exhibits distinct blockiness resulting in reduction in image quality.

FRACTALS DEFINED

For the purposes of this article, a fractal is an infinitely magnifiable picture that can be produced by a small set of instructions and data. With a fractal, the more you zoom in on an image, the more detail you see. Fractal objects contain their scaled down/rotated/translated/skewed replicas embedded in them. If you zoom in on a bit-mapped image, however, eventually all you will see is big blocks of the same colour.

FRACTAL IMAGE COMPRESSION

Fractal image compression relies on the assumption that image redundancy can be efficiently exploited through self-transformability on a block-wise basis. Fractal Compression was developed by Iterative Systems, Inc.. It offers a compression ratio approaching 100:1,. It is just beginning to be fast enough to do real-time compression. This has a promise to become the ultimate image compression standard.

The concept of an affine transformation is central to fractal image compression. An affine transformation is a mathematical function made up from some combination of a rotation, a scaling, a skew, and a translation in n-dimensional space. A simple example in two dimensions would be

$$w\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} b_1 \\ b_2 \end{pmatrix}$$

Where the a_{ij} 's and b_i 's are real constants. If A denotes the matrix (a_{ij}), $\vec{b}$ denotes the vector $(b_1, b_2)^t$, where t denotes the transpose, and $\vec{x}$ denotes the vector $(x_1, x_2)^t$, then we write

$$w(\vec{x}) = A\vec{x} + \vec{b}$$

The affine transformation is specified by six real numbers. Given an affine transformation, one can always find a non-negative number s so that

$$||w(\vec{x}) - w(\vec{y})|| \leq s.||\vec{x} - \vec{y}|| \quad \text{for all } \vec{x} \text{ and } \vec{y}.$$

Here $||X|| = \sqrt{x_1^2 + x_2^2}$. Such an affine transformation is called contractive if s < 1.

When such a contractive transformation is applied to a big image it results in a transformed small image. These affine transformations are important to the theory and practice of fractal image compression.

A <u>collage</u> of an image S is a finite set of N contractive affine transformations W_i with the property that

$$W_1 (s) \cup W_2 (s) \cup \ldots\ldots \cup W_N (S)$$

is approximately the same as S, and where U denotes the union of the images.

The Collage Theorem states that "the more accurately the union of the transformed images approximates the target image, the

more accurately the set of transformations provides an encoding of that target image.

Sierpinski Gasket: An Example of Fractal Coding

Note that the classical deterministic, fractal known as Sierpinski Gasket is obtained with N = 3, and the other parameter as given below.

	a_{11}	a_{12}	a_{21}	a_{22}	b_1	b_2
W_1	0.5	0	0	0.5	0	0
W_2	0.5	0	0	0.5	C	0
W_3	0.5	0	0	0.5	0	C

Where C is the half-width of the square picture area.

If we start with an arbitrary image; a triangle, a rectangle, a circle or any other shape, make three copies of it scaled down by half, place the three of them side by side by applying translation as follows; no translation for first copy, translate by C along x for second copy, translate by C along y for the third copy and then iterate the process of making a collage of scaled down copies, we end up with the Sierpinski gasket.

To obtain the fractal coding of an object, we shall have to solve the inverse problem, i.e. given an object, we have to find an iterated function system that represents that object within a given degree of accuracy.

AN IMAGE COMPRESSION PROCESS

The first step in the fractal-transform compression process is to partition the image into non overlapping domain regions. Taken together, the set of domain regions must cover the entire image, but they can be of any size or shape. Next, the program defines a collection of possible range regions, which must be larger than the domain regions, can overlap, and need not cover the entire image.

An iterative procedure is to be followed to find out affine transformation for each domain region to be reached from the range region after transformations are applied. The larger the domain regions, the fewer the number of transformations that are needed to model the image, and the smaller the fractal file. However, if a reasonably close match is not found between each of the domain regions and a transformed range region, the quality of the decompressed image is reduced.

In choosing an image compression scheme one has to keep in view the following three key issues.

(i) image fidelity

(ii) compression ratio

(iii) time complexity of the encoder/decoder

CONCLUSION

Commercial implementations of the fractal transform face some complex trade-offs when choosing domain regions, range regions, and allowed transformations. However suitable computer program can be written for this. Once an image compression is done, the decompression can be easily done; but the most important aspect is to improve the image coding technique, which at present requires long computational times.

The main advantages of the fractal compression scheme are its ability to provide high compression ratios for a large class of images and the speed of its decoding process.

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PATTERN RECOGNITION ON AQUATIC ANIMALS USING NEURAL NETWORK

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1. INTRODUCTION:

Computers are used by human being in almost all fields for efficient functioning. It supports quicker calculations and huge data handling. But of intelligence of human being is still a factor which makes human being supperior than the computer. Therefore Computer Scientists are trying to incorporate intelligence in computers artificially to make it more efficient. This is how the idea of Expert Systems or Intelligent Computers are conceived to mimic the activities of human being more naturally. The major role played in the building of such computers is that of artficial neurons. This architecture in known as Neural Network Architecture which can be applied in fields like Computer Vision and Speech Recognition. This will enable the computer to perform the mundane tasks which a child can do better but a computer can not do normally.

Aquatic animals are of numerous type. For each type different shapes and sizes are factors to be considered regarding its classification and many other uses. There may be a prototype for such classification but due to some reason or the other all the factors may not be available (like hazzy pictures collected from under water photography, an unusual or unfamiliar pattern etc.). At such a situation

conventional classification may not be helpfull and manual attempts will not be good enough to yeild satisfactory results. Here we can use the computers through neural network technique which can take care of all these factors due to its clustering capacity. We have made use of the Kohonen Network principle to exploit its clustering capacity which supports "Winner Take All" strategy.

Section 2 contains the description of Kohonen Neural Network. Section 3 has experimental values and Section 4 depicts the Results and Section 5 Conclusion.

2. KOHONEN NEURAL NETWORK:

Neural network is the network of artificial neurons where these neurons work like individual processors. In a simple neural network we has an input layer and an output layer consisting of neurons only. The input layer consists of input database and the output layer gives the output database. The input database is supplied with relevant weight functions and after the required number of cycles it gives the output which accomodates the idea of "Winner Take All" as in the Competetive Learning method. Here the maximum value is jointly considered towards the output or we can say node with largest activation level is declared to be the winner in the

competetion suppressing all other nodes to zero activation level. During learning this node along with its neighbours tried to study the current input pattern. For this we use the formula

$$\Sigma o_{ji} = \Sigma w_j x_i \qquad (1)$$

where o_j is the activation level of unit j, x_i is the input vector and w_j is the weight vector of unit j. Equation (1) can be written as

$$\Sigma O_j = \Sigma W_j X \qquad (2)$$

where vector O is the activation level, X the input vector and W the weight vector in a matrix. The training or learning is done by adjusting their weight vectors according to the following formula containing the New Weight Vector, Old Weight Vector and Input Vector

$$(W_{new} - W_{old}) \; \alpha \; (\text{Input} - W_{old})$$

$$\text{or } W_{new} = W_{old} + k\,(\text{Input} - W_{old})$$

$$\text{or } W_{new} = W_{old} + k\,(I - W_{old}) \qquad (3)$$

where k is the gain constant or learning rate which is the change in weight vector for a given output neuron and will have a value between Ø and 1. It is obvious that the winner's weighter vector generates the largest dot product with the input vector and thus the winning weight vector becomes closest to the input vector. Due to such Kohonen Learning the winning vector will be similar to the input vector.

3. EXPERIMENTS:

Recognition of patterns collected from under water shooting is difficult due to noised pictures. Again pictures received due to moving photography give confusing idea about a pattern. For exact classification of different types of aquatic animals needs a lot of skill as well as time. Human being has tried to do so manually so far. However due to the limitations in knowledge accurate classification or recognition may not be possible. But by the use of a computerised Knowledge Base of aquatic animals and applying the technique of Neural Network we can get a much better result.

We are on an attempt to recognise the pattern involved in a prototype fish assuming it to be a digitised data. The inputs are fed to each of the neurons in the Kohonen layer where this neuron determines its corresponding output according to the weighted sum formula as in equation (1). The weight with inputs is normalized and set to 1. The neurons with the largest output is the winner with its final output being 1. Here the network gets trained recognizing the input. Prototype of the fish is represented by a 9 x 9 grid of pixcels where blackened boxes represented value 1 and empty boxes represent value 0 leading to finer details.

4. RESULT:

We have done a pattern recognition of a prototype fish, the pictorial output being presented in Fig. 1. This figure shows both the initial state and final state output with corresponding weight vectors. Table 1 gives the numerical output describing the number of cycles used, the pattern, the winner index, the neighbourhood size and the average distance per pattern upto permissible average distance 0.001.

5. CONCLUSION:

The study on pattern recognition of a prototype fish is done here. This technique can be applied in a modified form to make a study for other types of aquatic animals and fossiles by getting the digitised picture value of those and making a knowledge base repsrentation for the same using neural network technique as done here.

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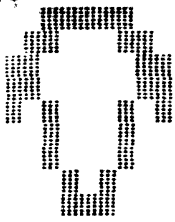
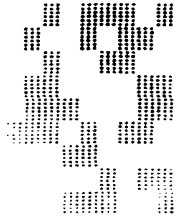
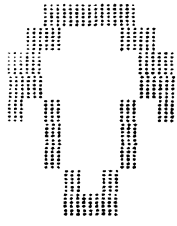
followed by a Kohonen (output) layer

81 81







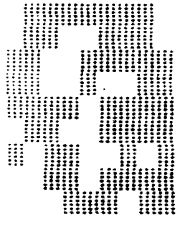


Figure - 1

Table - 1

cycle	pattern	win index	neigh_size	avg_dist_per_pattern
0	0	24	5	100.000000
0	1	24	5	100.000000
1	2	24	5	1.100846
1	3	24	5	1.100846
2	4	24	5	0.662925
2	5	24	5	0.662925
3	6	24	5	0.504549
3	7	24	5	0.504549
4	8	24	5	0.459917
4	9	24	5	0.459917
5	10	24	5	0.449400
5	11	24	5	0.449400
6	12	24	5	0.447236
6	13	24	5	0.447236
7	14	24	5	0.446904
7	15	24	5	0.446904
8	16	24	5	0.446916
8	17	24	5	0.446916
9	18	24	5	0.446963
9	19	24	5	0.446963
10	20	24	5	0.446997
10	21	24	5	0.446997
11	22	24	5	0.447015
11	23	24	5	0.447015
12	24	24	5	0.447025
12	25	24	5	0.447025
13	26	24	5	0.447030
13	27	24	5	0.447030
14	28	24	5	0.447033
14	29	24	5	0.447033
15	30	24	5	0.447034
15	31	24	5	0.447034
16	32	24	5	0.447034
16	33	24	5	0.447034
17	34	24	5	0.447035
17	35	24	5	0.447035
18	36	24	5	0.447035
18	37	24	5	0.447035
19	38	24	5	0.447035
19	39	22	5	0.447035
20	40	29	5	0.447035
20	41	23	5	0.447035
21	42	29	5	0.312924
21	43	22	5	0.312924
22	44	29	5	0.219047
22	45	22	5	0.219047
23	46	29	5	0.153333
23	47	20	5	0.153333
24	48	29	5	0.107333
24	49	21	5	0.107333
25	50	29	5	0.075133
25	51	19	5	0.075133
26	52	29	5	0.052593
26	53	20	5	0.052593
27	54	29	5	0.036815
27	55	20	5	0.036815
28	56	29	5	0.025771
28	57	20	5	0.025771
29	58	29	5	0.018039
29	59	19	5	0.018039

30	60	29	5	0.012628
30	61	19	5	0.012628
31	62	29	5	0.008839
31	63	19	5	0.008839
32	64	29	5	0.006188
32	65	19	5	0.006188
33	66	29	5	0.004331
33	67	19	5	0.004331
34	68	29	5	0.003032
34	69	19	5	0.003032
35	70	29	5	0.002122
35	71	19	5	0.002122
36	72	29	5	0.001486
36	73	19	5	0.001486
37	74	29	5	0.001040
37	75	19	5	0.001040

APPLICATION OF SPREADSHEETS IN DATA ANALYSIS

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INTRODUCTION

There are several spreadsheet packages available in the market, which are very much useful for decision making, statistical data analysis, graphical presentation, regression analysis, linear programming, etc. The most widely used packages for spreadsheet application are LOTUS 1-2-3, VISICALC, SUPERCALC, EXCEL, QPRO, etc. An electronic worksheet is a computer based version of manual worksheet. It is a class of computer software that arranges and stores interrelated values in a matrix form, which finds its application in statistical and mathematical problems.

EVOLUTION OF ELECTRONIC SPREADSHEETS

The most significant factor in starting up a trend towards business microcomputing was the introduction of electronic spreadsheets/worksheets. Prior to 1980, all the worksheet analyses were done manually. This meant, construction of a number of worksheets, each pertaining to a possible situation. Not only that, because of the strong inter-relationship among data items, change in one value meant reconstruction of entire worksheet.

In 1979, Danniel Bricklin, a graduate student at Havard Business School and Robert Franktson, a computer programmer developed VISCICALC, short for "visible calculator", to take care of the manual worksheets. They modified their program to run on a new computer APPLE II, which had an effective operating system and disk drives for data storeage. This software-hardware combination of VISCICALC and APPLE proved to be very useful in business offices and thus brought about microcomptuer revolution. Subsequently, many other versions of electronic worksheets came into the market, not only for micros but also for mini and mainframe computers. Of these, Supercalc and Micropro gained a lot of popularity. Supercalc was developed by Sorcim and Micropro by Calcstar. These software pakcages went beyond the capabilities of Viscicalc. As business decision makers started using these packages, there was a demand for more user-friendly packages which would support more powerful functions, aid pictorial representaiton of data (in form of charts, etc.) and provide database support.

CAPABILITIES OF SPREADSHEET

Most of the software packages available in the market do only one kind of processing e.g. dBASE III PLUS helps in managing data, WordStar does only word processing. Spreadsheet package on the other hand, in addition to its main functions of electronic spreadsheet performs database functions, has graphic capabilities and powerful file handling functions. All these capabilities make spreadsheet package very powerful. Spreadsheet packages are highly user-friendly in the sense that the user does not have to remember commands as these packages are menu driven. In an invoked menu, one line explanation for the highlighted menu item is also given, which enhances the ease of use of commands in packages. Most of the commands can be invoked by one or two keystrokes. These packages also provide on-line help which can be availed of by pressing the function key F1. For those who have been preparing/using the manual worksheets, electronic worksheet is easy to comprehend because it is exactly on the pattern of the manual worksheets. Further an electronic worksheet makes the working much faster and simpler. Also in a manual worksheet, if an error is made corrections have to be carried out in all the figures using this value. Firstly, it means reconstructing the worksheet and secondly, the scope of error is high in manual reconstructing. If we change any value in an electronic worksheet, all the formulas using that value are automatically recalculated, thus enabling us to observe the results of changes in a particular parameter and leaving no scope for error. If the value of a particular parameter is changed the result can be easily, accurately and quickly observed. The automatic recalculation comes as a handy tool in decision making. The case of plotting graphs (XY-graph, bar graph, pie chart, etc.), comes as a handy tool for observing the trends, the impact of one or more variables on other etc. The data handling functions include sorting of data, generation of frequncy distribution. The graphs help in illustrating the behaviour of the data. For example, the dependence of two variables on each other, i.e. how one changes with a change in other; how different variables behave over a period of time, etc. With the help of graphs, these behaviours are brought out more clearly. The graph types are briefly explained below :-

Line : In a line graph, all the data values of a range are plotted along the Y axis and joined with a line.

XY : In XY graph, one data range falls along X axis and a corresponding data range along the Y-axis. This graph type is used to illustrate the dependence of one data range on the other, i.e. how one data value changes with the other.

Bar : Each data range in a bar-graph is presented as a bar along the Y -axis. A maximum number of six data ranges can be presented in the same graph. For the same point on the axis, each of the bar chart belonging to a different data range is displayed along the side of the other.

Stacked Bar : The display is similar to the bar graph but the bars are not displayed along the side of the other but stacked on top of each other.

Pie : In one pie chart, only 'one data range' can be displayed. The display is in the form of a circle of which, each portion displays percentage of one data value.

In spreadsheet pakcages numerous built-in functions under the categories mathematical, statistica, string, financial, statistical-database, date-time, etc. are available. These functions provide a lot of strength to the user to carry out work of any complexity. In spreadsheet packages micro programming allows user to write his own programs to carry out specific tasks of repetitive nature or write programs for users who are not so well conversant with programming, which makes the package very powerful for statistical data analysis. These packages are also compartible with other software packages by which data import/export can be done. This facility makes the spreadsheet packages more powerful and easier for use, which saves the time of re-entry of data in other packages.

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DATA ANALYSIS THROUGH COMPUTERS BY STATISTICAL & GRAPHIC TOOLS

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INTRODUCTION

Statistics is the mathematics of experiments. Experiments are conducted with the object of answering some questions. The answer can be seen before the results have been subjected to some form of analysis. In biological experiments, the influence of any factors other than those whose investigation forms the reason of the research are seen. Some of these disturbances may be traced to know on partially known causes, but majority are unaccountable and consitutute sources of potential error in the interpretation of the results. Now statistical methods have become indispensible tools for collection and interpretation of all kinds of data. There is hardly any scientific or economic or social human activity in which statistical techniques have no role to play.

DEVELOPMENT IN COMPUTATIONAL STATISTICS

The advances in theory are made by the mathematicians/ statisticians in order to derive better inferences from the available data. This involves complex computational procedures dealing with voluminous data. Hence, use of calculating machines like calculators, computers etc. becomes essential. Advent of comptuers is a boon for this work. The relatively recent widespread use of computers has had a tremendous impact on biostatistical analysis. Development in computer architecture and programming languages result in friendly and easy to use packages for statistical data analysis. By this the researcher finds more time to concentrate on his\her problems other than spending time after computers for data analysis. The necessity to perform long and complex arithmetic computations as a part of the statistical analysis of data lives only in the memory of those researchers and practitioners whose careers antedate the so called "computer revolution".

Ready made and user-friendly software packages are available for performing most of the descriptive and inferential statistical procedures for the average investigators. Some widely used statistical data analysis packages are (i) IMSL (International Mathematical & Statistical Library) (ii) SPSS (Statistical Package for Social Sciences) (iii) SAS (Statistical

Analysis System) (iv) Minitabs, etc. These packages differ with respect to input formats and the specific calculation they will perform. Once an appropriate program has been located, its input requirements should be studied carefully prior to entering the data. Finally, the program's output form is studied so that proper interpretation of the results can be made. Sometimes, persons who have studied a computer language, develop their own programs for their use.

Available Resources in most Statistical Analysis Packages:

The most commonly used statistical tools available in almost all packages with their brief function are described below :

Tools	Brief description
a) Descriptive Statistics:	Calculates Arithmetic mean, Standard Deviation, Variance, Coefficient of Variation, Standar Error, Maximum, Minimum, Sum, Su of Squares, Deviation Sum o Squares, Moments about mean Skewness, Kurtosis, Norma Distribution goodness of fit test.
b) Frequency Distribution:	Gives us frequency distribution fo grouped as well as individua values.
c) Hypothesis Test for Mean:	Mean vs. hypothesised value difference between means an difference between two group mean are computed here.
d) Analysis of Variance:	Calculates analysis of varian (ANOVA) for one-way, two-way three-way classification models.
e) Linear Correlation:	Here correlation matrix for a da set is calculated.
f) Regression Analysis:	Linear as well as multip regression is computed.
g) Time series Analysis:	
h) Non-parametric Statistics:	Wald-Wolfowitz runs test, Wilco rank sum test for two groups Kruskal-Wallis test, Kolmogoro Smirnov test, Wilcoxon signed ra test, absolute normal scores tes Friedman test, Kendall coefficie of concordance, Sign test, Fish exact test, Spearman rank-ord correlation.
i) Chi-square tests:	Goodness of fit is tested.
j) Others:	Permutation/ Combinati Probability Distributio Hypothesis test, Duncan's Multip Range Test (DMRT), Bartlette's te for homogeneity etc.

GRAPHS

Diagrams and graphs with statistical analyses show the purpose of separating the relevant from the irrelevant in the data. Previously, graphs were plotted by the cartographers with the help of graph paper manually. But presently most of the statistical packages have their own graphics features so that the data entered for statistical analysis can also be used for graph plotting. The use of graphic packages has increased quite significantly and the leading software houses like LOTUS, Microsoft, Word Perfect, Corel, Borland, Software Publishing, etc. offer different types of packages with attractive designs and features.

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AQUACULTURE

CIFA - IN THE SERVICE OF THE NATION

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INTRODUCTION

Indian freshwater aquaculture has become an important sector of the Indian fisheries in the recent years, contributing one-third to the country's total fish production of over 49 lakh tonnes. With rich resources both in terms of water sheets as well as fish/shellfish species, the sector is receiving increasing investments. The freshwater aquaculture resources of the country amount to 2.25 million hectares of ponds and tanks and 1.3 million hectares of beels, jheels and derelict water, in addition to 0.12 million tonnes of carps and 3 million hectares of reservoirs that could be put to different fish culture practices or even culture-based capture in case of large water sheets. The sector with its present contribution of over 1.5 million metric tonnes of fish/shellfish worth over Rs.4000 crores has a potential of producing over 4.5 million metric tonnes annually if the available technologies are fully adopted and transfer of know-how and provisions of material inputs, properly organised.

CULTURE SYSTEMS

Being basically a carp country, Indian freshwater fish production mainly comprises the indigenous and exotic carps, viz., catla, rohu, mrigal, silver carp, grass carp and common carp. A host of culture systems are presently in vogue : i) Polyculture of Indian carps alone (mixed farming) or Indian and exotic carps together (composite carp culture) : a) Fertilisation and feed-based system, b) Wastewater-based system, c) Biogas slurry - based system, d) Aquatic weed-based system, e) Agriculture/horticulture-based system, f) Livestock-based system or integrated fish farming; ii) Mono and polycutlrue of air - breathing fishes; iii) Mono and polyculture of freshwater prawns; iv) Cage culture; v) Pen culture; vi) Running-water fish culture; vii) Recirculatory filtering system (open/closed); and viii) Molluscan/Pearl culture.

The culture systems are highly varied to suit the input availability in a region as well as the investment capabilities of the farmer. In extensive aquaculture in comparatively large water sheets (20-25 ha), only stocking of the fish species is carried out and the harvest is the result of the utilisation of normal productivity of the waters. In semi-intensive culture practices, elements of fertilisation and feeding are introduced

to sustain and supplement the natural productivity. In intensive culture systems, supplementary feeding is the only means of sustaining the production while super-intensive systems employ the use of balanced diet together with intensive aeration and water replenishment.

With carp culture being the main fish culture activity, the different culture systems that have been standardised with minimum achievable production rates are composite carp culture (4-6 g/ha/yr), sewage-fed fish culture (3-5 t/ha/yr), weed-based polyculture (3-5 t/ha/yr), biogas slurry-fed fish culture (3-5 t/ha/yr), integrated fish farming with poultry, pigs, ducks, horticulture, etc. (3-5 t/ha/yr), intensive pond culture with feeding and aeration (10-15 t/ha/yr), pen culture (4 t/ha/yr), cage culture (10-15 kg/m^2/yr) and running-water fish culture (20-50 kg/m^2/yr).

Integrated fish farming is a diversified and coordinated system of producing fish and agricultural/livestock produce in fish farms with fish as the main component for maximal utilisation of land/water through recycling of water and byproducts, reduced application of fertilizers and feeds and maintenance of a balanced ecosystem. Paddy-cum-fish culture is a well known practice in the north-east and eastern India with production possibility of about 1 tonne fish with 5-6 t paddy/ha/yr.

AQUACULTURE INFORMATICS

The role of information technology in the recent developments of science and technology needs no emphasis. The information on global research that had to be obtained through books and journals two decades back, is now available at the finger tips through the electronic media. Bioinformatics, an area of interaction between the life sciences and the information technology, as it is known, has contributed greately to R&D in freshwater aquaculture.

The different databases in aquaculture, like the ASFA, Fish Base, etc. brought through CD-ROM have provided the researcher ready information on intricate aspects, enabling modification of research findings elsewhere in the world to Indian conditions or initiation of new lines of work to increase aquaculture productivity. Networking in different disciplines is being accorded priority, as a means for effective collaborative research for avoiding repetitive work and achieving higher productivity.

CIFA - IN THE SERVICE OF THE NATION

The Central Institute of Freshwater Aquaculture has its beginnings in the Pond Culture Division of the Central Inland Fisheries Research Institute which was established at Cuttack, Orissa, in 1949. The Division was later upgraded as Freshwater Aquaculture Research and Training Centre (FARTC) established at Bhubaneswar in 1976 with UNDP/FAO assistance. Further, the centre attained the status of an independent institute under the reorganisation plan of ICAR during 1986 and the functional existence of the Institute came into effect on 1st April 1978.

The Institute has, as per the mandate, been engaged in research in freshwater aquaculture, in the disciplines of Production Technology, Soil-Water Environment, Fish Genetics, Fish Nutrition, Fish Physiology, Fish Pathology, Aquaculture Engineering, Aquaculture Economics and Statistics, and Aquaculture Extension, as thrust areas, along with training of manpower and extension. The Institute, being a Regional Lead Centre for Carp Farming under the Network of Aquaculture Centres in Asia-Pacific (NACA), has hosted three UNDP/FAO programmes and the Project on Centre of Advanced Studies (CAS) in Freshwater Aquaculture, in collaboration with the Orissa University of Agriculture and Technology, Bhubaneswar, provides for M.F.Sc. and Ph.D. degrees. The Institute offers training programmes in different aspects of freshwater aquaculture and has conducted seminars/workshops at frequent intervals. Along with the Extension Section, the Institute also has the provision for transferring the different technologies through the KVK/TTC at Kausalyaganga. Thus, the Institute is carrying out different aspects of research, training and extension in freshwater aquaculture, fulfilling the objectives.

The Institute has generated several technologies that have paved way for the new enterprises and much of the new developments in freshwater aquaculture sector have been catalysed by the achievements of the Institue. Having achieved high carp production levels of 17 tonnes/ha/yr, the Institue is presently formulating a national plan for freshwater aquaculture development on a district level basis for raising national productivity to 5 tonnes/ha/yr. Intensification and diversification of aquaculture systems with mixed culture of different species, organic recycling for sustained productivity, integrated aquaculture management, etc., are being promoted. Greater emphasis is being laid on technology transfer through intensive training programmes, Operational Research Project, on-farm demonstrations, consultancies and publications. Freshwater aquaculture holds the key for increasing fish production in the country in the years to come and CIFA is playing its role in increasing productivity on a sustained basis.

INDUSTRIAL AQUACULTURE BY RECIRCULATORY AND FLOW-THROUGH SYSTEMS

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INTRODUCTION

Fish is an important source of easily digestible animal protein which can reach the poorer section of the population. Production from capture fishery from seas, rivers, reservoirs etc. is not promising, providing more or less stagnated yield during last 1 or 2 decades. Therefore, to increase fish production, like many ohter countries around the world, India has also given considerable thrust for the development of scientific aquaculture for increasing fish production. To obtain maximum yield per unit area or unit volume of water many countries in the world are busy in developing intensive and superintensive aquaculture systems. In India also the successful trials have been made first time at the Central Institute of Freshwater Aquaculture, Bhubaneswar for the development of super intensive fish culture technologies through the Recirculatory system and the Flow-Through System.

RECIRCULATORY SYSTEM

The Aquaculture Engineering Division of the Central Institute of Freshwater Aquaculture (CIFA) designed and installed a recirculatory system of 5 m^3 water holding holding capacity. The system consisted of the following units :

a) Two FRP tanks of rectangualr shape having water holding capacity of 2.5 m^3 each for intensive culture of Indian Major Carps.

b) One biofilter of 0.33 m^3 capacity with filter media of 0.45 m depth (0.15 m each of stone chips of 12 mm size, charcoal and shell having void fractions of 0.66, 0.49 and 0.53 respectively) for cleaning the metabolites of used water from the intensive culture tanks.

c) A ferro-cement tank of 800 litres capacity installed in a position to collect clean water by gravity from the biofilter.

d) One 500 litres capacity FRP over head tank to provide adequate head for supply of clean water into the intensive culture tanks by gravity.

e) A monoblock pump fitted with 0.5 HP electric motor connected with an automatic water level guard switch for intermittent operation as per requirement for pumping clean water into the overhead tank.

f) In order to facilitate high density culture the arrangements were made for aeration of water with the help of an air-compressor fitted with 0.5 HP electric motor. The air-compressor was connected with an auto pressure control switch for intemittent operation for constant supply of air.

All these units were properly connected with well designed piping network and controllable valves for efficient functioning of the system (fig.1).

Short term raring experiments were conducted in the system by culturing the Indian Major Carps, particularly rohu (Labeo rohita) and mrigal (Cirrhinus mrigala). Both the species grew very well with a very high stocking desnity of 4 lakhs/ha(40/m^2). Rohu grew to an average weight of 366 g each within a period of 3 months when stocked with an initial average weight of 219 g each in the system. The rate of recirculation of water was 151/min for 5 m^3 water holding capacity. Feeding was given in trays with pelleted feed at 2% body weight per day in two equal instalments. The feed used was a formulated diet having a protein level of about 35%. Rohu registered an average daily weight gain of 1.6 g when stocked at 8.76 kg/m^3. Another Indian Major carp, mrigal (Cirrhinus mrigala) was stocked at a density of 4 lakhs/ha (40/m^2) with an average weight of 48.6 g each and cultured for a period of 4 months. The fishes grew to an average individual weight of 167.5 g registering an average daily weight gain of 0.91 g by each fish. The water quality of the system is monitored and maintained favourable for fish growth by recirculating water through the biofilter at the rate of 15 l/min. The metabolite level is effectively controlled by the biofilter by reducing the average ammonia nitrogen level from 0.25 mg/l to 0.15 mg/l.

This system has shown a promising future for the development of industrial aquaculture in metropolitian cities where fish can be growth within a very limited space and also in the desert areas where water is a very scarce commodity. The experiments have shown a net production of about 150 tonnes of quality fish per hectare per annum providing a tremendous scope of increasing fish production through industral aquaculture. Since the metabolities are cleaned totally through the biological means and no chemical is used at any stage, the system is alao evnironment frieldly. This was also first ime established that rohu and mrigal can be grown totally on artificial feeding.

FLOW-THROUGH SYSTEM

A flow-through system consisting of 27 tanks each of about 10 m^3 capacity is designed and installed by the Aquacultural Engineering Division of the Central Institute of Freshwater Aquaculture (CIFA). The system is having an arrangement of controllable water supply at each point from the nearby irrigation canal (Kanas Branch Kanal) so that each tank can have a running water flow up to 20 l/sec. Inlets and outlets of water into and from the tanks can be regulated either from bottom of the tanks or from the upper level of the tank having total water depth of average 1 m. Constant water depths are maintained by using an overflow arrangement through the control pits. The flow is regulated through the controllable valves (fig. 2). If desired, the discharge water can either be drained into the drainage system of the farm or can be passed through the adjacent ponds for reuse. Arrangements, also have been provided for recirculation of water through two nos of nearby ponds, with the help of portable diesel operated pumps, if so desired, during the lean period of canal water supply due to reparis/maintenance and other regulatory measures. Further arrangements have also been made for supply of water into the flow-through tanks from the adjacent reservoir as well as from the nearby open well during the lean period of the canal water supply. The culture tanks have necessary provisions of screens so as to avoid entry of any predator fish and also to avoid any escape of the culture animals; but the metabolites as well as sediments can be washed away by the constant running water flow.

A number of experiments were conducted for raising table size fish in the flow-through system with the varying stocking densities, ranging from 0.5 to 4.0 lakhs/ha. The highest production then achieved was 59.1 t/ha/yr (net), with a stocking density of 4 lakhs/ha with a linear relation between the stocking density and production rates. In these experiments a maximum biomass of 7.35 kg/m^3 of Indian major Carps was maintained in the system, with favourable water quality standards.

The recent fish production experiment was conducted by stocking Catla, Rohu and Mrigal at a ratio of 1:8:1 and with a high stocking density of 5 lakhs/ha having three different flow rates of 3, 6 and 91/sec in each tank of about 10 m^3 capacity. After three months of culture net average productions achieved 90.9, 94.7 and 100.9 t/ha/yr at the flow rates of 3.0, 6.0 and 9.0 l/sec respectively. The experiment was conducted in duplicate and the survivability obtained was above 95% in all cases. The fishes were healthy and there was no external sympton of disease. Their growth followed the cube law and there was no significant differences in their growth between the species. Environmental factors, such as DO, Ammonia, Carbon dioxide etc. are not found to be of concern in any of the above cases. The maximum holding biomass was calculated to be 8.12 kg/m^3 and the net biomass gain was in the range of 2.43 to 2.91 kg/m^3 over the

culture period of three months. The experiment showed that there existed linear relationship between the flow rate and the net biomass gain.

For the production of juveniles of Indian Major Carp fingerlings of Catla and Rohu at the ratio of 2:8 were stocked at a density of 6 and 8 lakhs/ha in two cistern and the experiment was conducted in duplicate. The initial stocking size of Catla and Rohu was 8 g and 4.9 g respectively. After culturing for a period of 3 1/2 months Catla and Rohu ;grew to an average size of 43 g and 35 g respectively with a survival rate of 70-75%.

This system is highly efficient for intensive aquaculture and also highly suitable for places where flow-through arrangement can be achieved by gravity. Particularly below the dams and other river vally projects where part of water can be diverted through this system for obtaining high production of Indian Major Carps profitably. The discharge water from this system can again be utilised for usual purposes of the river valley project. Therefore, from the same water source an addition very good income can be obtained. Similarly, water source from canals, streams and springs can also be utilised for the additional purpose of highly suitable super-intensive aquaculture.

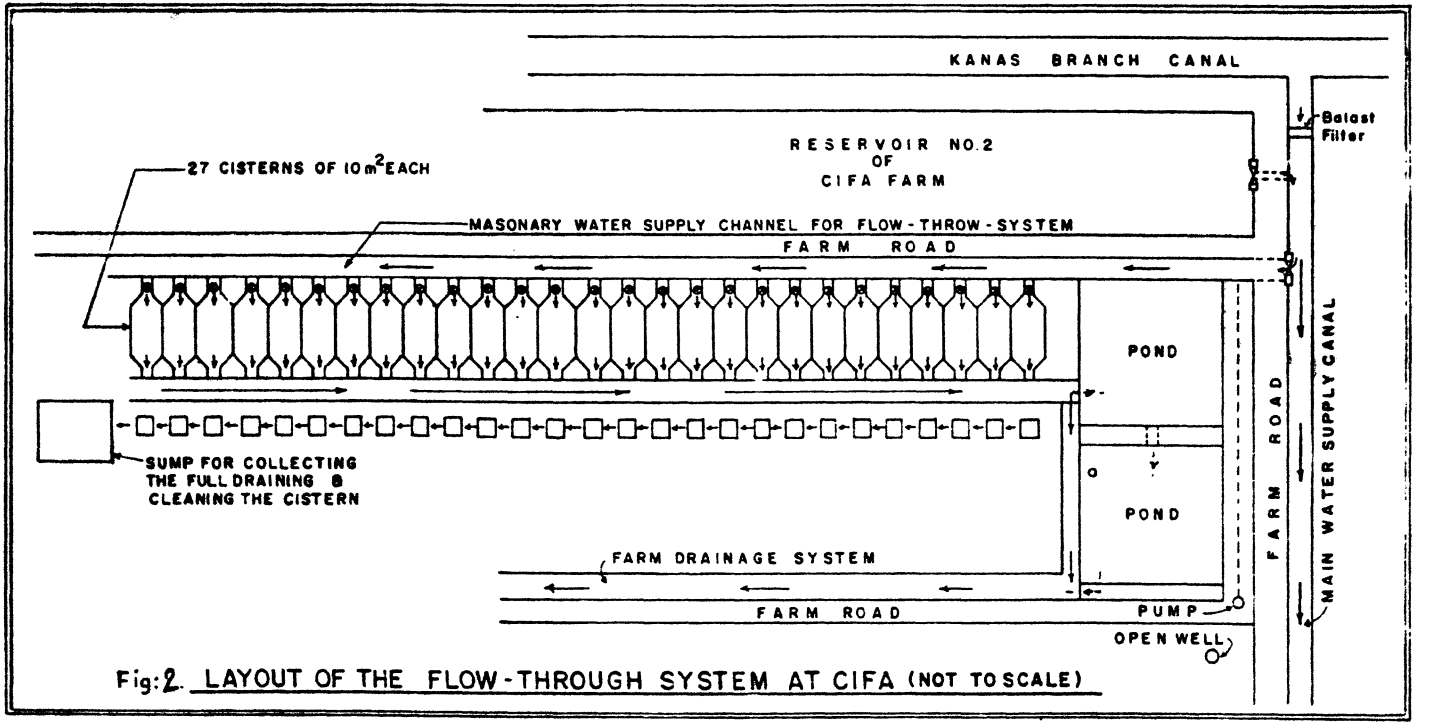

Fig: 2. LAYOUT OF THE FLOW-THROUGH SYSTEM AT CIFA (NOT TO SCALE)

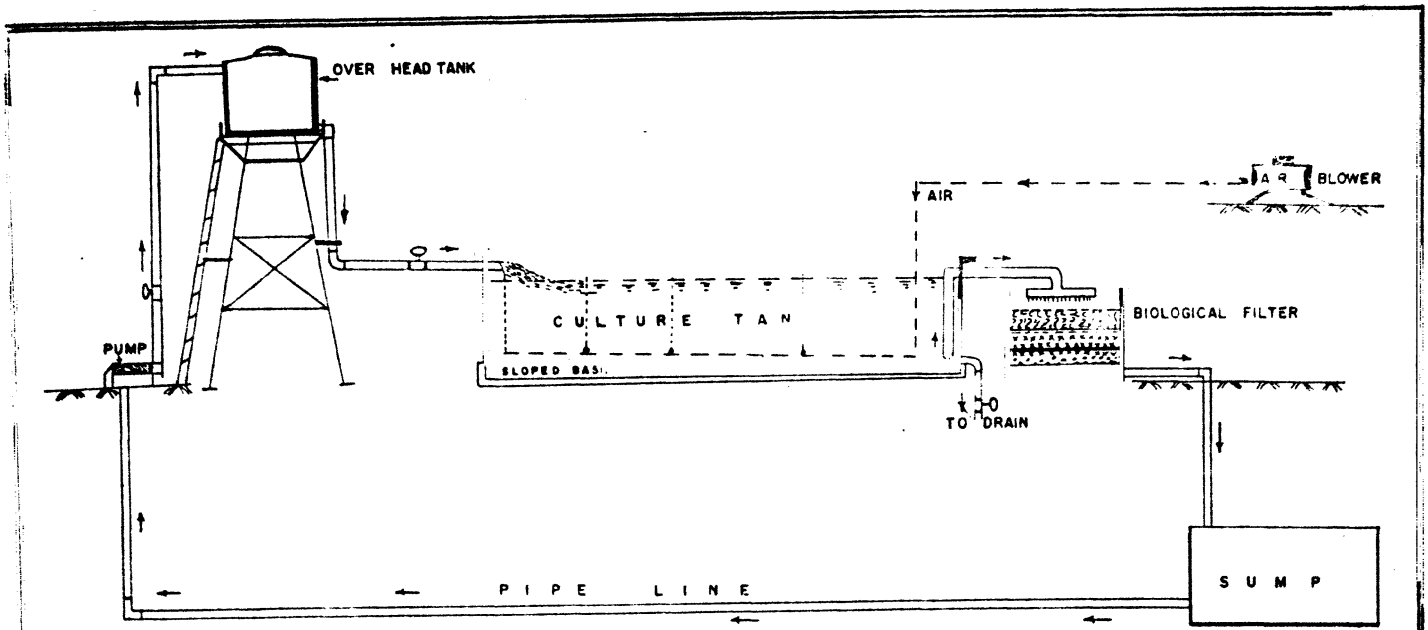

Fig:1. SCHEMATIC DIAGRAM OF A CLOSED-LOOP RECIRCULATORY SYSTEM.

ROLE OF GENETICS IN ENHANCING AQUACULTURE PRODUCTION

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INTRODUCTION

During the past decades India has achieved self sufficiency in food production. However, in view of the growing population of our country it is imperative to step-up the food production from all the concerned sectors in the country with no exception of aquaculture sector. The role of genetics in the Agriculture sector and the Animal husbandry to evolve high yielding varieties with regard to crops and milk and egg output respectively is well knwon. In aquaculture too, with the development of certain technologies, the production rates have been raised to lucrative levels during recent past.

However, whether it is in the case of high yielding varieties in agriculture or in the intensive multispecies culture for obtaining higher production of fish in aquaculture, application of heavy organic/inorganic fertilizers and use of pesticides/weedicides have to be resorted to attain the goal. These activities may gradually contribute to the deterioration of the culture medium on the environment.

Coming to the aquaculture senario, which the extensive culture technologies already developed are quite catering to the needs of marginal farmers, industrial aquaculture requires a technology that could yield a sustainable higher productions. For this, the most effective means, is to improve the biological abilities of our candidate species through genetic upgradation. There are different ways in this, depending on the species and its biological activities. An account of the most important ones is given below :

HYBRIDIZATION

Hybridization is one of the simple means of bringing about some kind of improvement in the progeny through interspecific or intergeneric crosses. The former is between the species of the same genus and the latter is between the species of two different genera. For example the hybrids crosses between the species of the genus Labeo i.e. Labeo rohita x Labeo calbasu and the reciprocal or L. rohita x L. bata and L. rohita x L. gonius come under interspecific hybrids, while those between L.

rohita x Catla catla and the reciprocal or C. catla x Cirrhinus mrigala and the reciprocal hybrids are known as the intergeneric hybrids.

Of the interspecific hybrids, the hybrids of calbasu-rohu and the reciprocals are highly viable and grow faster than calbasu. Similarly the intergeneric hybrids of Rohu - catla and Catla - mrigal are also highly viable and grow faster than one of the parents (rohu or mrigal)

Intergeneric hybridization also some times produce sterile individuals as in the case of common carp female x rohu or catla males, or even spontaneous natural gynogens as in the case of the grass carp female x silver carp male hybrids.

Whether it is of interspecific or intergeneric, the hybrids usually posses intermediate traits to their parent species, generally dominated by the maternal traits and some times the paternal traits too.

Some advantages of the above mentioned hybrids are that they grow faster than their slwo growing parent and posses more flesh content than the parent species. The sterile hybrids between common carp and Indian carps are useful for aquaculture not only for their more flesh content but also due to their inability to reproduce unlike common carp which breeds in the ponds and over-populates the culture medium.

Some times intraspecific hybridization between the strains of the same species with genetic diversity may also result in progeny with better adoptability and other heterosis effects as in the case of intraspecific hybrids between different strains of common carp.

SELECTIVE BREEDING

Selective breeding is a classical approach for stock improvement by evolving genetically improved superior brood stock for the production of quality fish seed. Through selection, strains with better rate of survival and growth, resistance to disease can be developed besides improvement in the quality of meat.

The other modern genetic tools for the development of improved varieties are the genome manipulation and gene transfer techniques. These come under the biotechnology.

Though genome manipulations or chromosomal engineering the genome of a given individual (fish) can be changed by eliminating the genetic input from one of the parents and replacing it with another set of chromosomes, either by preventing the reduction division in the egg (meiotic gynogenesis) or by blocking the first cleavage in the zygote

(mitotic gynogenesis) or by duplicating the chromosome sets (dispermy) leading to androgenesis.

While gynogenesis usually results in all female progeny where female homogamety exists, androgenesis given raise to all males. Gynogenesis and androgenesis have their own applied values. Gynogenesis is useful to increase production by producing all females in those species where females grow faster than the males. Similar is the case with androgenesis. Good heterosis effect for growth may be also possible by top-crossing the gynogen individuals with the normal ones.

Alteration of ploidy by the addition of one or more chromosome set(s) is also possible through genome manipulations leading to triploidy or tetraploidy as the case may be. These ploidy alterations are mainly aimed at producing triploids which in turn may become sterile individuals. Sterility has varied utility in aquaculture such as to prevent over population caused due to prolific pond breeding habit (tilapia or common carp), controlling weeds in open waters (grass carp). In some species sterile individuals may grow faster than the fertile ones. Tetraploids, though exhibit low survival, are fertile and may be useful to produce triploids on large scale by crossing with normal diploids.

GENE TRANSFER OR GENETIC ENGINEERING

Gene transfer is another novel technique in which the gene of specific interest is isolated, cloned and introduced into another for an improved performance in terms of better growth, resistance to disease and adverse environmental situations. The technology is relatively very young even in fishes but appears to hold good promise.

CONCLUSION

The technologies so far developed and available for higher fish production are mainly based on species ratio and stocking density manipualtions and other management practices. For any further improvement in the production levels it is very essential to genetically improve the stocks of over cultivated species of fish. In fact, development and use of genetically improved seed inputs clubbed with the already developed intensive culture technologies is very essential to obtain sustainable higher yields from aquaculture during the coming years.

INTENSIVE CARP POLYCULTURE

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Freshwater fish farming has taken up great attention now-a-days for adopting scientific pond management methods in the fish cultural practices. Carps being the major food fishes continue to be the single dominant group in our domestic market accounting for almost 70%. Improved management practices evolved through R&D efforts have contributed the increase fish production rates from 600 kg/ha/annum from traditional practices to 4-6 tonnes/ha/annum. A production level of 15 tonnes/ha/year have already demonstrated at CIFA when the national average productivity level stands to 1829 kg/ha/year and in FFDA farmers ponds at 2105 kg/ha/yr. With vast resources, suitable technologies and contribution through R&D efforts there is an immense scope for a manifold increase in fish production.

The principle of carp polyculture system are the judicious use of efficient fish species of complementary feeding habits and bahaviour for tapping the maximum production potential of the pond by utilization of all the available niches in the pond echosystem for a sustainable yield.

Scientific carp culture involves the stocking of fast growth fishes which efficiently utilize both natural and supplementary fish food without any competition between species. It also include the scientific manipulation in the number and size of fish species stocked in respect to area during the course of culture besides production of natural fish food by pond fertilization, provision of nutritious supplementary feeds and proper water quality and quantity management.

Though notable success has been achieved in spawning of carps and seed production, the rearing technology needs improvisation through better management. The major diversification on this line is the introduction of multi-tier rearing systems in fish culture.

The aquaculture practices currently being adopted can be grouped as extensive, semi-intensive and intensive. In traditional forms of fish farming, the fish seed collected from natural sources or from a seed farm are stocked for table size fish and are harvested using conventional fishing methods. The contribution of natural food is significant in these systems. Production rates of carps in these extensive culture is arround 1-5 tonnes/ha/year depending on the level of inputs used.

In semi-intensive aquaculture system, the rearing is done in ponds and pens where controlled use of nutrients from

decomposing organic matter is used for a larger part of fish production along with appalication of supplementary feeds. In these farming the yield of fish is in the range of 3-10 tonnes/ha/year depending on the level of inputs.

Intensive aquacultur etechnologies have as their main component of higher stocking densities and stockign sizes, provision of supplementary feeds and maintenance of optimum environmental conditions. Controlled use of nutrients from inorganic and organic materials especially the animal excreta, biogas slurry and biofertilizers has special significance. The main aspects involved being use of improved formulated feeds, more raliable water management techniques and effective aeration systems. The production from polyculture of carps in these systems ranged from 10-15 tonnes/ha/year depending on the various inputs used and the management measures.

The farming practices under scientific fish culture is to maintain the environment healthy, free from predatory and weed fishes. High plankton levels are maintained by fertilization to give natural food to fishes along with supply of protein rich artificial feeds. These measures are adapted to bring suitable and proper ecological and biological conditons in the pond to protect the fish for optimum survival and growth. Various operations involved in the farming practices are directed to meet the above objective. They are classified as pre-stocking, stocking and post-stocking management measures.

PRE-STOCKING MANAGEMENT MEASURES

Clearance of aquatic vegetation

An abundant growth of aquatic vegetation is undesirable in fish ponds as they absorb all nutrients, arresting the pond productivity, help in harbouring the predatory and weed fishes, hindering the free movement of fish and netting operations. Manual, mechanical, chemical and biological methods are used to eradicate aquatic weeds.

Eradication of predatory and weed fishes

Fishes form the preferred food of many animals. The predatory and weed fishes present in ponds also poses great problem in the survival of cultivated fishes besides competing with them for space and oxygen. Hence their complete eradication from the pond is of utmost importance in scientific pond management. Application of urea @ 100 kg/ha m followed the next day with bleaching powder 175 kg/ha m is effective to kill all the fishes. The pond becomes ready for stocking fish after 6-7 days.

Pond fertilization

Nitrogen, phosphorus and potassium are the three basic nutrients required for the growth of plankton, the preferred fish food organisms besides carbon. Their optimum requirements are 100-200 kg nitrogen, 50-100 kg P2O5 and 25-50 kg K2O per ha per year. They are obtained by organic and inorganic fertilization using raw cattle dung 10-15 t. single super phosphate 100-250 kg and urea 75-100 kg per ha per year. Initially 20% of the quantity is applied as a basal dose and the remaining as equal fortnightly or monthly instalments. Biogas slurry at 30 t/ha is a good substitute for raw cattle dung. The other biofertilizer is Azolla applied at 40 t/ha/year will supply the required nitrogen for the fish pond. Phased manuring using a mixture of deoiled groundnut cake, rice bran, slurry of animal excreta and single super phosphate gives sustainable plankton levels. To enhance the mineralization of organic matter and for prophylactic reasons lime is applied @ 200-350 kg/ha.

STOCKING

Polyculture is followed in carp farming where fingerlings of 80-100 mm are stocked. In intensive carp culture 25-50 g size is preferred to get better growth and survival. The standard stocking density is of 5000 Nos/ha and is increased in intensive culture upto 25000 nos/ha. The adjustment of species ratio is the main criteria of optimum production. Generally catla 15-20%, rohu7 20-25 %, mrigal 15-20%, silver carp 20-25%, grass carp 5-10% and common carp 20-25% is followed and adjusted every year depending on the performance of these fishes during the earlier operations.

POST-STOCKING OPERATIONS

Supplementary feeding

The natural fish food available in the pond is supplemented with artificial feed prepared out of groundnut cake 30-40%, rice bran 40-50%, soybean meal 10-20%, fish meal 3-5% and vitamin-mineral mix 0.2-1%.

The quanitity of feed per day is calculated @ 1 to 2 % for semi-intensive and 3% of fish biomass per day for intensive culture. Fishes were fed once in the morning. In intensive culture feeding frequencies are increased for better utilization of feed.

Aeration

Pond aeration is not required upto a level of production of 10 t/ha. Beyond that it becomes necessary to

aerate the fpond between 00 hrs to 6 hrs using suitable pond aerators of 5-6 nos/ha especially at the latter half of the rearing period.

Preventaion of fish disease

To prevent the entry of any pathogen or parasite in the culture system, at the time of stocking the seed is given a bath with 5% common salt or 15 ppm potassium per manganate solutions.

Pond maintenance

General daily checkup for fish behaviour, aeration, water level maintenance, deweeding, predation of fish, prevention of poaching etc. is necessary for higher produciton.

Fish harvest

Though the rearing period is kept for 12 months, fishes can be harvested and sold at any time depending on the market demand. It can be initiated after five months of rearing when the fishes reach more than 500 to 1000 g size.

In large water bodies having shallow zones, pens are suitable for fish culture. As per the area required for easy management, the portion is partitioned by the required mesh size webbing and is strengthened with rigid fencing material. There is great potential for using cages in deep water bodies for intensive aquaculture. It is a totally enclosed system mostly of floating type, with high fish stocking densities.

Intensive aquaculture system with recirculated water is an example of sophisticated rearing technology where a number of advantages exist for aquaculture production including controlled environment, control over disease agents and temperature controlled growth rates and production. Running water fish culture or flow-through systems are used for intensive rearing in places where abundant supply of water is available throughout the year. When water is flown continuously from one chamber to the other, the waste products are flushed out. The production depends on the quality and quantity of feed given and the flow rates of water.

Technologies for 5 t/ha/year to 15 t/ha/year production levels are available, the actual yield depends on the management of ponds irrespective of inptus used. Intensive aquaculture depends more on technological improvement rather than on expansion of farm areas. Aquaculture should be treated the same way as other industries as the initial input in the sector is always more. Irrespective of culture systems used, mass production can be reached to the poor sector of population in future.

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ANALYSIS

Rapid growth in the use of computers for biological data analysis has increased exponentitally throughout the world, due to availability of users friendly packages prepared in a general nature. This packaged computer software has become an important and permanent feature of statistical practice as an increasing number of researchers rely on packaged programs for their data analyses. Many researchers who have not had training in statistics can now perform their own statistical analyses, requiring only the guidance of a statistician and not his computational assistance.

Computing takes science beyond the traditional scientific method based on theoretical analysis on laboratory research. Simulation and modelling are necessary tools for understanding pond ecosystem and developing management practices to optimise resource uitlization. Multivariate analysis for developing models to analyse multiple measurements for identifying critical parameters that have higher effects on pond's productivity is a technique to be solved by developing various types of programs.

The programs at the Bioinformatics Centre have been developed keeping in the views of users need and requirement. FORTRAN 77 and FORTRAN IV programs developed at the centre are exclusively as per users need, befitting their research problems of work.. These are designed also to perform standard scientific computations in a laboratory. Such a comprehensive libraries of mathematical and statistical procedures written in fortran language can be easily implemented on a wide variety of comptuers.

```
C       COMPUTE MEAN, VARIANCE, STANDARD DEVIATION
        SUMX=0.0
        SUMSQ=0.0
        AN=0.0
        READ(*,10) ZN
10      FORMAT(F8.2)
20      READ(*,30) X
30      FORMAT(F5.2)
        SUMX=SUMX+X
        AN=AN+1.0
        SUMSQ=SUMSQ+X**2
        IF (AN-ZN) 20,40,40
40      XBAR=SUMX/AN
        VAR=(SUMSQ-(SUMX**2/AN))/(AN-1.0)
        STDEV=SQRT(VAR)
        WRITE(*,50) STDEV,VAR,XBAR
50      FORMAT(5X,'STANDARD DEVIATION= ',F5.2/5X,'VARIANCE= ',F5.2/
     15X,'MEAN= ',F5.2)
        STOP
        END
```

***

```
C     PROGRAM FOR T-TEST
C     PAIRED T-TEST
      SUBROUTINE MEAN(N,X,XMEAN)
      DIMENSION X(N)
      SUM=0.0
      DO 1 I=1,N
1     SUM=SUM+X(I)
      XMEAN=SUM/FLOAT(N)
      RETURN
      END
      SUBROUTINE STDDEV(M,Y,DEV)
      DIMENSION Y(M),YS(1000)
      CALL MEAN(M,Y,YMEAN)
      Y2MEAN=YMEAN*YMEAN
      DO 9 J=1,M
9     YS(J)=Y(J)*Y(J)
      CALL MEAN(M,YS,YSMEAN)
      DEV=SQRT(YSMEAN-Y2MEAN)
      RETURN
      END
      DIMENSION A1(1000),A2(1000)
      write(*,2)
2     FORMAT(4X, ' NOS.OF VARIABLES AND VALUES')
      READ(*,*) N1,(A1(J),J=1,N1)
      READ(*,*) N2,(A2(J),J=1,N2)
      CALL MEAN (N1,A1,AVERG1)
      CALL MEAN (N2,A2,AVERG2)
      CALL STDDEV(N1,A1,DEV1)
      CALL STDDEV (N2,A2,DEV2)
      WRITE(*,105) AVERG1,AVERG2
```

```
105   FORMAT(4X,'MEAN OF SET-1 = ',F5.2,2X,'MEAN OF SET-2 =',F5.2)
      SDX=SQRT(DEV1*DEV1/N1+DEV2*DEV2/N2)
      TTEST=(AVERG1-AVERG2)/SDX
      WRITE(*,108) DEV1,DEV2
108   FORMAT(4X,'STANDARD DEVIATION OF SET-1 = ',F10.2,/
     14X,'STANDARD DEVIATION OF SET-2 = ',F10.2)
      WRITE(*,110) TTEST
110   FORMAT(4X,'    VALUE OF T-RATIO = ',F8.3)
      STOP
      END
```

***

```
C     ANALYSIS OF VARIANCE FOR ONE WAY CLASSIFICATION
      INTEGER TTLDF,TRTDF,ERRDF
      DIMENSION X(100,100)
      WRITE(*,10)
10    FORMAT('  HI !  PLEASE GIVE NO.OF VARIABLES & NO.OF TREATMENTS')
      READ(*,*) NV,NT
      NO=NV*NT
      TTLDF=NO-1
      TRTDF=NT-1
      ERRDF=TTLDF-TRTDF
      WRITE(*,11)
11    FORMAT('       ENTER THE VALUES')
      DO 5 I = 1,NT
5     READ(*,*) (X(I,J),J=1,NV)
      WRITE(*,2) ((X(I,J),J=1,NV),I=1,NT)
2     format(/(1x,6f8.2)/)
      SUMX=0.0
      DO 6 I =1,NT
      DO 6 J =1,NV
6     SUMX=SUMX+X(I,J)
      GMEAN=SUMX/FLOAT(NO)
      CF=SUMX*SUMX/FLOAT(NO)
      TRTSS=0.0
      DO 8 I=1,NT
      SUMX=0.0
      DO 7 J =1,NV
7     SUMX=SUMX+X(I,J)
8     TRTSS=TRTSS+SUMX*SUMX
      TRTSS=TRTSS/FLOAT(NV)-CF
      TTLSS=0.0
      DO 9 I = 1,NT
      DO 9 J = 1,NV
9     TTLSS=TTLSS+X(I,J)*X(I,J)
      TTLSS=TTLSS-CF
      ERRSS=TTLSS-TRTSS
      TRTMS=TRTSS/FLOAT(NT-1)
      ERRMS=ERRSS/(FLOAT(NT)*FLOAT(NV-1))
      F=TRTMS/ERRMS
      CV=SQRT(ERRMS)/GMEAN*100.0
      WRITE(*,13)
```

```
13    FORMAT(//20X,'     CIFA  COMPUTER  CENTRE , KAUSALYAGANGA ')
      WRITE(*,14)
14    FORMAT(20X,'     ....................................')
      WRITE(*,4)
4     FORMAT(///20X,'ANALYSIS OF VARIANCE (ONE WAY)'/20X,30(1H*),4(/)
     13X,'SOURCE',11X,'DEGREE',12X,'SUM OF',12X,'MEAN',12X,
     2'OBSERVED'/5X,'OF',15X,'OF'/1X,'VARIATION',10X,'FREEDOM',
     310X,'SQUARES',10X,'SQUARE',15X,'F'/1X,79(1H-)/)
      WRITE(*,3) TRTDF,TRTSS,TRTMS,F,ERRDF,ERRSS,ERRMS,TTLDF,TTLSS,CV
3     FORMAT(1X,'TREATMENTS',7X,I4,14X,F10.2,7X,F10.2,6X,F10.2/1X,
     1'EXPERIMENTAL',5X,I4,12X,F12.2,5X,F12.2/1X,'ERROR'/1X,79(1H-)/1
     2'TOTAL',12X,I4,12X,F12.2/1X,79(1H-)/12X,'CV = ',F10.3,'%')
      WRITE(*,19)
19    FORMAT(//20X,'------ END RUN ANOVA ------')
      STOP
      END
```

***

```
C     PROGRAM FOR ANOVA (TWO WAYS)
C     NV IS THE NUMBER OF BLOCKS
      INTEGER TTLDF,BLKDF,TRTDF,ERRDF
      DIMENSION BLOCK(100,100)
      WRITE(*,91)
91    FORMAT('    PLEASE GIVE NO.OF VARIABLES & NO.OF TREATMENTS ')
      READ(*,*)NV,NT
      NO=NV*NT
      TTLDF=NO-1
      BLKDF=NV-1
      TRTDF=NT-1
      ERRDF=BLKDF*TRTDF
      WRITE(*,92)
92    FORMAT('     ENTER THE VALUES')
      DO 30 I=1,NT
30    READ(*,*) (BLOCK(I,J),J=1,NV)
      WRITE(*,6) ((BLOCK(I,J),J=1,NV),I=1,NT)
6     FORMAT(/(1X,5F9.3)/)
      GTOTL=0.0
      TTLSS=0.0
      DO 5 I=1,NT
      DO 5 J=1,NV
      TTLSS=TTLSS+BLOCK(I,J)**2
5     GTOTL=GTOTL+BLOCK(I,J)
      CF=GTOTL*GTOTL/FLOAT(NO)
      GMEAN=GTOTL/FLOAT(NO)
      TTLSS=TTLSS-CF
      WRITE(*,21)GMEAN,CF,TTLSS
21    FORMAT(1X,'GRAND MEAN = ',F12.3/1X,'CF= ',F12.3,/
     11X,'TOTAL SS = ',F12.3)
      BLKSS=0.0
      DO 15 I=1,NV
      BLKTL=0.0
      DO 10 J=1,NT
```

```
10    BLKTL=BLKTL+BLOCK(J,I)
      BLKMN=BLKTL/NT
      WRITE(*,22)I,BLKTL,BLKMN
22    FORMAT(1X,'TOTAL FOR BLOCK ',I3,5X,F12.3,5X,
     1'MEAN= ',F10.3/)
15    BLKSS=BLKSS+BLKTL**2
      BLKSS=BLKSS/FLOAT(NT)-CF
      TRTSS=0.0
      DO 20 I=1,NT
      TRTTL=0.0
      DO 25 J=1,NV
25    TRTTL=TRTTL+BLOCK(I,J)
      TRTMN=TRTTL/NV
      WRITE(*,23)I,TRTTL,TRTMN
23    FORMAT(1X,'TREATMENT - ',I3,'TOTAL = ',F12.3,5X,
     1'MEAN= ',F10.3/)
20    TRTSS=TRTTL**2+TRTSS
      TRTSS=TRTSS/FLOAT(NV)-CF
      ERRSS=TTLSS-BLKSS-TRTSS
      BLKMS=BLKSS/FLOAT(BLKDF)
      TRTMS=TRTSS/FLOAT(TRTDF)
      ERRMS=ERRSS/FLOAT(ERRDF)
      F1=BLKMS/ERRMS
      F2=TRTMS/ERRMS
      CV=SQRT(ERRMS)*100.0/GMEAN
      WRITE(*,3)
3     FORMAT(20X,'ANALYSIS OF VARIANCE [TWO WAY]'/20X,30(1H*),
     14(/)3X,'SOURCE',11X,'DEGREE',12X,'SUM OF',12X,'MEAN',
     212X,'OBSERVED'/5X,'OF',15X,'OF'/1X,'VARIATION',10X,
     3'FREEDOM',10X,'SQUARES',10X,'SQUARE',15X,'F'/1X,79(1H-)/)
      WRITE(*,44)BLKDF,BLKSS,BLKMS,F1,TRTDF,TRTSS,TRTMS,F2,ERRDF,
     1ERRSS,ERRMS,TTLDF,TTLSS,CV
44    FORMAT(1X,'BLOCK',12X,I4,14X,F10.3,7X,F10.3,6X,F10.3/1X,
     1'TREATMENTS',7X,I4,14X,F10.3,7X,F10.3,6X,F10.3/1X,'ERROR',
     212X,I4,12X,F12.3,5X,F12.3/1X,79(1H-)/1X,'TOTAL',12X,I4,
     312X,F12.2/1X,79(1H-)/12X,'CV =',F10.2,'%'/)
      READ(*,13)N1
13    FORMAT(I3)
      STDTRT=SQRT(ERRMS/N1)
      STDERRD=STDTRT*SQRT(2.0)
      WRITE(*,14)STDTRT,STDERRD
14    FORMAT(1X,'STANDARD ERROR OF TREATMENT MEAN= ',F8.3/
     11X,'STANDARD ERROR OF DIFFERENCE OF TWO MEANS= ',F8.3/)
      READ(*,16)SIGVALUE
16    FORMAT(F8.2)
      CRTD=STDERRD*SIGVALUE
      WRITE(*,17)CRTD
17    FORMAT(1X,'CRITICAL DIFFERENCE VALUE = ',F8.3/)
      STOP
      END
```

***

```
C     PROGRAM FOR ANOVA (DMRT)
C     NV IS THE NUMBER OF BLOCKS
      INTEGER TTLDF,BLKDF,TRTDF,ERRDF
      DIMENSION BLOCK(100,100)
      WRITE(*,93)
93    FORMAT(/20X,'CIFA  COMPUTER  CENTRE , KAUSALYAGANGA ')
      WRITE(*,94)
94    FORMAT(20X,'.................................')
      WRITE(*,91)
91    FORMAT('   HI ! PLEASE GIVE NO.OF VARIABLES & NO.OF TREATMENTS ')
      READ(*,*)NV,NT
1     FORMAT(2I3)
      NO=NV*NT
      TTLDF=NO-1
      BLKDF=NV-1
      TRTDF=NT-1
      ERRDF=BLKDF*TRTDF
      WRITE(*,92)
92    FORMAT('     ENTER THE VALUES')
      DO 30 I=1,NT
30    READ(*,*) (BLOCK(I,J),J=1,NV)
      WRITE(*,6) ((BLOCK(I,J),J=1,NV),I=1,NT)
6     FORMAT(/(1X,6F8.2)/)
      GTOTL=0.0
      TTLSS=0.0
      DO 5 I=1,NT
      DO 5 J=1,NV
      TTLSS=TTLSS+BLOCK(I,J)**2
5     GTOTL=GTOTL+BLOCK(I,J)
      CF=GTOTL*GTOTL/FLOAT(NO)
      GMEAN=GTOTL/FLOAT(NO)
      TTLSS=TTLSS-CF
      WRITE(*,21)GMEAN,CF,TTLSS
21    FORMAT(1X,'GRAND MEAN = ',F12.2/1X,'CF= ',F12.2,/
     11X,'TOTAL SS = ',F12.2)
      BLKSS=0.0
      DO 15 I=1,NV
      BLKTL=0.0
      DO 10 J=1,NT
10    BLKTL=BLKTL+BLOCK(J,I)
      BLKMN=BLKTL/NT
      WRITE(*,22)I,BLKTL,BLKMN
22    FORMAT(1X,'TOTAL FOR BLOCK ',I3,5X,F12.2,5X,
     1'MEAN= ',F10.2/)
15    BLKSS=BLKSS+BLKTL**2
      BLKSS=BLKSS/FLOAT(NT)-CF
      TRTSS=0.0
      DO 20 I=1,NT
      TRTTL=0.0
      DO 25 J=1,NV
25    TRTTL=TRTTL+BLOCK(I,J)
      TRTMN=TRTTL/NV
      WRITE(*,23)I,TRTTL,TRTMN
23    FORMAT(1X,'TREATMENT - ',I3,'TOTAL = ',F12.2,5X,
     1'MEAN= ',F10.2/)
```

```
20    TRTSS=TRTTL**2+TRTSS
      TRTSS=TRTSS/FLOAT(NV)-CF
      ERRSS=TTLSS-BLKSS-TRTSS
      BLKMS=BLKSS/FLOAT(BLKDF)
      TRTMS=TRTSS/FLOAT(TRTDF)
      ERRMS=ERRSS/FLOAT(ERRDF)
      F1=BLKMS/ERRMS
      F2=TRTMS/ERRMS
      CV=SQRT(ERRMS)*100.0/GMEAN
      WRITE(*,3)
3     FORMAT(20X,'ANALYSIS OF VARIANCE [TWO WAY]'/20X,30(1H*),
     14(/)3X,'SOURCE',11X,'DEGREE',12X,'SUM OF',12X,'MEAN',
     212X,'OBSERVED',5X,'OF',15X,'OF'/1X,'VARIATION',10X,
     3'FREEDOM',10X,'SQUARES',10X,'SQUARE',15X,'F'/1X,79(1H-)/)
      WRITE(*,44)BLKDF,BLKSS,BLKMS,F1,TRTDF,TRTSS,TRTMS,F2,ERRDF,
     1ERRSS,ERRMS,TTLDF,TTLSS,CV
44    FORMAT(1X,'BLOCK',8X,I4,12X,F12.3,5X,F12.3,5X,F12.3/1X,
     1'TREATMENTS',4X,I4,10X,F12.3,5X,F12.3,5X,F12.3/1X,'ERROR',
     210X,I4,10X,F12.3,4X,F12.3/1X,79(1H-)/1X,'TOTAL',10X,I4,
     310X,F12.2/1X,79(1H-)/10X,'CV =',F12.2,'%'/)
      READ(*,*)N1
      STDTRT=SQRT(ERRMS/N1)
      STDERRD=STDTRT*SQRT(2.0)
      WRITE(*,14)STDTRT,STDERRD
14    FORMAT(1X,'STANDARD ERROR OF TREATMENT MEAN= ',F8.3/
     11X,'STANDARD ERROR OF DIFFERENCE OF TWO MEANS= ',F8.3/)
      READ(*,*)SIGVALU
      CRTD=STDERRD*SIGVALU
      WRITE(*,17)CRTD
17    FORMAT(1X,'CRITICAL DIFFERENCE VALUE = ',F8.3/)
      STOP
      END
```

***

```
C       PROGRAM FOR COMPARISION AMONG MEANS
C       X MATRIX CONTAINS THE DATA
C       NR = No OF REPLICATIONS
C       NT = No OF TREATMENTS
C       X HAS NR COLUMNS AND NT ROWS
C       NR+1 COLUMN CONTAINS TREATMENTWISE SUMS
C       NT+1 ROW CONTAINS REPLICATIONWISE SUMS
C       1ST ROW CONTAINS DATA FOR CONTROL
        DIMENSION X(100,100)
10      WRITE(*,*) 'Enter No of Replications & No of Treatments'
        READ(*,*) NR,NT
        WRITE(*,3) NR,NT
3       FORMAT(//24X,'COMPARISON AMONG MEANS'/24X,22(1H-)//15X,
     1'TEST FOR ',I4,' REPLICATIONS AND ',I4,' MEANS'//'INPUT DATA'/
     210(1H-))
        READ(*,*) ((X(I,J),J=1,NR),I=1,NT)
        DO 11 J=1,NR
11      X(NT+1,J)=0.0
```

```
      DO 12 I=1,NT+1
12    X(I,NR+1)=0.0
      TTLSS=0.
      DO 13 I=1,NR
      DO 13 J=1,NT
      X(NT+1,NR+1)=X(NT+1,NR+1)+X(I,J)
      TTLSS=TTLSS+X(I,J)**2
      X(I,NR+1)=X(I,NR+1)+X(I,J)
13    X(NT+1,J)=X(NT+1,J)+X(I,J)
      WRITE(*,1) ((X(I,J),J=1,NR),I=1,NT)
1     FORMAT(6(F10.3,2X))
      WRITE(*,4)
4     FORMAT(/'REPLICATIONWISE SUMS'/20(1H-))
      WRITE(*,1) (X(NT+1,J),J=1,NR)
      WRITE(*,5)
5     FORMAT(/'TREATMENTWISE SUMS'/18(1H-))
      WRITE(*,1) (X(I,NR+1),I=1,NT)
      C=X(NT+1,NR+1)**2/FLOAT(NR*NT)
      TTLSS=TTLSS-C
      TRTSS=0.0
      DO 15 I=1,NT
15    TRTSS=TRTSS+X(I,NR+1)**2
      TRTSS=TRTSS/FLOAT(NT)-C
      RPLSS=0.0
      DO 16 J=1,NR
16    RPLSS=RPLSS+X(NT+1,J)**2
      RPLSS=RPLSS/FLOAT(NR)-C
      CHKVSS=0.0
      DO 17 I=2,NT
17    CHKVSS=CHKVSS+X(I,NR+1)
      CHKVSS=CHKVSS**2/FLOAT(NR*NT-NT)+X(1,NR+1)**2/FLOAT(NR)-C
      AMGCSS=TRTSS-CHKVSS
      ERRSS=TTLSS-RPLSS-TRTSS
      REPDF=FLOAT(NR)-1
      TRTDF=FLOAT(NT)-1
      AMGDF=TRTDF-1
      CHKDF=1.
      TTLDF=FLOAT(NT*NR)-1
      ERRDF=TTLDF-REPDF-AMGDF-CHKDF
      REPMS=RPLSS/REPDF
      CHKMS=CHKVSS/CHKDF
      ERRMS=ERRSS/ERRDF
      AMGMS=AMGCSS/AMGDF
      F1=REPMS/ERRMS
      F2=CHKMS/ERRMS
      F3=AMGMS/ERRMS
      WRITE(*,7) C,TRTSS,CHKVSS,AMGCSS,TTLSS
7     FORMAT(/'CORRECTION FACTOR = ',F12.4//'TREATMENT SUM OF SQUARE'
     1,F12.4//'CHECK VS. CHEMICALS SUM OF SQUARES = ',F12.4//
     2'AMONG CHEMICALS SUM OF SQUARES = ',F12.4//'TOTAL SUM OF SQUARE '
     3,F12.4/)
      WRITE(*,2) REPDF,RPLSS,REPMS,F1,CHKDF,CHKVSS,CHKMS,F2,AMGDF,
     1AMGCSS,AMGMS,F3,ERRDF,ERRSS,ERRMS
2     FORMAT(/70(1H=)/'SOURCE OF',18X,'DEGREE OF',4X,'SUM OF',7X,
     1'MEAN',7X,'F'/'VARIATION',19X,'FREEDOM',5X,'SQUARE',6X,'SQUARE',
```

```
     25X,'RATIO'/70(1H-)/'REPLICATION',18X,F4.0,5X,F10.4,1X,F10.4,1X,
     3F10.4//'TREATMENTS:'/2X,'CHECK VS. CHEMICALS',8X,F4.0,5X,F10.4,1X,
     4F10.4,1X,F10.4/2X,'AMONG CHEMICALS',12X,F4.0,5X,F10.4,1X,F10.4,1X,
     5F10.4//'ERROR',24X,F4.0,5X,F10.4,1X,F10.4/70(1H-)/)
      SD=SQRT(ERRMS/FLOAT(NR))
      WRITE(*,6) SD
6     FORMAT('STANDARD DEVIATION = ',F12.4/)
      WRITE(*,*) 'Enter r value from table for 5% error df'
      READ(*,*) TBLF
      D=SD*TBLF
      WRITE(*,110) D
110   FORMAT('SIGNIFICANT DIFFERENCE AT 5% LEVEL = ',F12.4/)
      GO TO 10
      STOP
      END
```

***

```
C     PROGRAM FOR BARLET'S TEST OF HOMOGENEITY
C     SAMPLE EQUAL IN SIZE
C     REF:- G.W. SNEDECOR, PAGE-285, ART. 10.20
      REAL MEANSQ(50),MEAN,LOGSQ(50),LOGSSQ
      DIMENSION X(50,50),SUMX(50)
      ISET=1
      WRITE(*,*) 'No of Lots '
      READ(*,*) NL
      WRITE(*,*)'No of Items per Lot '
      READ(*,*) NI
99    READ(*,*) ((X(I,J),J=1,NL),I=1,NI)
      WRITE(*,6) ISET,NL,NI
6     FORMAT(10X,10HBartlete's,' Test of Homogeneity for set - ',I2//
     115x,' For ',I2,' Lots and ',I2,' Items per lot'//)
      WRITE(*,*) 'Now check for Entered Data'
      WRITE(*,*)
      DO 1 I=1,NI
1     WRITE(*,7) (X(I,J),J=1,NL)
7     FORMAT(4(F8.3,2X))
      DO 2 I=1,50
2     SUMX(I)=0.0
      DO 3 J=1,NL
      SUM1=0.0
      SUM2=0.0
      DO 4 I=1,NI
      SUM1=SUM1+X(I,J)
4     SUM2=SUM2+X(I,J)**2
3     SUMX(J)=SUM2-SUM1**2/FLOAT(NI)
      SUMSSQ=0.0
      SUMLOGSQ=0.
      WRITE(*,8)
8     FORMAT(65(1H-)/'Sample',7x,'Sum of Squares',5x,'Mean Square',
     15x,'Log Mean Square'/65(1h-))
      DO 5 J=1,NL
      MEANSQ(J)=SUMX(J)/FLOAT(NL)
```

```
      SUMSSQ=SUMSSQ+MEANSQ(J)
      T=MEANSQ(J)
      LOGSQ(J)=ALOG10(T)
      SUMLOGSQ=SUMLOGSQ+LOGSQ(J)
5     WRITE(*,9) J,SUMX(J),MEANSQ(J),LOGSQ(J)
9     FORMAT(2X,I2,10X,F8.3,9X,F8.3,9X,F10.6)
      WRITE(*,10)
10    FORMAT(65(1H-))
      WRITE(*,11) SUMSSQ,SUMLOGSQ
11    FORMAT(15X,'SUM = ',10X,F8.3,9X,F8.3)
      MEAN=SUMSSQ/FLOAT(NL)
      LOGSSQ=ALOG10(MEAN)
      WRITE(*,12) MEAN,LOGSSQ
12    FORMAT(14X,'MEAN = ',5X,F8.3,5X,'LOG MEAN=',F8.3)
      WRITE(*,10)
      ALOGSSQ=NL*LOGSSQ
      DIFF=ALOGSSQ-SUMLOGSQ
      CHISQ=2.3026*(NI-1)*DIFF
      CF=1+FLOAT((NL+1))/FLOAT(((NL-1)*NL*(NI-1)))
      CORCHISQ=CHISQ/CF
      WRITE(*,14) DIFF,CHISQ
14    FORMAT('DIFFERENCE = ',F8.3,5X,' CHI SQUARE = ',F8.3)
      WRITE(*,13) CF,CORCHISQ
13    FORMAT('CORRECTION FACTOR = ',F8.3,5X,'CORRECTED CHI SQUARE =
     1F8.3//)
      ISET=ISET+1
      STOP
      END
```

***

```
C     PROGRAM FOR BARTLETT'S TEST OF HOMOGENEITY
C     SAMPLES DIFFEREING IN SIZE
C     REF:- G.W.SNEDECOR, PAGE-287, ART. 10.20
      REAL LOGSSQ(50),LGSSQ1(50)
      DIMENSION X(50,50),N(50),SMXSQ(50),DF(50),RESI(50),
     1SSQMEAN(50)
100   WRITE(*,*) 'Enter No of Observations'
      READ(*,*) NO
      DO 1 I=1,NO
      WRITE(*,*) 'Enter Sample Size for Observations -',I
1     READ(*,*) N(I)
      READ(*,*)((X(I,J),J=1,N(I)),I=1,NO)
      DO 22 I=1,NO
22    WRITE(*,2)(X(I,J),J=1,N(I))
2     FORMAT(10(F6.2,2X))
      DO 4 I=1,NO
      SUM1=0.
      SUM2=0.
      DO 3 J=1,N(I)
      SUM1=SUM1+X(I,J)
3     SUM2=SUM2+X(I,J)**2
4     SMXSQ(I)=SUM2-SUM1**2/FLOAT(N(I))
      SUM1=0.
```

```
      SUM2=0.
      SUM3=0.
      SUM4=0.
      SUM5=0.
      SUM6=0.
      WRITE(*,24)
24    FORMAT(//10X,'COMPUTATION OF BARTLETT TEST  OF HOMOGENEITY OF ',
     1'VARIANCE'/15X,'SAMPLES DIFFERING IN SIZE'/1X,80(1H=)/20X,'DEGREE'
     2,' OF',16X,'MEAN'/20X,'FREEDOM',5X,'RECIPROCAL',2X,'SQUARE'/
     3'SAMPLE',2X,'SUM X SQ',7X,'N-1',7X,'1/(N-1)',3X,'S SQUARE',5X,
     4'LOG S SQR',2X,'(N-1) LOG (S SQR)'/1X,80(1H=))
      DO 5 I=1,NO
      DF(I)=N(I)-1
      RESI(I)=1./FLOAT(N(I)-1)
      SSQMEAN(I)=SMXSQ(I)/DF(I)
      LOGSSQ(I)=ALOG10(SSQMEAN(I))
      LGSSQ1(I)=DF(I)*LOGSSQ(I)
      SUM1=SUM1+SMXSQ(I)
      SUM2=SUM2+DF(I)
      SUM3=SUM3+RESI(I)
      SUM4=SUM4+SSQMEAN(I)
      SUM5=SUM5+LOGSSQ(I)
      SUM6=SUM6+LGSSQ1(I)
5     WRITE(*,23) I,SMXSQ(I),DF(I),RESI(I),SSQMEAN(I),LOGSSQ(I),
     1LGSSQ1(I)
23    FORMAT(1X,I2,6(2X,F10.4))
25    FORMAT(1X,80(1H-)/1X,I2,6(2X,F10.4)/1X,80(1H-))
      WRITE(*,25) NO,SUM1,SUM2,SUM3,SUM4,SUM5,SUM6
      SBARSQ=SUM1/SUM2
      CHISQ=2.3026*(ALOG10(SBARSQ)*SUM2-SUM6)
      CF=1.+1./(3.*FLOAT(NO-1))*(SUM3-1./SUM2)
      COCHISQ=CHISQ/CF
      WRITE(*,26) SBARSQ,CHISQ,CF,COCHISQ
26    FORMAT(10X,'SBAR SQR = ',F8.5/10X,'CHI SQR = ',F8.5/10X,
     1'CORRECTION FACTOR = ',F8.5/10X,'CORRECTED CHI SQR = ',F8.5/)
      GOTO 100
      STOP
      END
```

***

```
C     PROGRAM FOR CORELATION COEFFICIENT
      DIMENSION X(1000),Y(1000)
      READ(*,*)N,(X(I),I=1,N),(Y(I),I=1,N)
      SX=0.0
      SY=0.0
      SXY=0.0
      SX2=0.0
      SY2=0.0
      XN=1.0/FLOAT(N)
      DO 1 K=1,N
      SX=SX+X(K)
      SY=SY+Y(K)
```

```
      SX2=SX2+X(K)*X(K)
      SY2=SY2+Y(K)*Y(K)
1     SXY=SXY+X(K)*Y(K)
      XNUM=SXY-SX*SY*XN
      DEN1=SX2-SX*SX*XN
      DEN2=SY2-SY*SY*XN
      CORR=XNUM/SQRT(DEN1*DEN2)
      WRITE(*,110)CORR
110   FORMAT(4X,'CORRELATION COEFFICIENT IS ',F8.3)
      STOP
      END
```

***

```
C     PROGRAM FOR CHI-SQUARE TEST
C     NT IS THE NUMBER OF TRIAL
      DIMENSION OBSN(50,50),EXPTD(50,50)
      WRITE(*,69)
69    FORMAT(10X,'  CIFA COMPUTER CENTRE, KAUSALYAGANGA',)
      WRITE(*,68)
68    FORMAT(10X,'  ..................................')
      WRITE(*,70)
70    FORMAT('   PLEASE ENTER NO.OF TRIALS AND NO.OF OBS.IN I3 FORM')
      READ(*,1) NTRL,NOBS
1     FORMAT(2I3)
      WRITE(*,71)
71    FORMAT('   ENTER VALUES ' )
      READ(*,*) ((OBSN(I,J),J=1,NOBS),I=1,NTRL)
      DO 20 I=1,NTRL
      TRLMN=0.0
      DO 10 J=1,NOBS
10    TRLMN=TRLMN+OBSN(I,J)
      TRLMN=TRLMN/FLOAT(NOBS)
      DO 30 J=1,NOBS
30    EXPTD(I,J)=TRLMN
20    CONTINUE
      TCHISQR=0.0
      WRITE(*,9) ((OBSN(I,J),J=1,NOBS),I=1,NTRL)
      WRITE(*,9) ((EXPTD(I,J),J=1,NOBS),I=1,NTRL)
9     FORMAT(/1X,2(5X,F10.4))
      DO 5 I=1,NTRL
      CHISQR=0.0
      DO 6 J=1,NOBS
6     CHISQR=CHISQR+((OBSN(I,J)-EXPTD(I,J)**2)/EXPTD(I,J))
      TCHISQR=TCHISQR+CHISQR
5     WRITE(*,7) I,CHISQR
7     FORMAT(1X,59(1H-)/ ' TRIAL = ',I3,5X,' CHI SQUARE = ',F10.5/)
      WRITE(*,8) TCHISQR
8     FORMAT(1X,/ ' TOTAL CHI-SQUARE = ',F10.5)
      STOP
      END
```

***

```
C       PROGRAM TO CALCULATE THE NUTRITIONAL VALUES
          REAL NATM,NBI
        READ(*,*) WI,WF,T,PTN,PTN1,PTN2,NI,NF
        WRITE(*,12) WI,WF,T,PTN,PTN1,PTN2,NI,NF
12      FORMAT(6F8.2,2I3)
        ABG=WF-WI
        REG=ABG/WI
        INSTG=ALOG(WF/WI)
        SGR=100.0*(ALOG(WF)-ALOG(WI))/T
        AVWT=(WI+WF)/2.0
        TQFG=AVWT*0.05*T
        WGAIN=(WF-WI)
        FCR=TQFG/WGAIN
        PER=WGAIN/PTN
        PRTN=(PTN2-PTN1)*100/PTN
        X1=WF*NF
        X2=WI*NI
        NBI=X1-X2
        SURV=100.-((NI-NF)*100/NI)
        NATM=(100.-SURV)
        WRITE(*,2)ABG,REG,INSTG,SGR,FCR,PER,PRTN
2       FORMAT(3X,'AVERAGE GROWTH = ',F8.2/
       13X,'RELATIVE GROWTH = ',F8.2/
       23X,'INSTANTANEOUS GROWTH =  ',I3/
       33X,'SPECIFIC GROWTH = ',F8.2/
       43X,'FOOD CONVERSION RATIO = ',F8.2/
       53X,'PROTEIN EFFICIENCY RATIO = ',F8.2/
       63X,'PROTEIN RETENTION = ',F8.2)
        WRITE(*,3)NBI,SURV,NATM
3       FORMAT(3X,'NORMALIZED BIOMASS = ',E12.4/
       73X,'SURVIVAL RATE = ',F8.2/3X,'MORTALITY RATE = ',F8.2)
        STOP
        END
```

***

```
C     PROGRAM OF LINEAR REGRESSION
C     N IS THE NUMBER OF OBSERVATIONS
C     N IS TO BE ENTERED FIRST
C     X IS THE INDEPENDENT AND Y IS DEPENDENT VARIABLES
      REAL INTPT,MEANX,MEANY
      SUMX=0.0
      SUMY=0.0
      SUMXY=0.0
      SUMXS=0.0
      SUMYS=0.0
        WRITE(*,*) 'ENTER NUMBER OF CASES'
      READ(*,*) N
      T=FLOAT(N)
3     FORMAT(I3)
      WRITE(*,4)
4     FORMAT(/1X,'SL NO',5X,'VALUE OF X',5X,'VALUE OF Y'/
     11X,35(1H-))
      DO 11 I=1,N
      READ(*,*)X,Y
      WRITE(*,9)I,X,Y
9     FORMAT(1X,I4,6X,F10.3,10X,F10.3)
      SUMX=SUMX+X
      SUMY=SUMY+Y
      SUMXY=SUMXY+X*Y
      SUMXS=SUMXS+X*X
      SUMYS=SUMYS+Y*Y
11    CONTINUE
      MEANX=SUMX/n
      MEANY=SUMY/N
      WRITE(*,5)SUMX,SUMY,MEANX,MEANY
5     FORMAT(5X,'SUMX= ',F10.3/5X,'SUMY= ',F10.3/5X,
     1'MEANX= ',F10.3/5X,'MEANY= ',F10.3/)
      INTPT=(SUMX*SUMXY-SUMY*SUMXS)/(SUMX*SUMX-T*SUMXS)
      SLOPE=(T*SUMXY-SUMX*SUMY)/(T*SUMXS-SUMX*SUMX)
      R=(T*SUMXY-SUMX*SUMY)/SQRT((T*SUMXS-SUMX*SUMX)*
     1(T*SUMYS-SUMY*SUMY))
      WRITE(*,13)SLOPE,INTPT
13    FORMAT(5X,'SLOPE= ',F12.5/5X,'INTERCEPT= ',F15.5)
      WRITE(*,14)R
14    FORMAT(3X,'CORRELATION COEFFICIENT = ',F10.4)
      RESMSQ=((SUMYS-SUMY**2/T)-(SUMXY-(SUMX*SUMY)/T)**2/
     1(SUMXS-SUMX**2/T))/(T-2.0)
      TESTSTAT=SLOPE/SQRT(RESMSQ/(SUMXS-SUMX**2/T))
      WRITE(*,15)RESMSQ,TESTSTAT
15    FORMAT(5X,'RESIDUAL MEAN SQUARE= ',F13.5/5X,
     1'TEST STATISTIC T= ',F10.5)
      TTLDF=T-1
      REGDF=1.0
      ERRDF=TTLDF-1.0
      TTLSS=0.0
      REGSS=0.0
      TTLSS=TTLSS+(SUMYS-SUMY*SUMY/T)
      REGSS=REGSS+((SUMXY-SUMX*SUMY/T)**2)/(SUMXS-SUMX*SUMX/T)
      ERRSS=TTLSS-REGSS
      REGMS=REGSS/REGDF
```

```
      ERRMS=ERRSS/ERRDF
      F=REGMS/ERRMS
      WRITE(*,12)
12    FORMAT(20X,'ANALYSIS OF VARIANCE'/20X,30(1H*)//3X,
     1'SOURCE',16X,'SS',12X,'DF',12X,'MS',12X,'F'/1X,69(1H-)/)
      WRITE(*,20)REGSS,REGDF,REGMS,F,ERRSS,ERRDF,ERRDF
20    FORMAT(1X,'REGRESSION',8X,F12.3,5X,F4.1,7X,F12.3,5X,F7.3/
     11X,'ERROR',13X,F12.3,5X,F4.1,7X,F12.3/69(1H-)/)
      WRITE(*,21)TTLSS,TTLDF
21    FORMAT(1X,'TOTAL',10X,F12.3,5X,F4.1)
      STDEREST=SQRT(SUMYS-INTPT*SUMY-SLOPE*SUMXY)/(T-2)
      WRITE(*,22)STDEREST
22    FORMAT(1X,'STANDARD ERROR OF ESTIMATE= ',F8.3)
      STOP
      END
```

***

```
C     MULTIPLE COORELATION PROGRAM
      CHARACTER * 1 OPTN
      DIMENSION X(10),Y(10),A(10,10),B(10),C(10),D(10),E(10)
 1    WRITE(*,*) 'Enter No. of tests, Subjects & IT '
      READ(*,*) M,N,IT
      EN=FLOAT(N)
      WRITE(6,7) M,N
 7    FORMAT(' MULTIPLE COORELATION ',I3,' TESTS',I6,' SUBJECTS'/)
 19   DO 21 J=1,M
 21   READ(*,*) (A(J,K), K=J,M)
      DO 22 J=1,M
      DO 22 K=J,M
 22   A(K,J)=A(J,K)
      WRITE(*,17)
 17   FORMAT(' CORELATION MATRIX ' )
      CALL MPRINT(A,M)
 20   MP=M-1
      CALL MATINV(A,MP,DET)
      WRITE(*,23) DET
 23   FORMAT(' DETERMINANT= ',F16.5)
      DO 24 J=1,MP
      B(J)=0.0
      DO 24 K=1,MP
 24   B(J)=B(J)+A(J,K)*A(K,M)
C     B NOW CONTAINS THE BETA WEIGHTS
      RSQ=0.0
      DO 25 J=1,MP
      C(J)=B(J)*B(J)
      D(J)=B(J)*A(J,M)
 25   RSQ=RSQ+B(J)*A(J,M)
      WRITE(*,26) RSQ
 26   FORMAT('MULTIPLE R SQUARE = ', F8.3)
      RMULT=SQRT(RSQ)
      WRITE(*,27) RMULT
 27   FORMAT(' MULTIPLE R =', F8.3)
      XNDF1=M-1
```

```
      XNDF2=N-M
      F=(RSQ*XNDF2)/((1.0-RSQ)*XNDF1)
      WRITE(*,28) F
 28   FORMAT(' F FOR ANALYSIS OF VARIANCE ON R= ', F10.3)
      WRITE(*,29) XNDF1,XNDF2
 29   FORMAT(' N.D.F.1 = ',F3.0,5X, ' N.D.F.2 = ', F10.0)
      DO 30 J=1,MP
 30   E(J)=A(J,M)/RMULT
      WRITE(*,31)
 31   FORMAT(' Predictor     Beta     Beta SQ    R(Criterion)    Beta*R
     1Structure R')
 32   FORMAT(I6,5X,F8.3,5X,F10.3,5X,F8.3,5X,F8.3,5X,F8.3)
      DO 33 J=1,MP
 33   WRITE(*,32) J, B(J), C(J), A(J,M), D(J), E(J)
C     NEXT WRITE OUT BETAS
      WRITE(*,16) (B(J),J=1,MP)
 16   FORMAT( ' BETAS ',  5F14.7/(10X,5F14.7))
      IF(IT) 1,1,34
 34   CI=0.0
      READ(*,*) (Y(J),J=1,M)
      READ(*,*) (X(J),J=1,M)
      WRITE(*,12)
 12   FORMAT ('  TEST        MEAN          S.D ')
      DO 39 J=1,M
      WRITE(*,40) J, Y(J), X(J)
40      FORMAT(I5,10X,F8.3,8X,F8.3)
 39   CONTINUE
      DO 35 J=1,MP
      B(J)=B(J)*(X(M)/X(J))
 35   CI=CI+B(J)*Y(J)
      CI=Y(M)-CI
      WRITE(*,36)
 36   FORMAT( ' B  WEIGHTS')
      WRITE(*,37) (B(J), J=1,MP)
 37   FORMAT(10F8.3)
      WRITE(*,38) CI
 38   FORMAT('  INTERCEPT CONSTANT = ', F9.3)
      STOP
      END
      SUBROUTINE MPRINT(R,M)
C     R(I,J) MATRIX TO BE PRINTED
C     M=ORDER
      DIMENSION R(10,10), J(10)
      L1=9
      N=10
      J1=0
      J2=0
      JSEC=0
      DO 8 I=1,M
 8    J(I)=I
 9    J1=J2+1
      J2=J1+L1
      IF (J2-M) 13,13,12
 12   J2=M
 13   JSEC=JSEC+1
```

```
      WRITE(*,17) JSEC
17    FORMAT( ' SECTION ' , I3/)
      WRITE(*,27) (J(I),I=J1,J2)
27    FORMAT( ' ROW', 3X, 10I5)
      DO 29 I=1,M
29    WRITE(*,*) I,(R(I,K),K=J1,J2)
      IF (J2-M) 9,32,32
32    RETURN
      END
      SUBROUTINE MATINV(A,M,DET)
      DIMENSION A(10,10)
      DET=1.0
      DO 1 J=1,M
      PVT=A(J,J)
      DET=DET*PVT
      A(J,J)=1.0
      DO 2 K=1,M
2     A(J,K)=A(J,K)/PVT
      DO 1 K=1,M
      IF (K-J) 3,1,3
3     T=A(K,J)
      A(K,J)=0.0
      DO 4 L=1,M
4     A(K,L)=A(K,L)-A(J,L)*T
1     CONTINUE
      RETURN
      END
```

***

```
C        PROGRAM FOR COMPLETE BLOCK DESIGN ANOV
C        NR=NO OF REPLICATIONS
C        NA=LEVEL OF FACTOR A
C        NB=LEVEL OF FACTOR B
C        A=MATRIX CONTAINING DATA
C        REF: GOMEZ AND GOMEZ (PAGE 91, SECTION
         CHARACTER * 1 OPTN
         DIMENSION A(100,100),TRTOTAL(100),
         IK=0
100      IK=IK+1
         WRITE(*,112) IK
112      FORMAT(//18X,'CALCULATION FOR
         WRITE(*,*) 'Enter No of Replications
         READ(*,*) NR
         WRITE(*,*) 'Enter Level of A'
         READ(*,*) NA
         WRITE(*,*) 'Enter level of B'
         READ(*,*) NB
         NAB=NA*NB
         READ(*,*) ((A(I,J),J=1,NR),I=1,NAB
         G=0.0
         TOTALSS=0.0
         DO 1 I=1,NAB
```

```
      TRTOTAL(I)=0.0
      DO 1 J=1,NR
      TRTOTAL(I)=TRTOTAL(I)+A(I,J)
      TOTALSS=TOTALSS+A(I,J)**2
1     G=G+A(I,J)
      DO 2 J=1,NR
      RPTOTAL(J)=0.0
      DO 2 I=1,NAB
2     RPTOTAL(J)=RPTOTAL(J)+A(I,J)
      WRITE(*,3) G
3     FORMAT(1X,'Grand Total = ',F10.4//1X,'Replication Totals'/)
      WRITE(*,4) (RPTOTAL(J),J=1,NR)
4     FORMAT(1X,5(F10.4,5X)/)
      WRITE(*,5)
5     FORMAT(/1X,'Treatment Totals '/)
      WRITE(*,4) (TRTOTAL(I),I=1,NAB)
      CF=G*G/FLOAT(NAB*NR)
      TOTALSS=TOTALSS-CF
      REPSS=0.0
      DO 6 I=1,NR
6     REPSS=REPSS+RPTOTAL(I)**2
      REPSS=REPSS/FLOAT(NAB)-CF
      TRTSS=0.0
      DO 7 I=1,NAB
7     TRTSS=TRTSS+TRTOTAL(I)**2
      TRTSS=TRTSS/FLOAT(NR)-CF
      ERRSS=TOTALSS-REPSS-TRTSS
      ASS=0.0
      BSS=0.0
      DO 9 I=1,NAB/NB
      PQ=0.0
      DO 8 J=(I-1)*NB+1,I*NB
8     PQ=PQ+TRTOTAL(J)
9     ASS=ASS+PQ**2
      ASS=ASS/FLOAT(NR*NB)-CF
      DO 11 I=1,NAB/NA
      PQ=0.0
      DO 10 J=I,NAB,NB
10    PQ=PQ+TRTOTAL(J)
11    BSS=BSS+PQ**2
      BSS=BSS/FLOAT(NR*NA)-CF
      RPDF=NR-1
      TRDF=NAB-1
      ADF=NA-1
      BDF=NB-1
      ABDF=ADF*BDF
      TOTALDF=NAB*NR-1
      ERRDF=TOTALDF-RPDF-TRDF
      ABSS=TRTSS-ASS-BSS
      REPMS=REPSS/RPDF
      TRTMS=TRTSS/TRDF
      AMS=ASS/ADF
      BMS=BSS/BDF
      ABMS=ABSS/ABDF
      ERRMS=ERRSS/ERRDF
```

```
      FR=REPMS/ERRMS
      FT=TRTMS/ERRMS
      FA=AMS/ERRMS
      FB=BMS/ERRMS
      FAB=ABMS/ERRMS
      CV=SQRT(ERRMS)/(G/FLOAT(NAB*NR))*100.0
      WRITE(*,13)
13    FORMAT(15X,'ANALYSIS OF VARIANCE FOR TWO FACTOR RCB DESIGN '//
     11X,75(1H-)/1X,'Source of',9x,'Degree of',5x,'Sum of',
     210x,'Mean',15x,'F'/1x,'Variation',9x,'Freedom',7x,'Squares',8x,
     3'Squares'/1x,75(1H-))
      WRITE(*,12)RPDF,REPSS,REPMS,FR,TRDF,TRTSS,TRTMS,FT,ADF,ASS,AMS,FA
      WRITE(*,14) BDF,BSS,BMS,FB,ABDF,ABSS,ABMS,FAB,ERRDF,ERRSS,ERRMS
      WRITE(*,15) TOTALDF,TOTALSS,CV
12    FORMAT(1X,'Replication',8x,f4.0,5x,f10.3,5x,f10.3,7x,f10.3//1x,
     1'Treatment',10x,f4.0,5x,f10.3,5x,f10.3,7x,f10.3/4x,'A',15x,f4.0,
     25x,f10.3,5x,f10.3,7x,f10.3)
14    FORMAT(4x,'B',15x,f4.0,5x,f10.3,5x,f10.3,7x,f10.3/2x,
     1'A X B',13x,f4.0,5x,f10.3,5x,f10.3,7x,f10.3//1x,'Error',
     214x,f4.0,5x,f10.3,5x,f10.3,7x,f10.3)
15    FORMAT(1X/1x,'Total',14x,f4.0,5x,f10.3/1x,75(1h-)/25x,'cv = ',
     1f10.3))
      STOP
      END
```

***

```
C     PROGRAM FOR ANOVA FOR SPLIT-PLOT DESIGN (2 FACTOR)
C     NR= NO OF REPLICATIONS
C     NVA=NO OF VARIETIES A
C     NVB=NO OF VARIETIES B
C     REF: GOMEZ AND GOMEZ (PAGE 97, ARTICLE 3.4)
      DIMENSION A(50,50),REPTTL(50),VARATTL(50),RA(50,50),
     1AB(50,50),VARBTTL(50)
      WRITE(*,*) 'Enter No of Replications'
      READ(*,*) NR
      WRITE(*,*) 'Enter No of Variety A'
      READ(*,*) NVA
      WRITE(*,*) 'Enter No of Variety B'
      READ(*,*) NVB
      NVAB=NVA*NVB
      READ(*,*) ((A(I,J),J=1,NR),I=1,NVAB)
      WRITE(*,1)
1     FORMAT(1X,'CHECK LIST FOR ENTERED DATA'//)
      WRITE(*,2)((A(I,J),J=1,NR),I=1,NVAB)
2     FORMAT(1X,3(F10.3,3X))
      G=0.0
      TOTALSS=0.0
      DO 3 I=1,NVAB
      DO 3 J=1,NR
      G=G+A(I,J)
3     TOTALSS=TOTALSS+A(I,J)**2
      CF=G*G/FLOAT(NR*NVAB)
```

```
      TOTALSS=TOTALSS-CF
      WRITE(*,111) G,TOTALSS,CF
111   FORMAT(1X,'G= ',F15.3,'    TOTALSS = ',E20.10,'   CF= ',F20.10/
      DO 4 I=1,50
      VARBTTL(I)=0.0
      VARATTL(I)=0.0
      REPTTL(I)=0.0
      DO 4 J=1,50
      RA(I,J)=0.0
4     AB(I,J)=0.0
      DO 5 I=1,NVAB,NVB
      DO 5 J=1,NR
      SUM=0.0
      DO 51 I1=I,I+NVB-1
51    SUM=SUM+A(I1,J)
      IK=I/NVB+1
5     RA(IK,J)=SUM
      WRITE(*,*) 'VALUES FOR RA TOTAL MATRIX'
      WRITE(*,2) ((RA(I,J),J=1,NR),I=1,NVA)
6     FORMAT(4(F10.3,3X))
      ICOL=1
      DO 7 I=1,NVAB
      SUM=0.0
      DO 71 J=1,NR
71    SUM=SUM+A(I,J)
      IROW=I/NVB+1
      IF (MOD(I,NVB).EQ.0) IROW=IROW-1
      IF (ICOL.GT.NVB) ICOL=1
      AB(IROW,ICOL)=SUM
7     ICOL=ICOL+1
      WRITE(*,114)
114   FORMAT(/1X,'VALUES FOR AB MATRIX '/)
      WRITE(*,6) ((AB(I,J),J=1,NVB),I=1,NVA)
      DO 8 J=1,NR
      DO 8 I=1,NVA
8     REPTTL(J)=REPTTL(J)+RA(I,J)
      DO 10 I=1,NVA
      DO 10 J=1,NR
10    VARATTL(I)=VARATTL(I)+RA(I,J)
      DO 11 I=1,NVA
      DO 11 J=1,NVB
11    VARBTTL(J)=VARBTTL(J)+AB(I,J)
      WRITE(*,115)
115   FORMAT(/1X,'REPLICATION TOTAL '/)
      WRITE(*,6) (REPTTL(I),I=1,NR)
      WRITE(*,116)
116   FORMAT(1X,'VARIABLE A TOTAL '/)
      WRITE(*,6) (VARATTL(I),I=1,NVA)
      WRITE(*,117)
117   FORMAT(/1X,'VARIABLE B TOTAL '/)
      WRITE(*,6) (VARBTTL(I),I=1,NVB)
      REPSS=0.0
      DO 12 I=1,NR
12    REPSS=REPSS+REPTTL(I)**2
      REPSS=REPSS/FLOAT(NVAB)-CF
```

```
      WRITE(*,*) 'REPSS = ',REPSS
      ASS=0.0
      DO 13 I=1,NVA
13    ASS=ASS+VARATTL(I)**2
      ASS=ASS/FLOAT(NR*NVB)-CF
      ERRASS=0.0
      DO 14 I=1,NVA
      DO 14 J=1,NR
14    ERRASS=ERRASS+RA(I,J)**2
      ERRASS=ERRASS/FLOAT(NVB)-CF-REPSS-ASS
      BSS=0.0
      DO 15 I=1,NVB
15    BSS=BSS+VARBTTL(I)**2
      BSS=BSS/FLOAT(NR*NVA)-CF
      ABSS=0.0
      DO 16 I=1,NVA
      DO 16 J=1,NVB
16    ABSS=ABSS+AB(I,J)**2
      ABSS=ABSS/FLOAT(NR)-CF-ASS-BSS
      ERRBSS=TOTALSS-REPSS-ASS-ERRASS-BSS-ABSS
      REPDF=NR-1
      ADF=NVA-1
      ERRADF=(NR-1)*(NVA-1)
      BDF=NVB-1
      ABDF=(NVA-1)*(NVB-1)
      ERRBDF=NVA*(NR-1)*(NVB-1)
      TOTALDF=NR*NVAB-1
      REPMS=REPSS/REPDF
      AMS=ASS/ADF
      ERRAMS=ERRASS/ERRADF
      BMS=BSS/BDF
      ABMS=ABSS/ABDF
      ERRBMS=ERRBSS/ERRBDF
      FA=AMS/ERRAMS
      FB=BMS/ERRBMS
      FAB=ABMS/ERRBMS
      CVA=SQRT(ERRAMS)/G*(NR*NVAB)*100.
      CVB=SQRT(ERRBMS)/G*(NR*NVAB)*100.
      WRITE(*,17) REPDF,REPSS,REPMS,ADF,ASS,AMS,FA,ERRADF,ERRASS,
     1ERRAMS,BDF,BSS,BMS,FB,ABDF,ABSS,ABMS,FAB,ERRBDF,ERRBSS,ERRBMS,
     2TOTALDF,TOTALSS
17    FORMAT(4(F15.3,2X))
99    CLOSE(5)
      CLOSE(6)
      STOP
      END
```

***

```
C       ANALYSIS OF COVARIANCE
C       X = ARRAY CONTAINING THE WHOLE SET OF X.
C       Y = ARRAY CONTAINING THE WHOLE SET OF Y.
C       IC= ARRAY CONTAINING THE NUMBER OF OBSERVATIONS PER SAMPLE.
C       CSXS= ARRAY CONTAINING SUM OF X*X.
C       CSXY= ARRAY CONTAINING SUM OF X*Y.
C       CSYS= ARRAY CONTAINING SUM OF Y*Y.
C       SSXS= ARRAY CONTAINING CSXS-C.
C       SSXY= ARRAY CONTAINING CSXY-C.
C       SSYS= ARRAY CONTAINING CSYS-C.
C       DF1= ARRAY CONTAINING DEGREE OF FREEDOM.
C       DF2= ARRAY CONTAINING REGRESSION DEGREE OF FREEDOM.
        DIMENSION X(1000),Y(1000),IC(10),CSXS(10),CSXY(10),CSYS(10),
     1SSXS(10),SSXY(10),SSYS(10),SUMX(10),SUMXY(10),SUMY(10),TBL(15,8),
     2DF1(10),DF2(10)
111     WRITE(*,*) 'ENTER NO SAMPLE SETS '
        READ(*,*) IS
        TCASE=0.0
        DO 1 I=1,IS
        WRITE(*,*) 'ENTER CASES FOR SAMPLE - ',I
        READ(*,*) IC(I)
1       TCASE=TCASE+IC(I)
        WRITE(*,*) 'TCASE = ',TCASE
        READ(*,*) (X(I),Y(I),I=1,IFIX(TCASE))
C       DO 2 I=1,IS
C       WRITE(*,3) I
C3      FORMAT(/'DATA FOR SET - ',I2/)
C2      WRITE(*,4) (X(J),Y(J),J=(I-1)*IC(I-1)+1,(I-1)*IC(I-1)+IC(I))
C4      FORMAT(2(F12.4,3X))
        IK=1
        IS1=IS+1
        WRITE(*,11)
11      FORMAT(//20X,'ANALYSIS OF COVARIANCE'/20X,22(1H*)//75(1H-)/10X,
     1'SUM X*X',17X,'SUM X*Y',17X,'SUM Y*Y')
        DO 6 I=1,IS
        CSXS(I)=0.0
        CSXY(I)=0.0
        CSYS(I)=0.0
        SUMX(I)=0.0
        SUMXY(I)=0.0
        SUMY(I)=0.0
        DO 5 I1=(I-1)*IC(I-1)+1,(I-1)*IC(I-1)+IC(I)
        CSXS(I)=CSXS(I)+X(I1)*X(I1)
        CSXY(I)=CSXY(I)+X(I1)*Y(I1)
        CSYS(I)=CSYS(I)+Y(I1)*Y(I1)
        SUMX(I)=SUMX(I)+X(I1)
        SUMY(I)=SUMY(I)+Y(I1)
        SUMXY(I)=SUMX(I)*SUMY(I)
        TC=FLOAT(IC(I))
        C1=SUMX(I)**2/TC
        C2=SUMXY(I)/TC
        C3=SUMY(I)**2/TC
        SSXS(I)=CSXS(I)-C1
        SSXY(I)=CSXY(I)-C2
        SSYS(I)=CSYS(I)-C3
```

```
      WRITE(*,10) I,CSXS(I),CSXY(I),CSYS(I),C1,C2,C3
10    FORMAT(75(1H-)/25X,'SET-',I2,/75(1H-)/10X,F9.2,15X,F9.2,15X,
     1F9.2/'C: ',7X,F9.2,15X,F9.2,15X,F9.2)
      CSXS(IS1)=0.0
      CSXY(IS1)=0.0
      CSYS(IS1)=0.0
      C1=0.0
      C2=0.0
      C3=0.0
      DO 7 I=1,IFIX(TCASE)
      CSXS(IS1)=CSXS(IS1)+X(I)**2
      CSXY(IS1)=CSXY(IS1)+X(I)*Y(I)
      CSYS(IS1)=CSYS(IS1)+Y(I)**2
      C1=C1+X(I)
      C2=C2+X(I)*Y(I)
7     C3=C3+Y(I)
      C11=C1*C1
      C12=C1*C3
      C13=C3*C3
      C1=C11/TCASE
      C2=C12/TCASE
      C3=C13/TCASE
      SSXS(IS1)=CSXS(IS1)-C1
      SSXY(IS1)=CSXY(IS1)-C2
      SSYS(IS1)=CSYS(IS1)-C3
      WRITE(*,12) CSXS(IS1),CSXY(IS1),CSYS(IS1),C1,C2,C3
12    FORMAT(75(1H-)/25X,'TOTAL'/75(1H-)/10X,F9.2,15X,F9.2,15X,
     1F12.2/'C: ',7X,F9.2,15X,F9.2,15X,F12.2/75(1H-))
      IS2=IS+2
      IS3=IS+3
      IS4=IS+4
      IS5=IS+5
      TBL(IS1,6)=0.0
      TBL(IS1,7)=0.0
      TBL(IS1,8)=0.0
      TBL(IS3,1)=0.0
      TBL(IS3,2)=0.0
      TBL(IS3,3)=0.0
      TBL(IS3,4)=0.0
      WRITE(*,13)
13    FORMAT(//75(1H-)/'SET',2X,'D.F.',3X,'SUM x*x',3X,'SUM x*y',3X,
     1'SUM y*y',2X,'REG. COF.',2X,'D.F.',4X,'b',6X,'MEAN SQ'/75(1H-))
      DO 9 I=1,IS
      TBL(I,1)=FLOAT(IC(I)-1)
      TBL(I,2)=SSXS(I)
      TBL(I,3)=SSXY(I)
      TBL(I,4)=SSYS(I)
      TBL(I,5)=SSXY(I)/SSXS(I)
      TBL(I,6)=TBL(I,1)-1
      TBL(I,7)=TBL(I,4)-(TBL(I,3)**2/TBL(I,2))
      TBL(I,8)=TBL(I,7)/TBL(I,6)
      TBL(IS1,6)=TBL(IS1,6)+TBL(I,6)
      TBL(IS1,7)=TBL(IS1,7)+TBL(I,7)
      TBL(IS3,1)=TBL(IS3,1)+TBL(I,1)
      TBL(IS3,2)=TBL(IS3,2)+TBL(I,2)
```

```
      TBL(IS3,3)=TBL(IS3,3)+TBL(I,3)
      TBL(IS3,4)=TBL(IS3,4)+TBL(I,4)
9     WRITE(*,110) I,(TBL(I,J),J=1,8)
110   FORMAT(I2,2X,F4.0,2X,F9.2,2X,F9.2,2X,F9.2,2X,F6.2,2X,F4.0,
     12X,F9.2,2X,F7.2)
      TBL(IS1,8)=TBL(IS1,7)/TBL(IS1,6)
      TBL(IS3,5)=TBL(IS3,3)/TBL(IS3,2)
      TBL(IS3,6)=TBL(IS3,1)-1
      TBL(IS3,7)=TBL(IS3,4)-(TBL(IS3,3)**2/TBL(IS3,2))
      TBL(IS3,8)=TBL(IS3,7)/TBL(IS3,6)
      TBL(IS2,6)=TBL(IS3,6)-TBL(IS1,6)
      TBL(IS2,7)=TBL(IS3,7)-TBL(IS1,7)
      TBL(IS2,8)=TBL(IS2,7)/TBL(IS2,6)
      TBL(IS5,1)=TCASE-1
      TBL(IS5,2)=SSXS(IS1)
      TBL(IS5,3)=SSXY(IS1)
      TBL(IS5,4)=SSYS(IS1)
      TBL(IS5,6)=TBL(IS5,1)-1
      TBL(IS5,7)=TBL(IS5,4)-(TBL(IS5,3)**2/TBL(IS5,2))
      TBL(IS4,6)=TBL(IS5,6)-TBL(IS3,6)
      TBL(IS4,7)=TBL(IS5,7)-TBL(IS3,7)
      TBL(IS4,8)=TBL(IS4,7)/TBL(IS4,6)
      WRITE(*,14) (TBL(IS1,J),J=6,8)
14    FORMAT(75(1H-)/51X,F4.0,2X,F9.2,2X,F7.2)
      WRITE(*,14) (TBL(IS2,J),J=6,8)
      WRITE(*,15) (TBL(IS3,J),J=1,8)
15    FORMAT(4X,F4.0,2X,F9.2,2X,F9.2,2X,F9.2,2X,F6.2,2X,F4.0,
     12X,F9.2,2X,F7.2)
      WRITE(*,14) (TBL(IS4,J),J=6,8)
      WRITE(*,17) (TBL(IS5,J),J=1,4),(TBL(IS5,J),J=6,7)
17    FORMAT(4X,F4.0,2X,F9.2,2X,F9.2,2X,F9.2,2X,F6.2,6X,
     12X,F9.2,2X,F7.2)
      WRITE(*,16)
16    FORMAT(75(1H-)//)
      STOP
      END
```

```
C       PROGRAM FOR F-TEST
        REAL MEAN(25)
        DIMENSION A(25,25),SUM(25)
        WRITE(*,91)
91      FORMAT(5X,'CIFA COMPUTER CENTRE,KAUSALYAGANGA')
        WRITE(*,92)
92      FORMAT(5X,'.................................'//)
        WRITE(*,1)
1       FORMAT(1X,'ENTER NUMBER OF REPLICATIONS ')
        READ(*,2) NR
2       FORMAT(I2)
        WRITE(*,3)
3       FORMAT(1X,'ENTER NUMBER OF TREATMENTS')
        READ(*,4) NT
4       FORMAT(I2)
        WRITE(*,5)
5       FORMAT(1X,'ENTER DATA'/)
        READ(*,*) ((A(I,J),J=1,NR),I=1,NT)
        WRITE(*,*) ((A(I,J),J=1,NR),I=1,NT)
        DO 7 I=1,NT
        SUM(I)=0.0
7       MEAN(I)=0.0
        DO 9 I=1,NT
        DO 9J=1,NR
9       SUM(I)=SUM(I)+A(I,J)
        DO 10 I=1,NT
10      MEAN(I)=SUM(I)/FLOAT(NR)
        TTLSUM=0.0
        DO 11 I=1,NT
11      TTLSUM=TTLSUM+SUM(I)
        CRCN=TTLSUM*TTLSUM/FLOAT(NR*NT)
        TRTMS=0.0
        DO 12 I=1,NT
12      TRTMS=TRTMS+SUM(I)**2
        TRTMS=TRTMS/FLOAT(NT)
        TRTMS=TRTMS-CRCN
        CVC=SUM(1)*SUM(1)/FLOAT(NR)
        SUM2=0.0
        DO13 I=2,NT
13      SUM2=SUM2+SUM(I)
        SUM2=SUM2*SUM2
        NNR=NR*NT-NR
        SUM2=SUM2/FLOAT(NNR)
        CVC=CVC+SUM2-CRCN
        AMCML=TRTMS-CVC
        WRITE(*,14)
14      FORMAT(1X,'ENTER DATA '/)
        WRITE(*,15) ((A(I,J),J=1,NR),I=1,NT)
15      FORMAT(1X,5(3X,F5.2)/)
        WRITE(*,16) (SUM(I),I=1,NT)
        WRITE(*,16) (SUM(I),I=1,NT)
16      FORMAT(1X,'SUM IS ',3X,5(3X,F8.3))
        WRITE(*,17) (MEAN(I),I=1,NT)
        WRITE(*,17) (MEAN(I),I=1,NT)
17      FORMAT(1X,'MEAN IS ',3X,5(3X,F8.3))
```

```
      WRITE(*,18) CRCN
      WRITE(*,18) CRCN
18    FORMAT(1X,'COORELATION IS',8X,F12.5)
      WRITE(*,19) TRTMS
      WRITE(*,19) TRTMS
19    FORMAT(1X,'TREATMENTS',12X,F8.3)
      WRITE(*,20) CVC
      WRITE(*,20) CVC
20    FORMAT(1X,'CHECK VERSUS CHEMICALS',4X,F12.5)
      WRITE(*,21) AMCML
      WRITE(*,21) AMCML
21    FORMAT(1X,'AMONG CHEMICALS ',8X,F12.5)
      STOP
      END
```

***

```
C     PROGRAM FOR SIMPLE NON-LINEAR REGRESSION Y=Ae**BX
C     N IS THE NO. OF OBSERVATIONS
C     X IS THE INDEPENDENT AND Y IS THE DEPENDENT VARIABLE
      SUMX=0.0
      SUMY=0.0
      SUMZ=0.0
      SUMXS=0.0
      SUMZS=0.0
      SUMXZ=0.0
      READ(*,*) N
      T=FLOAT(N)
      WRITE(*,3)
3     FORMAT(/1X,'SL.NO.',5X,'VALUE OF X',6X,'VALUE OF Y'/1X,37(1H-))
      DO 5 I=1,N
      READ(*,*) X,Y
      WRITE(*,4) I,X,Y
4     FORMAT(1X,I3,6X,F10.5,6X,F10.5)
      Z=ALOG(Y)
      SUMX=SUMX+X
      SUMZ=SUMZ+Z
      SUMXS=SUMXS+X*X
      SUMZS=SUMZS+Z*Z
      SUMXZ=SUMXZ+X*Z
5     CONTINUE
      A0=((SUMZ*SUMXS)-(SUMX*SUMXZ))/((T*SUMXS)-(SUMX*SUMX))
      A1=((T*SUMXZ)-(SUMX*SUMZ))/((T*SUMXS)-(SUMX*SUMX))
      INTPT=EXP(A0)
      SLOPE=-(A1)
      WRITE(*,7) SLOPE,INTPT
7     FORMAT(5X,'SLOPE=',3X,F10.6//5X,'INTERCEPT=',2X,I7)
      STOP
      END
```

***

```
C     PROGRAM FOR SIMPLE NON-LINEAR REGRESSION Y=AB**X
C     N IS THE NO. OF OBSERVATIONS
C     X IS THE INDEPENDENT AND Y IS THE DEPENDENT VARIABLE
      SUMX=0.0
      SUMY=0.0
      SUMZ=0.0
      SUMXS=0.0
      SUMZS=0.0
      SUMXZ=0.0
      READ(*,*) N
      T=FLOAT(N)
      WRITE(*,3)
3     FORMAT(//1X,'SL.NO.',5X,'VALUE OF X',6X,'VALUE OF Y'/1X,37(1H-))
      DO 5 I=1,N
      READ(*,*) X,Y
      WRITE(*,4) I,X,Y
4     FORMAT(1X,I3,6X,F10.5,6X,F10.5)
      Z=ALOG(Y)
      SUMX=SUMX+X
      SUMZ=SUMZ+Z
      SUMXS=SUMXS+X*X
      SUMZS=SUMZS+Z*Z
      SUMXZ=SUMXZ+X*Z
5     CONTINUE
      A0=((SUMZ*SUMXS)-(SUMX*SUMXZ))/((T*SUMXS)-(SUMX*SUMX))
      A1=((T*SUMXZ)-(SUMX*SUMZ))/((T*SUMXS)-(SUMX*SUMX))
      INTPT=EXP(A0)
      SLOPE=EXP(A1)
      WRITE(*,*) SLOPE,INTPT
      STOP
      END
```

***

```
C     PROGRAM FOR SIMPLE NON-LINEAR REGRESSION 1/Y=A+BX
C     N IS THE NO. OF OBSERVATIONS
C     X IS THE INDEPENDENT AND Y IS THE DEPENDENT VARIABLE
      SUMX=0.0
      SUMY=0.0
      SUMZ=0.0
      SUMXS=0.0
      SUMZS=0.0
      SUMXZ=0.0
      READ(*,*) N
      T=FLOAT(N)
      WRITE(*,3)
3     FORMAT(/1X,'SL.NO.',5X,'VALUE OF X',6X,'VALUE OF Y'/1X,37(1H-))
      DO 5 I=1,N
      READ(*,*) X,Y
      WRITE(*,4) I,X,Y
4     FORMAT(1X,I3,6X,F10.5,6X,F10.5)
      Z=1.0/Y
```

```
      SUMX=SUMX+X
      SUMZ=SUMZ+Z
      SUMXS=SUMXS+X*X
      SUMZS=SUMZS+Z*Z
      SUMXZ=SUMXZ+X*Z
5     CONTINUE
      A0=((SUMZ*SUMXS)-(SUMX*SUMXZ))/((T*SUMXS)-(SUMX*SUMX))
      A1=((T*SUMXZ)-(SUMX*SUMZ))/((T*SUMXS)-(SUMX*SUMX))
      INTPT=A0
      SLOPE=A1
      WRITE(*,9) SLOPE,INTPT
9     FORMAT(/5X,'SLOPE = ',5X,F10.3//5X,'INTERCEPT = ',2X,I7)
      STOP
      END
```

****

```
C     PROGRAM FOR SIMPLE NON-LINEAR REGRESSION Y=A+B/X
C     N IS THE NO. OF OBSERVATIONS
C     X IS THE INDEPENDENT AND Y IS THE DEPENDENT VARIABLE
      SUMX=0.0
      SUMY=0.0
      SUMZ=0.0
      SUMXS=0.0
      SUMZS=0.0
      SUMXZ=0.0
      READ(*,*) N
      T=FLOAT(N)
      WRITE(*,3)
3     FORMAT(/1X,'SL.NO.',5X,'VALUE OF X',6X,'VALUE OF Y'/1X,37(1H-
      DO 5 I=1,N
      READ(*,*) X,Y
      WRITE(*,4) I,X,Y
4     FORMAT(1X,I3,6X,F10.5,6X,F10.5)
      Z=1.0/X
      SUMY=SUMY+Y
      SUMZ=SUMZ+Z
      SUMYS=SUMYS+Y*Y
      SUMZS=SUMZS+Z*Z
      SUMYZ=SUMYZ+Y*Z
5     CONTINUE
      A0=((SUMY*SUMZS)-(SUMZ*SUMYZ))/((T*SUMZS)-(SUMZ*SUMZ))
      A1=((T*SUMYZ)-(SUMY*SUMZ))/((T*SUMZS)-(SUMZ*SUMZ))
      INTPT=A0
      SLOPE=A1
      WRITE(*,7) SLOPE,INTPT
7     FORMAT(5X,'SLOPE=',3X,F10.6//5X,'INTERCEPT=',2X,I7)
      STOP
      END
```

***

```
C     PROGRAM FOR SIMPLE NON-LINEAR REGRESSION Y=1/(A+B/X)
C     N IS THE NO. OF OBSERVATIONS
C     X IS THE INDEPENDENT AND Y IS THE DEPENDENT VARIABLE
      SUMX=0.0
      SUMY=0.0
      SUMZ=0.0
      SUMW=0.0
      SUMZS=0.0
      SUMWS=0.0
      READ(*,*) N
      T=FLOAT(N)
      WRITE(*,3)
3     FORMAT(/1X,'SL.NO.',5X,'VALUE OF X',6X,'VALUE OF Y'/1X,37(1H-))
      DO 5 I=1,N
      READ(*,*) X,Y
      WRITE(*,4) I,X,Y
4     FORMAT(1X,I3,6X,F10.5,6X,F10.5)
      Z=1.0/X
      W=1.0/Y
      SUMZ=SUMZ+Z
      SUMW=SUMW+W
      SUMWS=SUMWS+W*W
      SUMZS=SUMZS+Z*Z
      SUMZW=SUMZW+Z*W
5     CONTINUE
      A0=((SUMW*SUMZS)-(SUMZ*SUMZW))/((T*SUMZS)-(SUMZ*SUMZ))
      A1=((T*SUMZW)-(SUMZ*SUMW))/((T*SUMZS)-(SUMZ*SUMZ))
      INTPT=A0
      SLOPE=A1
      WRITE(*,7) SLOPE,INTPT
7     FORMAT(5X,'SLOPE=',3X,F10.6//5X,'INTERCEPT=',2X,I7)
      STOP
      END
```

```
C       PROGRAM FOR MULTIPLE REGRESSION
C       FIRST COLUMN IS FOR DEPENDENT VARIABLE
C
        DIMENSION BETA(20),A(20),B(20),SE(20),C(20,20),T(20)
        COMMON R(100,20),IR(20),IC(20),SX(20),X(20),SDEV(20),S(20,20),
     1SM(20)
        COMMON M,N,MM,AN,DET
        CALL CRN
        MM=M-1
        CALL INVT(R)
        IF (DET) 9,10,9
10      WRITE(6,101)
101     FORMAT(5X,'MATRIX IS SINGULAR, NO INVERSE EXISTS')
        GOTO 2
9       WRITE(6,102)
102     FORMAT(20X,'MULTIPLE REGRESSION ANALYSIS'/)
        WRITE(6,103) DET
103     FORMAT(5X,'DETERMINANT = ',E16.8)
        WRITE(6,104)
104     FORMAT(5X,'MATRIX INVERSION')
        DO 20 I=1,MM
20      WRITE(6,105) (R(I,J),J=1,MM)
105     FORMAT(8(1X,F8.2))
        DO 4 I=1,MM
        B(I)=0.0
        DO 4 J=1,MM
4       B(I)=B(I)+S(M,J)*R(J,I)
        DO 24 I=1,MM
24      BETA(I)=B(I)*(SQRT(S(I,I)/S(M,M)))
        WRITE(6,168) (BETA(I),I=1,MM)
168     FORMAT(5X,'STANDARD PAR. REG. COEFF.'/5X,8(2X,F8.3))
        CEPT=0.0
        DO 5 I=1,MM
5       CEPT=CEPT+B(I)*SX(I)/AN
        CEPT=SX(M)/AN-CEPT
        AM=M
        DF1=AM-1.0
        DF2=AN-AM
        NDF1=DF1
        NDF2=DF2
        WRITE(6,108)
108     FORMAT(5X,'PARTIAL REG. COEFF.'/)
        WRITE(6,109) (B(I),I=1,MM)
109     FORMAT(8(2X,F8.3))
        SEM=0.0
        DO 11 I=1,MM
11      SE(I)=0.0
        DO 12 I=1,MM
12      SEM=SEM+B(I)*S(M,I)
        SMM=SEM/DF1
        SME=(S(M,M)-SEM)
        SEM=SME/DF2
        DO 14 I=1,MM
        SE(I)=SE(I)+(SEM*R(I,I))
        SE(I)=SQRT(SE(I))
```

```
14      CONTINUE
        DO 19 I=1,MM
19      T(I)=0.0
        DO 21 I=1,MM
21      T(I)=T(I)+(B(I)/SE(I))
        F=SMM/SEM
        RSQ=1.0-(SME/S(M,M))
        WRITE(6,112) (SE(I),I=1,MM)
112     FORMAT(5X,'SE. OF REG. COEFF.'/5X,8(2X,F8.3))
        WRITE(6,113) (T(I),I=1,MM)
113     FORMAT(5X,'T-VALUES FOR REG.COEFF.'/5X,8(2X,F8.3))
        WRITE(6,110) CEPT,RSQ
110     FORMAT(5X,'INTERCEPT = ',F12.4,5X,'R-SQUARE = ',F10.4)
        WRITE(6,111) F,NDF1,NDF2
111     FORMAT(5X,'VARIANCE RATIO = ',F10.4,5X,'DF FOR REG = ',I3,5X,
     1'DF FOR ERROR = ',I3)
        WRITE(6,155)
155     FORMAT(2(/))
2       CLOSE(6)
        STOP
        END
        SUBROUTINE CRN
        COMMON R(100,20),IR(20),IC(20),SX(20),X(20),SDEV(20),S(20,20),
     1SM(20)
        COMMON M,N,MM,AN,DET
        OPEN(UNIT=5,FILE='P16.TXT',STATUS='OLD')
        OPEN(UNIT=6,FILE='P16.OUT',STATUS='NEW')
        WRITE(*,*) 'ENTER NO. OF CHARACTERS & NO. OF CASES'
        READ(*,*) M,N
        NC=0
        DO 8 I=1,M
        SX(I)=0.0
        SM(I)=0.0
        DO 8 J=1,M
        S(I,J)=0.0
8       R(I,J)=0.0
7       READ(5,*,END=99) (X(I),I=1,M)
        DO 9 I=1,M
        SX(I)=SX(I)+X(I)
        DO 9 J=1,M
9       R(I,J)=R(I,J)+X(I)*X(J)
        NC=NC+1
        IF (NC-N) 7,10,10
10      AN=N
        DO 11 I=1,M
        DO 11 J=1,M
        R(I,J)=R(I,J)-SX(I)*SX(J)/AN
        S(I,J)=S(I,J)+R(I,J)
11      CONTINUE
        DO 21 I=1,M
21      SM(I)=SM(I)+SX(I)/AN
        WRITE(6,156) (SM(I),I=1,M)
156     FORMAT(5X,'MEAN OF EACH CHARACTER'/5X,8(2X,F8.3))
        WRITE(6,103)
103     FORMAT(3X,'SUM OF SQUARES & PRODUCTS')
```

```
      DO 6 I=1,M
6     WRITE(6,104) (R(I,J),J=1,M)
104   FORMAT(8(2X,F8.3))
      DO 15 I=1,M
      DO 15 J=1,M
15    R(J,I)=R(I,J)
99    CLOSE(5)
      RETURN
      END
      SUBROUTINE INVT(A)
      COMMON R(100,20),IR(20),IC(20),SX(20),X(20),SDEV(20),S(20,20)
     1SM(20)
      COMMON M,N,MM,AN,DET
      DIMENSION A(100,20)
      DET=1.0
      WRITE(*,*) 'M=',M,' N= ',N
      NI=0
      DO 18 ID=1,N
      PIV=A(ID,ID)
      IM=ID
      JM=ID
      DO 1 I=ID,N
      DO 1 J=ID,N
      IF (ABS(PIV)-ABS(A(I,J))) 9,1,1
9     PIV=A(I,J)
      IM=I
      JM=J
1     CONTINUE
      IF (ABS(PIV)-0.00001) 22,23,23
22    DET=0.0
      RETURN
23    IF (IM-ID) 21,25,21
21    DO 24 J=1,N
      TEMP=A(ID,J)
      A(ID,J)=A(IM,J)
24    A(IM,J)=TEMP
      NI=NI+1
25    IR(ID)=IM
      IF (JM-ID) 20,27,20
20    DO 26 I=1,N
      TEMP=A(I,ID)
      A(I,ID)=A(I,JM)
26    A(I,JM)=TEMP
      NI=NI+1
27    IC(ID)=JM
      DO 30 I=1,N
      AP=A(I,ID)/PIV
      IF (I.NE.ID) THEN
              DO 301 J=1,N
              IF (J.NE.ID) A(I,J)=A(I,J)-AP*A(ID,J)
301   CONTINUE
      ENDIF
30    CONTINUE
      DO 31 I=1,N
31    A(I,ID)=A(I,ID)/PIV
```

```
      DO 32 J=1,N
32    A(ID,J)=A(ID,J)/(-PIV)
      DET=DET*PIV
18    A(ID,ID)=1.0/PIV
      IF (NI-2*(NI/2)) 34,34,33
33    DET=-DET
34    DO 35 L=1,N
      K=N-L+1
      IF (IR(K)-K) 38,35,38
38    INT=IR(K)
      DO 36 I=1,N
      TEMP=A(I,K)
      A(I,K)=A(I,INT)
36    A(I,INT)=TEMP
35    CONTINUE
      DO 37 L=1,N
      K=N-L+1
      IF (IC(K)-K) 40,37,40
40    INT=IC(K)
      DO 39 J=1,N
      TEMP=A(K,J)
      A(K,J)=A(INT,J)
39    A(INT,J)=TEMP
37    CONTINUE
      RETURN
      END
```

NUMBER OF CASES = 10.

ENTERED DATA

12.00
13.00
14.00
10.00
15.00
18.00
11.00
12.00
13.00
14.00

STANDARD DEVIATION= 2.25
VARIANCE= 5.07
MEAN= 13.20

****

57.000	120.000	101.000	137.000	119.000	117.000
104.000	73.000	53.000	68.000	118.000	
89.000	30.000	82.000	50.000	39.000	22.000
57.000	32.000	96.000	31.000	88.000	

MEAN OF SET-1 = 97.00 MEAN OF SET-2 =56.00
STANDARD DEVIATION OF SET-1 = 27.75
STANDARD DEVIATION OF SET-2 = 26.54
VALUE OF T-RATIO = 3.541

******

2537.00	2069.00	2104.00	1797.00	3366.00	2591.00
2211.00	2544.00	2536.00	2459.00	2827.00	2385.00
2387.00	2453.00	1556.00	2116.00	1997.00	1679.00
1649.00	1859.00	1796.00	1704.00	1904.00	1320.00
1401.00	1516.00	1270.00	1077.00		

CIFA COMPUTER CENTRE , KAUSALYAGANGA

ANALYSIS OF VARIANCE (ONE WAY)

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	OBSERVED F
TREATMENTS	6	5587184.00	931197.30	9.83
EXPERIMENTAL ERROR	21	1990216.00	94772.19	
TOTAL	27	7577400.00		

CV = 15.093%

------ END RUN ANOVA ------

*****

2537.000 2069.000 2104.000 1797.000 3366.000

2591.000 2211.000 2544.000 2536.000 2459.000

2827.000 2385.000 2387.000 2453.000 1556.000

2116.000 1997.000 1679.000 1649.000 1859.000

1796.000 1704.000 1904.000 1320.000 1401.000

1516.000 1270.000 1077.000

GRAND MEAN = 2039.643

CF= **********

TOTAL SS = 7577400.000

TOTAL FOR BLOCK 1 16020.000 MEAN= 2288.572

TOTAL FOR BLOCK 2 14471.000 MEAN= 2067.286

TOTAL FOR BLOCK 3 13521.000 MEAN= 1931.571

TOTAL FOR BLOCK 4 13098.000 MEAN= 1871.143

TREATMENT - 1TOTAL = 8507.000 MEAN= 2126.750

TREATMENT - 2TOTAL = 10712.000 MEAN= 2678.000

TREATMENT - 3TOTAL = 10207.000 MEAN= 2551.750

TREATMENT - 4TOTAL = 8512.000 MEAN= 2128.000

TREATMENT - 5TOTAL = 7184.000 MEAN= 1796.000

TREATMENT - 6TOTAL = 6724.000 MEAN= 1681.000

TREATMENT - 7TOTAL = 5264.000 MEAN= 1316.000

ANALYSIS OF VARIANCE [TWO WAY]
****

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	OBSERVED F
BLOCK	3	719620.600	239873.500	3.398
TREATMENTS	6	**********	931197.300	13.192
ERROR	18	1270596.000	70588.640	
TOTAL	27	7577400.00		

CV = 13.03%
STANDARD ERROR OF TREATMENT MEAN= 62.623
STANDARD ERROR OF DIFFERENCE OF TWO MEANS= 88.562

CRITICAL DIFFERENCE VALUE = 185.980

*****

2537.000 2069.000 2104.000 1797.000 3366.000

2591.000 2211.000 2544.000 2536.000 2459.000

2827.000 2385.000 2387.000 2453.000 1556.000

2116.000 1997.000 1679.000 1649.000 1859.000

1796.000 1704.000 1904.000 1320.000 1401.000

1516.000 1270.000 1077.000
GRAND MEAN = 2039.643
CF= **********
TOTAL SS = 7577400.000
TOTAL FOR BLOCK 1 16020.000 MEAN= 2288.572

TOTAL FOR BLOCK 2 14471.000 MEAN= 2067.286

TOTAL FOR BLOCK 3 13521.000 MEAN= 1931.571

TOTAL FOR BLOCK 4 13098.000 MEAN= 1871.143

TREATMENT -	1TOTAL =	8507.000	MEAN=	2126.750
TREATMENT -	2TOTAL =	10712.000	MEAN=	2678.000
TREATMENT -	3TOTAL =	10207.000	MEAN=	2551.750
TREATMENT -	4TOTAL =	8512.000	MEAN=	2128.000
TREATMENT -	5TOTAL =	7184.000	MEAN=	1796.000
TREATMENT -	6TOTAL =	6724.000	MEAN=	1681.000
TREATMENT -	7TOTAL =	5264.000	MEAN=	1316.000

ANALYSIS OF VARIANCE [TWO WAY] - DMRT
****

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	OBSERVED F
BLOCK	3	719620.600	239873.500	3.398
TREATMENTS	6	**********	931197.300	13.192
ERROR	18	1270596.000	70588.640	
TOTAL	27	7577400.00		

CV = 13.03%

STANDARD ERROR OF TREATMENT MEAN= 62.623

STANDARD ERROR OF DIFFERENCE OF TWO MEANS= 88.562

CRITICAL DIFFERENCE VALUE = 185.980

****

92.000	90.000	88.000	87.000	89.000	98.000
94.000	93.000	89.000	95.000	96.000	90.000
91.000	92.000	90.000	97.000	95.000	91.000
90.000	94.000	91.000	93.000	95.000	95.000
97.000					

REPLICATIONWISE SUMS

474.000	462.000	458.000	453.000	465.000

TREATMENTWISE SUMS

446.000	469.000	459.000	467.000	471.000

CORRECTION FACTOR = 213813.8000

TREATMENT SUM OF SQUARE= 83.8344

CHECK VS. CHEMICALS SUM OF SQUARES = 67.2344

AMONG CHEMICALS SUM OF SQUARES = 16.6000

TOTAL SUM OF SQUARE =, 220.2344

SOURCE OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARE	MEAN SQUARE	F RATIO
REPLICATION	4.	49.8344	12.4586	2.3027
TREATMENTS:				
CHECK VS. CHEMICALS	1.	67.2344	67.2344	12.427(
AMONG CHEMICALS	3.	16.6000	5.5333	1.0227
ERROR	16.	86.5656	5.4104	

STANDARD DEVIATION = 1.0402

SIGNIFICANT DIFFERENCE AT 5% LEVEL = 3.7968

Bartlete's Test of Homogeneity for set - 1

For 4 Lots and 5 Items per lot

Now check for Entered Data

40.000	29.000	11.000	17.000
24.000	27.000	31.000	21.000
46.000	20.000	17.000	28.000
20.000	39.000	37.000	33.000
35.000	45.000	39.000	21.000

Sample	Sum of Squares	Mean Square	Log Mean Square
1	472.000	118.000	2.071882
2	396.000	99.000	1.995635
3	616.000	154.000	2.187521
4	164.000	41.000	1.612784
	SUM =	412.000	7.868
	MEAN =	103.000	LOG MEAN= 2.013

DIFFERENCE = .184 CHI SQUARE = 1.690
CORRECTION FACTOR = 1.104 CORRECTED CHI SQUARE = 1.531

*****

2.00	2.80	3.30	3.20	4.40	3.60	1.90	3.30	2.80	1.10
3.50	2.80	3.20	3.50	2.30	2.40	2.00	1.60		
3.30	3.60	2.60	3.10	3.20	3.30	2.90	3.40	3.20	3.20
3.20	3.30	3.20	2.90	3.30	2.50	2.60	2.80		
2.60	2.60	2.90	2.00	2.00	2.10				
3.10	2.90	3.10	2.50						
2.60	2.20	2.20	2.50	1.20	1.20				
2.50	2.40	3.10	1.50						

COMPUTATION OF BARTLETT TEST OF HOMOGENEITY OF VARIANCE
SAMPLES DIFFERING IN SIZE

SAMPLE	SUM X SQ	DEGREE OF FREEDOM N-1	RECIPROCAL 1/(N-1)	MEAN SQUARE S SQUARE	LOG S SQR	(N-1) LOG (S SQR)
1	8.1840	9.0000	.1111	.9093	-.0413	-.3715
2	3.4787	7.0000	.1429	.4970	-.3037	-2.1257
3	.6760	9.0000	.1111	.0751	-1.1243	-10.1187
4	.7150	7.0000	.1429	.1021	-.9908	-6.9356
5	.7333	5.0000	.2000	.1467	-.8337	-4.1683
6	.2400	3.0000	.3333	.0800	-1.0969	-3.2907
7	1.9683	5.0000	.2000	.3937	-.4049	-2.0244
8	1.3075	3.0000	.3333	.4358	-.3607	-1.0820
8	17.3029	48.0000	1.5746	2.6397	-5.1562	-30.1170

*****

SBAR SQR = .36048
CHI SQR = 20.37140
CORRECTION FACTOR = 1.07399
CORRECTED CHI SQR = 18.96798

****

71.000	69.000
68.000	64.000
66.000	65.000
67.000	63.000
70.000	65.000
71.000	62.000
70.000	65.000
73.000	64.000
72.000	66.000
65.000	59.000
66.000	62.000

CORRELATION COEFFICIENT IS .558

****

```
        67.0000        172.0000
       74.0000        109.0000
       54.0000        117.0000
       97.0000        204.0000

       119.5000        119.5000
       91.5000         91.5000
       85.5000         85.5000
      150.5000        150.5000
-----------------------------------------------------------
TRIAL =   1       CHI SQUARE = -237.00000

-----------------------------------------------------------
TRIAL =   2       CHI SQUARE = -181.00000

-----------------------------------------------------------
TRIAL =   3       CHI SQUARE = -169.00000

-----------------------------------------------------------
TRIAL =   4       CHI SQUARE = -299.00000


TOTAL CHI-SQUARE = -886.00000


                              ****


SL NO     VALUE OF X     VALUE OF Y
-----------------------------------
   1            .000          4230.000
   2          50.000          5442.000
   3         100.000          6661.000
   4         150.000          7150.000
    SUMX=    300.000
    SUMY=  23483.000
    MEANX=     75.000
    MEANY=   5870.750

    SLOPE=     19.95800
    INTERCEPT=       4373.90000
  CORRELATION COEFFICIENT =       .9845
    RESIDUAL MEAN SQUARE=   78921.05000
    TEST STATISTIC T=    7.94284
```

ANALYSIS OF VARIANCE
****

SOURCE	SS	DF	MS	F
REGRESSION	4979022.000	1.0	4979022.000	63.091
ERROR	157836.000	2.0	2.000	
TOTAL	5136858.000	3.0		

STANDARD ERROR OF ESTIMATE= 198.644
Grand Total = 297.3900

*****

Replication Totals

76.9920	73.6880	77.2020	69.5080

Treatment Totals

12.4960	18.8940	17.8380	22.8680	23.2920
14.1920	19.2240	21.7440	22.9580	22.7220
15.1120	19.0140	21.2800	22.2100	23.5460

ANALYSIS OF VARIANCE FOR TWO FACTOR RCB DESIGN

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F
B	4.	41.235	10.309	68.153
A X B	8.	2.291	.286	1.893
Error	42.	6.353	.151	
Total	59.	53.531		

CV = 7.847

****

CHECK LIST FOR ENTERED DATA

4430.000	4478.000	3850.000
3944.000	5314.000	3660.000
3464.000	2944.000	3142.000
4126.000	4482.000	4836.000
5418.000	5166.000	6432.000
6502.000	5858.000	5586.000
4768.000	6004.000	5556.000
5192.000	4604.000	4652.000
6076.000	6420.000	6704.000

6008.000	6127.000	6642.000
6244.000	5724.000	6014.000
4546.000	5744.000	4146.000
6462.000	7056.000	6680.000
7139.000	6982.000	6564.000
5792.000	5880.000	6370.000
2774.000	5036.000	3638.000
7290.000	7848.000	7552.000
7682.000	6594.000	6576.000
7080.000	6662.000	6320.000
1414.000	1960.000	2766.000
8452.000	8832.000	8818.000
6228.000	7387.000	6006.000
5594.000	7122.000	5480.000
2248.000	1380.000	2014.000

G= 394481.000 TOTALSS = .2047478000E+09

VALUES FOR RA TOTAL MATRIX

15964.000	17218.000	15488.000
21880.000	21632.000	22226.000
22874.000	24015.000	23506.000
22167.000	24954.000	23252.000
23466.000	23064.000	23214.000
22522.000	24721.000	22318.000

VALUES FOR AB MATRIX

12758.000	12918.000	9550.000	13444.000
17016.000	17946.000	16328.000	14448.000
19200.000	18777.000	17982.000	14436.000
20198.000	20685.000	18042.000	11448.000
22690.000	20852.000	20062.000	6140.000
26102.000	19621.000	18196.000	5642.000

REPLICATION TOTAL

128873.000 135604.000 130004.000

VARIABLE A TOTAL

48670.000	65738.000	70395.000	70373.000
69744.000	69561.000		

VARIABLE B TOTAL

117964.000 110799.000 100160.000 65558.000

REPSS = 1082709.0000000

2.000	1082709.000	541354.700	
5.000	30429180.000	6085837.000	42.867
10.000	1419691.000	141969.100	
3.000	89888200.000	29962730.000	85.712
15.000	69343290.000	4622886.000	13.224
36.000	12584700.000	349575.100	
71.000	204747800.000		

****

DATA FOR SET - 1

46.0000	181.0000
52.0000	228.0000
39.0000	182.0000
65.0000	249.0000
54.0000	259.0000
33.0000	201.0000
49.0000	121.0000
76.0000	339.0000
71.0000	224.0000
41.0000	112.0000
58.0000	189.0000

DATA FOR SET - 2

18.0000	137.0000
44.0000	173.0000
33.0000	177.0000
78.0000	241.0000
51.0000	225.0000
43.0000	223.0000
44.0000	190.0000
58.0000	257.0000
63.0000	337.0000
19.0000	189.0000
42.0000	214.0000
30.0000	140.0000
47.0000	196.0000
58.0000	262.0000
70.0000	261.0000
67.0000	356.0000
31.0000	159.0000
21.0000	191.0000
56.0000	197.0000

ANALYSIS OF COVARIANCE

	SUM X*X	SUM X*Y	SUM Y*Y
	SET- 1		
	32834.00	127235.00	515355.00
C:	31005.09	121312.70	474656.80
	SET- 2		
	45677.00	203559.00	957785.00
C:	40112.05	189532.90	895559.20
	TOTAL		
	78511.00	330794.00	1473140.00
C:	70761.63	311312.30	1369603.00

SET	D.F.	SUM x*x	SUM x'	SUM y*y	REG. COF.	D.F.	b	MEAN SQ
1	10.	1828.91	5922.27	40698.19	3.24	9.	21521.00	2391.22
2	18.	5564.95	14026.11	62225.81	2.52	17.	26873.87	1580.82
						26.	48394.87	1861.34
						1.	709.05	709.05
	28.	7393.86	19948.38	102924.00	2.70	27.	49103.92	1818.66
						1.	5456.45	5456.45
	29.	7749.37	19481.66	103536.60	28.00		54560.38	

[redacted]

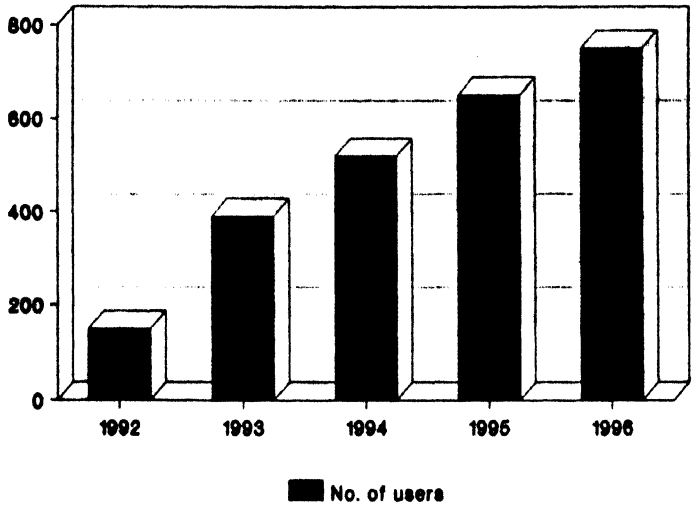
COMPUTER GRAPHICS FOR FISHERIES MANAGEMENT

Computer graphics models of fisheries can have a significant impact in improving fisheries management by helping to narrow down the communication gap between the fishery managers and the fish farmers. Inadequate communication is one of the main constraints to progress in improving the management. Computer communication packages and the availability of powerful computer at low cost have paved the way for modern research and management in aquaculture.

The way that a user interacts with a computer is called an "interface". An effective user interface can make data and models that were previously understood by scientists. The graphic technology enables scientists to transfer their understanding to others, thereby ensuring that research results, and the money and time spent are used effectively and not wasted, as is often the case.

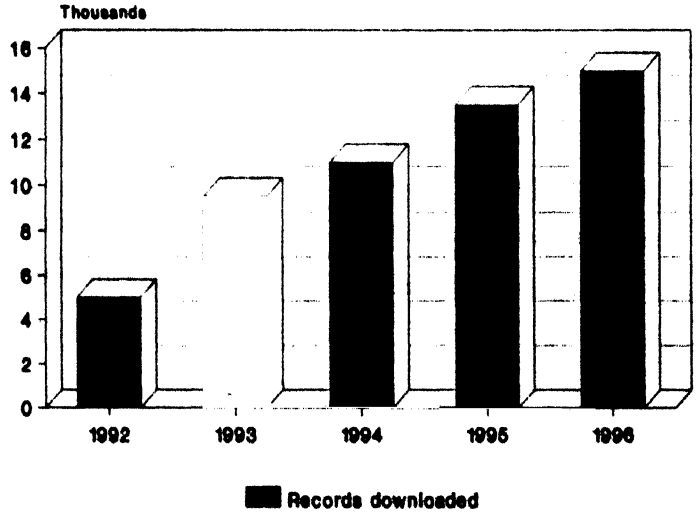
Today an interactive graphic system directly linked to powerful computers is a vital core in the biological laboratories for research, planning, training and lastly decision making.

USERS OF CD-ROMs

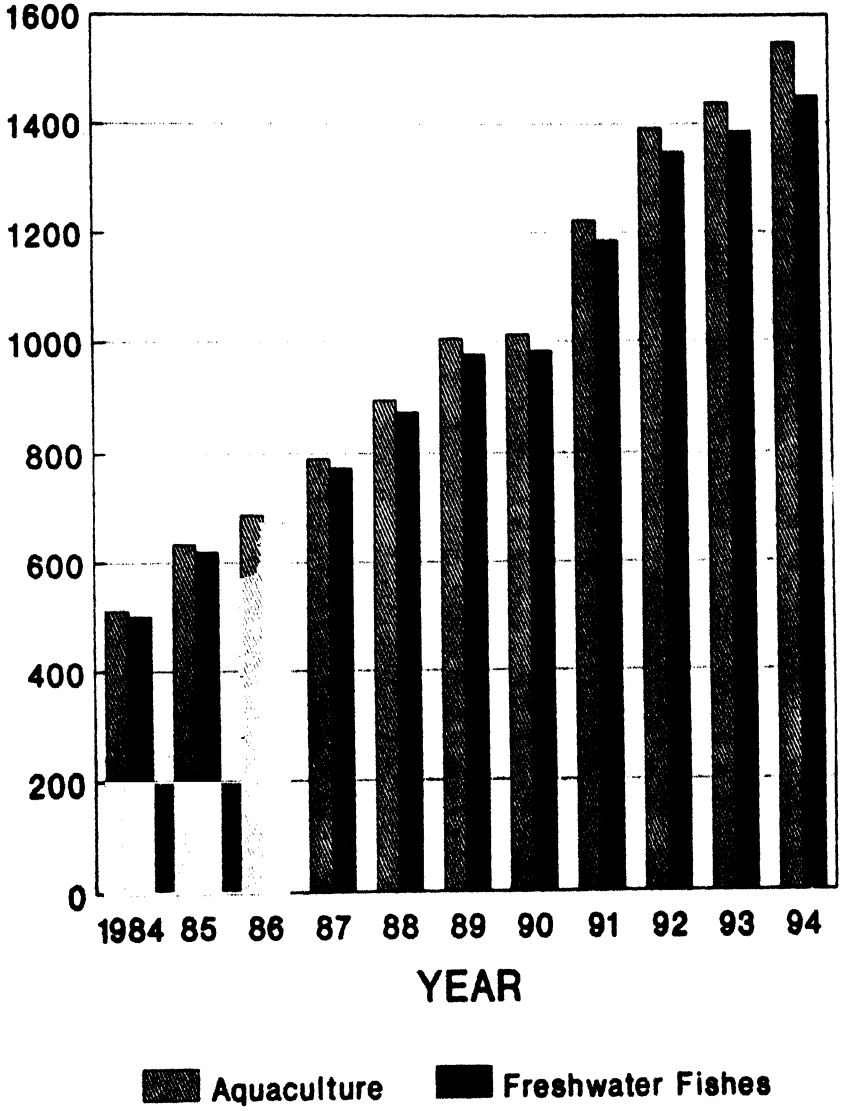


OFF-LINE RETRIEVAL OF BIBLIOGRAPHIC INFORMATION FROM CD-ROMs AT CIFA

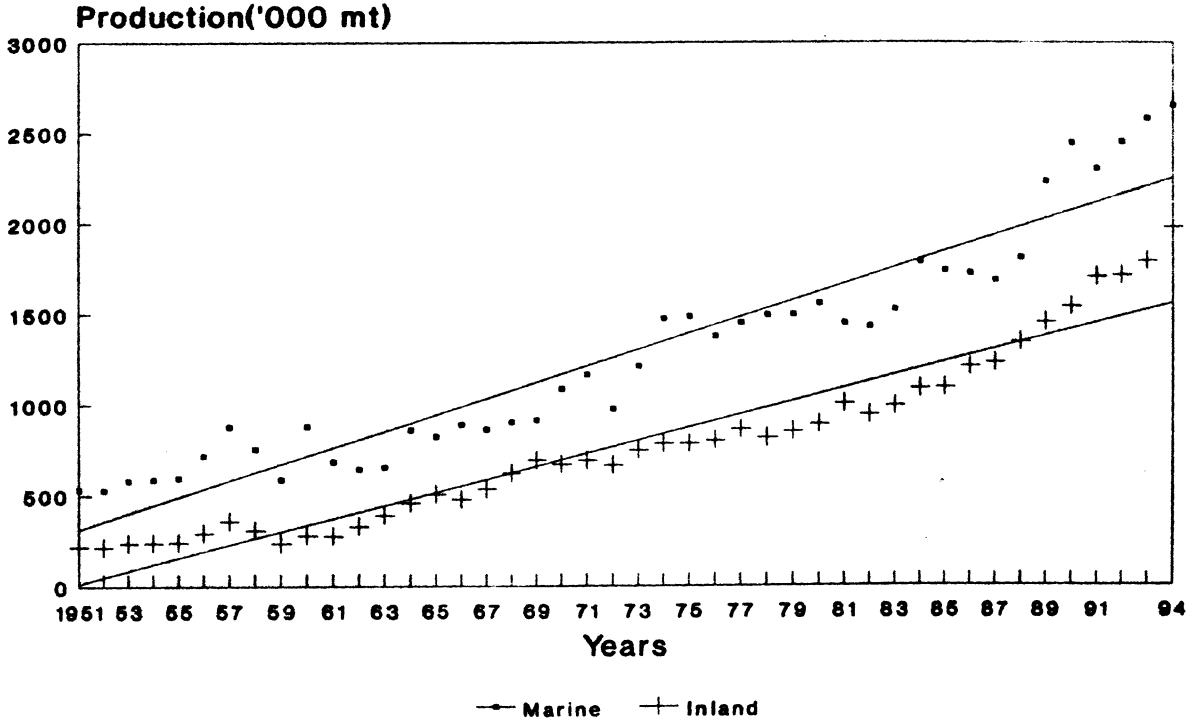
RECORDS DOWNLOADED



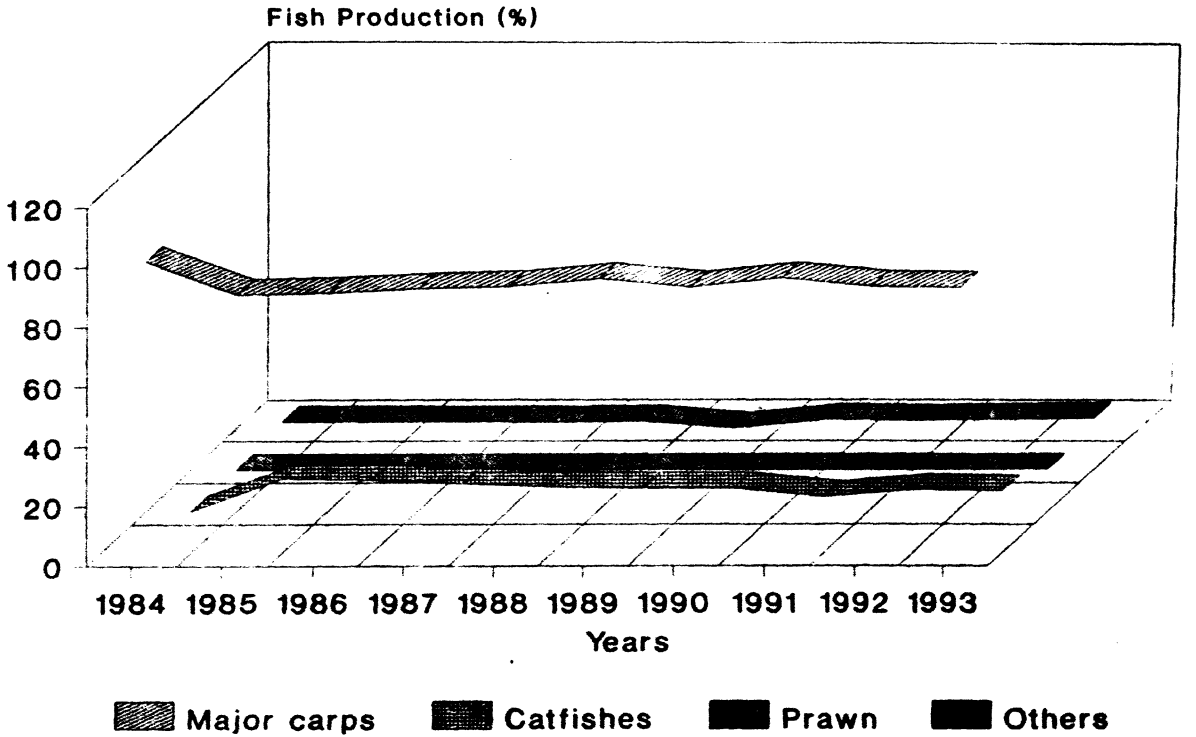
Aquaculture production of India ('000 tonnes)



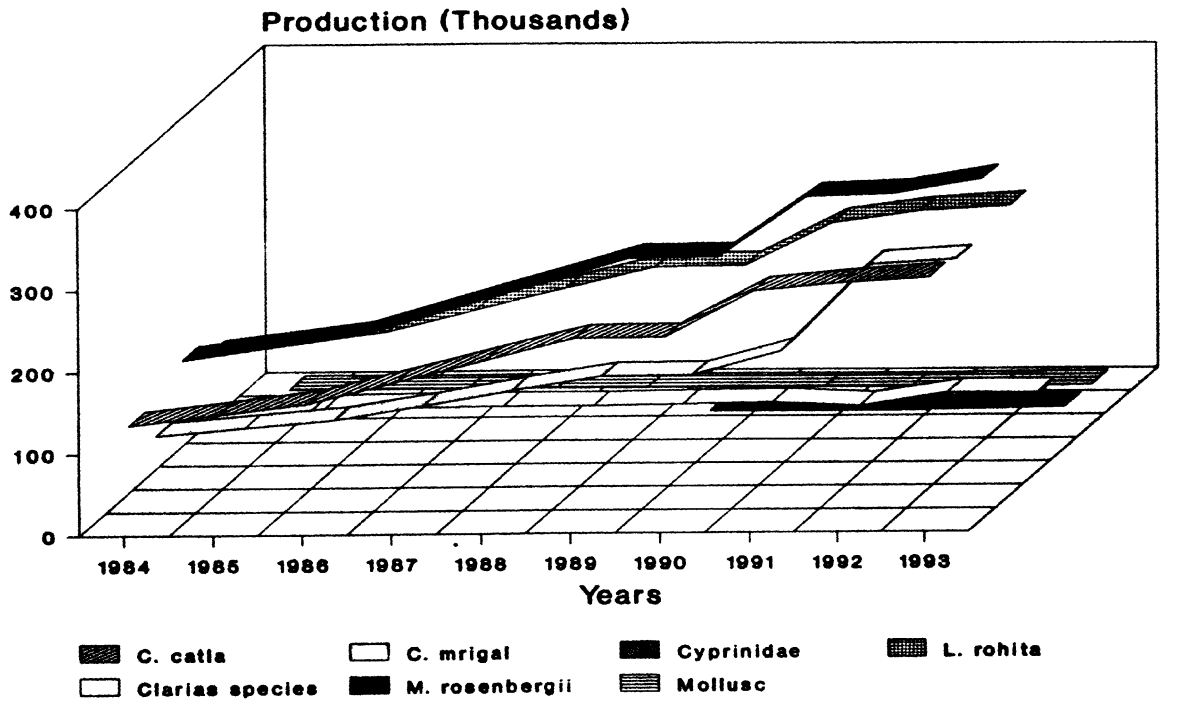
Fish production trend from 1951-94 in India



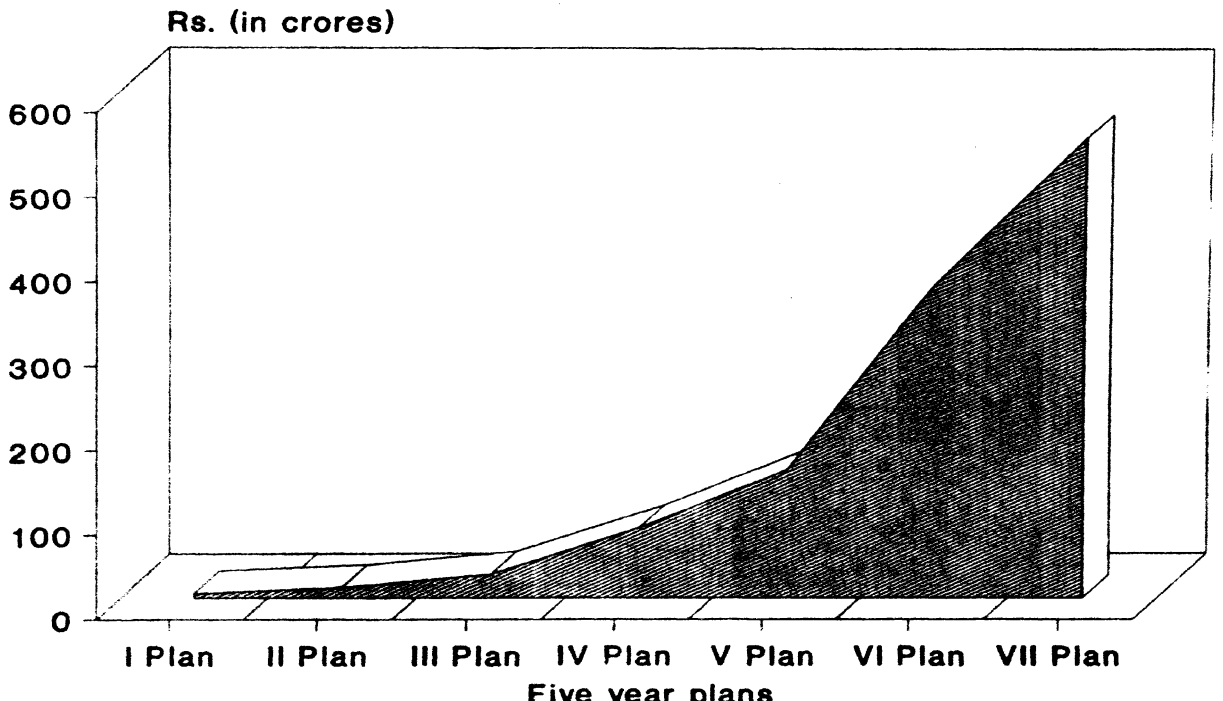
PRODUCTION FROM AQUACULTURE BY CATEGORY



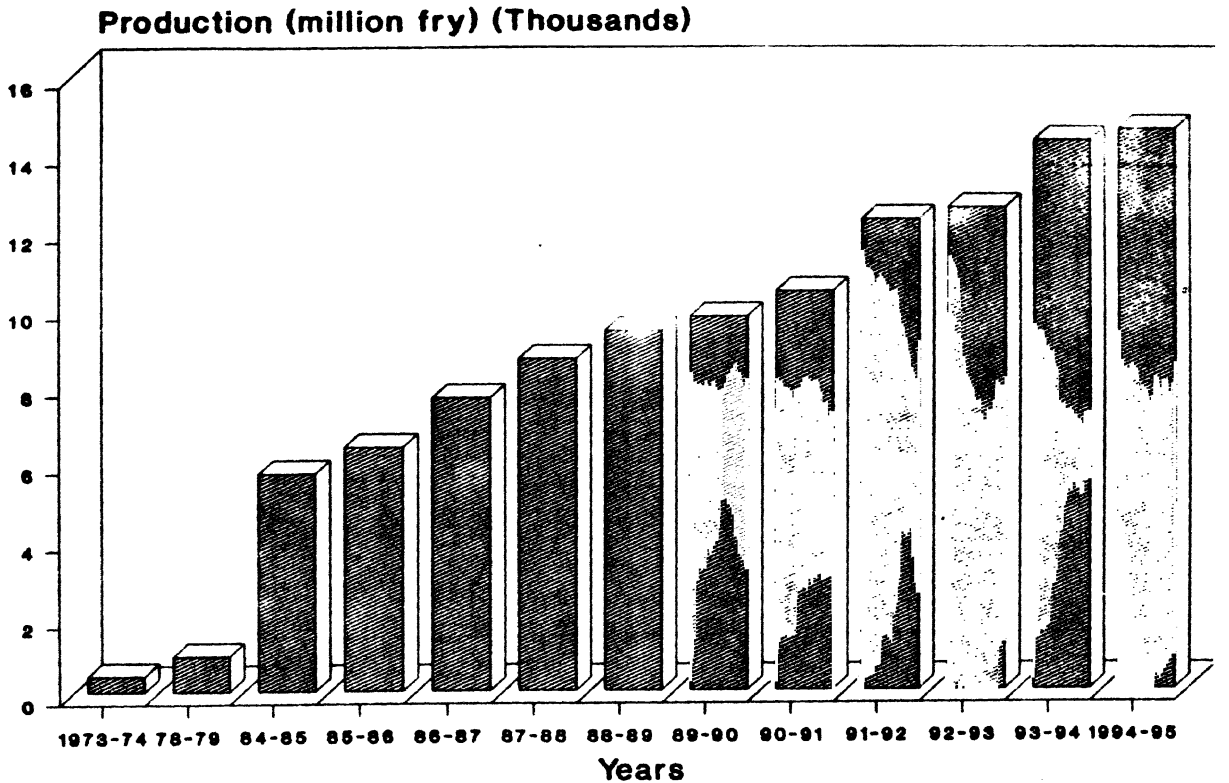
SPECIES-WISE AQUACULTURE PRODUCTION



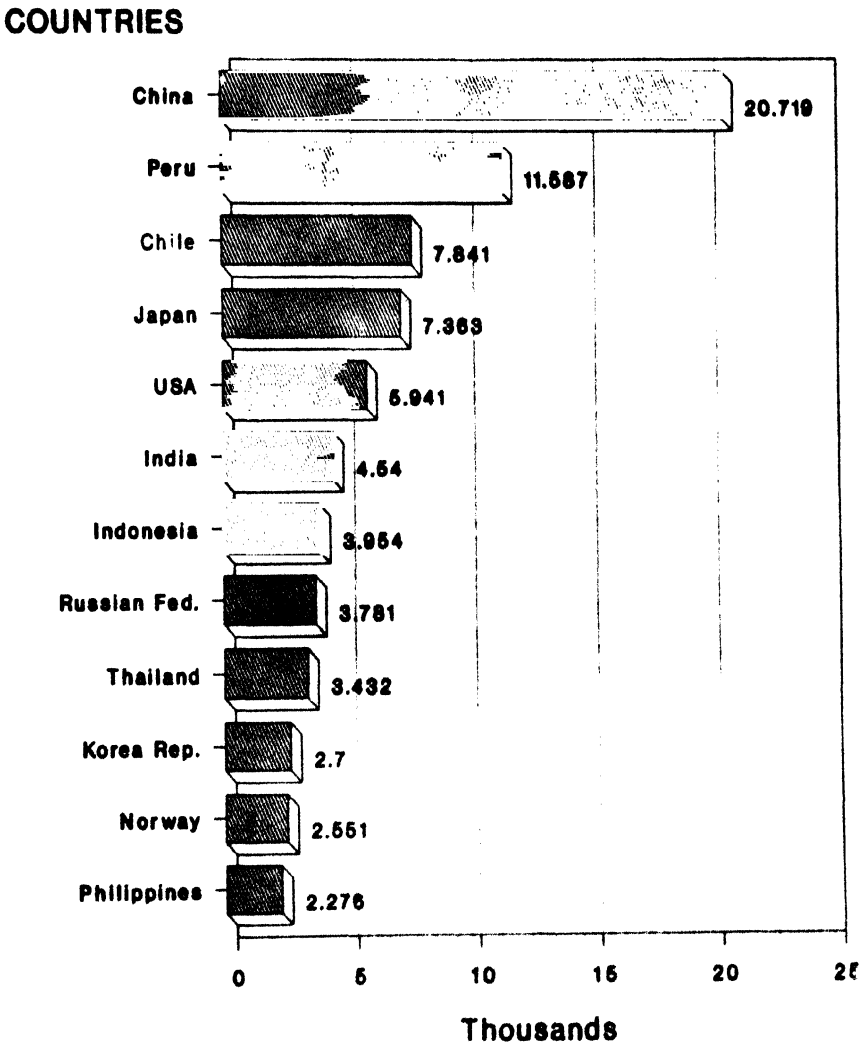
INVESTMENT IN VARIOUS FIVE YEAR PLANS (OUTLAY FOR FISHERIES)



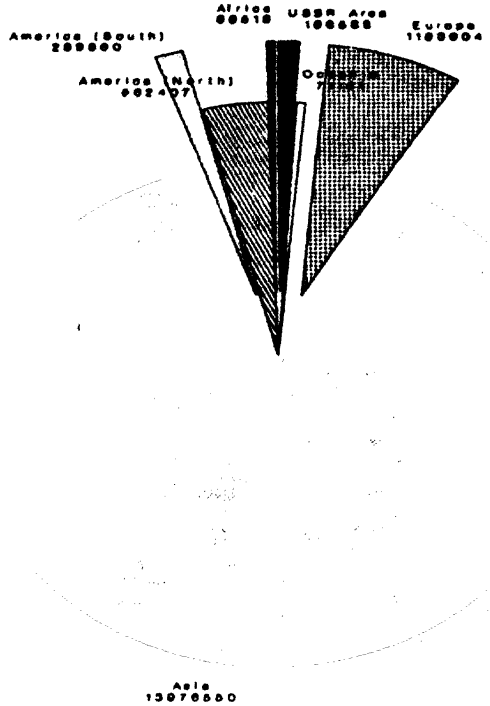
FISH SEED PRODUCTION OVER THE YEARS



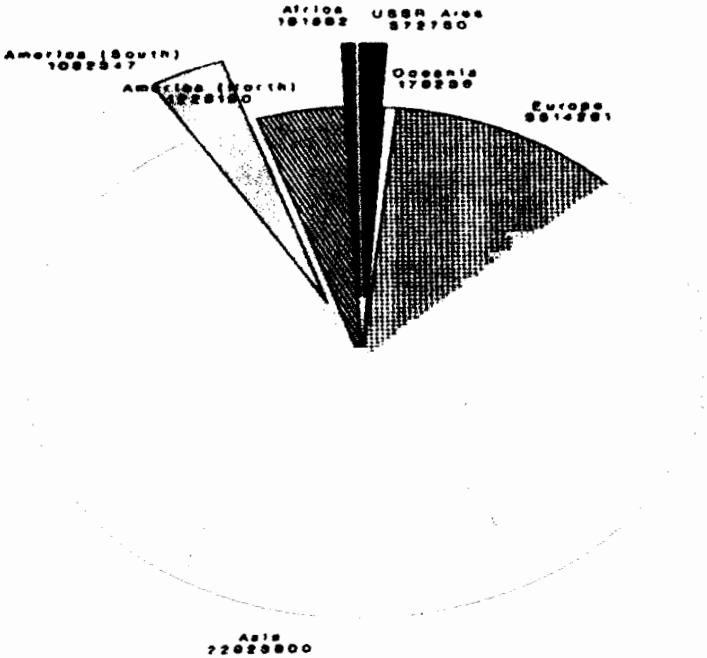
Production of fish by 12 leading countries ('000 mt) in 1994



World aquaculture production by continent (mt)



Value of world aquaculture production by continent ($)



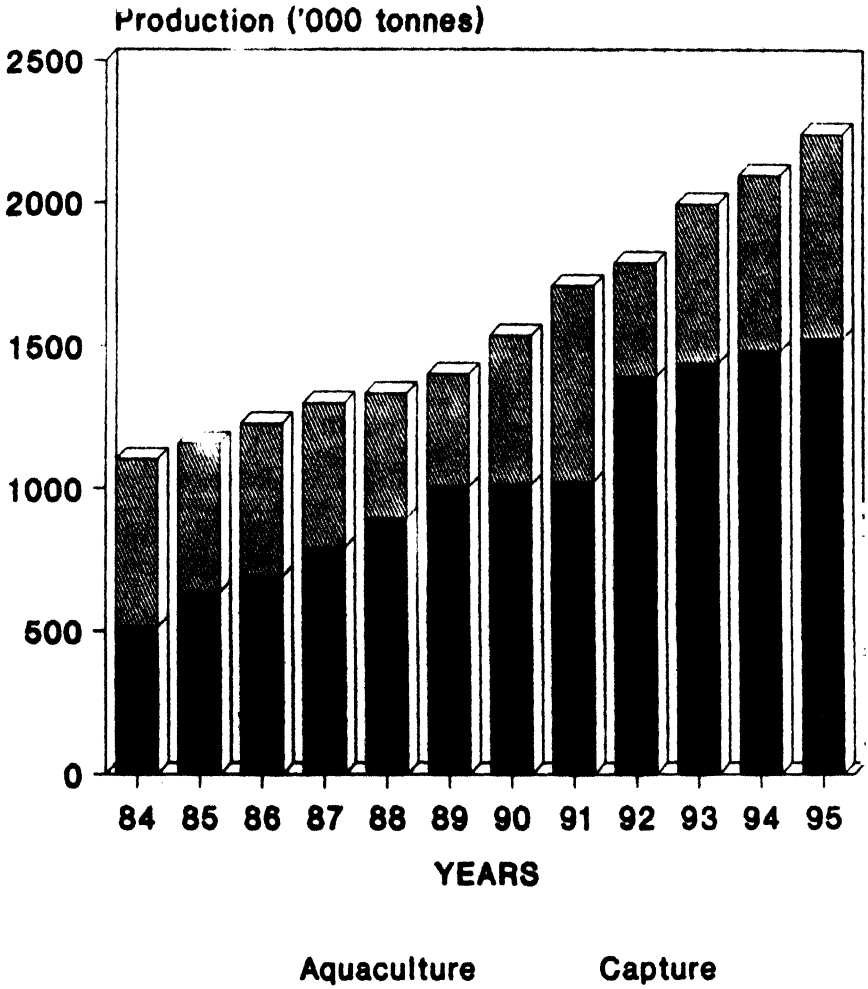


Fig. 3. Trend of Total Culture and Capture Fisheries in Total Inland Fish Production