An Intelligent Multilingual Farm Advisory System for Controlling Hazardous Effects of Pesticides on Human Health

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Abstract

Pest attacks on crops poses serious risk on crop yield and the economy of any nation. These crop attacks are caused by different crop pests calling for use of different pesticides to control their attack. The use of these pesticides in turn has hazardous effects when they are exposed to humans, the primary contact being the farmers. Due the hazardous effects of these pesticides on farmers' health, there is high demand for advice on their applications to curtail these effects. Since most of the farmers have language barriers, the advisory system will be based on a multilingual framework for easy translation and onward communication with all farmers without language barrier. This paper is aimed at designing and implementing an intelligent multilingual farm advisory system (IMFAS) that classify the crops, pests and pesticides to intelligently control the hazardous effect of pesticides on human health during and after the application on crops. Ontology is adopted as the underlying schema for the classification and intelligent control to enable knowledge reuse. IMFAS seeks to provide advice to farmers in their choice language for clearer understanding of ways to prevent the hazardous effects of these pesticides on human health during consumption and at a time of spraying on the farmland.

Keywords: Farm Advisory System, Ontology, Classification, Health, Knowledge Representation.

1. Introduction

Agriculture is one of the most important sectors for human beings all over the world. The credit of the increased production of the agriculture products in the past could be given to the efforts of farmers. Now when the production is stagnating due to several reasons, the majority of the farming community is not getting upper bound yield because of pest, the harm done by pests is great. Pest is animal which harms or causes damage to man, his animals, crops, or possession. Agricultural pests include insects, mites, plant pathogens, and weeds; while household pests include cockroach, fleas, mosquitoes, termites, bedbugs, rodents etc.

Some pests occur perennially and could cause serious and persistent economic damage if not controlled, while some cause economic damages only on certain occasions, when there is disturbance in the ecosystem. Others migrate from one geographic zone to

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another under various environmental influences. Every day farmers as well as the commercial growers use chemical pesticides to kill pests and weeds and to get rid of diseases in their farm with aim of increasing production. Though the use of pesticides has some advantages of increase in yield, its haphazard and excessive use also create a serious impact on the environmental components and human health [1]. Most farmers respond by spraying chemical pesticides (such as DDT and mixture of 30g Cypermethrin and 250g Dimethoate) as many as 7-8 times weekly, such massive usage of a persistent pesticide like DDT is injurious to both the farmer and the environment. It has become essential that the farmers collect important and updated information about any farming activities and to get the proper advice regarding the farming such as the proper use of pesticide. Keeping this in view, there is a need for an Intelligent Multilingual Farm Advisory System (IMFAS) for farm entrepreneur which could help them in farming.

An advisory system for farmers provides expert advices to farmers on many activities in a farming process, also used as material for students in universities. With this system, farmers can access virtual agricultural experts as and when needed. On the other hand, developing such an advisory system for farmers is not so easy. The applicability of such a system across different regions may not be possible. The farming process and techniques may be varied from region to region. Depending on the geographical and atmospheric difference, the type of crop to be planted may be varied among regions. In addition, some farmers may prefer to their local varieties of crop. Thus, developing such an advisory system for farmers needs deep knowledge of the agriculture domain and huge knowledge acquisition from mainly experts and farmers.

Pesticides are chemical compounds that are used to kill pests, including insects, rodents, fungi and unwanted plants (weeds). Pesticides are used in public health to kill vectors of disease, such as mosquitoes, and in agriculture, to kill pests that damage crops. The term pesticide includes all of the following: herbicide, insecticides nematicide, molluscicide, piscicide, avicide, rodenticide, bactericide, insect repellent, animal repellent, antimicrobial, and fungicide. Excessive and uncontrolled use of pesticides can be hazardous to human health. Pesticides can be toxic to other animals such as birds, fish, bees, beneficial insects as well as non-target plants and animals. Farmers and workers like pesticide handlers and crop pickers are mainly at high risk because of their direct contact with treated crops, hazardous usage methods, low quality of equipment, unsafe repository and disposal techniques and lack of preventive apparatus [2, 3, 4].

Pesticides can enter the body through various routes such as inhalation of aerosols, dust and vapours contaminated with pesticides; through consuming contaminated food/water; and through direct contact with skin. The toxicity of chemicals and the duration of exposure determine the effects of pesticides on human health [5].

According to WHO, each year about 3,000,000 cases of pesticide poisoning and 220,000 deaths are reported in developing countries [6]. Children are more susceptible to pesticides since they have weak immune system than adults. Farm workers and their families experience the greatest exposure to agricultural pesticides through contact. Pesticides can cause several effects such as mild skin irritation, birth defects, tumors, genetic change, nervous disorder, endocrine disruption, and finally coma or death at last [5]. Pesticide exposure can affect the nervous system such as loss of coordination and memory, reduced visual ability, reduced motor signaling; damages the immune system; and can cause hypersensitivity, asthma and allergies [6, 7]. Therefore, design and implementing a web-based farm advisory system for monitoring and controlling hazardous effects of pesticides on human health is necessary.

This paper is aimed at designing an intelligent multilingual farm advisory system for monitoring and controlling hazardous effects of pesticides on human health. Sharing of knowledge among agricultural experts, farmers, students and research scholars are very important to the growth of the agriculture sector as well as health sector.

2. Related Literature

According to [8], agriculture is most important economic sector, as every nation dependent on food to feed its populace. Agriculture and allied activities constitute the single largest contributor to the Gross Domestic Product (GDP), almost 33% of it. This increase in agricultural production has been brought about by bringing additional area under cultivation, extension of irrigation facilities, the use of improved high yielding variety of seeds, better machinery tools and techniques evolved through agricultural research, water management, and plant protection through judicious use of fertilizers, weather conditions, soil moisture evolved through agriculture field sensors, pesticides and cropping practices.

However, agriculture is still facing a multitude of problems to maximize productivity. Due to several reasons, the majority of the farming community is not getting upper bound yield despite successful research on new agricultural practices like inventing new crop varieties, crop cultivation, weed control and pest control techniques. One of the reasons is that the use of natural resources for agriculture is gradually decreasing, and using of pesticides is increasing (expensive in cost), so number of farmers also gradually decreasing because of economic loss in the agriculture. The second reason is the present agricultural extension/advisory services employed which follows traditional information dissemination which fails to share information where and when needed, or are constrained by time slots, etc. (committing human experts). Farmers, who do not have direct access to scientific knowledge about farming often relies on peers for the same and hence, may get incomplete and/or distorted information. Furthermore, the complexity of a whole farming process is growing because it is constrained by many factors such as requirements, goals, regulations, etc. that farmer must satisfy or consider. Thus, manual evaluation of all the possible combinations of factors that affects the farm planning is impractical and prone to errors. Because of these complexities involved to achieve an optimal crop plan, computer-based systems such as Intelligent Multilingual Farm Advisory System (IMFAS) is required to automate many activities like pest control, disease control, weed control, crop variety selection, crop rotation, weather monitoring, irrigation scheduling, seed cleaning, soil conditions etc. in a planning process [9, 10].

Farm Advisory System (FAS) is commonly seen as a key component in increasing productivity and triggering sustainable economic growth in developing regions around the world. Many policy-related studies particularly emphasize the role that advisory services can play in reaching marginalized farmers, reducing food insecurity, and breaking patterns of persistent rural poverty [11, 12]. In addition, farm advisory system is often perceived as an important instrument to address new challenges related to environmental degradation and climate change [13, 14]. Farm Advisory System for farmers provides expert advices to farmers on many activities in a farming process, also used as material for students in universities. With this system, farmers can access virtual agricultural experts as and when needed change [10, 15]

On the other hand, developing such an advisory system for farmers is not so easy. The applicability of such a system across different regions may not be possible. The farming process and techniques may be varied from region to region [16]. Depending on the geographical and atmospheric difference, the type of crop to be planted may be varied among regions. In addition, some farmers may prefer to their local varieties of crop. Thus, developing such an advisory system for farmers needs deep knowledge of the agriculture domain and huge knowledge acquisition from mainly experts and farmers [10].

According to the findings of Anderson [17], agricultural advisory (extension) services are a vital element of the array of market and non-market entities and agents that provide critical flows of information that can improve farmers' and other rural peoples' welfare [18, 19, 20, 21]. After a period of neglect, agricultural advisory services have returned strongly to the international development agenda. Apart from their conventional function of providing knowledge for improved agricultural productivity, agricultural advisory services are expected to fulfill a variety of new functions, such as linking smallholder farmers to high-value and export markets, promoting environmentally sustainable production techniques.

According to [22], the agricultural advisory services offered are far from meeting people's needs. With regard to quantity, data is unfortunately lacking, but it is agreed that the coverage of advisory services is far below the FAO's standard of one advisor for every 200 to 350 farmers. With regard to quality, there are frequent and therefore worrying discrepancies between the messages provided and farmers' actual needs. In the past, the major extension programmes focused mainly on transferring agricultural research techniques to farmers based on assumptions about their needs. Today, not only are those programmes no longer in operation, but demand for advisory services has expanded into many different areas (agricultural techniques, farm management, sales, advisory services for the management of shared resources, legal advisory services, taking into account the impact of agricultural practices on the environment, etc. [23].

Existing advisory services are struggling to offer a diversified response to that demand in a way that is tailored to: each type of farm (family farm, family farm with some salaried employees, farm business, etc.); each type of value chain (local food production, national food production, export, etc.); how peasant-farmer organizations are structured (few or many field officers, general-purpose field officers or field officers specializing in a particular value chain, etc.); geographical isolation or connection to markets (existence of transport infrastructure, distance to markets, etc.). Lastly, advisory services are struggling to take into account the fact that those needs are changing over time, it become increasingly sophisticated as farmers develop their farms. Aspects such as gender, age, level of schooling, and adherence to a minority group (e.g. transhumant livestock farmers) have also been insufficiently taken into account in advisory services. And yet, advisory schemes have become more diversified in recent years in West Africa. In the past, the state was more or less the exclusive provider of agricultural advisory services, through its civil servants based in the field. Structural adjustments and the withdrawal of the state have reduced the coverage of advisory services, but have also led to the emergence of new stakeholders capable of offering a wider range of services. Today, in addition to state-run schemes, there are also schemes run by the agricultural profession (field officers, chambers of agriculture, management centres), the private sector (input sellers, downstream companies), and service providers (consultants, NGOs, etc.). Moreover, despite the dominance of "top-down" approaches to advisory services, which are often poorly adapted to the realities and needs of farmers, several approaches have been developed over the past thirty years allowing for greater consideration of the knowledge of farmers, and this has led to the emergence of more participatory approaches where the aim is to assist and empower farmers [24].

2.1 The Concept of Pesticide

According to Kumar [25], two major concerns in fast growing human population throughout the world are environmental safety and food security. Serious damages caused by pests in agriculture in terms of productivity and high price of chemicals that cost a huge price annually and increases the agricultural production budget. Every day farmer as well as the commercial growers use chemical pesticides to kill pests and weeds and to get rid of diseases in their farm with the aim of increasing production. Though the use of pesticides has some advantages of increase in yield, its haphazard and excessive use also create a serious impact on the environmental components and human health to [1].

According to Wikipedia, the term "pesticide" includes all of the following: herbicide, insecticides nematicide, molluscicide, piscicide, avicide, rodenticide, bactericide, insect repellent, animal repellent, antimicrobial, and fungicide. The widespread use of chemical pesticides has been preferred due to the benefits they got in agriculture, especially by protecting crops from pest damage and increase the productivity. But on the other side the use of these pesticides causes a serious threat to the environment and human health. Farmers are at a high risk of exposure to pesticides, those directly involved in the handling of pesticides during mixing and spraying pesticides or while working in the treated fields and from residues on food and drinking water. Sometimes due to lack of knowledge, farmers face great risks of exposure particularly when they use toxic chemicals that are banned, incorrect method of applications, poorly maintained or totally inappropriate spraying equipment and often the reuse of pesticide containers for food storage, poor use of personal protection equipment (PPE) and other safety measures. There are various types of human health problems directly related to related with use of pesticides, ranging from short term impacts like headaches and nausea to chronic impacts like various types of cancers, endocrine disruption infertility, and birth effects. Children, in particular are more susceptible to pesticide exposure. Furthermore, injudicious use of pesticides may lead to the destruction of non-target species, destruction of biodiversity and also lead to contamination of soil, water, and air [26, 25].

2.1.1 Benefits of Pesticide

Pesticides have both beneficial and harmful effects on the people and the environment. The primary benefit of using pesticides is ***killing of insect pests that feed on crops***. It has been estimated that about 40% of the agriculture produce is lost worldwide due to disease, pest and weeds [27]. Weeds infestation during crop establishment stage accounts for a reduction of 40% in yield [28]. Thus, pesticides provide both ***economic and labor benefits to the people***. Pesticides also help to ***prevent diseases outbreaks*** by controlling rodents and insects' vector and many insect-borne diseases such as encephalitis, yellow fever, bubonic plague, typhoid fever, typhus, rocky mountain spotted fever etc. have been kept in control by using pesticides [27].

2.1.2 Pesticide Misuse and Abuse

There is abundant evidence of poor pesticide education leading to extensive misuse of pesticide by farmers [27, 28, 29, 30]. For instance, cases of over-dosage, for one reason or the other, have been reported as common. Even among government-trained, or agency-trained and assisted small-scale farmers, far more quantity of pesticides than prescribed is applied with the general expectation that it would affects more rapid killing of crop pests. Other unfortunate but common misuse of pesticides happening all around us include:

1. Pouring pesticides (particularly old stock of Gammalin – Lindane) into rivers to kill fish which is then sold for human consumption. Many have become poisoned as a result of such practices.
2. Spraying Gamalin 20 on drying cocoa beans to prevent moulds and maggot development.
3. Mixing of different classes of pesticides (e.g. fungicides and insecticides) together so as to reduce the workload of spraying each differently. Apart from affecting effectiveness, such a practice could also dramatically worsen the potential health hazards [28].
4. Wrong use of nozzles for spraying equipment, making it difficult for desired quantity of pesticides to be administered. Both over-dispensing and under dispensing could have significant adverse impacts on the environment and on human health.
5. Lack of knowledge on the time needed for degradation of pesticides
6. Use of wrong formulations and doses, and wrong timing of application (all borne out partly due to inability to properly distinguish one pest from the other)
7. Counterfeiting, faking, and recycling of old stocks, manufacturing of empty plastic containers to market adulterated agrochemicals, which are sold at reduced prices.
8. Careless disposal of expired pesticides into the environment as regular waste, due to lack of proper disposal facilities or protocols.

2.1.3 Hazardous Effect of Pesticides on Human Health

Kumar [25] emphasized that pesticides poisoning is a global public health problem and large number of deaths occur worldwide every year due to pesticide poisoning. Different cases of acute and chronic poisoning occur worldwide due to pesticide poisoning, with effects of varying hazard on human health, from mild effects to death. According to WHO, each year about 3,000,000 cases of pesticide poisoning and 220,000 deaths are reported in developing countries [6]. Children are more susceptible to pesticides since they have weak immune system than adults. Farm workers and their families experience the greatest exposure to agricultural pesticides through contact. Generally, people become the victim of pesticide poisoning when they get exposure to pesticides while preparing the spray solutions, loading the pesticide solutions in the spray tank and while applying the pesticide in their fields [25]. Bhandari et al. [31] states that pesticides can enter the body through various routes such as inhalation of aerosols, dust and vapours contaminated with pesticides; through consuming contaminated food/water; and through direct contact with skin.

2.2 The toxicity of chemicals and the duration of exposure determines the effects of pesticides on human health

Several studies have shown that continuous exposure of pesticides for a long period of time, may lead to chronic illnesses in humans such as mild skin irritation, birth defects, tumors, genetic change, nervous disorder, endocrine disruption, and finally coma or death at last [5]. Pesticide exposure can affect the nervous system such as loss of coordination and memory, reduced visual ability, reduced motor signaling; damages the immune system; and can cause hypersensitivity, asthma and allergies [7, 6]. Also, the

presence of pesticides in the human body affects reproduction capabilities by altering the levels of male and female reproductive hormones [27]. A study by Adithya [32] found that increase in case of incidences of congenital anomalies, delayed puberty, mental retardation, abortion and cancer in the areas spread with endosulfan in India. Researches emphasized that the exposure during pesticide storing, mixing, applying and disposing of chemicals gets summed up to form total exposure. Also, epidemiological studies in humans indicated that the second most common cancer in men, after lung cancer is the prostate cancer found mostly in male farm workers of age above 50 years, due to the use of chlorinated pesticides and methyl bromide [33].
Focusing on fact that short term and long-term consequences of pesticide are real, Atreya and Sitaula [34] stressed that long term effects of the pesticide have not yet been studied, however, it is clear that pesticides are being applied at a higher rate than those recommended which is inviting serious risk. Most of the vegetables sold are grown by independent farmers who set their own protocol for the dose of pesticide being indifferent to the standard recommendation that makes consumers at high risk of buying a significantly high amount of pesticide residues. Compared to cereals heavier application of pesticides is found in vegetable s up to 90% of total pesticides. A group researchers found that safety measures used by farmers were not satisfactory; further the negligence on safety measures during storage, handling and application of pesticides, even by the farmers who were aware of negative effects on pesticides [31].

2.3 The Impact of ICT-enabled Farm Advisory Services in Agricultural Development

According to Fabregas et al. [35], digital technologies are an important pillar of agricultural transformation towards food security and sustainability. Information and Communication Technologies (ICT) in particular have received increasing attention for their potential to disseminate information to farmers in developing countries. The availability and use of ICT is increasing rapidly across the globe, raising questions on potential impacts. ICTs can act on different levels, from digital platforms for input procurement and capital access to digital advisory services and marketing channels. Within the agricultural advisory services targeting farmers, there are different communication channels including videos, interactive voice recordings, smart phone apps for extension agents and SMS. Empirical studies found positive impacts of the provision of digital advice via ICTs on farmer's knowledge, recommended practice adoption and yields. Recent evidence indicates availability of substantial evidence on the impact of various digital technologies on multiple outcome dimensions. However, depending on the local conditions such as reliability on electricity and network coverage, literacy of the target group and available end-user devices, the effectiveness of different communication tools is expected to be heterogeneous. In addition, the emerging evidence assessing impacts on selected outcomes uses different methods and is always embedded in specific contexts. Therefore, it remains to be studied which factors (e.g., intervention-design/study-context) help to disentangle the heterogeneity in observed impacts [35].
Agricultural advisory (extension) services have long been recognized as an important factor in promoting agricultural development [36, 37]. The terms agricultural advisory services and agricultural extension refer to the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills and technologies to improve their livelihoods. Agricultural advisory services are relevant in all three types of countries identified in the WDR 2008—

agriculture-based economies, transforming economies and urbanized economies—yet the scope and types of advisory services and the ways in which these services are best provided and financed differs between as well as within these groups.

The services provided by agricultural extension have significant public-good attributes. It is, therefore, not surprising that there are more than half a billion official extension workers worldwide [38]. About 90% of the world's extension personnel are located in developing countries, even though the farmer: extension agent ratio is more favorable in industrialized countries. The magnitude of investment in extension in most developing countries is similar to that for agricultural research so it is a significant component of agricultural development effort and thus warrants careful reflection.

From a development-policy perspective, the investment in extension services or the facilitation of non-government extension, are potentially important tools for improving agricultural productivity and increasing farmers' incomes. Accordingly, the conceptual framework developed in the WDR 2008 identifies access to science, technology and skills as an entry point for public interventions that aim at using agriculture as a pathway out of poverty by improving returns to households' assets. Apart from the "classical" objective of agricultural advisory services to improve agricultural productivity, advisory services can also play an important role to meet the new challenges agriculture is confronted with: changes in the global food and agricultural system including how to control pest and proper use of pesticide, etc.

In assessing the impact of extension on agricultural productivity, one needs to take into account that productivity improvements are possible only if a differential exists between the actual productivity on the farms and what could potentially be produced with better know-how, subject as always, to farmers' preferences and resource constraints. In the past, rapid technological advances have created such a differential in many developing countries. This productivity differential can be broadly classified into two types of "gaps": a technology gap and a management gap. The former might entail additional investment and higher recurring costs (e.g., for inputs such as seeds of improved cultivars or fertilizers) while the latter may offer the farmer a low-cost means of raising productivity by applying improved management practices [39]. These gaps are, in the first instance, a manifestation of the difference in knowledge and skills that farmers possess and the best-practice knowledge that exists at any point in time. Extension helps to reduce the differential between potential and actual yields in farmers' fields by accelerating technology transfer (i.e., to reduce the technology gap) and helping farmers become better farm managers (i.e., to reduce the management gap).

Agricultural advisory services also have an important role to play in helping the research establishment tailor technology to the agroecological and resource circumstances of farmers. Extension thus has a dual function in bridging blocked channels between scientists and farmers: it facilitates both the adoption of technology and the adaptation of technology to local conditions. The first involves translating information from the store of knowledge and from new research to farmers, and the second by helping to articulate for research systems the problems and constraints faced by farmers. Moreover, it has increasingly been recognized in recent years that important innovations, for example, those relevant in natural resource management, are developed by farmers themselves rather than from agricultural research stations. Agricultural advisory services can play an important role in promoting the spread of farmer-based innovations. These several interactions among research, extension, education and farmers are well articulated in a world view described as agricultural knowledge and information systems (AKIS), which can serve as a useful organizing principle for discussions of policy relevant to agricultural advisory services [40, 41].

Adoption of innovations by farmers is inevitably affected by many factors. In general, farmers will adopt a particular technology if it usefully suits their socioeconomic and agro-ecological circumstances. The availability of improved technology, access to "modern" inputs and resources, and profitability at an acceptable level of risk are among the critical factors in the adoption process. Adoption can be influenced by educating farmers about improved varieties, cropping techniques, optimal input use, prices and market conditions, more efficient methods of production management, storage, nutrition, etc. To do so, extension agents must be capable of more than just communicating messages to farmers. They must be able to comprehend an often-complex situation, have the technical ability to spot and possibly diagnose problems, and possess insightful economic-management skills in order to advise on more efficient use of resources. The training extension workers receive in many cases unfortunately does not prepare them well for such demanding tasks [42].

2.4 Empirical Literature Review of Farm Advisory System

According to Anderson [36], the role of services for the agricultural development has been recently reconsidered; their tasks are not limited to "traditional" agricultural activity, but it extends to a number of other interventions, aimed at qualifying agricultural products, at fostering farm diversification and other strategies incorporated in the new philosophy of rural development and rural innovation to Labarthe [43]. Besides, recent environmental and sanitary compulsory standards have engendered "new needs for advice". As a matter of fact, the continuously shifting scenario settles new tasks for farmers and calls for a renewed supply of advisory services. Researchers emphasized that to cope with a more complex consumer of advisory services, supply has changed: from the simple linear technological transfer, through approaches of facilitation advisory services, a recent holistic view is emerging, where interconnections among agents, farmers and socioeconomic and territorial characteristics are prevalent. Faced with these trends, recent rural development policies envisage an important role for advisory services and technical assistance to farms.

Contrarily to what Hagerstrand [44] fostered in the past, personal contact is not sufficient to spread information and innovation. The complexity of the process, the specificity of potential beneficiaries and territorial characteristics could give raise to profound differences in the propensity to adopt agricultural services. The necessity to revise the system of agricultural advisory system to the new scenario has fostered pluralistic views of extension supply [45], which contextualize the agricultural extension systems to induce higher participation on behalf of potential users: in this perspective, farmers are assimilated to "consumers" of services, who sustain costs, in terms of spending time and money to gain access to services [46].

Transmission of knowledge and information is not more considered as a linear an automatic process, as demonstrated by the numerous examples of failure in agricultural extension. As Knickel et al. [47] point out: there is a gap between the need for change and farmers' willingness to adjust, and the insufficient capacities of innovation agencies and advisory services to effectively support changes. To avoid this, a rigorous system of evaluation should be encouraged, through which monitoring supply of advisory service: many systems of evaluation are useful even if lots of them are linked by the lack of data [48, 49].

Evenson [50] explained agricultural extension through the awareness-knowledge-adoption-productivity (AKAP) sequence as:

- A: Farmer awareness
- K: Farmer knowledge, through testing and experimenting
- A: Farmer adoption of technology or practices
- P: Changes in farmers' productivity

Awareness is not knowledge. Knowledge requires awareness, experience, observation, and the critical ability to evaluate data and evidence. Knowledge leads to adoption, but adoption is not productivity. Productivity depends not only on the adoption of technically efficient practices, but of allocative efficient practices as well. Productivity also depends on the infrastructure of the community and on market institutions [50].

To promote knowledge, transfer and impact on farm activity, advisory services should affect farmers' advance through the sequence [51]. Awareness and knowledge are key-phases of the sequence, where advisory services can strongly impact on agricultural activity [52]. As demonstrated in other studies, the AKAP sequence represents a good method to test agricultural advisory service as achieving its ultimate goal in terms of economic impact by providing information and educational training to each step of the sequence [53]. In fact, it has been investigated to estimate the impact of advisory services on agricultural productivity in developing countries.

Farm Advisory System in rural areas are challenging even under normal circumstances, they must be provided consistently throughout a country, even in remote areas and despite limited incentives for providing them efficiently. Monitoring and evaluating the quality of the advisory services provided requires substantial resources. Advisory services are subject to the "triple challenge" of market, state, and community failure. Already under-resourced, the advisory services often face difficulties in adding new responsibilities for their staff without the requisite training, incentives, and resources. Advisory services today, are viewed from a broad systems perspective, which focuses on the roles and capacities needed at individual, organizational, and system levels to address current challenges [54].

In addition to the traditional role of promoting agricultural innovation and technology adoption, Christoplos [55] noted that advisory services now must deal with myriad issues, including human nutrition, risk and disasters, climate change adaptation, and rebuilding after emergencies. These issues present additional challenges not only to the extension workers but especially to the farmers themselves. If these challenges can be overcome, advisory services may be able to aid in enhancing the resilience of farmers in several ways. One way is by acting as a coordinating body for multiple support organizations as well as by providing more relevant services. A strong farm advisory system is well positioned to coordinate multiple groups at various stages of a shock because of its linkages at local, subnational, and national levels. Due to its potential access to timely information, the system can identify relevant actors with whom to work to ensure that intervention strategies are harmonized, relevant, effective, and timely. In this way, short-term emergency responses can be harmonized with long-term resilience-building strategies. From the service angle, another possible way advisory services could enhance farmers' resilience is by providing information and knowledge regarding weather and climate change, proper use of pesticides, market prices, regulatory structures, quality standards, and consumer demands so that farmers can make informed decisions [55].

3. Research Methodology

The main method of research concerning this study was interview with some agricultural experts and farmers in Akwa Ibom State. After frequent visits to the Ministry of Agriculture and farms, it was easy to draw out conclusions from some observations about the current advisory system. Brief interviews with some farmers who have an idea of the current advisory system were of great help to this study.

3.1 Area of the Study

The study was conducted in Akwa Ibom State. Akwa Ibom State is located in the coastal South-South region of Nigeria. The region is popularly called the Niger Delta region or the oil rich region of Nigeria. The latitude and longitude coordinates of State are 05°00'N and 07°50'E. It has a total land area of 7,081 km^2. It is bordered in the east by Cross River State, in the west by Rivers and Abia States, and in the South by the Atlantic Ocean. Akwa Ibom State was split from Cross River State in 1987; her capital is Uyo with 31 local government areas. Akwa Ibom State has a population of about 5,450,758 ("Akwa Ibom State", 2022). The main crops grown in the area include cassava, cocoyam, yam, maize, melon, okra and vegetables (green, fluted pumpkin, water-leaf and bitter leaf). The livestock reared include; sheep, goats, pigs and poultry while fish is also cultured.

3.2 Fact Finding Techniques

This involves a formal way of gathering important information and opinions about the study. It enables the researcher to learn about the terminologies, problems, opportunities, constraints, requirements and priorities of the study. Some of these techniques include:

i. **Interview**: it is the most commonly used and usually the most useful fact-finding technique. It enables collection of information from individuals face-to-face. There are two types the open-ended questions which allow the interviewee to respond in any way that seems appropriate and the close-ended question which restrict answers to specific choices. In this study Agricultural experts and farmers will be extensively interviewed for first-hand information.
ii. **Observation**: is an effective way to understand a system, observation is made by watching or participating in activities. It is usually adopted when the complexity of an aspect of the system prevents a clear explanation by the end-users, it therefore enables the observer to see exactly what is being done. In the course of this study, Observations will be made during visit to the Ministry of Agriculture and farms in the study area.
iii. **Research**: it is regarded as a secondary source of information, which includes gathering information from textbooks, journals and magazines, newspapers, blog posts, materials from internet, seminars, lectures and personal researches. It provides information on how others have solved similar problems.

Problems Associated with the Current (old) System

The current situation in Akwa Ibom State agricultural advisory/extension services is that of a highly fragmented and ineffective system. The number of extension workers in Akwa Ibom is very low compared to the number of farmers. These bring about poor farm advisory service delivery to farmers in Akwa Ibom, hence obstruct farmer's awareness on hazardous effect of pesticide on human health.

3.3 Architecture of the Web-based IMFAS

The fundamental organization of a system, embodied in its components, their relationships to each other, the environment, and the principles governing its design and evolution is referred to as the Architecture of the system. The system will be developed to help farmers improve their crop production practices as shown in the block diagram in figure 1. The Farm Advisory System architecture is embodied with a Farmer portal, where the farmer registered with his/her personal details as requested. These details are stored in the knowledge-based system (KBS) for ease of retrieval when requested.

The farmer log in using the username and password already registered in the KBS, thereafter enters a particular crop type attacked by pest. In the WHO and GHS classifications of pesticides, there are different mode of entry, action and chemical composition in other to checkmate the control of hazards done to crops and plants. For the purpose of this research project, focus will be on the GHS classification because of its flexibility in handling hazardous effect on human health.

A corresponding pesticide is chosen for application to the supposed crop type with a warning to the farmer on the method of application to avoid exposing the body to the pesticides.

Figure 1 shows the block diagram of the step-by-step architectural framework of IMFAS.

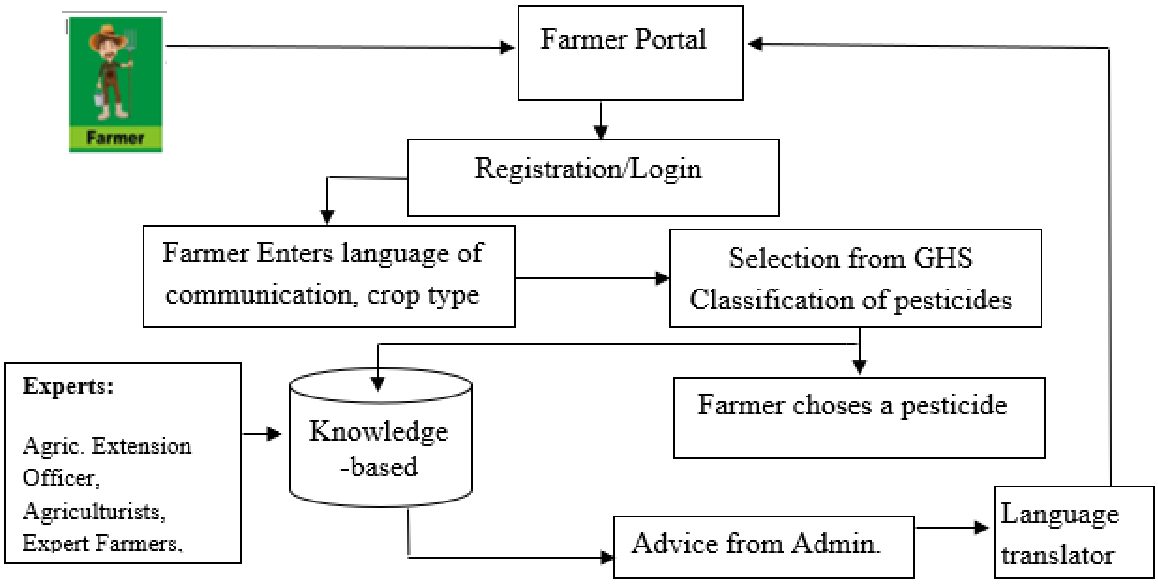


Figure 1: Block Representation of Web-based IMFAS

3.3.1 Crop Pest Control Ontology

The general model of crop pest control consists of related datasets on crops, pests and pest control measures. Each dataset contains classes of biological or chemical objects. The names of classes and objects can be used to define complex relationships among them. "Damage and disease" present the natural processes in the path 'crop pests". Treatment of damaged crops includes human control measures and biological enemies of pests usually encouraged by human in order to protect the crops.

Ontological framework of crop pest control is presented on the figure 2. Biological nature and scientific classification (taxonomy) of crops and pests predetermine hierarchical structures that contain class biological and chemical objects. The crops hierarchy is realized based on agronomic purpose of crops. The class of pests consists of three hierarchies: pathogens, weeds and enemies. A class pest control measure covers sub-classes pesticides (chemicals and bio-pesticides), bio-agents and other measures. Vertical arrows in hierarchies mean a relation, that is "class – sub-class – object (s). Despite vertical relations in hierarchies, the knowledge about crops pest control leads to horizontal relations between biological and chemical classes, sub-classes and objects. Horizontal relations here have the following meanings: diseases of crops caused by pathogens, negative influence of weeds and enemies and pest control measures (treatments) by pesticides, bio-agents and other practices. The real existing relations are in both directions: "crops - pests - pest control measures" and "pest control measures – pests – crops". There is a strong correlation between sub-classes and entities of pests (fungi, viruses, insects, etc.) and pesticides (fungicides, antivirus, insecticides, etc.). The crop pest control ontology is a typical domain ontology with features of task ontology with knowledge and information for task definition and problem solving provided as pointed out by [56]. The fundamental concepts of object-oriented approach fully correspond to the ontology of crop pest control giving opportunity for data modeling and analysis of semantically related biological and chemical data.

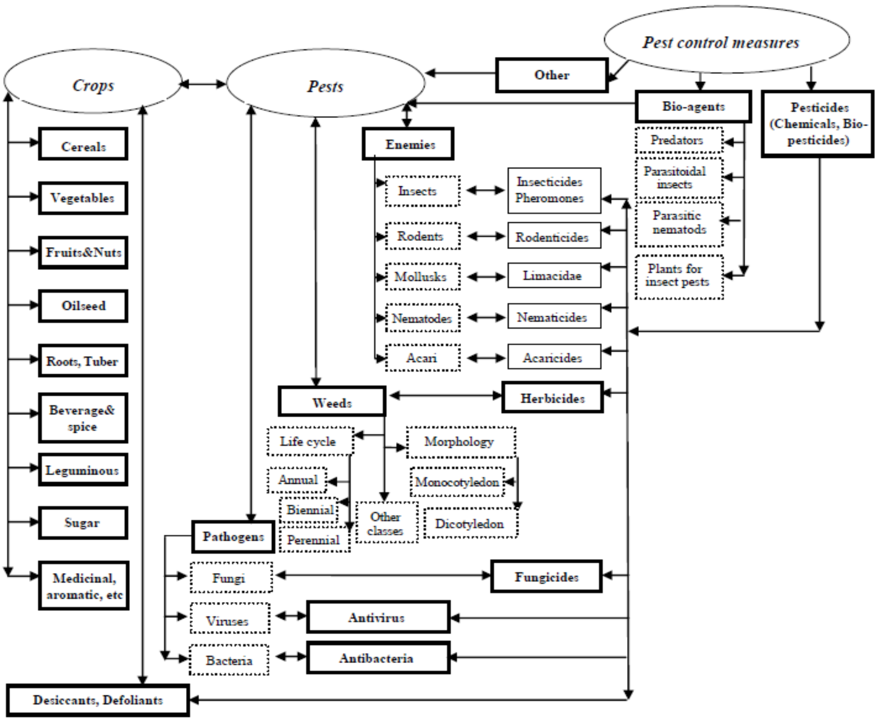


Figure 2: Crop Pest Control Ontology

Table 1: Crop Control Measures

	Pests	Crops Attacked	Control Measures
1	Leaf Miner	Vegetables (okra, tomatoes)	Apply Spinosad pesticide. It can also be control by cultural method
2	Aphids	Vegetables, Cereal (maize)	Spray plants with water. For a large garden use Ortho insect, mite and disease 3-in-1pesticide will help control/prevent aphids.
3	Thrips	Vegetables	Application of contact spray such as horticultural oil, natural pyrethrins (plus piperonyl buxoide) or insecticidal soaps to underside of infected leaves.
4	Cutworms	Vegetables (okra), cereal (maize)	Apply pesticides such as carbaryl cyfluthrin and permethrin
5	Cabbage Looper	Vegetables	Bacillus thuringiensis and moderately selective insecticides (such as chlorantraniliprole and spinetoram are recommended.
6	Earthworms and hornworms	Vegetables, cereal (maize)	Apply carbamate insecticide to like earthworm. Bacillus thurisgensis (Bt) organic pesticide can be used to kill hornworms.
7	Spider mites	Vegetables (okra)	Natural derived miticidal sprays like neem oil, pyrethrins, azadirachtin and horticultural oil can be sprayed directly on adult mite larvae, nymphs and eggs
8	Stem borers	Vegetables, cereal (Maize)	Apply pesticide like Furadan, deltamethrin, fipronil, etc. Eggs can be destroyed by hand picking.
9	Root-knot nematodes	Vegetables, tuber	Metham potassium, metham sodium or 1,3 dichloropropene can be used as pre-plant soil fumigant for control of nematodes.
10	Snails and slugs	Vegetables	Molluscides such as Antimillace, Ariotox, slug-tox which contains methaldehyde chemical can be use
11	Grasshoppers	Cereals (Maize), cassava	Spray plants with insecticides like carbaryl, permethrin, malathion and bifenthrin.
12	Yam tuber beetle	Yam	Insecticides such as pirmiphosmethyl or deltamethrin should be applied once per week for three weeks, starting from 12 weeks after planting.
13	Termites	Cassava, Yam	Pesticides like Avesthrin, NOPEST, Premise 200SC, Rocket-termite control, Taurus SC, BifenXTs, etc, insecticides can be used to get rid of termites.
14	White flies	Cassava	Start with blasting white flies with watering hose or a spray bottle. It can also be control by insecticide like insecticidal soaps and neem oil
15	Rodent	Cassava, cereals, vegetable, etc.	Clean up environment, set traps, e.g. glue boards placed along rodent runway tracks

As part of entity fields of Farmers, the following field names (Fullname, username, password, gender, date of birth, Id.No, State of origin, nationality, farm location, typeof crop, type of attack and pesticide applied), data type and size would be captured in the data-base structure for emphasis of identification of Farmers in consultation with the agricultural extension officer for some form of agricultural awareness and education.

The following classification as provided in the ontology are required to intelligently provide control on the identified pest attack, pesticide application and hazardous effect control on human health:

- **User details:** Username, Age, Identity, Location, etc.
- **Crop types:** Cereals, vegetables, fruits and nuts, oilseed, roots and tubers, beverage and spices, leguminous, etc.
- **Pest Classification:** Insects, Mammals, Rodents, Birds, Snails, etc.

- **Pesticides Application:** Malathion, Temephos, Carbaryl cyfluthrin and permethrin, etc.
- **Expertize:** Agric. Extension Officer, Agriculturists, Expert Farmers, Consultants, etc.
- **Control Measures:** Chemical, Biological, Physical/Mechanical, Quarantine, Cultural and Legislative Controls, amongst others.
- **Hazardous Effects:** Environmental Pollution, fatal to health if swallowed, Poisonous to health, could affect eyes and nose respectively, etc.
- **Precautions and Preventive Measures of using pesticides against Human Health:**
    - It is advisable to always **read the pesticide label first** before selecting the appropriate product for the farm site, method of application and the goal of achievements.
    - It is best to identify the **least-toxic way to control pest**; by learning about Integrated Pest Management (IPM).
    - The farmer must read all **precautions and warnings on the label prior to use**. These are intended to help prevent harmful exposures.
    - Take **steps to minimize your exposure**, even when using low toxicity pesticides.
    - Mix only what you need to use in the short term to avoid storing or disposing of excess pesticide.
    - **Storage:** Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.
    - **Container disposal:** Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your agricultural extension officer for correct procedures for handling and disposal of large quantities of empty containers.
    - **Protection of non-pest animals and plants:** Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. *Take precautions to protect non-pest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues*. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.
    - **Posting treated fields:** For some materials, ***restricted entry intervals* are established** to protect field workers. **Keep workers out of the field for the required time after application** and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your agricultural extension officer for latest restricted entry interval.
    - **Permit Requirements:** Many pesticides require a permit from the Federal or State Ministry of Agriculture before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of that publication.

Crop pest control in agriculture consists of biological, chemical, physical techniques and measures applied by agricultural specialists that depress the development of crop pest populations.

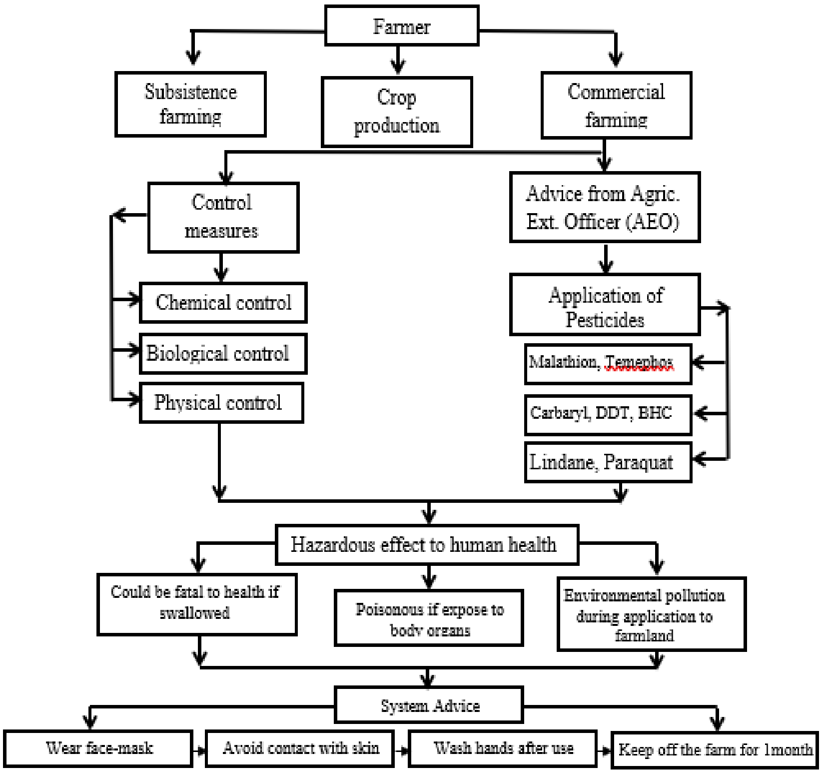


Fig. 3 Hazardous Effect of Pesticides

3.4 Classification of Pesticides

Pesticides are classified on the basis of various criteria. Most commonly used criteria for classification of pesticides are its mode of entry, its chemical composition and target it kill. But giving importance to public health, World Health Organization (WHO) and Globally Harmonized System (GHS) classified pesticides according to their toxicity or hazardous effects. Without ignoring risk factors of pesticides, we must have to use it for better crop production & food preservation. But by using it judiciously with the help of different classification of pesticides, its gross use, exposure and toxic effects can be minimized.

World Health Organization (WHO) has highlighted only acute toxicity for the classification of pesticides. According to WHO, pesticides are classified by acute oral and acute dermal toxicity using the estimated respective lethal dose LD_{50} (the pesticide dose that is required to kill half of the tested animals when entering the body by oral or dermal route). At present, widely used 'WHO recommended classification of pesticides by hazard' suggests allocating pesticides to 'the specific WHO Hazard classes'. After revision in 2009 these classes were harmonized with the 'Globally Harmonized System (GHS) Acute Toxicity Hazard Categories.

WHO recommended classification of 'Pesticides by Hazard' is shown in Table 3.3 and revised Globally Harmonized System (GHS) classification of pesticide is shown in Table 3.

Table 3: WHO Recommended Classification of Pesticides

World Health Organization (WHO) CLASS		LD_{50} for Rats (mg/kg body wt.)		Examples
		Oral	**Dermal**	
Ia	Extremely Hazardous	< 5	< 50	Parathion, Dieldrin, Phorate
Ib	Highly hazardous	5 -50	50 – 200	Aldrin, Dichlorvos
II	Moderately hazardous	50-200	200-2000	DDT, Chlordane
III	Slightly hazardous	Over 2000	Over 2000	Malathion
U	Unlikely to present acute hazard	5000 or higher	5000 or higher	Carbetamide, Cycloprothrin

Table 4: GHS Classification of Pesticides

Globally Harmonized System (GHS) Category	Classification Criteria			
	Oral		**Dermal**	
	LD_{50} (mg/kg bw)	**Hazard Statement**	**LD_{50} (mg/kg bw)**	**Hazard Statement**
Category 1	< 5	Fatal if swallowed	< 50	Fatal in contact with skin
Category 2	5 – 50	Fatal if swallowed	50 – 200	Fatal in contact with skin
Category 3	50 – 300	Toxic if swallowed	200 – 1000	Toxic in contact with skin
Category 4	300 – 2000	Harmful if swallowed	1000- 2000	Harmful in contact with skin
Category 5	2000 – 5000	May be harmful	2000 – 5000	May be harmful

Under this classification, pesticides are classified on the basis of pest organism they kill and their functions which is shown in details in Table 5.

Table 5: Pesticides Classification on the Basis of Pest Organism they kill and Pesticide Function

S/No	Type of pesticide	Target pests/Functions	Examples
1	Acaricides	Substances that are used to kill mites and ticks or to disrupt their growth or development	DDT, dicofol, chlorpyrifos, permethrin, etc.
2	Algicide	Substances that used to kill or inhibit algae	Copper Sulphate, diuron, oxyfluorfen, etc.
3	Antifeedants	Chemicals which prevent an insect or other pest from Feeding	Chlordimeform, azadirachtin, etc.
4	Avicides	Chemicals that are used to kill birds	Strychnine, fenthion, etc.
5	Bactericides	Compounds that isolated from or produced by a microorganism or a related chemical that is produced artificially, which are used to kill or inhibit bacteria in plants or soil	Streptomycin, tetracycline, etc.
6	Bird repellents	Chemicals which repel the birds	Diazinon, methiocarb, etc
7	Chemosterillant	Chemicals that render an insect infertile and thus prevent it from reproducing	Diflubenzuron

8	Desiccants	Act on plants by drying their tissues	Boric acid
9	Fungicides	Chemicals which are used to prevent, cure eradicate the fungi.	Cymoxanil, thiabendazole, Bordeaux Mixture
10	Herbicide softener	A chemical that protects crops from injury by herbicides, but does not prevent the herbicides from killing weeds	Benoxacor, cyometrinil
11	Herbicides	Substances that are used to kill the plants, or to inhibit their growth or development.	Alachlor, paraquat, 2,4-D
12	Insect attractant	A chemical that lures pests to trap, thereby removing them from crops animals and stored products	Gossyplure, Gyplure
13	Insect growth Regulator	A substance that works by disrupting the growth or development of an insect	Diflubenzuron
14	Insecticides	A pesticide that is used to kill insects or to disrupt their growth or development	Azadirachtin, DDT, chlorpyrifos, malathion, etc.
15	Larvicides	Inhibit the growth of larvae	Methoprene
16	Lampricides	Target larvae of lampreys which are jawless fish like Vertebrates	Nitrophenol
17	Mammal repellent	A chemical that deters mammals from approaching or feeding on crops or stored products	Copper napthanate, trimrethacarb, etc.
18	Mating disrupters	Chemicals that are interfere with the way that male & female insects locate each other using airborne chemicals, thereby preventing them from reproducing	Disparlure, gossyplure, etc.
19	Molluscicides	Substances used to kill slugs and snails.	Metaldehyde, thiadicarb, etc.
20	Moth balls	Stops any damage to cloths by moth larvae	Dichlorobenzene
21	Nematicides	Chemicals which are used to control nematodes	Carbofuron, chlorpyrifos, methyl bromide, etc.
22	Ovicides	Inhibit the growth of eggs of insects and mites	Benzoxazin
23	Piscicides	Acts against fishes	Rotenone
24	Plant growth Regulators	Substances alters the expected growth, flowering or reproduction rate of plants	2,4-D, gibberellic acid, etc.
25	Rodenticides	Substances used to kill rats and related animals	Strychnine,Warfarin, zinc phosphide, etc.
26	Silvicides	Acts against woody vegetation	Tebuthiuron
27	Synergists	A chemical enhances the toxicity of a pesticide to a pest but that is not by itself toxic to pest	Piperonyl butoxide
28	Termiticides	Kill termites	Fipronil
29	Virucide	An agent having capacity to destroy an inactivate viruses	Ribavirin
30	Miscellaneous	-	Aluminium phosphide, sodium cyanide.

3.4.1 Classification of pesticides on the basis of Mode of Entry

The ways pesticides come in contact with or enter the target are called ***modes of entry*** which is shown in Table 6.

Table 6: Classification of pesticides on the basis of Mode of Entry

S/No.	Type of Pesticide	Description	Examples
1.	Systemic Pesticides	These are pesticides which are absorbed by plants or animals and transfer to untreated tissue	2,4 –D, glyphosate
2.	Contact pesticides	It acts on target pests when they come in contact	Paraquat, diquat
3.	Stomach poisons	It enters the pest's body through their mouth and digestive system	Malathion
4.	Fumigants	Pesticides which acts or may kill the target pests by producing vapour and enter pest's body through tracheal system.	Phosphine
5.	Repellents	Repellents do not kill but distasteful enough to keep pests away from treated area. They also interfere with pest's ability to locate crop.	Methiocarb

3.4.2 Classification of pesticides on the basis of Mode of Action

Pesticides are also classified according to their mode of action which is shown in Table 7.

Table 7: Classification of Pesticide according to Mode of Action

S/ No.	Type of pesticide	Mode of Action	Example
1	Physical poison	Pesticides bring about killing of one insect by exerting a physical effect	Activated clay
2	Protoplasmic poison	Pesticides are responsible for precipitation of protein.	Arsenicals
3	Respiratory poison	Chemicals which inactivate respiratory enzymes	Hydrogen cyanide
4	Nerve poison	Chemicals inhibit impulse conduction	Malathion
5	Chitin inhibition	Chemicals inhibit the chitin synthesis in pests.	Diflubenzuron

3.4.2 Classification of Pesticides on the basis of Chemical Composition

This is the most common and useful method of classifying pesticide which is based on their chemical composition. Pesticides like insecticides, fungicides, herbicides and rodenticides are also classified on the basis of their chemical compositions as follows:

- **Insecticides:** On the basis of chemical composition insecticides are classified as, Carbamates (Carbaryl), Organochlorine (Endosulfan), Organophosphorus (Monocrotophos), Pyrethroids (permethrin) Neonicotinoids (Imidacloprid), miscellaneous pesticides such as Spinosyns (Spinosad), Benzolureas (diflubenzuron), Antibiotics (abamectin), etc. Insecticides are the important pesticides that can be further classified into several sub-classes which is shown in Fig. 3.4. Fungicides are classified as aliphatic nitrogen fungicides (dodine), amide fungicides (carpropamid), aromatic fungicides (chlorothalonil), dicarboximide fungicides (famoxadone), dinitrophenol fungicides (dinocap) etc.

- **Herbicides**- The herbicides are anilide herbicides (flufenacet), phenoxyacetic herbicides (2, 4-D), quaternary ammonium herbicides (Paraquat), chlorotriazine herbicides (atrazine), sulfonylurea herbicides (chlorimuron), etc.
- **Rodenticides** – They are classified as inorganic rodenticides (Zinc phosphide, Aluminium Phosphide), coumarin rodenticides (organic) (bromadiolone, coumatetralyl).

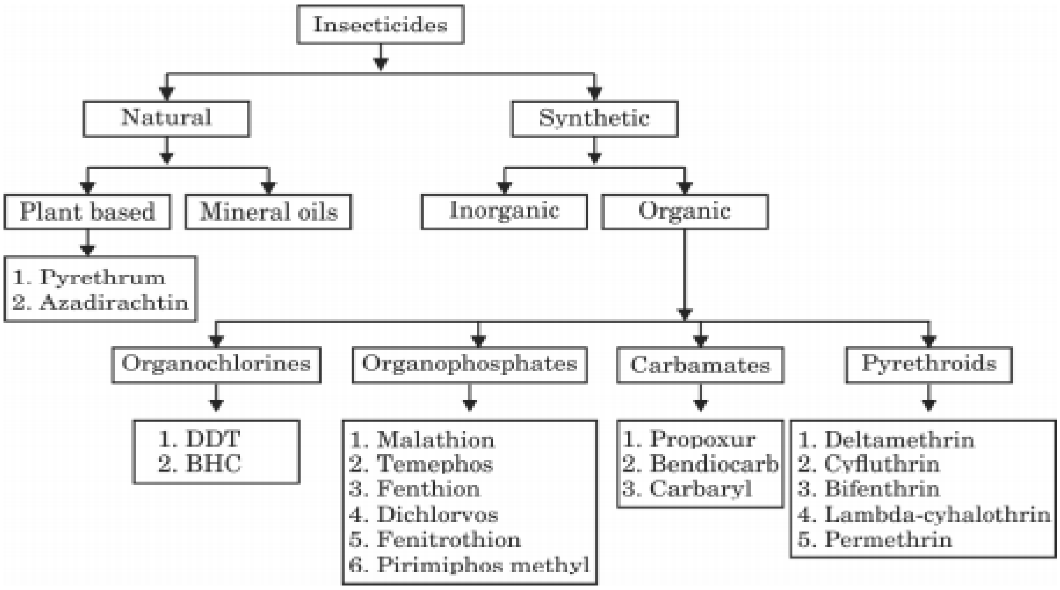


Fig. 4: Classification of Insecticides

According to its chemical structure, insecticides are classified into different families, ranging from organochlorine and organophosphorus compounds to inorganic compounds. In this paper, we refer only to some families of insecticides relevant for the damage they cause to human health and high demand for its use. The most common way to classify them based on their chemical structure is split into four main groups as shown in Figure 4.

Further classification of pesticide is based on toxicity, mainly depends on two factors namely **dose** and **time.** Hence, how much of the substance is involved (dose) and how often the exposure to the substance occurs (time) give rise to two different types of toxicity- acute and chronic toxicity.

- **Acute Toxicity-** Acute toxicity refers to how poisonous a pesticide is to a human, animal or plant after a single short-term exposure. A pesticide with a high acute toxicity is deadly even when a very small amount is absorbed.
- **Chronic toxicity**- Chronic toxicity is delayed poisonous effect from exposure to a pesticide. Chronic toxicity of pesticides concerns the general public as well as those working directly with pesticides because of potential exposure to pesticides on/in food products, water and the air.

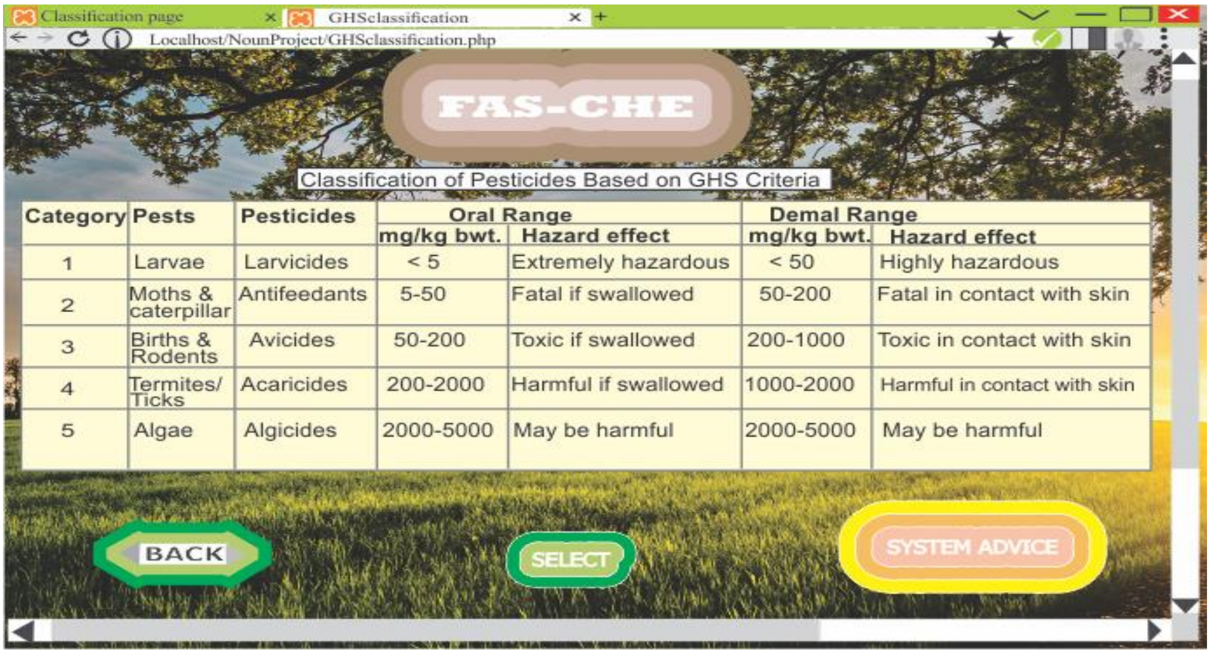
4. IMFAS Implementation

The IMFAS processes the data in the server and sends the information-based recommendations to the farmer's by the Agric. Extension Officer through the login portal. The proposed IMFAS consists of the following main components: a database, fast working memory; data processing chain; user interface and the FAS performance flowchart algorithm.

Crop Types	Pest Attack	Control Measures
Okra & Tomatoe	Leave miner	Apply spinosad pesticides
Cereal (Maize)	Aphids	Spray plant with water or use Ortho insecticide
Vegetables (tuber)	Root knot namatodes	Metham potassium or sodium can be used as pre-plant soil fumigant
Vegetables (leaves)	Termites	Application of contact spray such as horticultural oil to under-side of infected leaves
Cassava/yam	Thrips	Use Avesthrin NOPEST, Premise 200SC, BifenXTs or Rocket-termite pesticides to get rid of termites.

Fig. 5: Crop Types

Various types of crops were displayed on this screen marked as Fig. 5 with its corresponding pest attack and control measures. By clicking on a particular type of crop, the system further requests the farmer to click on the SELECT button for activation. A WARNING light blinks indicating the severity or effect of the attack by the pest. A classification notes of pesticides pops up.



Category	Pests	Pesticides	Oral Range		Demal Range	
			mg/kg bwt.	Hazard effect	mg/kg bwt.	Hazard effect
1	Larvae	Larvicides	< 5	Extremely hazardous	< 50	Highly hazardous
2	Moths & caterpillar	Antifeedants	5-50	Fatal if swallowed	50-200	Fatal in contact with skin
3	Births & Rodents	Avicides	50-200	Toxic if swallowed	200-1000	Toxic in contact with skin
4	Termites/ Ticks	Acaricides	200-2000	Harmful if swallowed	1000-2000	Harmful in contact with skin
5	Algae	Algicides	2000-5000	May be harmful	2000-5000	May be harmful

Fig. 6: GHS of Pesticides Classification

In Fig. 7 of GHS classification, the system displays various classes of pesticides to be applied with oral and dermal range in mg/kg bwt. A particular pesticide corresponding to a certain pest has hazard effect to the farm sprayer. Therefore, clicking the SYSTEM ADVICE button pops up the general advice being the output result of the hazardous statement to the farmer.

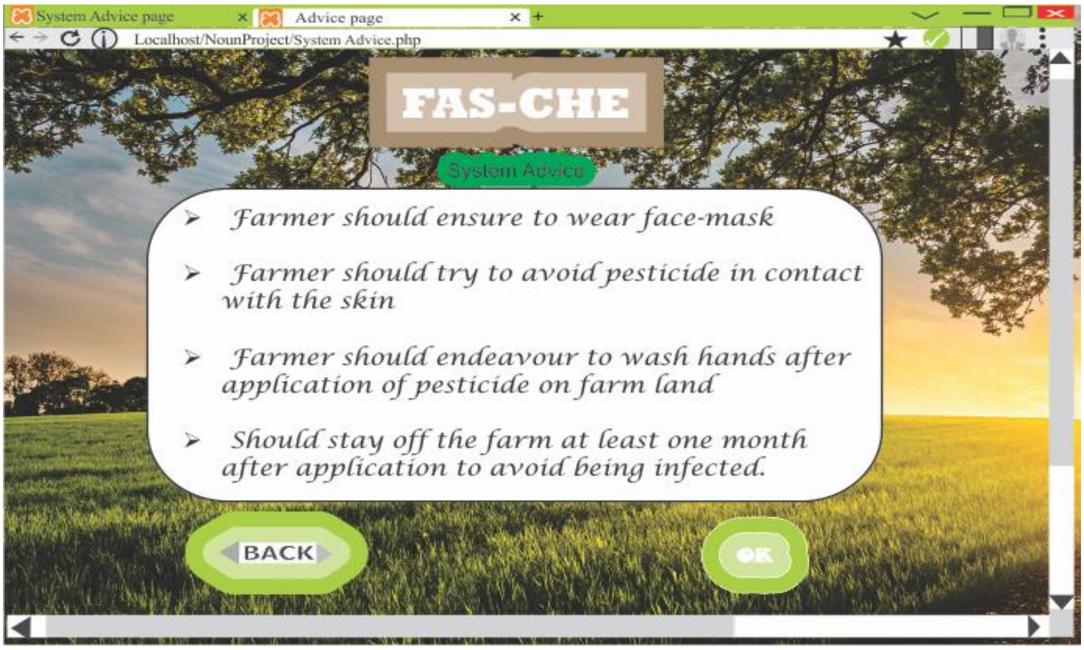


Fig.7: Advice Screen

Fig. 7 is the FAS-CHE advice page, where the farmer adhered to the system advice in order to avoid any form of contamination and infection arising from pesticide application. If these advices are maintained and appropriate control measures followed, the crops and plants in the farm will bear good fruits to the farmer. The farmer clicks on OK button to accept the advice.

5. Conclusion

This Project covers the design of a web-based farm advisory system for monitoring and controlling the hazardous effects of pesticide on human health. It explains the existing method of pest control in the farming system and goes ahead to introduce the new method through the use of an advisory farm system.

The requirements of the new system via; database structure and overall structure of the system are also covered, as well as the system implementation plan which explains the various interfaces of running the system.

Amongst the different technological development in agricultural system is the farm advisory system. As a researcher of this project, it is my believe that further application of this web-based system will enhance effective monitoring and control of pest on crops and subsequent application of pesticides in such a way that will not be hazardous to human health in the event of consumption.

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