**The Role of Computing in Advancing Agricultural Science: A Review**

*Authors: 1. Mr. Deepak Kumar Nalwaya (Assistant Professor, Department of Computer Science, RNT PG College Kapasan, Chittorgarh, Rajasthan)*

*2. Mr. Ram Niranjan Vijayvargiya (Head of IT Department, RNT PG College Kapasan, Chittorgarh, Rajasthan)*

*3. Mr. Nikhil Garg (Assistant Professor, Department of Computer Science, RNT PG College Kapasan, Chittorgarh, Rajasthan)*

**Abstract:**

Computer usage in agricultural science is an innovative technology that has transformed the nature of conventional agricultural systems throughout the history of human evolution worldwide. This document intends to offer comprehensive information on the use of computers in agriculture and addresses a diverse array of topics that include MIS and its representations in science, computers along with their principal types and components, applications of statistics, and useful services of different mobile apps in animal, increase, yield and veterinary fishery, soil forestry research. Computer usage influences every aspect and element of agriculture and guarantees sustainable food security and economic development across all countries. Research and evaluations in animal science, agricultural extension, crop science, fishery, forestry, and soil science have progressively utilized computer applications for various objectives. Different types of computer application systems (mainframe, minicomputer, PC, supercomputer, workstation), hardware and software, including MS Word, Excel, and PowerPoint have been essential in agriculture. These distinct types of computers provide the most sophisticated analyses of agricultural findings through documentation and statistical computation. The employment of computers and computer technologies in various agricultural studies must be approached with caution. Utilizing agricultural computers will assist in ensuring the precision of findings and technical analyses, resulting in heightened food production, animal efficiency, and sustainable economic growth.

*Keywords: Farming, Computers, Technology in computers, Management of information, Mobile applications, Data analysis*

**1. INTRODUCTION**

Technological advances have led to drastic changes in various agricultural systems, resulting in a tremendous increase in production capacity . These technological advances also ensure food security, meat and milk availability and the use of raw materials for industrial development . Technological advances in agriculture are increasingly replacing human effort and intervention in traditional farming machinery and other equipment. Technological advances have facilitated the successful automation of support functions for farming, such as the delivery of machinery and fertilizers and the production of raw products. With the development of computer technology and computer systems (Table 1), the cost is further reduced, and the efficiency of farming systems is becoming increasingly powerful . Computer applications in agriculture are highlighted in three significant fields: image analysis, croping models, and IT Solution. Computers and their applications in these three areas have changed the appearance of most traditional agricultural farming activities from the most basic land use in agronomy to the highest level of industrial processing. However, computer information systems (CISs) are the basic foundation for delivering the information needed for global development in agricultural and nonagricultural sectors. CISs can be considered sets of information needed for different sectors in human development. The major types of CISs are the executive support system (ESS), decision support system (DSS), management information system (MIS), and transaction processing system (TPS). The ESSs commonly known as expert information systems (EISs) are information systems that combine many of the features of MISs and DSSs, where data is shown in a manner customized to the tastes of the executive utilizing the system, such as utilizing a graphical user interface (GUI). The DSS provides information to top managers, who are responsible for making judgments about particular situations, and supports decision makers in situations that are not well structured, e.g., risk analysis.

***Table 1:*** *Examples of computer systems*

|  |  |  |
| --- | --- | --- |
| **System**  | **Terms**  | **Definition**  |
| CISs  | Computer information systems  | Sets of information needed for different sectors in human development  |
| ESS  | Executive support system  | Information systems that combine many of the features of MISs and DSSs  |
| ESSs  | Expert information systems  | Computer program that uses artificial intelligence (AI) technologies to suggest the decision and actions of agricultural organization that has expertise and experience in a field of e.g. soil science, crop science, animal science etc.  |
| DSS  | Decision support system  | Information to top managers  |
| MIS  | management information system  | MIS use for and provide manager that information and support for effective decision making  |
| GUI  | Graphic user interface  | System through which users interact with computer devices by visual indicator symbol.  |
| EIS  | Educational information system  | Used for educational purpose  |
| GIS  | Global information system  | Comprise technologies and software that collect, understand and present information assembled from multipal sources to help the researchers for better decision.  |
| GPS  | Global Positioning system  | Satellite-based radio navigation system  |

An Management information System is use for delivers managers with information and assistance for efficient decision making. MIS offers insights on daily operational data through reports, which is viewed as a unified assembly of subsystems generally arranged according to functional categories within an organization (e. g. , the educational information system (EIS)). . It is a tactical framework for gathering, preserving, and circulate performs and records the daily routine transactions necessary data in the shape of information required to execute management functions in agriculture. The TPS is a fundamental business system designed for operational levels and is defined as a computerized system.

The TPS achives and records the schedule of everyday transactions are need for the code of the business (e.g., budgeting, general ledgers, billing, cost accounting, personnel and product records). The components of computer information technology highlighted are needed for a variety of purposes. This is due to the fact that promptness is a key element supporting agricultural statistics and related monitoring system data that becomes useful only if it is accessible in a timely manner. Computer applications in agriculture can be utilized to support agriculture in this regard. There are several advantages of utilizing these applications for various agricultural components. These several advantages include (a) providing a suitable and correct picture of the production and productivity of agriculture, (b) providing information about a large area in an accurate manner, (c) providing information about whether the parameters of a particular area are simple, (d) helping in identifying the vegetation vigor of a particular area and monitoring drought stress, (d) helping in assessing crop phonological development, (f) assisting in gathering information about crop **assessing cultivated land area and mapping agricultural fields**, (g) detecting and mapping land disturbances and LULC (land use/land cover) dynamics, and (h) facilitating the management and control of disease and pests occurring in specific areas. Likewise, computers are widely used in various fields because, from the life of human society to work places, many activities cannot take place without the application of computers, computer intelligence, automation and other characteristics. These activities can effectively improve work efficiency and substantially improve agricultural production and sustainability. The objective of this paper focused on the role of computers and CISs in agriculture with specific objectives to cover subtopics such as MIS, PC basic components, and introduction to the application of statistics and mobile app applications in agriculture.

**2. MANAGEMENT INFORMATION SYSTEM (MIS)**

The idea of a Management Information System (MIS) can be seen from various viewpoints. For the manager who is responsible for the management of the system, MIS is considered an implementation of the organizational systems and procedures, whereas for a programmer who is programmed, MIS is regarded as filling the structures and processing the files. MIS is a compound concept with three components: Management (M), Information (I) and System (S). This indicates that the system proposes integration and a comprehensive perspective; information pertains to processed data, while management is the final user and decision-maker . These three elements constitute what MIS signifies, in the context of global advanced computer technology, and they are separately defined as follows : (a) management, encompassing the planning, control, and administration of an organization's operations; (b) information, which denotes the refined data that assist management in plan, controlling, and operating; and (c) system, which pertains to the data transformed in the information with the aid of a system. The MIS is a structured system created for gathering, collecting, and distributing data in the format of information necessary to perform the functions of management. MIS serves as a platform for data processing to supply appropriate information to management for conducting its tasks across various scientific disciplines. The primary goals are to implement the organizational structure and dynamics of the enterprise to manage the organization more effectively. These goals encompass a thorough understanding of the following objectives : (a) capturing data, (b) processing data, (c) storing information, (d) retrieving information, and (e) propagating information. MIS plays a crucial role in agriculture. Cofas and Chiurciu indicated 19that these categories of information management actions provide solutions for numerous agribusinesses.

*a. The administration of agricultural activities centers around the planning, execution, and oversight of agricultural operations and the required resources (labor, usage, materials).*

1. *b. Mapping consists of charting plots and geo-locating through integration with GIS solutions.*
2. *c. Processed forecasts aim at predictions based on information and alerts from weather stations and field sensors.*
3. *d. Alerts are vigilant and are produced based on inspections and observations as well as external data (drones, other devices).*
4. *e. Planning agricultural activities involves creating work orders based on inspections and alerts while allocating resources.*
5. *f. Treatments that modify crop care depend on challenges (diseases, pests), weather predictions, past treatments, and field observations.*
6. *g. Personnel management focuses on the distribution of staff for each task with a distinct assignment of hours and quantities performed individually and collaboratively.*

**3. THE COMPUTER AND ITS COMMON TYPES**

Computers are now controlling most of our everyday activities and devices in all components of life, including banks, markets, schools, hospitals, sports centers, and shopping centers. Different types of computers are classified according to their size and power, as outlined in Table 2.

1. ***Table 2:*** *Different types of computers classified according to their size and power*

|  |  |  |
| --- | --- | --- |
| **S/N**  | **Types of computers**  | **Description**  |
| a.  | PC  | This is a narrow and it is a not support multi user its support only single-user computer based on a microprocessor. These computers, which were designed for an individual user, first appeared in the 1970s.  |
| b.  | Workstation  | This is a robust, single-user computer that resembles a PC but features a stronger microprocessor and a superior quality monitor in comparison to a PC. These systems are used for engineering purposes (CAD/CAM), desktop publishing, software creation, and many other kinds of activities that require a moderate amount of computing capabilities and fairly high-quality visuals. They come with a substantial, high-resolution display, considerable RAM, built-in network capability, and a visual user interface. Their disk drive provides ample storage space. |
| c.  | Minicomputer  | This is a multiuser computer that can accommodate as many as hundreds of users at once. These computers are medium-sized with a multiprocessing system that can support up to 200 users simultaneously. |
| d.  | Supercomputer:  | This is an exceptionally fast computer that possesses the ability to perform hundreds of millions of instructions each second. These kinds of computers are designed for specific applications and require a large amount of mathematical calculations. They are utilized for software such as weather prediction, scientific modeling, graphics rendering, fluid dynamics calculations, nuclear energy investigations, electronic design, and examination of geological data, including photochemical and energetic pesticide components. |
| e.  | Mainframe  | This is a powerful multiuser computer that can accommodate hundreds of thousands of users at the same time. The term mainframe refers to the enclosure that contains the central processor unit of a room-filling Stone Age batch machine. The term was used to describe computers that excel in speed and efficiency in problem-solving. The main difference between supercomputers and mainframes is clearly apparent. Supercomputers focus all their power on executing a small set of programs as quickly as possible, whereas mainframe computers use their power to operate many programs at the same time. |

Different types of computers have been developed and manufactured for different purposes. A computer is a machine that can be programmed to manipulate symbols. A computer operates on fundamental principles that involve reacting to a designated collection of instructions in a clearly defined way, implementing a prearranged series of instructions, and efficiently saving and accessing a substantial quantity of data. However, the most commonly used differences kinds of computers are portable computers, palmtop computers, notebook computers, laptop computers, docking stationary computers, desktop computers, workstations and terminals, hand-held computers and subnotebook computers.

**3.1. Hardware and Software**

The classes of computers outlined above are built with hardware and software. Hardware refers to physical devices and other bits of equipment that are used in computer systems, such as a hard drive or a hard disk drive, whereas software consists of devices that are nonphysical parts of a computer, e.g., programs. Similarly, some of these computers have navigating windows of various types and forms. The windows 3, 7, 8 and even 95/98 and the WindowsXP millennium and the most recent version, Windows 11, are available. Windows are common in most PC computers. Some of these windows protect important system files and help end users develop more stable operating systems. Working with these windows requires regular practical exercise that can help the user become more conversant to them.

**3.3. MS Word, Excel and PowerPoint**

PC computers are provided with important programs that operate as MS office packages. These MS office packages include Microsoft Word, Excel and PowerPoint. MS Word is widely used as a processing program that allows for the creation of both simple and compound documents. From a typical overview of your PC, when you open the Word document, the dialog box field name will appear. This provided a set of items that guided you to use Word easily and functionally. These items included File, Insert, Home, Design, Layout, Mailings, References, Review and View. On the top left, there are Save box (Ctrl+S), Undo typing (Ctrl+Z) and Repeat typing (Ctrl+Y) icons, and on the right end, there are Minimize, Restore Down and Close icons. However, below these cross-referenced items, there are other sets of functions that are made available by clicking each of the main items highlighted at the head of the Word document. For example, by clicking the Insert, you will be display with sets of items such as Cover Page, Table, Pictures, Online Pictures, Shapes, SmartArt, Chart, Screenshot, Store, My Add-ins, Wikipedia, Online Video Media, Hyperlink, Bookmark, Cross-reference, and many others. These sets of items are made available for different purposes, such as the formation of tables, charts, and cover pages. A large volume of information can be developed in Word by typing or copied and pasted. This information can be saved, stored and retrieved for a variety of uses.

MS Excel is a spreadsheet program for educational research and business applications that gives users the opportunity to format, organize and calculate data within a short period of time. With Excel, millions of items can be calculated in the second step. In this program, an absolute cell reference identifies the location of a cell or group of cells, which are used in formulas. It consists of column and row numbers surrounded by dollar signs ($) and is used when you want a cell reference to stay fixed on a specific cell. This signifies that when a formula or function is duplicated and inserted into other cells, the cell references within the formula or function remain unchanged. In this regard, conditional formatting allows the presentation of numeric data in different colors and presents list data against a background pattern of altering shades. AutoFill is a convenient feature that allows automatic filling of cells with preset data and the customization of the lists of data with AutoFill so that data can be smoothly added for frequent use. The data validation allows you to define what type of data you want to enter in a cell; these include the numbers, dates and times, length, and list of values. Likewise, for each cell you validate, you can display two different massages – the one that appears before the user enters data and the one that appears after the user tries to enter data that does not meet your requirements. They are classified as input messages and error messages, respectively. This means that the input message appears as soon as a user clicks the validated cell, whereas the error message appears only when the user types of data are not valid and presses Enter.

Therefore, to validate the data in Excel, the following processes must be considered: (a) set up a worksheet (enter data and formula), (b) define the setting for a cell (use the data validation dialog box), (c) set up validation for other cells, (d) test the validation rules, (e) set up lists of valid choices, (f) apply protection, if desired, (g) share the workbook, if desired, and (h) check the results for invalid data. This setting would help you carry out various statistical analyses with Excel.

**PowerPoint** is a program that helps you to create a style presentation of data to the public, students or research colleagues. The Slide Master (SM) contains the format on which the titles and text of all slides will be based. In addition, the background and any graphics or text to be displayed on all slides can be set. The SM can change at any time. Individual slides can be set to differ from the SM if desired. The SM can be accessed from the View menu. Generally, from SM, you can also add footers and slide numbers to any presentation. You can do many things with PowerPoint in your presentation, including Bullet Styles, Overriding Master Styles, Handout Master View, and Note Master View, among others.

**3.4. PC (Personal Computer) Basics**

A PC is normally used privately for education, business, communication, or research purposes. This PC c used for basic operation just like a writing, calculations, analyses, graphics, data processing, data storage, data manipulation, and a variety of educational activities, such as online meetings, online lectures, and conferences. PCs are also employed for publishing, printing, chatting, and leisure purposes. Indeed, PCs are already more important to everyday life than most people realize because, to many people, the question is not ‘do I need it’ or ‘how to use it’ but which type, class or model do I need to buy or possess. This indicates the need to understand PC itself in the global educational environment. Specifically, the PC has three separate parts: the display screen or the monitor, the keyboard, and the console that contains the computer itself. Portable computers of all sizes are expected to have all three components so that they can work easily and portably.

There are several key elements inside the PC, including the processor, the RAM and the hard disk. The processor is the true computer and is considered to be the ‘brain’ playing a vital function in the PC. It is the part that sits at the core of machine and works out how to do whatever you tell it to do. The type and speed of a PC processor are two elements that indicate how good a processor is and depend greatly on megahertz (MHz) frequencies; the greater the frequency is, the better the processor is. Therefore, this needs to be checked whenever a particular PC is chosen. RAM, on the other hand, is alphabetically defined as random access memory (RAM), which is the area in which the user stores instructions for the machine to obey them. Thus, all the programmes installed or software are placed in the RAM before the PC can process it. This means that when you install or download software, it goes directly into the RAM, and any information held in the RAM can be stored for later recall (i.e., saving). Conversely, the hard disk is a memory that stores programs and information so that PCs can find them before they can be loaded into the RAM. Hard discs play the role in storing and saving all the information and programs, especially when PCs are shut down. Sometimes, a backup floppy memory disk is used on a PC to store and save information that can later be retrieved for future use. Other discs include optical disc drives such as CDs, CD-ROMs or zip drives such as 100,250 or 500 megabytes, 1 million bytes, 1000 kilobytes (KBs), 50 megabytes (MBs), and 1 gigabyte (GBs or gigabytes), among others. Memory chips, e.g., RAM and ROM (read-only memory) chips, are also available for this purpose and are used for holding the programs and data either temporarily or permanently. RAM holds the data and instructions that the central processing units (CPUs) are presently processing, whereas ROM stores instructions and data permanently.

**3.5. Statistical Analyses**

Agricultural studies allow science to be more relevant in everyday life by enabling scientific discoveries to extend beyond the enhancement of human knowledge, thereby assisting in making choices regarding diverse objectives. A research effort carried out by Bayo noted that statistical approaches are used in agriculture to guarantee efficient planning of experiments and for analyzing experimental results. Statistical methods are also utilized for economic assessments and future forecasts of various enterprises that are significantly beneficial to human advancement. Statistical evaluations are taken into account across numerous agricultural disciplines to respond promptly and effectively to a prevailing issue for future resolutions. This has emerged from the incorporation of various statistical instruments and models into agricultural science and is regarded as part of ongoing research in agronomy, animal husbandry, extension services, fisheries, forestry, and soil science for many years . The computer has become a model for accomplishing numerous statistical evaluations in the realm of agriculture. A variety of analyses have been applied for agricultural assessments. These analyses consist of descriptive data analysis, farm business evaluation, financial analysis, cash-flow assessment, livestock productivity evaluation, comparative analysis, and statistical analysis, among others .

The utilization of statistics in agriculture has been the primary method for most analyses applied in the field of agriculture. Numerous agricultural research efforts have relied on statistical analysis for the interpretation and discussion of the findings obtained. The FAO highlighted that the fundamental statistical tools typically employed for agricultural analyses in various statistical programs are the sum, mean, standard deviation, coefficient of variation, confidence limit of a measurement, and error propagation, while the statistical tests included two-sided versus one-sided tests, F tests for precision, t tests for bias, linear interrelationship and replace, and analysis of variance (ANOVA).

Generally, the fundamental assumption to be established concerning a collection of data derived from consistent analysis of the identical analyte in the same sample in the reliable conditions is that it follows a typical or Gaussian delivery; nonetheless, when the delivery is not symmetrical, the statistical assessment becomes more intricate, and in this context, the key parameters to be utilized are the mean (or average) and the standard disparity, while the principal instruments to be taken into account include the F test, the t test, together with regression and correlation analysis.

The typical statistical software utilized for this aim includes Excel spreadsheet, SPSS (Statistical Package for Social Science), SAS (Statistical Analysis Software), GENSTAS, Stata, Minitab, R, Epi-info, Epi-data, NVivo, and ATLAS. ti. These dedicated programs are created to conduct intricate statistical analyses, help in the structuring and understanding of the outcomes, and compute and display the overall findings for current and future application. A concise overview of these software applications is provided below for convenient reference.

1. *a. SPSS is a statistical software use for more advanced statistical analysis developed by IBM 56 years ago (from 1968). It is used for data management, advanced analysis of results, multivariate analysis, business intelligence, and criminal investigation.*
2. *b. JMP statistics software is a suite of computer applications designed for statistical analysis and machine learning, created by JMP, which is a subsidiary of SAS Institute. The latest version (v17.2) was launched in March 2023 and is intensively used for statistical evaluations of studies in the fields of crop science and horticulture.*
3. *c. GENSTAS is a statistical software used for analysis, primarily to offer a range of tools, including modelling relationships between variables through linear or nonlinear regression, especially in agriculture.* *These typical model types consist of generalized linear models, generalized additive models, generalized linear mixed models, and hierarchical generalized linear models. The package offers 26a broad array of statistical methods related to the design and evaluation of experiments, which is a significant advantage, the resources accessible, statistical modeling, time-series analysis, and spatial analysis, among others.*
4. *d. R Statistic: This is domain-specific statistical software designed for statistical computing and graphic visualizations.*
5. *e. Stata: This statistical software was first launched in 1985 for data science analysis. It is designed for general purposes – data manipulation, visualization, statistics and automated reporting.*
6. *f. SAS is an artificial intelligence and data management software for statistical analysis. The SAS was created in 1972 (51 years ago) by the SAS Institute at North Carolina State University for analytics in advance mode, multivariate analysis, intelligence of bussiness, criminal investigation and predictive analysis.*
7. *g. Minitab: This statistical software was developed at Pennsylvania State University by a group of researchers headed by Barbara. This software performs various common statistical analyses, such as t tests, ANOVA and regression analysis.*
8. *h. Epi info: This is a local domain statistical software suite create for public health researchers and practitioners that offers simple questionnaire and database creation, data input and evaluation with epidemiological statistics, charts and maps.*
9. *i. Epi data: This statistical software application was first launched in 2007 for data entry and data documentation, as well as for quantitative data analysis.*
10. *j. NVivo: This computer software package for qualitative data analysis was created in 1997 by Lumivero and is designed for use in various fields, including agriculture, sociology, criminology, anthropology, and communication. The software facilitates qualitative and mixed methods research, enabling researchers to manage, organize, visualize, store, and analyze data.*
11. *k. ATLAS-ti: This tool is a qualitative data analysis tool that enables the researcher to organize all the text data in one place. The software was developed by ATLAS-ti Scientific Software Development GmbH.*
12. **4. Computer Applications in Agriculture (The main Role of MIS)**

There are increasing advancements in the contemporary agricultural system, and this has impacted nearly all elements of agriculture, specifically agricultural economics and extension, agronomy, animal science, forestry and fisheries, food science, and soil science. During the era of steam and the industrial revolution, the utilization of computers has evolved, and computer usage has become a regular activity in numerous domains of human progress. The potential for employing computers in agriculture has been explored and researched in various facets of the primary components of agriculture. This applications of computers in agriculture has evolved into more sophisticated technology in recent years. It has been viewed as a solution for a cultivated planet and aids in achieving sustainable food security for the worldwide population.

1. The outcomes of technological progress have resulted in the creation of significant quantities of big data within agricultural farming systems through computational expertise and analytical abilities to offer appropriate data, which is advantageous to farmers at local field, national , and scales of world level. This innovative technology has been designed for making decisions regarding several essentials necessary for cultivation and encompasses various sensors that can transform information into digital data. Additionally, there is the creation of technical instruments for recording the environmental parameters and processes, which are of interest to scholars, along with the development of software for specific purposes in agriculture. Computer technology has established the groundwork for modernizing scientific inquiry and has produced new opportunities for handling information for numerous agricultural advantages.
2. Contemporary supercomputers are capable of seeking solutions to worldwide environmental challenges at a qualitatively enhanced level. Computer applications in farming contexts tackle the impact of computers on the agricultural sector and emphasize comprehensive technological management, encompassing climate regulation, greenhouse management, greenhouse climate feedback/feed-forward regulation, and glasshouse management. Additional technological management strategies comprised crop drying management, sulfur dioxide management, retort management, animal management, broiler house ventilation management, poultry house management, rainfall interception observation, grain drying, ammonia observation methods, and various approaches for remote surveillance.
3. According to Day, the utilization of computers in agriculture can be categorized into three techniques: image analysis, crop models, and information technology. Image analysis methods are capable of handling the variability commonly found in biological targets and have significant potential for application in robot control. Crop models continue to be a focus of research, and within the greenhouse sector, they are considered a fundamental basis for environmental control strategies. Information technology offers chances to integrate computer technology throughout agricultural ecosystems, ranging from targeted field operation controls to the implementation of expert systems for the management of crops and farming processes. Consequently, computer simulations enable the execution of numerical experiments on virtual entities that could pose a threat to real entities in order to develop forecasts for a wide array of scenarios, from ordinary occurrences to catastrophic events, and to suggest actions that can reduce their impacts. There are three key areas in which these have seen success in agriculture: (a) resource-conserving technologies like integrated pest management, nutrient recycling, soil and water conservation, water harvesting, and waste recycling; (b) organizations and communities assisting farmers in becoming proficient at managing farms as ecosystems; and (c) most policies are still actively promoting farming that relies on external inputs and technologies.
4. The applications of computers in agriculture encompass comprehensive summaries of the subsequent concepts, which are more or less associated with modern computer technology in recent years: (a) software that assists in forecasting weather conditions and estimating agricultural yields; (b) computers that are mainly utilized for maintaining records of information related to expenses incurred in production, transportation, agricultural operations, and in the assessment and calculation of profit and/or loss; and (c) the internet, which facilitates communication among farmers and between farmers and agricultural specialists, resulting in a knowledge exchange and serving as guidance for farmers to enhance production and increase profits. Nevertheless, with the implementation of computer technology in agriculture, there are numerous advantages, which have benefited both researchers and farmers.

These advantages consist of (a) assistance with various alternatives to pinpoint issues and particular targeted areas, (b) help with large-scale data processing technologies founded on rough and random data collection concerning patterns, water management, and pesticide needs, and (c) support to navigate toward making appropriate choices for the protection of plant health. It is also capable of enhancing cultivation output, (d) applying pesticides at suitable levels can boost productivity, (e) enable farmers to manage and aid in decision-making, (f) allow agronomists to enhance their efficiency by offering crucial cues, and (g) assist them in continuously adapting to requirements and providing insights at every phase of the process.

In summary, computers can be used for various activities under commercial and non-commercial agricultural systems. An observation by Basharat explained this overview to involve various farm sectors. This clarification has yielded the following points, which are worthy of consideration in agricultural systems. The graphical concept of these major points of consideration in agricultural systems is depicted in Figure 1.

1. *Maintaining records: The utilization of computers in agriculture has resulted in the preservation of large quantities of agricultural data that may be utilized for both now and later. The computer is employed to document the yield of crops and livestock alongside the comprehensive farm records. It is also utilized for financial details and machinery. Gains and setbacks can be comprehended, and records enable the identification of the significant variances between the two. The inputs and outputs can be logged from different elements of farm operations.*
2. *Geography: Computer technology in farming can be utilized to chart environmental elements, soil dynamics, and socioregional aspects that may influence agricultural progress in a specific region. Generally, a global positioning system (GPS) has been employed for geographic and geological practical assessments.*
3. *Geographic Information Systems (GISs): GISs have been extensively utilized in the characterization, modeling, and forecasting of spatiotemporal processes and phenomena, including those that are especially pressing for humanity and associated with environmental preservation.*
4. *Agricultural software: Software applications for computers have been developed across different agricultural sectors, such as soil monitoring, animal husbandry, poultry farming, cropping systems, and forest management. Numerous agricultural software programs have been utilized for identifying animal health issues and diseases, milk yield, and feeding practices. Likewise, a number of these techniques are employed to produce data on the reproductive cycles of animals and the duration of egg incubation.*
5. *Internet media: The development of online libraries and diverse open access resources in agriculture offers essential information about agricultural challenges, methods, and technologies. Numerous farmers are obtaining resource information directly from the internet while at home, on farms, and/or during travels. Through this online media, farmers receive guidance on how to cultivate in a more advanced way. Practical insights have been imparted to farmers via internet advancements..*
6. *Communication: The utilization of computers in agriculture is beneficial for interaction among specialists and farmers. Instruction and techniques are provided to the farmers through online seminars and workshops. Farmers engage in discussions with one another to address issues and explore potential solutions in every facet of agricultural advancement.*
7. *Delivery of machinery: A computer has reduced the workload for individuals and created a much simpler method for agricultural systems to assist the rapidly increasing global population. Farmers can conveniently buy machinery online with little hassle or wait time.*
8. *Autonomous farm equipment: Computer technology has begun to substitute human tasks on farms. Using computer machinery, numerous farming activities can be completed in a brief timeframe. Plowing, planting, watering, harvesting, processing, packaging, weighing, and selling are essential farming activities that can be executed with computer machinery.*
9. *Agricultural robots: Agricultural robots are computerized devices utilized for the application of fertilizer and pesticides. These devices have been created to address the dangers linked to chemical hazards and safeguard human health*
10. *Data processing: Computers can serve as tools for processing data in the preparation of agricultural development projects and the establishment of general agricultural principles .*

*Figure 1: Computer applications used in agriculture*

**4.1. Studies: Classical Examples**

The quantity of research in agriculture that utilizes computer applications has risen in recent years. In soil science and ecology, the application of computers is typically associated with the initial gathering of data, its processing, following analysis, and the visualization of outcomes . Numerous areas of interest within soil science have been examined, utilizing advanced computer applications in the domain. These areas of study included research on soil erosion, conservation of water and soil, and relationships between soil and crops.

Damene and Satyal employed the geographical information system (GIS) method combined with the revised universal soil loss equation (RUSLE) to create information on slope gradient and length. They observed that the GIS method and remote sensing data may be utilized in RUSLE-based erosion risk forecasting for extensive regions, including at the basin, sub-basin, and macro-watershed scales. Numerous environmental studies have investigated the current potentials and future prospects of information and computing technologies within soil science and ecology, promoting the implementation of computerization as a modern scientific method

 The use of liquid chromatography tandem mass spectrometry for detecting polyoxin in cucumber and soil was outlined by Song et AI. In the same vein, gas chromatography‒mass spectrometry has been utilized for the examination of aromatic organochlorines in soil. Likewise, soil nutrients were evaluated through spectroscopic computer techniques.

A study conducted by Vivek observed that the utilization of computer applications in veterinary science involved Geographic Information System (GIS), Remote Sensing (RS), and Global Positioning System (GPS) for swift global communication regarding the management of animal diseases. His observations indicated that the advanced technologies utilized in animal science within these three domains include image intensifier TV system (IITV), ultrasound, computerized tomography (CT), magnetic resonance imaging (MRI), nuclear scintigraphy, digital subtraction angiography (DSA), laparoscopy, endoscopy, and pulse oximetry.

The application of distant sensing has transformed the methods agricultural scientists employ to manage and interpret geographic data. Remote sensing, defined as the collection of geographic data without direct interaction with the studied site, has been recognized as crucial in soil and crop evaluations, animal monitoring, forest evaluations, pesticide use, and environmental studies. Nevertheless, a significant area to consider for a comprehensive understanding of different elements of agricultural science in sophisticated computer systems is the utilization of mobile applications.

Various applications have been created for application in agronomy, soil research, animal science, forestry, fisheries, extension services, and veterinary science. This progress can be associated with innovations in digital agriculture, in which data is gathered, stored, analysed, and transmitted electronically.

**4.2. Mobile Applications in Agriculture**

Digital transformation is serving as a complete game changer in worldwide agricultural systems, and this has resulted in the emergence and growth of numerous mobile applications, which have been create to assist farmers in performing diverse agricultural tasks on their farms. Mobile applications can be utilized in agriculture to generate revenue and facilitate programs aimed at ensuring sustainable economic development.

They may be utilized to assist current government programs and additional agriculture-related information in reaching farmers in rural regions where cost factors and security issues could pose obstacles. Nevertheless, with the utilization of computer mobile applications in agriculture, rural farmers can obtain all essential information with a simple button press. Numerous mobile applications can be created to correspond with the user’s common language for improved communication and comprehension. Based on the findings of a straightforward basic survey carried out through an internet search and the usage of the mobile Play Store application, around forty (40) distinct apps were recognized for user advantage [Table 3].

***Table 3:*** *List of 40 beneficial mobile apps for diverse agricultural activities*

|  |  |  |
| --- | --- | --- |
| **Name of App**  | **Link (Approved for public use by the owners)**  | **Purpose of used**  |
| 1  | Digital Agriculture farmers  | Can be downloaded and used from Google play via a Play store  | Digital record keeping: fertilizer, pesticides, seeds  |
| 2  | Agromedix  | https://play.google.com/store/apps/details?id=com.iqra.agromedix  | Agronomic functions  |
| 3  | AgriApp  | https://play.google.com/store/apps/details?id=com.criyagen  | Agriculture  |
| 4  | VOLEST  | Can be downloaded and used from Google play via a Play store  | Tree volume estimation  |
| 5  | AgriApp  | Can be downloaded and used from Google play via a Play store  | Smart farming app  |
| 6  | Farm Bee  | https://play.google.com/store/apps/details?id=com.rml.Activities  | Bee management and productivity  |
| 7  | Plant App  | Can be downloaded and used from Google play via a Play store  | Education free plant identification  |
| 8  | Crop Insurance  | https://play.google.com/store/apps/details?id=in.farmguide.farmerapp.central&hl=en  | Crop assessment  |
| 9  | Agriculture Business  | https://play.google.com/store/apps/details?id=com.AgriculturalBusiness3dsp  | Business in agriculture  |
| 10  | Zero Budget Natural Farming  | https://play.google.com/store/apps/details?id=com.oyepages.zbnf  | Farm budgeting and analysis  |
| 11  | Plantix  | Can be downloaded from Google play via a Play store  | Crop doctor  |
| 12  | Machinery guide  | https://play.google.com/store/apps/details?id=hu.zbertok.machineryguide&hl=en  | Farm machinery guide  |
| 13  | Farmable  | Can be downloaded and used from Google play via a Play store  | Farm management app  |
| 14  | Outgrow  | Can be downloaded and used from Google play via a Play store  | Farming solution app  |
| 15  | Market yard  | https://play.google.com/store/apps/details?id=com.globalfarm.marketyard  | Farm marketing  |
| 16  | Fieldmargin  | Can be downloaded from Google play via a Play store  | Manage your farm  |
| 17  | Farm City  | Can be downloaded and used from Google play via a Play store  | Faming and building  |
| 18  | Agri Live  | https://play.google.com/store/apps/details?id=agri.live  | Agriculture  |
| 19  | Big Farm  | Can be downloaded and used from Google play via a Play store  | Mobile harvest  |
| 20  | My Crop Manager  | Can be downloaded and used from Google play via a Play store  | Farming app  |
| 21  | BigHeat  | Can be downloaded and used from Google play via a Play store  | Smart farming  |
| 22  | My Poultry  | Can be downloaded and used from Google play via a Play store  | Poultry farming  |
| 23  | Rock Identifier  | Can be downloaded and used from Google play via a Play store  | Rocks identification  |
| 24  | ZyAgric Farmer  | Can be downloaded and used from Google play via a Play store  | Business farming  |
| 25  | e-Gram  | Can be downloaded and used from Google play via a Play store  | Agriculture  |
| 26  | Soil Science and Technology  | Can be downloaded and used from Google play via a Play store  | Soil education app  |
| 27  | Soil for Science  | Can be downloaded and used from Google play via a Play store  | Soil education app  |
| 28  | Agricultural Science Textbook  | Can be downloaded and used from Google play via a Play store  | Agricultural books and references  |
| 29  | Soil Sampler  | Can be downloaded and used from Google play via a Play store  | Soil sampling app  |
| 30  | Soil Dictionary  | Can be downloaded and used from Google play via a Play store  | Soil terminology guide  |
| 31  | Insect Spider and Bug identifier  | Can be downloaded and used from Google play via a Play store  | Social insect identifier  |
| 32  | Animal Information  | Can be downloaded and used from Google play via a Play store  | Book and references on animal science  |
| 33  | vet-Anatomy  | Can be downloaded and used from Google play via a Play store  | Education on animal health  |
| 34  | Zoology  | Can be downloaded and used from Google play via a Play store  | Animal kingdom study  |
| 35  | Forest Tree Identification  | Can be downloaded and used from Google play via a Play store  | Forest trees education  |
| 36  | Forest Seed Science  | Can be downloaded and used from Google play via a Play store  | Education on forest seeds  |
| 37  | Forest Engineering  | Can be downloaded and used from Google play via a Play store  | Forest education  |
| 38  | My Fish Manager  | Can be downloaded and used from Google play via a Play store  | Fish farming app  |
| 39  | FishBase Guide  | Can be downloaded and used from Google play via a Play store  | Fishery science education  |
| 40  | Food Science  | Can be downloaded and used from Google play via a Play store  | Food science education  |

1. Overall, various mobile applications have been created to meet different goals in farming. To illustrate this idea of mobile applications in today's technological progress, we examined the subsequent elements of agriculture concerning the relevance to multiple applications listed in Table 2. This research sought to illustrate how mobile applications significantly assist farmers in engaging in agriculture in the most progressive way. It is also thought to offer the most effective means for enhanced communication among farmers in agriculture.
2. *Crop Science: Crop science apps such as Digital Agriculture 4 Farmers, AgriApp, Plantix, Agromedix, My Crop Manager, Crop Insurance and Outgrow can help farmers monitor agronomic activities, from land use practices to planting and fertilizer application. The apps will guide farmers on the best time for planting, manuring, and weeding, among others. These applications can assess the amount of fertilizer a crop might need using the data supplied by the application included in the apps.*
3. *Soil Science: This component of agriculture addresses the nature and condition of the properties of soils. Soil samplers, soil dictionaries, soil science and technology offer vital resource information for educating farmers and students to understand the soil and its natural conditions. The apps help farmers determine the fertility status of their soils and fertilizer requirements. They will guide students on the right point of sampling and right location for soil profile assessment. Soil moisture and water use efficiency are crucial to plants; soil apps can help farmers understand how to manage and improve the use of water by plants. The best irrigation time can be achieved with soil apps.*
4. *Animal Science: Animal and poultry health productivity data are needed all the time. The development of animal science mobile apps such as Animal Information, My Poultry, vet-Anatomy and Farm Bee is playing a key role in helping farmers with the most advanced information to improve the health status of their animals. The time of delivery, egg production and feeding can be easily understood with mobile animal apps.*
5. *Forestry: The management and maintenance of forest trees and vegetation can be achieved easily with mobile apps such as Forest Engineering, VOLEST, Forest Seed Science, and Forest Tree Identification. Estimations of tree volume, length, population density and classification of trees and various plants can be made instantly in the forest.*
6. *Fishery: My Fish Manager and Fish Base Guide are apps used for fish production, management and marketing. These apps can help farmers and commercial fish businesses improve the quality and productivity of their fishponds.*
7. **5. CONCLUSION**
8. The results demonstrate that computer role in agriculture has significant value for supporting agricultural development to ensure sustainable economic development. The resource information combined in this presentation can provide useful insights for a range of relevant guides toward better understanding the advanced relationship between computer technologies and agriculture. There is wide spatial knowledge that needs to be understood in terms of this relationship and how it can be used by local farmers to achieve more food, resources and money with agriculture as a business enterprise. The use of mobile apps may be an easy way for farmers to achieve some aspects of this development. However, in many instances, training and practice are needed. State and local government areas, particularly in sub-Saharan Africa, should use this opportunity to advance these trainings and practices to rural farmers. In this regard, computer application in agriculture is believed to help reduce farmers’ workload and achieve maximum efficiency in all aspects of farming systems. This will significantly ensure holistic environmental security among rural citizens in the region.
9. **Acknowledgments**
10. This work was recommended by the Department of Agriculture, RNT College of agriculture, Kapasan, Chittorgarh, Rajasthan. The wish to thank Professor D.L.K Dashora for their helpful comments and suggestions.
11. **REFERENCES**

Choudhary, P., Sharma, S. Kr., Kaswan, P. K. & Jat, R. Use of Computer in Agriculture. JUST Agriculture e-Newsletter, 2022; 2(3); 1–5.

1. Khosrowpour, M. Encyclopedia of Information Science & Technology. 2009; 1–5; 3807. Idea Group Inc (IGI).
2. Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E.S., Gerber, J. S., Johnston, M., Mueller, N. D., O’Connell C., Ray, D. K. & West, P. C., et al. Solutions of a cultivated planet. Nature, 2011; 478; 337–342 DOI: http://dx.doi.org/10.1038/nature10452.
3. Cai, D. & Xu, W. Analysis on the Application of Computer Technology in Water & Soil Conservation Monitoring in Production & Construction Projects. Advances in Intelligent Systems Research, 2016; 130; 1377–1381 DOI: 10.2991/mcei-16.2016.280
4. FAO. Global Strategy to Improve Agricultural & Rural Statistics; Report No. 56719-GB. 2011; Food & Agriculture Organization of the United Nations (FAO) Rome, Italy. https://www.fao.org/in-action/global-strategy-agricultural-statistics
5. Rahaman, A., Jingdong, L. & Khatoon, R. Modern Agricultural Technology Adoption its Importance, Role & Usage for the Improvement of Agriculture. Life Science, 2017; 14(2); 70–74 DOI: 10.7537/marslsj140217.10.
6. Day, W. Computer applications in agriculture & horticulture: a view. In Proceedings of IFAC, 1991; 24(11); 247-251 DOI: https://doi.org/10.1016/B978-0-08-041273-3.50048-3.
7. Klen, M.J. & Philip, L.F. Encyclopedia of Artificial Intelligence. 2021; 408; Idea Group Inc. (IGI).
8. Mamikhin, S.V., Badawy, W.M. & Khomyakov, D.M. Information & Computing Technologies in Soil Science and Ecology. Moscow University Soil Science Bulletin, 2014; 69; 4 DOI:10.3103/S0147687414040061.
9. Henderson, H. Encyclopedia of Computer Science & Technology. 2009; 552–580. Infobase Publishing.
10. Clarke, J. How to Manage your Computer in just 2 hours. 2006; 88; MMIII the Windsor Group, Bromley, Kent, UK.
11. Kumar, S. & Sarkar, S. Advancement of Computer Applications & Technology for Agriculture Development. Science for Agriculture and Allied Sector. Monthly e-Newsletter, 2015; 3(6); 19–26.
12. Upton, M. African farm management. Agricultural Systems, 1989; 29(1); 93–96. Cambridge University Press, New York.
13. Noble, C., Bennett, J. & Boucher, C. PCS made easy: A practical course – stage 3. 2001; 123–160. Published by Reader’s Digest Association Ltd, De Agostini UK ltd.
14. Flynn, R. (ed.) Computer Science. 2002; 1-4. Macmillan, New York, USA.
15. Butterfield, A., Ngondi, G. E. & Kerr, A. (eds.) Dictionary of Computer Science, 7th ed. 2016. DOI: 10.1093/acref/9780199688975.001.0001
16. John, J. M. Encyclopedia of Software Engineering. 2002; 1–2; 1511–1584. J. Willey, University of Michigan, USA.
17. Bayo, L. Applied Statistical Methods in Agriculture. Health and Life Sciences, 2014; 711–799. Springer Cham Heidelberg New York and Dordrecht London DOI: 10.1007/978-3-319-05555-8
18. Lind, D. A., Marchal W. G. & Wathen, S. A. Statistical techniques in business and economics. 2011; 794–800. New York, NY: McGraw-Hill/Irwin.
19. Borrelli, P, Alewell, C., Alvarez, P., Anache, J. A. A., Baartman, J., Ballabio, C., Bezak, N., Biddoccu, M., Cerdà, A., Chalise, D., Chen, S., & Chen, W. et al. Soil erosion modeling: A global review and statistical analysis. Science of The Total Environment, 2021; 780; 146494 DOI: https://doi.org/10.1016/j.scitotenv.2021.146494.
20. Quintero, D., Ancel, T., Cassie, G., de Castro, R. C. F., Darwish, A., Felix, G., He, J. J., Keshavamurthy, B., Makineedi, S., Nikalje, G., Pal, S., Salie, Z. & Tiwary, A. Workload Optimized Systems Turning POWER7 for Analytics. 2012; IBM company.
21. Warwick University. GenStat (General Statistical). 2023; University of Warwick, Coventry, CV4 7AL.
22. Erick, L. S., Cynthia, M. P., Graciela, M. N. & Camille, M. Biostatistics in Public Health Using STATA. 2016, CRC Press.
23. Ayyappan, S. & Gnanasekaren, S. Application of Big Data Processing Technologies in Agriculture. International Conference on Computer Communication & Informatics (ICCCI). INSPEC Accession Number: 21684742. Coimbatore, India. 2022; DOI: 10.1109/ICCCI54379.2022.9740846.
24. SAS Institute SAS Software. 2023; North Carolina State University.