Agriculture Industry: Past and Present

1.1 Introduction

The agriculture revolution in 8000 and 3500 B.C have had a great impact on human civilization where it was the foundation which gave rise to the human culture which combines; fine arts, customs, beliefs, values, behaviour and material habits that constitute a human's way of life. Agriculture revolution took people away from a barbarian lifestyle where social units were formed promoting a more standard way of living. Farming was the chief way of living until the industrial revolution in the recent history; therefore people adopted many mechanisms from the beginning to ensure the sustainability in farming.

In order to cultivate crops on a regular basis people got help from each other; animals were first domesticated and used in various aspects of farming. They raised cattle, sheep, goat, chickens as live stock; donkeys, cattle, camel as transportation; mechanical separation of husk and grain was done by cattle or sheep which were driven over the floor by men wielding sticks, treading the kernels out of their husks. Natural pesticides were used by combining natural chemical substances present in various plant species such as Kohomba (Azadirachtaindica), tobacco (Nicotianatabacum), castor bean (Ricinuscommunis), garlic (Allium savitum) and other natural substances such as animal urine, mineral oil were also used [6]. After harvesting, processed grain was kept in silos but often rodent and other insect damages were encountered and it became a nuisance. This is where 9500 years ago people domesticated the modern day house cats which were natural predators of rodents and insects that destroy the post-harvest [11].

Civilized social units formed during the agriculture revolution expanded into villages, towns and cities with time. When the demand for goods and services were rapidly increasing, the mankind was revolutionized through industrialization. This indeed pushed previously manual labour and animal based agricultural techniques towards mechanization. Even though ancient farmers were using simple equipments such as

ploughs the idea of mechanized agriculture is the vast use of modern machinery to increase the farm output. Current mechanized agriculture includes the use of tractors, trucks, helicopters and airplanes, among other more advanced machinery such as cultivators, planters, seeders, sprayers, harvesters and many more.

1.2   Background and motivation

While agriculture industry is evolving throughout decades it is also under increasing pressure due to growing population, consumer affluence, pressure from globalization, and shrinking of global natural resources. More common challenges to agro production have been met globally through improvements in traditional agricultural inputs such as seeds and agrochemicals, but present challenges in modernized world need different solutions. Better management, which involves higher degrees of information and knowledge, is widely seen as a way of addressing these challenges thus, modern day agriculture has become a knowledge intensive industry where information matters for effective decision making on various aspects of farming and crop production. Effective management of a farm requires obtaining and processing of financial, climatic, and agro technical information such as pest and weed information, fertilizer advising so on.

Sri Lanka is essentially an agrarian economy as society basically depends on agricultural production. Apart from being a small Island in the Indian Ocean, the country is well thrived with all the natural resources, best climate zones for a more diversified agro production. In early days, these factors combined with the less population density in the overall country made it a destination for Portuguese, the Dutch and the British colonists who introduced tea and coffee cultivation and made huge amount of revenue out of it for themselves. Even after many years of colonization still the county is making a substantial income from exporting spices, tea and coffee. Other than these export crops the counties' diversified agro production includes all the vegetables and fruits grown in up country, paddy which grown anywhere, coconut which is authentic to coastal regions.

Sri Lanka said to be culturally inclined and attached to agriculture, with 80 percent of rural areas [13] and 70 percent of the population living in rural areas depending on

agriculture for their livelihoods [18]. Currently agriculture sector represents eighteen percent of the country's GDP and thirty percent of the employment [18] [3]. Farming is mainly done by rural farmers using the tacit knowledge coming from their elders. Even though this was successful in ancient days for small scale productions, traditional farming methods are no longer sustainable to provide the ever growing food supply the country demands. Farmers has to compete with irregular monsoon rains, frequent drought conditions, declining soil productivity, new weeds and pests and diversified market conditions to increase agricultural productivity[10]. Not only that, but also Sri Lankan farmers face lot of financial pressure due to very thin profit margin they gain for their harvest. Debt, finance and mortgage worries put them into more devastating conditions. Low productivity of the agriculture industry contributes to 23 percent of household income as against 60 percent by nonfarm activities [18]. When it comes to most of the agricultural commodities produced in Sri Lanka, cost of production is higher than in many other countries in the South Asia as well as in some of countries in East Asia. When compared to the cost of the production of Indian farmers, Sri Lanka farmers spent twice or more for cultivation of potatoes, rice, chilli, onions.

Research carried out in population and housing census [13] underestimates the rapid urbanization and does not actually reflect the ground situation at the moment which has impacts both positive and negative for the growth or decline of the local agriculture industry. Urbanization on its outset opens up lot of opportunities to the educated youth in farming communities who are devastated with financial pressure. It is also seen that unlike in developed countries, the agriculture sector in Sri Lanka is not attractive enough to absorb the rural unemployed compared to the other sectors of the economy [18]. Provided the fact that Sri Lanka is a country with high literacy levels and free education, youth in 21st century is mostly inclined to leave the occupation their parents were culturally attached to and employ themselves in the country's most demanding service sector for wealth and recognition. For an example in 2008 Horizon Lanka foundation in Mahawilachchiya was able to bring many employment opportunities to rural youth in ICT sector, as a result the Ministry of Education started replicating the model island wide in all 9 provinces [29].

During the past sixty years, the governments have been trying to get more people specially the rural community to do agriculture. Good examples are the concepts such as "Govi Rajas" of the 1960s and The "Waga Sangramaya" of the 1970s and the propaganda songs that dominated the government radio. From above examples it is apparent that resource and knowledge restrictions are the main barriers for the Agriculture Industry in Sri Lanka. As a country, unlike other developed nations Agriculture is a heritage to us, therefore it is essential to improve the employment opportunities in agriculture sector, promote and popularise and to create wealth of doing inherited farming. The strategies of doing Agriculture should shape according to the dynamics of the twenty fist century and then only it will be sustainable enough to support the socio economic development of the country. Rapid growth of the agricultural sector, particularly the domestic food production, floriculture and export crop sectors is essential to achieve self-reliance at national level, ensure food security and to bring about equity in the distribution of income and wealth for alleviating of poverty [29].

1.3   Agriculture as a complex domain

Agriculture can be consider as a combination of several inter related and interconnected sub domain such as Environment, Crop, Soil conditions, Marketing, Pest controlling and Weed controlling. These sub domains are interconnected and interoperate with each other, these relationships are nonlinear and contain feedback loop. For example environmental conditions directly related to plant fertilization, when it comes to fertilization, it will directly affect the crop management and the soil conditions. Similarly, it is also possible to see some emergent properties when considering all these domains as a whole.

All the above discussed properties indicate the appropriateness of concluding the agriculture domain as a complex system.

1.4   Aim and objectives

Agriculture is a vast domain which requires many aspects of knowledge and resources for sustainability. However, inadequacies in providing consistent, accurate, timely and

easily accessible information present several challenges to farmers [16]. For an example recent Mealy bug attack on crops left farms helpless for a long period of time, by the time they received information on controlling the pest the devastating results already observed.

Government aide Sri Lankan farmers through "Govi Jana Seva" centers where qualified officers are available to solve matters of farmers related to crop production. This is generally a slow process where sometimes many farmers depends on few such officers and the quality of this service strictly vary from location to location where certain villages does not even have these centres.

With the diversification of the agricultural environments modern day farmers require up-to-date easily accessible information to produce large scale harvest and have a good return on investment. According to a well recognized local news forum [22] a system using IT that addresses the information needs from the decision making phases through the growth and sale of agricultural products will help balance the welfare of both consumers and farmers. Such an Information and Communication Technology (ICT) system can help the government's 10 year vision of transforming subsistence agriculture to a commercially oriented and highly productive sector.

Agricultural giants in world economy utilize the power of ICT to ensure the quick dissemination of research outputs to end users (farmers) and avoid technology lag. Today these approaches contribute to the success of multimillion crop productions worldwide. Modern farms even use computers in conjunction with satellite imagery and GPS guidance to increase yields. Numerous studies have been carrying out worldwide on using ICT to deliver agro information on demand. In most of the world's developed economies, agriculture is backed by the application of ICT where necessary. This includes various automation based systems, precision farming, Agriculture information systems. According to literature depending on the volume of information, nature of processing those information and more importantly interpretation of those information in a user friendly manner suggests that AI systems can support a more natural, simple, interactive, participatory and effective approach to managing agriculture information [9].

Among all AI applications in agriculture field, traditionally expert systems are the most common approach. The suitability of this technology has been recognized and realized in the field of agriculture [28] and many researches has been carried out using expert system as the foundation technology for last two decades. In agriculture, expert systems unite the accumulated expertise of individual disciplines, for an example plant pathology, entomology, horticulture and agricultural meteorology, into a framework that best addresses the specific needs of farmers. Further these systems combine the experimental and experiential knowledge with reasoning skills of various specialists to aid farmers in making the best decisions for their crops [30].

However expert systems address most of the problems by only considering a single aspect but when it comes to complex domains such as agriculture it is necessary to consider all the aspects of a given problem which is a limitation when it comes to the accuracy and quality of the processed output from the system. When it comes to humans, real world problems in complex domains are solved by communicating with each other. This behaviour influenced the idea of multi agent technology and we hypothesise that it is possible to solve problems in complex domains through the negotiation by the help of simple message passing.

As a conclusion it is possible to summarise the aim of the this project as,
How to handle the complexity of the agricultural domain using Multi Agent based AI technique.

Consequently, hypothesis could be stated as,
It is possible to solve problems in complex domains through the negotiation by the help of simple message passing.

In the way of proving above hypothesis following objectives have been defined in order to make sure all the relevant areas being captured.

1. To critically study about agricultural domain and their influence factors.
2. To critically study about existing ICT approaches
3. To study about the multi agent technology and ontological knowledge definition
4. To investigate swarm intelligence and communication method

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5. Meet and interview with relative domain experts

6. Design and develop prototype of the multi agent system

7. Develop web based solution

8. Enabled mobile base information access point

9. Evaluate the proposed MAS

10. Document the final dissertation.

1.5   Structure of the dissertation

Rest of the report is structured as, section two critically review about what are the approaches that have been carried out to help farmers by addressing various issues related to agricultural domain. It also pointed out the technologies that have been used for developing such agricultural information systems. It also highlights the most promising solutions related to agricultural information systems available for farmers around the world. At the end of the section two, it will introduce the identified approach to address the problems and limitations of the existing systems.

Section three will mainly focus on the technologies which are possible to use when building an Agriculture Information system (AIS). It will discuss the traditional technological approaches as well as modern AI based approach in complex problem solving. Furthermore it also focuses on the importance of each technology.

Section four will introduce our approach with AIS system. It describes a system from end users point of view such as Inputs to the system, outputs from the system, processors, technologies and features of the system. Finally it also describes how the system could be used for Agriculture related problem solving.

Section five will discuss on the architectural and design aspect of the system. It introduces the main modules of the system, how each module connected with others and it highlights the main components of each module as well.

Section six is about the implementation details of the system. It will highlight how the components have been implemented, technologies have been utilised with this

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implementation, information related to tools and frame works that are used with the implementation also included with this section.

Section seven discuss about how the evaluation process has been carried out. It gives the information about how the evaluation test cases have been selected, what are the things focused during the evaluation process, how the evaluation scenario developed based on the test cases.

Chapter eight contain the conclusion of the project. It validates whether the objective been achieved or not. Furthermore it also contains the information related to limitations of the system or methodology chosen. It also point out the improvements which could accompany in future. Finally it reveals the difficulties encountered during the process of implementing the AIS.

Finally reference section will include all information about the supporting materials that have been used for study.

1.6   Summary

This chapter introduces the background information about problem domain and the importance of addressing the problem. Most importantly it lists the aim and objectives of the work.

The next chapter will provide information about the current approaches that have been taken to address the issues and problems in the domain of Agriculture Information Systems.