

Review Paper

Economical, Financial and Allied Concerns in healthy Agricultural Information Systems Practice: *The Context of Developing Countries*

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ABSTRACT

Informatics is a domain not only for practicing but also a field of study which is really dedicated to study about the information activities such as collection, selection, organization, processing, management and delivery using technologies. The utilization of Informatics in various fields and sectors responsible in developing other domain focused areas and fields such as Bio Informatics, Health Informatics, Geo Informatics, Agricultural Informatics, and so on. Agricultural Informatics is also called as Agricultural Information Technologies and Agricultural Information Science which is simply the merger of the Agricultural Science with Information Science. Basic and latest applications of the IT and Computing in Agriculture and other allied domains are developing and modernizing better and healthy Agricultural practice with ICT. Various other technologies and systems also dedicated in agricultural activities for proper and effective and healthy Agricultural Practice. Many countries worldwide dedicated in ICT applications in Agricultural Systems for effective and progressive situation. Though, modern researchers find-out some of the critical issues and challenges in Agricultural Informatics, and most of the issues are related to the finance and economics including social. This work highlights fundamentals of Agricultural Informatics including technologies and impact of Agricultural Information Science with reference to the latest and researched issues, challenges of ICT in Agricultural Systems related to the economy and financial concern.

HIGHLIGHTS

- ① Agricultural Information System (AIS) is highly dedicated in agricultural development using proper agricultural information IT, Computing and Documentations.
- ② Agricultural Information Systems also known as Agricultural Informatics and Agro IT dedicated in pre and post agricultural development.
- ③ This is become an instrumental for solid and sustainable agricultural development but there are issues related to the economy, and finance and some social concerns which are disrupted proper Agro Development.
- ④ Financial issues are Emerging in purchasing technologies, systems, evaluations and skill development.
- ⑤ Proper steps, and measures can boost Agro Informatics and solid AIS Development.

Keywords: Agricultural Information Systems, Agro Informatics, Digital Agriculture, Development Studies, Smart Agriculture, Developing Countries

The field Agricultural Information System (AIS) is highly dedicated in agricultural development using proper agricultural information management. It is a proper and effective way in managing technologies,

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information and documentation in the field of agriculture (Barakabitze *et al.* 2017; Channe *et al.* 2015; Pau1 *et al.* 2014). As far as field of study it is concerned Informatics Departments and Schools remarked this as a field with the nomenclature of 'Agricultural Informatics' and in certain cases as 'Agricultural Information Technology'. This is the ICT Applications in Agriculture, for agro-product development including pre and post production (Behera *et al.* 2015; Behera *et al.* 2015; Gómez-Chabla *et al.* 2019; Pau1 *et al.* 2014). The field also known as Agricultural Information and Communication Technology that uses various technologies of Informatics and IT components viz.—

- ♦ Software Development, Systems and Technologies
- ♦ Network Systems, Management and Technologies
- ♦ Database Systems, Management and Technologies
- ♦ Web Systems, Management and Technologies
- ♦ Multimedia Systems, Management and Technologies and so on.

Internationally many developed countries as well other developing countries focused on Agricultural Informatics for better agro development, because all we depends on Agro Systems and Products. For better survive of the human being worldwide many organizations as well as ministries including institutions, associations and firms related to the agro and allied areas have involved and use the Agricultural Informatics practice. Even it has wider benefits but it has several issues and concerns in technology, skilling, manpower and implementation related purposes and overcoming of all these may lead to a sustainable agro system development for a effective and advanced agricultural systems which is smarter and digitally impactful (Chauhan 2010; Kontsevov *et al.* 2020; Nayyar & Puri 2016).

Objective

The present work titled 'Economical, Financial and Allied Concerns in healthy Agricultural Information Systems Practice-The Context of Developing Countries' is a theoretical and conceptual work which is dedicated with following aim and objectives—

- ♦ To know about the basic of Agricultural Information Systems including major and remarkable features as well as attributes.
- ♦ To know about the functions and emerging impact of the Agricultural Informatics specially for the digital or smart agricultural systems development.
- ♦ To gather about the potential economical and financial issues and concerns of Agricultural Informatics uses and practices specially for the proper and sustainable impact in Agricultural Sector.
- ♦ To know about the possible suggestions in respect of emerging issues and challenges of effective Agricultural Information System development practice in the developed and developing countries.

Methodology Adopted

The work titled 'Economical, Financial and Allied Concerns in healthy Agricultural Information Systems Practice-The Context of Developing Countries' as conceptual and theoretical nature therefore various existing sources of knowledge have utilized and included in this paper. Review of literature of journals, conference papers, scientific articles have been utilized and reported in this work. Various thesis related to the Agro Informatics, Agricultural Information Systems, Agro Technologies have been utilized and such works helps in preparing this paper.

Root and Fundamental Need of the work

As Agricultural Information Systems helps in developing and transforming agriculture sector using proper information driven systems with modern equipments and Information and Communication Technology (ICT), therefore it is developing a faster information transfer cycle accessing information (Demiryurek *et al.* 2008; Fritz *et al.* 2019; Nandyala & Kim 2016). Agriculture sector is equipped with modern and proper tools, and therefore it is changing the scenario of agriculture production and bringing a competitive environment. The existing transfer of technology mechanisms and extension programs are changing rapidly, and different government bodies and departments are identified vast gaps within 'research' and

'farmers linkages'. The inadequate uses of ICT and Computing products lead the development of Agro Systems and there are other conventional ways for information activities which are lies on extension methods including uses of manual systems and print media in the Agriculture. The introduction and applications of ICT especially devices like mobile phone impacting farmers and there are lot of potential benefits they are enjoying with mobile phones (Goraya & Kaur 2015; Kajol & Akshay 2018; Reznik *et al.* 2015). Mobile phone uses just one example of Agriculture Informatics, and there are other tools and devices available dedicated in advancing Agro Sector (Refer Fig. 1).

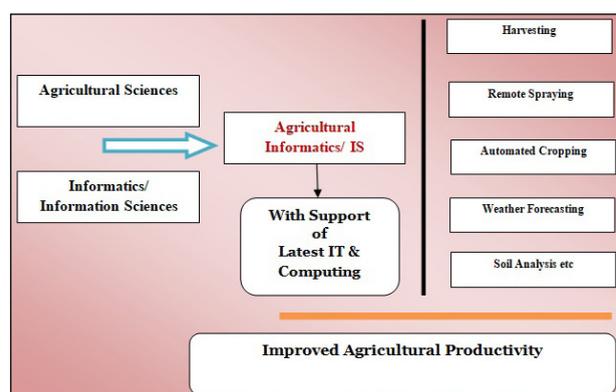


Fig. 1: Foundation of Agro Informatics and its supporting to the systems to the agriculture

Basics of Agricultural Information Systems and Agricultural Informatics

Agriculture is most important and valuable for each and everyone directly and indirectly, because we will be unable to survive without agro products. The development also depends on better and effective agricultural operations in many ways. Proper agricultural development as lead the general development as a whole, therefore proper uses of Agricultural Information Systems considered as a development and in this regard (Gorshkova & Kusmartseva 2019; Kaniki 1988; Paul *et al.* 2015) Agricultural Informatics or Agricultural Information Systems not only about the Computer Applications or basic Computing, rather it is about the application and utilizations of the basic uses of different Information Technology components such as Software, Networking, Multimedia Systems, Web Systems and Technologies, Database Systems and Technologies, and so on. As far as proper and effective agricultural information management is

concerned it lies on different emerging and latest disrupted technologies such as—

- ♦ Big Data Analytics and Management.
- ♦ Data Science and Analytics.
- ♦ Cloud and Fog Computing.
- ♦ Statistical Systems and Management.
- ♦ Edge Computing and IoT.
- ♦ Converged and Wireless Network.
- ♦ Usability Systems, UXD and allied Engineering.
- ♦ 3D Media and VFX.
- ♦ Human Centered Computing.
- ♦ Wireless Censor Network.
- ♦ Multimedia Systems and Database.
- ♦ Satellite Systems and effective Technology etc.

Due to impact of the technologies and growing number of sub-technologies today different universities nationally and internationally offering Agricultural Information Systems related degree at Bachelors, Masters, and Doctoral Degrees level. Here some of the popular nomenclature is including Agricultural Informatics, Agricultural Information Technology (Kamble *et al.* 2020; Liu *et al.* 2019; Manos *et al.* 2011). The applications and integration of Agricultural Technologies into the better and effective Informatics Development lead the agro sector more productive. Agricultural plants are habituated with different weather condition such as heat, cold, flood, drought, insect, pest infestations, and disease, etc. even the aspects of climate change, also fall under the management and periphery of effective Agricultural Information Systems practice. Development and availability of skilled manpower in modern agriculture is also very important, and here effective and modern computational support is urgent and leads the concern of food security, proper and required nutritional requirements, agro related global trade, effective system and technological support, ecological management, etc. and in all these, Agricultural Information Systems is highly important and beneficial (Paul *et al.* 2019; Sørensen *et al.* 2010). In strengthening a effective and advanced agricultural systems Agricultural Information Systems is useful for the following purposes—

- ♦ Input and output of the Agriculture

- ♦ In managing and integrating Agricultural systems with proper facilities.
- ♦ In developing and building Agro Marketing and Business.
- ♦ For the Pre and Post Production and Transportation easiness.
- ♦ In securing and managing food security systems (Khatab *et al.* 2016; Kizilaslan 2006; Levkina *et al.* 2019).
- ♦ In healthy and effective operation of Agricultural Systems.
- ♦ In operational value-chain development systems including climate related.

Different technological subjects which are deals with information like Information Sciences, Information Technologies, Information and Communication Technology, Computing Sciences, etc. are impactful for better and healthy Agricultural Informatics development. And all these are dedicated in better pre production and post production agro activities. Moreover in global innovations and management also Agricultural Information Systems is required such as agro-space, productivity, economic and social development, etc. IT is major field in Agricultural Informatics and this field is contributing various concerned, and other allied science and technology related jobs for various healthy agricultural dynamism (Koester 2001; Milovanović 2014; Ozdogan *et al.* 2017). Agricultural Informatics or Agricultural Information Systems needed for the following purposes—

- ♦ Proper and accurate skilling level.
- ♦ Knowledge and skill of the Agricultural field.
- ♦ Communication skills for the Agricultural Systems and Sciences.
- ♦ Entrepreneurship skills and managerial with leadership qualities etc (Mtega & Msungu 2013; Na & Isaac 2016).

Like different parts of the world in India and other developing countries also Digital Agricultural Systems is emerging and this trend is growing everywhere, even though there are certain issues and concern in starting, proper implementing Agricultural Information Systems and among some of them few is depicted in next sections in developing countries point of view (Teye *et al.* 2012).

Issues in Sustainable and Healthy Agro Informatics Practices

Agricultural Information System or practicing of Agro Informatics is depends on various IT components uses different technologies and thus it also affects with various issues and concerns and among them major are economical and financial, social and allied (Refer Fig. 4). Here in this section brief about the issues and challenges are well described.

1. Economical and Financial Issues and Concerns

As far as Agricultural Information Systems is concerned Finance is an important attributes in different contexts and sectors. In regard to Agriculture; financial aspect is important and valuable, and there are certain cases where finance is important such as in purchasing of the crops, proper harvesting, in effective plantation, proper and effective irrigation, proper soil management, purchasing and developing and; including its proper management, marketing of the agro business, etc (Muangprathub *et al.* 2019; Othman & Shazali 2012; Zhang *et al.* 2016). Manpower related cost is also important for the effective Agricultural Information Systems development, further for the technology and equipment purchasing also fund is important and mandatory, proper technological maintenance is subject to availability of the fund, fund is important in proper skilling and development, initiation of the training programs, effective technology transfer, etc. furthermore all the latest technologies and devices are costly and proper fund is important, in regard to purchasing software and hardware also proper fund is important involvement. In developing countries fund related issues are crucial and various other lacunas need effective attention by proper funding.

(a) Equipments and Products

Agricultural Information Systems needs various equipments such as computers, servers, routers, switches, storage systems, mobile devices, drones, CCTV Systems, small intelligent devices; and all such devices are highly costly therefore proper fund and financial support is important in effective Agricultural Information Systems practice (Gorshkova & Kusmartseva 2019; Ojha *et al.* 2015).

In a developing country like India such purchasing is also important, and tough as proper budget allotment most of the time is critical. In maintaining Agricultural Information Networks, Websites related to the Agricultural Systems, Agricultural robots purchasing and operation proper and adequate fund is highly desirable.



Fig. 2: Different facets and devices where Agro Informatics may be applied

Agricultural Information Systems further needs devices for purchasing smart applications and devices for the root level farmers, and those who are engaged with purchasing or marketing of the products (Paul *et al.* 2016).

(b) Maintaining Technologies

In maintaining technologies and systems of the Agricultural Information Systems appropriate amount of fund required and highly desirable. Maintaining required for the storage systems, servers, computing and robots related devices. Integrating and updated various technologies (*such as Big Data Analytics and Management, Data Science and Analytics, Cloud and Fog Computing, Statistical Systems and Management, Edge Computing and IoT, Converged and Wireless Network, Wireless Sensor Network, Multimedia Systems and Database*) in existing systems also proper fund is highly required. All such technologies need a timely updating and maintenance, and in a developing country such amount may be really difficult to bear in certain cases.

(c) Skill Development

Agricultural Informatics practice is highly depends on various core technologies for effective and healthy Agricultural Informatics practice and skilling is important for the farmers, root level

human resources, technician, information managers, documentation professionals, effective big data management professionals, etc. regarding many latest technologies such as Data Analytics, Cloud and Fog Computing, Virtualization and Internet of Things, Converged and Wireless Sensor Network, Usability Systems and User Experience Designing, Multimedia systems development and Database administration (Paul *et al.* 2020; Reznik *et al.* 2015) Therefore, proper skilling in Agricultural Informatics of such sub-technologies are highly required. It is essential to organize the skill development program for all the stakeholders of agro-informatics including re-enhancement and skilling. In the developing countries and developed countries also as well proper awareness campaign, short term program, training programs are important to conduct and implement. There are different professionals in Agricultural Information Systems practice, and some of them are depicted in Fig. 3. and their proper skilling is continuous process in developing Agricultural Information Systems.

Managerial Agro Jibs
Agro Commerce Portal Manager
Weather Forecasting Expert
Agricultural Financial Analyst & Expert
Agricultural Commodity Trader
Agro Documentation Officer
Agricultural Business Informatics Professionals
Knowledge Manager (Agricultural)
Agricultural Supply Chain Expert
Agricultural Consultant
Agricultural Business Management
Agricultural Systems Administrators
Crop and Agro Insurance Manager

Fig. 3: Various professional and their requirement in sustainable Agro Development

(d) Technology Transfer

Emerging technologies like Big Data Management, Data Analytics, Cloud and Fog Computing, Virtualization based Applications, Internet of Things and Edge Computing, Converged and Wireless Network are lies on proper technology transfer. They may need effective and proper transfer as per need and demand. Similarly some other technologies such as Usability Engineering which are required in agro networks and websites usability enhancement including in User Experience Designing seeks technology transfer (Rao 2007; Reddy & Ankaiah 2005). Human Computer Interaction and Human Centred Computing is highly depends on proper

cycling and its needs good amount of fund and financial support. In the following technologies and their technological transfer appropriate amount of fund is highly required.

- ♦ Software Development, Systems and Technologies
- ♦ Network Systems, Management and Technologies
- ♦ Database Systems, Management and Technologies
- ♦ Web Systems, Management and Technologies
- ♦ Multimedia Systems, Management and Technologies and so on.

Like this changes of file formats also needs proper cycling and up-gradation as per need and requirements (Fritz *et al.* 2019; Tsekouropoulos *et al.* 2013).

(e) Software and Technology Upgradation

Agricultural Informatics and proper utilizations is depends on various system and application software specially emerging application software. And all such software, file and technological apps are truly depends on proper funding and financial assistance. General applications to licensing and newer versions of the software need to purchase and for that adequate amount spending is important and required.

(f) Digital Divide and Financial Aspects

Digital Divide is the divide of the systems and technology among the ‘have’ and ‘have not’ and this may be surrounded by various tools and equipments, or may be purchasing of the technologies. Therefore proper fund is important in removing the Digital Divide, and that may lead the Agricultural Informatics practice with a new height. Digital and technological involvement is crucial and alarming in Digital Divide, and this may lead to the unfair or unsuccessful agro informatics practice, and all these needs proper financial support. Further, less or non availability of technologies, non or poor products, poor or non-internet connections, lack of broadband, etc. are also being considered as a problem of finance in Agricultural Information Systems practice (Channe *et al.* 2015; TongKe 2013).

2. Other Concerns and Issues in Healthy Agro Informatics Practice

There are other concerns and issues in implementing Agricultural Information Systems practice in developing countries and among them important are include the following (but not limited to).

(a) Issues and Concerns related to the Government

For an effective and required Agricultural Information System development Governmental Support is urgent to reach it desired mission as well as fulfillment of the scheme (Bauckhage & Kersting 2013; Kontsevoy *et al.* 2020) Further actual technological implementation is also required in practicing proper Agricultural Informatics, and for this healthy Governmental support is essential, and proper technological implementation completely lies on government funding.

(b) Literacy Requirement and similar concerns and Issues

Agricultural Informatics is now not only a practicing area but also an interdisciplinary field of study; though it is a fact that proper awareness is highly required and need to be practiced. As Agricultural Information System is comes with ample advantages for the development of the healthy, intelligent and smarter agricultural development.

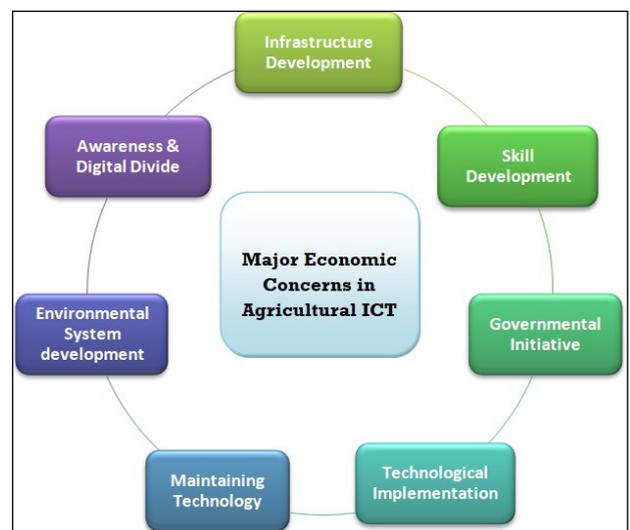


Fig. 4: Economic Issues for Agro Informatics vis-à-vis Agro Development

Though proper awareness is highly required in a developing country like India, here healthy and

effective initiative is highly important to introduce (Paul *et al.* 2020; TongKe 2013). Such literacy drive may be organized by different bodies such as Government bodies, agricultural and proper farms, agro related companies, agricultural associations, etc (Barakabitze *et al.* 2017; Behera *et al.* 2015).

(c) Localization and awareness related Issues

There are issues related with the environment as Agricultural Informatics uses different types of IT devices such as computing machinery, IT and so on. Moreover aspects and issues of localization including awareness to the community level is lacking regarding the benefit of the Agricultural Information System (Velu 2017; Zhang *et al.* 2016).

(d) Issues on proper Policies and Framework

Agricultural Information System as deals with technology, agriculture and systems and dedicated in Agriculture and Environment including Society, therefore shortage of policies and rules must be considered as important concern and lacking proper framework and issues are really challenges and same can be improved and indirectly may be beneficial in Governmental Ministries and other bodies including Higher Educational Institutes, Scientific laboratories and Research Centers, Foundation and Associations related to the agriculture (Velu 2017; Yan-e 2011).

Proposed Framework and Solutions

Agricultural Information System is not only a practicing domain but also a study area that deals with proper applications and utilizations of the Agricultural IT and Computing for information management. Apart from its ample opportunities, good amount of issues or obstacles are important in developing proper Agricultural Information System, though few suggesting measure and solutions related initiative may undertake for healthy and effective agro informatics practices.

Effective Manpower development related Solutions regarding Agricultural Information System or allied subjects may be introduced by the universities and other educational institutes where agriculture or computing or allied branches are offered. Further in sciences related to the environment or horticulture with the nomenclature Agricultural Information Technology, Digital Agriculture, etc. Agricultural

Information Management is also offered in the subjects and programs like Management, Commerce and Business (Manos *et al.* 2011; Zamora-Izquierdo *et al.* 2019). Further different level of farmers may gain agro technologies, agro documentation related training or short term courses leading to certificates, professional certificate, diplomas, and so on.

Effective and proper implementation of the technologies and regarding this the real and strategic applications may lead the proper implementation of Agricultural Information System. Accurate technological implementation with proper patches, firewalls, utilities, proper reviewing may lead the development of the smart Agricultural Information System practice (Manos *et al.* 2011; Zamora-Izquierdo *et al.* 2019). Latest technologies such as Data Analytics, Cloud and Fog Computing, Virtualization and Green ICT, Internet of Things and Edge Computing etc. must be applied as per need and application of the with trained and skilled human resources.

Financial Management and Possible Steps are important and the issues of finance may be solved by proper cooperation of the bodies of Government including relevant and allied agro related organizations and foundation, so that technological implementation is perfectly possible. Moreover, good amount of budget allocation is required for solving fund related matters specially in the developing countries. In addition to these, adequate loan facilities from such organizations including allied ministries, departments and of course from the international bodies are highly essential.

Suggestion and initiation in regard to Digital Divide is really important problem mostly in developing countries, though developed countries are not exception. Digital Divide may be resolved with proper initiative, organizing training program, fulfilling technological gap, awareness and literacy drive and more involvement to the common people with Agricultural Information System.

Proper support in Government and regarding this each and every country is offering social services through various projects and initiatives offered by the ministries and departments, and in this context a proper and routine wise modification, evaluation of old and new policies as well as projects also need to review and enacted time to time (Paul *et al.* 2016; Zhai *et al.* 2020). Further adequate training

programs as well as proper funding with creating an environment for the Digital Agriculture must be ensure.

Awareness and Literacy related solutions Proposal is essential for enforcing Agricultural Informatics practice and for this importance of different associations, Higher Educational Institutes (HEIs) must be offered by with initiation of awareness and training programs, agro-tech extension services, etc. And for this, proper steps to the Agricultural Informatics are highly required. In this segment farmers and cultivators must be attentive with basic IT literacy (Pau1 *et al.* 2014).

Possible solutions in environment friendliness also important as computing and allied products generates various harmful gases etc., therefore proper Agricultural Information System must be ensure with green computing and technological practices leading to safety and eco-friendliness to the environment.

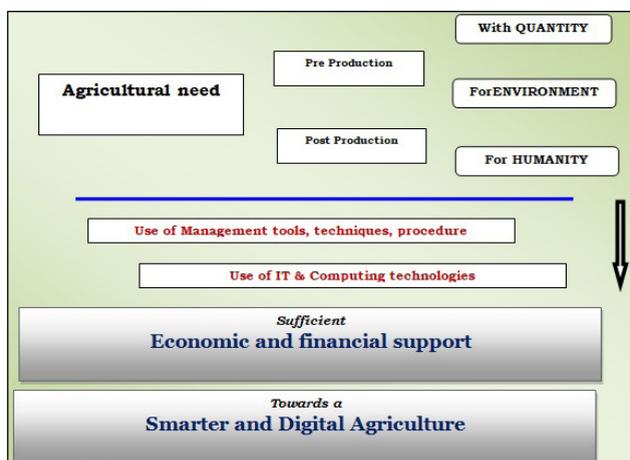


Fig. 5: Sustainable Development of Agriculture with proper economic support

Implementing required Framework is also important for ensuring real-life and value added Agricultural Information System practice solid policies, effective regulations are highly required in the developing countries, and territories (Na & Isaac 2016; Zhang *et al.* 2016). Agricultural Information System is practicing area and interdisciplinary field therefore proper policies and framework must be initiated by the agricultural training or research institutes, or government bodies and allied associations.

New Technological Integration and required proposal is important for the Implementation of newer information technologies is the need of the hour.

And it needs proper integration of new and old technologies. Further, adequate and proper timing, frequent review of existing technologies and systems must be ensure as per the need and requirement.

CONCLUSION

Agricultural Information System is deals by the Computing Technologies with all the latest technologies such as Data Analytics and Management, Cloud and Fog Computing, Virtualization Techniques and Systems, Internet of Things (IoT) and Edge Computing Usability Systems and UXD, Human Computer Interaction and HCC, Multimedia etc. further Agricultural Information System also depends on various management techniques and ways. As Agricultural Information System practice concerns with various issues and challenges specially economical and financial, therefore all such can be resolved with proper planning, and framework implementation throughout and whenever needed. India and other developing countries may entertain adequate steps and planning for a healthy and solid smart agricultural development, as depicted in Fig. 5. And it is also essential to note that apart from addressing economical and financial issues and allied concerns such as technological implementation, social and environmental issues must be addressed properly in order to develop a sustainable agricultural development.

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