# Agricultural Informatics: An Overview of Integration of Agricultural Sciences and Information Science

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*Abstract -* **Information Science is an important field of study with the nature of Interdisciplinary Sciences. It is also called as Applied Sciences. The field also synonymously treated and considered as Informatics in different parts of the globe. The branch holds both practicing natures as well as the characteristics of a field of study. Due to its applicability in other subjects and different areas and new subjects have been created viz. Bio Informatics, Geo Informatics, Health Informatics, etc. Among the domain specific Informatics, one important is Agricultural Informatics. In general, it is considered that the applications of IT and Computing in different branches and subjects, societal areas is Information Science. Thus, the application of Computing Systems, Technologies and IT in the practicing field of agriculture and academic field of agriculture is called Agricultural Informatics or short Agro Informatics. However, the integration of techniques, technologies and methodologies of both the subjects viz. Informatics and Agriculture results in the origin of Agro Informatics. The analysis, management and processing of agricultural and allied data by the Computer and IT Systems may also be called as Agricultural Informatics. We know that Agriculture is dedicated to the production of food, feed, fiber and other products with the process of cultivation not only plants but also domesticated animals by various scientific methods. And, Agricultural Informatics thus dedicated to IT based solutions in complete Agro and allied areas. This research work is conceptual in nature and theoretical and demonstrates various features, functions, stakeholders, evolution, technologies, future of Agro Informatics and related branches as well. The paper also highlighted the basics of Agricultural Sciences and Information Science, to reach the goal and objective of the paper as well.**
*Keywords:* **Information Technology, Computing, Agricultural Informatics, Agro ICT, Environmental Information Sciences, Degrees, Interdisciplinary**

## I. INTRODUCTION

Farming is the process of practicing of agriculture and the way for improving farming and cultivating by different kinds of methods including implements is called as agriculture. Farming can be done in a small area with limited inputs and specially to meet the need of a family is also farming where as the commercial intensive agriculture involves large fields as well as number of animals with huge or many inputs and methods, tools, etc. are called Industrial Agriculture. The field and branch of Computing and IT is suitably practiced in commercial agriculture and here is the core reason for introducing Agricultural Informatics [1], [5], [26]. At the early stage, only Agriculture becomes considered as the user of Agricultural Informatics, but gradually other subjects viz. agriculture, horticulture, veterinary sciences, etc are also considered as important users of the field. In the developed countries and territories, the field, Agricultural Informatics is more common and widely available [2], [3], [22]. Even in many countries Agricultural Informatics and allied nomenclature become a field of study for the development of agriculture.

Information Technology is responsible for information related activities with the help of sub components viz. database technologies, networking technologies, web technologies, multimedia technologies, etc. It is important to note that, for the activities of the branch traditional software technologies also played a leading role. Whereas, the branch Information Science much broader and interdisciplinary in nature. It consists with IT and additionally management sciences and principles including its applications in diverse fields; hence it is very close with societal applications and community.

Academic institutes worldwide started different academic, training and research programs on Agro Informatics and allied areas in different level of education; with various nomenclatures viz. Agricultural Information Science, Agricultural Information Technology, Agricultural Information Systems, Agricultural Computing, Agricultural Data Science, Digital Agriculture, etc. Though, PhD and Post Doctoral Research Position is quite common in Agricultural Informatics or in allied areas in Higher Educational Institutes including in universities and research centers in, dealing both the fields. Agricultural Informatics is required in some of the agro industrial parts viz.

1. Integrate and facilitate trade
2. Food Systems management and
3. Security Systems with technologies
4. Supply Chain Management with HRM.

## II. OBJECTIVES

The current paper entitled 'Agricultural Informatics: The integration of Agricultural Sciences & Information Science-An Overview' is proposed and deals with the following aim and objects (however, but not limited to):

1. To get the knowledge on Informatics; including its allied and related nomenclature with evolution, briefly.
2. To get the basic knowledge of Information Science and Agricultural Sciences with reference to Agro Informatics.
3. To know the fundamental features and nature of Agricultural Informatics and changing scenarios.
4. To get the stakeholders of Agricultural Informatics in a brief manner.
5. To get improved knowledge on emerging applications of IT, emerging Technologies and Information Sciences in Agricultural Informatics and allied fields.
6. To learn the allied nomenclature of Agricultural Informatics with educational programs and emerging programs in brief.
7. To find out the challenges, issues and concerns of Agricultural Informatics as well as allied fields.

## III. AGRICULTURAL SCIENCES&INFORMATION SCIENCES: THE FOUNDATION

Agricultural Sciences is a kind of Science; which is an Applied Science is a combination of methods, tools and principles of science and art regarding the cultivation of plants, livestock and animals. Agriculture is responsible for the sedentary human and makes enable people to live in cities. Historically according to experts, agriculture concepts were started about thousands of years ago. Initially started about 105,000 years ago (at least); whereas nascent farmers were started it around 11,500 years ago. Whereas, animals (pigs, sheep and cattle become domesticated may be about10, 000 years ago [8], [12], [30].

Currently in about at least 11 regions of the world are cultivating commercially. Farming is the concept of practicing the cultivation and agriculture is about the commercialization of the farming of the plants, trees, seeds, etc apart from the animal to get the maximum financial income. Even some other products viz. fertilizers, animal hides, leather, chemicals like sugar, alcohols, various types of fibers like cotton, wool, silk, etc are considered as agriculture [6], [7], [21]. Even biomass, ethanol including biodiesel, nursery plants, fish production, etc treated as Agriculture. Biopharmaceuticals, tobacco, cocaine, etc; both in a legal and illegal form considered as Agriculture as well. Agricultural practices are rapidly changes in the recent past there are much new concern in agriculture viz.

### A. Agricultural Chemistry

Agricultural chemistry is considered as important branch of agriculture which is responsible for the use of the chemical fertilizer and insecticides, including chemical fungicides in cultivation. Further soil makeup, analysis of agricultural products, etc may also be considered as a branch of Agricultural Chemistry.

### B. Green revolution & Agriculture

Beginning in the Western world, the green revolution spread many of these changes to farms throughout the world, with varying success. Other recent changes in agriculture include hydroponics, plant breeding, hybridization, gene manipulation, better management of soil nutrients, and improved weed control [9], [18], [29].

### C. Genetic engineering based Agriculture

Genetic Engineering is an important branch of applied science and engineering and applicable in developing agro products, crops, household animal production with the use of genetic engineering principles, tools, methods, etc.

### D. Organic Agriculture/Farming

The agricultural production and cultivation in which absence of the use of (or very minimal) pesticides, fertilizers, antibiotics including growth hormones etc. It is an alternative agricultural and began in the 20th century for rapid agro production practices. Today according to the study, 70 million hectares globally practiced this kind of agriculture.

### E. Corporate Agriculture/Farming

This is a business based cultivation and farming and it is been practices by the mega corporations and large-scale farms. In this kind of agriculture corporate bodies only do the farming in which more direct or immediate profit are possible.

### F. Vertical Farming/Agriculture

In this method or type of agriculture crops basically grows vertically in the stacked layers. So, it reduces the space problem in some extend and it is also called as environment agriculture. It uses the soilless farming techniques like aquaponics, aeroponics etc. It is normally done within a particular area and even building floor, etc [11], [17], [34].

Information Science is an important interdisciplinary field of fields responsible for the information activities ranging from the following affairs mainly (but not limited to)

1. Collection
2. Selection
3. Organization
4. Processing
5. Management
6. Dissemination

However apart from these mentioned, evaluation of the information also another important component and activities. This branch is also called as Informatics in some context and countries and territories [4], [13], [20]. There is a basic difference between Information Technology and Information Science and among these important is its role and nature. Information Technology and Information Science both are applied in nature but Information Technology in mainly concentrated on technological tools and systems whereas Information Sciences may be both manual information activity based and technological nature. Information Science is also broad among such information related subjects viz. Computer Science, Computer Applications, IT, etc and further in regard has been provided in Fig: 1.



**CT**-Computer Technology, **CS**-Computer Science, **IT**-Information Technology, **ISys**-Information Systems, **IS**-Information Science
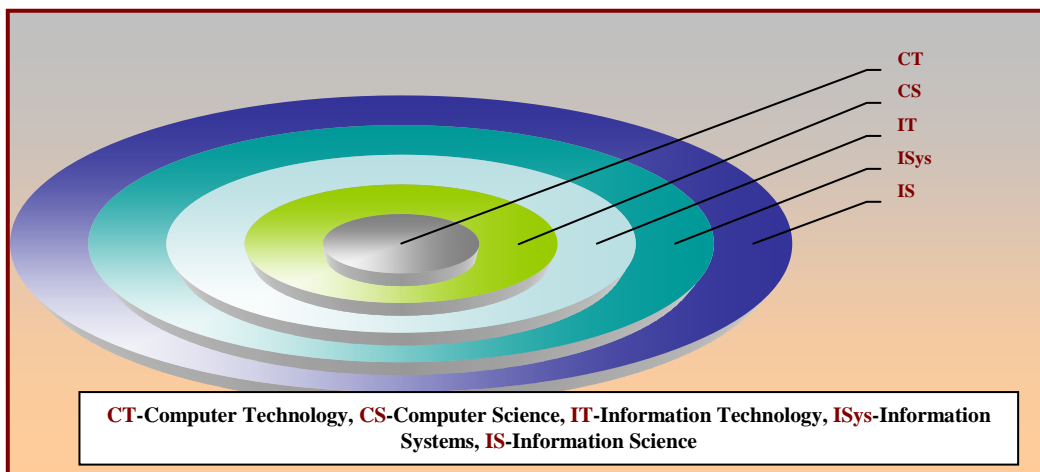
Fig.1 Smaller and larger gradients of Information Science

Further, Information Science uses Information Technological components for the fulfilment of its aim/ agenda and therefore uses different technologies for information jobs viz. Data base technologies, networking technologies, web technologies, multimedia technologies, etc [14], [28], [33]. Moreover, as Information Science is interdisciplinary in nature so it useful in various places as well as organizations and field of study/ subjects such as

1. Education, Training and Research
2. Government, Administration and Management
3. Business, Commerce and Industries
4. Healthcare and Medicine
5. Transportation including Tourism
6. Entertainment and Leisure
7. Sociology and Human Development
8. Biological Sector/ Sciences
9. Mathematical Sector/ Sciences
10. Chemical Sector/ Sciences

As a result, different kinds of Information Sciences have been created and most of them are depicted in Fig 2.
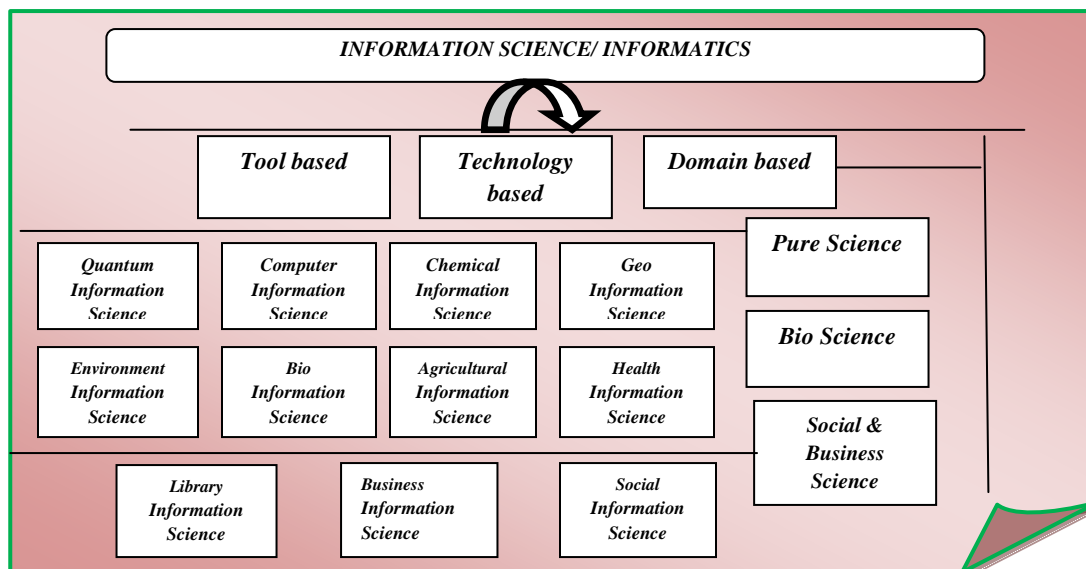


Fig.2 Domain Based Information Science at a Glance

Further, it is important to note that, apart from the technologies mentioned above other technologies are also emerging to reach the goal of Information Science and some of them are mention in the next section.

## IV. AGRO INFORMATICS: FEATURES, CHARACTERISTICS & FACTS

Agricultural Informatics is an emerging field and basically deals with following features and facts viz.

1. Agricultural Informatics is very broad and combines with both Agricultural Sciences and Information Sciences.
2. The field is interdisciplinary and apart from Agricultural Sciences and Information Sciences, it also combines with other allied areas viz. horticulture, veterinary sciences, ecology, geography, anthropology, etc.
3. Agricultural Informatics is dedicated to build advanced agriculture, smart agriculture or digital agriculture, etc.
4. Agricultural Informatics deals with tools, techniques and technologies apart from management science.
5. It deals with traditional IT components viz. database technologies, networking technologies, web technologies, multimedia technologies, etc.
6. The field Agro Informatics is also associated with partially Computer Science, Computer Engineering and allied fields [15], [16], [27].
7. In Agricultural Informatics, content is most important as it deals with Agricultural Documentation as well.
8. Human resources and manpower development are major requirements in the response of the application of the Agricultural Informatics practice.

Agricultural Informatics has also associated with Information Studies and Information Management principles due to various reasons. It is a fact that for proper Agricultural Informatics practice awareness, governmental supports, etc are highly required for different reasons.

## V. ROLE AND FUNCTIONS OF AGRO INFORMATICS

Agriculture is an important and valuable field and, in most countries, Agriculture has received an important role due to the economic role of agriculture. It is treated as a tool for development. It is noted that apart from the developed nations, Agricultural Informatics is responsible for the creation of healthy and ICT enable agriculture in developing and undeveloped countries also. Agro Informatics is even also responsible for the employment generation as well. It is a real fact that till date, millions of farmers with very minimum or marginal holdings are not well skilled in modern agriculture or cultivation methods and here computing and IT is a very important tool i.e. Agro Informatics. In the agriculture systems, there are different issues viz. heat, cold, flood, drought, insect, pest infestations, disease including the weather and climate change. In all such cases, Agro Informatics is applicable nicely with modern computational support. Though, in the areas and issues such as food habits, in nutritional requirements, global trade and development, technological and computational systems, ecological concern as well Agro Informatics may be applied directly and indirectly [23], [24], [31]. Agro Informatics can be applicable directly and indirectly in many other systems and concerns. Strategically as well as methodologically in the following areas, Agro Informatics are applicable for strengthening agricultural systems (but not limited to)

1. Input and Output systems of the Agriculture
2. Agro and allied trade related activities i.e. integrating and facilitating
3. Agro Marketing.
4. Agricultural Post Production.
5. In food security systems on Agriculture.
6. Development of the effective in Agricultural Systems development and promotion.
7. Value-chain development in Agriculture and allied areas.
8. In Climate systems and development.
9. In supply-chain systems and models in respect of Agriculture and allied areas.

Technologies such as Information Sciences, Information Technologies, Information and Communication Technology, Computing Sciences, etc are important in Agriculture systems development including preproduction and post production activities. And this trend is gaining internationally. Moreover, for better results and efficiency skills in both the areas 'Agricultural Sciences' and with good 'IT and Computing' are essential. Agricultural Informatics is also dedicated in global innovations in agro-space, productivity, economic and social development, etc. Study reveals that "agricultural graduates with skill in IT/ Computing are able in of science and technology related jobs and in this context agricultural development ultimately will help in agricultural dynamism in the country. Agricultural Informatics and similar nomenclature and areas such as IT, Computing, Informatics, Agriculture, Environmental Sciences, etc are important in developing agro systems. With the initiation of Agricultural Informatics or allied areas in technologies (mainly IT/Computing etc) or Information or Agriculture Sciences, the whole development of Agriculture becomes possible [10], [25], [32]. Here attentions in the following areas are most important and valuable such as

1. Right and accurate amount of skilling
2. Knowledge of Agricultural field.
3. Communication skills among the graduates in Agricultural Sciences.
4. Entrepreneurship skills among the Agricultural Informatics professionals.
5. leadership qualitiesin Agriculture and allied field, etc.

Ultimately Agro Informatics will help in Increased Efficiency and will do betterment in the monitoring of cultivation as well as agro products management, in real time.

Expansion of traditional Agricultural Systems even smart closed-cycle agricultural systems will also grow. Further in Cleaning and Purity of Agro Space also, Agro Informatics can be a good tool and useful in other affairs viz. managing pesticides and fertilizers etc. With the initiation of Agricultural Informatics, the Quicker Agricultural Systems become possible using modern tools viz. robotics, analytics, etc Moreover, Agro Informatics is also needed in doing Healthy & Quality Production of Agricultural Systems using emerging IT tools and even aerial drone monitoring systems, etc. In Post production activities such as in Livestock Management including post production, marketing, agro business promotion, etc Agro Informatics or similar subjects can be an important name.

## VI. STAKEHOLDERS OF AGRICULTURAL INFORMATION SCIENCES

As noted that Agricultural Informatics is an emerging field and basically deals with various subjects and having a good role in Agriculture so it is having many stakeholders viz.

### A. Technologies

IT: Important Component of Information Science - Agro Informatics Context Initially, only Agricultural Documentation was treated as an important and valuable domain for agro content systems but gradually Agro Informatics was emerged and become a popular field of study. Even many other subjects have been evolved as a field of study like

1. Agricultural Information Systems
2. Agricultural Information Technology
3. Agricultural Information Science
4. Smart Agriculture
5. Digital Agriculture
6. ICT in Agriculture, etc

In all these subjects and also in Agro Informatics, IT (Information Technology) is an important and all its subcomponent or sub technologies are valuable—Database technology is dedicated in the promotion of collecting, selecting, storing, processing, retrieving of data logically and scientifically and this will help in the activities of Agricultural Informatics. Network Technology is dedicated in designing and development of the networking, electronic systems, devices for the building of healthy connected and intelligent Agriculture Networks. In the promotion of the agro industries and cultivators Networking Technology; directly and indirectly, play a valuable role. Among the components of networking few important are includes wireless networks, IoT, converged networks, etc for healthy networking systems [5], [27]. Web Technology is

responsible for agricultural website and web portal designing and development. This is helpful in Agro web portals development and further promotion of the agro products, services and systems. Software Technology i.e. Software Engineering is required in planning, designing, development, and management of agricultural software for better agro products development, cultivation and marketing.

Agro based apps and software are the core of Software Technology field. Multimedia is another tool required for the healthy and interaction of information systems and its representation. As far as Agriculture Informatics is concerned, multimedia is responsible for agro related content designing and development. Agricultural Informatics as a branch gaining rapidly and it becomes an important tool in the strategic development of IT in Agricultural Systems and apart from these technologies mentioned few other and emerging are also become valuable and gaining popularity for pre production in cultivation, modernization and post production of Agricultural systems; and among the emerging technologies important are

1. Cloud computing,
2. Big data Management/ Data Analytics
3. Decision support system with ERP
4. Artificial intelligence and expert system
5. Geographic Information System
6. Remote Sensing
7. Robotics
8. Human Computer Interaction, etc.

### B. Contents

Contents are the most important and valuable matter in agricultural systems. Contents include information, data, knowledge, and documents of various kinds and format important in Agricultural Informatics practice. And contents are treated valuable in software development related to the Agriculture, websites and web portals related to the Agriculture, Agricultural Networking and Systems development, etc. Further in the development of multimedia based agro products and tools contents are most important.

### C. Agricultural Products/ Objects

In Agricultural Systems, among the components a few important products and objects are field i.e. cultivating zone, seed, animals, tools and machines use, etc and in all these, directly and indirectly Agricultural Informatics become possible. Further, the marketing based components viz. vehicles can also be considered as important and valuable [6], [26].

### D. Human Resources

Human Resources are core for any organization, sectors and services. As far as Agriculture is concerned the cultivators

are the core users; however, the designers, developers of the Agricultural products also become important and valuable in other contexts. Ultimately the users of the agricultural product i.e. common people are also indirectly use the benefits of Agricultural Informatics.

## VII. MANPOWER CONTEXT

Agricultural Informatics are responsible for the development of agriculture activities by different sorts, ways, tools and methods. Ultimately this will lead the enhancing the cultivation, including post agricultural production activities viz. marketing, better supply-chain management, etc and as a whole, the skilled manpower will help to the farmers, Agricultural Industry and organizations, Agricultural research and extension services, Agricultural scientific organizations development, Educational Institutes related to the Agricultural field. Healthy as well as sustainable Agro development becomes possible with Agricultural Informatics practice. Today many organizations and educational institutes are moving towards educational, training and research based programs on Agricultural Informatics due to several reasons and among them few important are include— for the development of comprehensive understanding on Agricultural IT and on allied fields, to get knowledge on potential uses of the sensor systems in agricultural activities including cultivation and post cultivation. Better management, manipulating of database designing and development With solid and strategically designed and developed Agricultural Informatics programs many things in agro fields become easy and efficient viz. Irrigation, cultivation, weather, marketing, supply chain management, etc. Agro

related to agriculture with skill. For the development of good relations and knowledge on some other fields viz. horticulture, ecology, forestry, etc. With skilled Agro Informatics professionals, agricultural data may move in a more meaningful way and may result in smarter Agricultural systems at par current trends of modern and developed nations. Agricultural Information Science and allied subjects become an important and emerging field in some of the international universities. Even short-term programs and courses also have been started by some of the universities in the recent past [7], [24], [30]. However, among the common and most valuable topics, few important are includes

1. Basics of Agricultural Sciences/ Systems.
2. Foundation in IT and Computing
3. Basics of Remote Sensor s in Agricultural and allied Systems.
4. Spatial Systems and its applications in Agriculture/ food production.
5. Basics of Information Management
6. Basics of Knowledge Economy and Agriculture
7. Sustainable Development
8. Agricultural Production and Marketing
9. Big Data Analytics &Agriculture
10. Ecological Agriculture
11. Decision making and DSS
12. Cloud Computing and Agro Informatics.

Informatics is skilful may get jobs in diverse areas like technological, managerial and agricultural based. Among the popular titles few are mentioned in Table1

TABLE I FEW POPULAR JOB TITLES IN AGRO INFORMATICS

| Techno Based Agro Jobs | Managerial Agro Jibs |
|---|---|
| Agro IT Facility Manager | Agro Commerce Portal Manager |
| Agricultural Database Manager | Weather Forecasting Expert |
| Agricultural Web Designer &Developer | Agricultural Financial Analyst& Expert |
| Agricultural Software Developer/ Engineer | Agricultural Commodity Trader |
| Agricultural Network Technician | Agricultural Business Informatics Professionals |
| e-Governance Architect (Agro) | Knowledge Manager (Agricultural) |
| Agricultural ERP & Systems Manager | Agricultural Supply Chain Expert |
| Agricultural Content Developer | Crop and Agro Insurance Manager |

## VIII. SUGGESTIONS AND FUTURE REQUIRED STEPS

Agricultural Informatics is offered huge help in cultivators, professionals as well as stakeholders including the marketing of agricultural products and commodities. The following should be paid importance in developing healthy Agricultural systems.

1. Agricultural Informatics practice requires a healthy investment of the technologies for its initial set up as well in continuation of the services.
2. Regarding the design, development, further management of Agricultural IT, it is essential to have skilled, developed and knowledgeable manpower.
3. Better connectivity of internet and electricity are very important for the continuation of the Agro Informatics services.

4. Still there is a shortage in manpower development in Agro Informatics field and this it is needed to start and offer academic programs, specializations, degrees in Agricultural Informatics or in another allied domain.

5. In addition to Agro Informatics, the specialization may be offered in other allied fields viz. Agricultural Information Systems, Agricultural Information Technology, Smart Agriculture, Digital Agriculture, ICT in Agriculture, etc.

6. Agricultural Information Systems as techno-managerial in nature so, better industrial tie-ups, collaboration are important in a different context.

7. Emerging Technologies including the IoT, Cloud Computing and Virtualization, Data Analytics, HCI, Usability Engineering are very important to offer healthy and emerging smart agricultural practices.

## IX. CONCLUSION

Sustainable agricultural systems is the need of hour and government of different countries are moving with their best to introduce such healthy Agro based systems; and in this context initiation of Agro Informatics play a leading role. Modern technologies including IoT, Big Data, Cloud, etc are helpful in developing agriculture system as it helps in water, optimization real-time manner, time saving and post production activities of the agriculture, etc. Even with Agro Informatics support, the humidity, temperature, soil may also possible to get. Proper implementation and continuation have become an important challenge in the better practice of Agro Informatics especially in the developing countries and such are needed to tackle with proper steps and consideration, etc. Manpower development is also vital in the planning, educational policies, academic and industrial collaboration in healthy Agro Informatics implementation. In IT and computing subjects and also in Agriculture Sciences, Agro Informatics and allied specialization may be started to offer. The integration of modern technologies viz. Agro Informatics & IoT, Agro Informatics & Cloud, Agro Informatics &Robotics are very much important for healthy Agro Informatics practice. The involvement of the Agricultural firms, trusts, and companies are highly solicited in further promotion of Agro based systems.

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