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# **Dynamic Responses of Livestock Farmers to Smart Farming**

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Abstract. Nowadays, livestock has made clear changes in industrial and semi-industrial production organizations or smart farming. The adoption of livestock technology is extremely important to enhance the quality and quantity of livestock products. Besides, technology may help farmers to increase their profit and protect the health of costumer and environment. Advanced technologies in smart farming were widely applied by livestock farmers such as data management, Internet of Things technology, precision farming, agriculture drones, and so forth. Those technologies may make a great livestock system like closed livestock production from breeding to processing and consumption. Moreover, when using smart farming techniques, farmers can better monitor or observe the need for individual animals and adjust their nutrition correspondingly, thereby preventing diseases and improving herb health. There are many benefits from adopting smart farming and also have some obstacles that farmers have to face when they would like to access to smart farming. This paper also gives extensions and innovations for small farmers that can be utilized to facilitate the processing of smart farming implementation.

Keywords : farmers, livestock technology, smart farming, internet of things

#### 1. Introduction

Smart farming is a farming management concept using modern technology to increase the quantity and quality of agricultural or animal products. According to Wolfert et al. [1] smart farming is a development that emphasizes the use of information and communication technology in the cyberphysical farm management cycle. The new emerging technology have allowed people to incorporate modern and advanced solutions that not only improve the productivity of the agricultural sector but also reduce costs, save time, improve the health and safety of the producer, increase product quality, and reduce losses within and out of the field. The implementation of technology by itself does not convert a conventional farm into an intelligent farm. In the 21st century, farmers have access to new technologies in the world such as GPS, data management and the Internet of Things technology that propelled the rapid development of smart farming. Smart farming goes beyond other technologies (as precision farming) by basing management tasks not only on location but also on data [2]. Additionally, smart farming also helps farmers control their cattle and prevent them from diseases, for example, cattle herd management bases on remote-sensing signals and sensors or actuators attached to livestock.

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Any system, machine, process, or domain is considered intelligent if, in addition to using state-ofthe-art technology, it also has the capacity to adapt to meet any requirement, to sense changes in the surrounding environment, to infer conclusions based on results and observations, to learn from the results to improve their performance and anticipate preventing unwanted scenarios. In addition, smart farming needs smart consumers and producers with the ability to use the implemented technology and to interpret the information generated in the system [3]. From the technological point of view, the Smart Farming is composed mainly of three interrelated fields of science and engineering: biotechnology, nanotechnology, and information and communication technology.

Biotechnology is the field of science that manipulates molecular, genetic and cellular processes through knowledge and techniques of biology. It has an important application in agriculture since it allows the producer to increase the productivity of the crops, implement a mechanism of resistance to pests and diseases, develop strategies to combat climate change, improve the quality and durability of the products during harvest or shipment [4]. Biotechnology can be very helpful as long as it is accompanied by reasonable biosecurity regulations and appropriate policies. Nanotechnology is the field of science that allows the manipulation of physical and chemical characteristics by materials and equipment at a scale of 100 nm or less. This technology can be implemented in all phases of agriculture: production, processing, storage, packaging, and transport of products [5] [6]. Among the most outstanding applications are: 1) Precision cultivation; 2) Improvement of the capacity of plants to absorb nutrients; 3) Efficient and directed use of inputs; 4) Detection and control of diseases; 5) Mechanisms of resistance to climate change; 6) Food processing, storage, and packaging tools; 7) Use of nanoparticles in animal sciences; and 8) Detection of environmental contamination.

The information and communication technology (ICT) are those technological tools that allow generation, processing, storing, and retrieving information through communication equipment and services [7] [1]. In the agricultural sector, with the implementation and interconnection of different technological solutions through the use of ICT, producers will be able to replace conventional agricultural tools, obtaining a more intelligent, efficient, reliable, and sustainable system [8]. There are a large number of ICT solutions that can be applied to the agricultural sector such as precision agriculture, tracking, and animal tracking systems, food safety and quality management, food processing and manufacturing, consumer food awareness. These can be categorized fundamentally into five main types of technology:

- 1. Monitoring and environmental sensing;
- 2. Specialized hardware and software;
- 3. Telematics and positional reference;
- 4. Communication systems (IoT, 5G, Wifi, smartphones, televisions, etc.); and
- 5. Analysis of Information systems.

# 2. Overview Smart Farming/Precision Livestock Farming

Berckmans [9] explains that the PLF aims to manage each livestock at any time and every day on an ongoing basis in accordance with real-time conditions to monitor animal health, welfare, production and reproduction, and environmental impacts. Livestock supervision can be done by using cameras and real-time image analysis, microphones and real-time sound analysis, or with sensors around or in livestock. Therefore PLF is a hi-tech management tool used to monitor various aspects that affect livestock production [10]. According to Banhazi et al. [11] with correct application, PLF can provide benefits between:

- 1. Improve or at least objectively document animal welfare on farms;
- 2. Reduce greenhouse gas (GHG) emission and improve environmental performance of farms;
- 3. Facilitate product segmentation and better marketing of livestock products;
- 4. Reduce illegal trading of livestock products; and
- 5. Improve the economic stability of rural areas.

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## 3. Technology Solutions and Application of Precision Livestock Farming

The integration of these solutions using communication networks to create more efficient agricultural systems is known as smart farming, which aims to implement advanced technology into traditional agriculture, in order to allow the producer to increase the sustainability and productivity of their crops using efficient tools and system resources [3]. Figure 1 shows models some of the main technological solutions implemented in the agro-industrial sector using communication networks to interconnect each component.



Figure 1. Models implementation of technology solutions in the agroindustry sector

The rapid growth of technology recent has allowed the development of a large number of technology suitable for agriculture (plant and animal) in rural and urban areas. With the introduction of technology in food production, there has been a positive change in many sectors of the population, mainly in the way of working of farmers, researchers, and all personnel in the agricultural sector. Among the main benefits of the implementation of technology in agriculture, we can mention:

- 1. Better productivity in farming systems;
- 2. Decrease in pollution;
- 3. Efficient use of water, fertilizers, pesticides, feed ingredients;
- 4. Reduction in food and feed prices;
- 5. Monitoring and operation in real-time; and
- 6. Less environmental impact.

The application of the PLF requires hi-tech use so that it requires human resources including farmers who use it competently and expertly in the animal physiology, welfare and behaviour. This is intended to be able to understand the various results of livestock surveillance analysis both images, sounds and sensors [12].

## 4. Benefits of Using Technology for Small Farmers

There are many benefits of using livestock technology to smart farming that were achieved by developed countries. Recently, in developing countries, smart farming also becomes a phenomenon and was widely used by Asian countries. Bringing great income for farmers and enhancing economic development. Smart farming can make agriculture more profitable for farmers. Decreasing resource inputs will save the farmer money and labor, and increased reliability of spatially explicit data will reduce economic risks [13]. Smart farming can also reduce risks for economic by preventing livestock from diseases, new technology can monitor animal around-the-clock and it can recognize which animals got diseases. Meet the increasing demand for human and animals. Population in the world is increasing while agricultural products, especially livestock products are insufficient to human. In

developing countries, the demand for livestock products is lifting in a rush, mainly as a consequence of increased human population, urbanization and rapidly increasing incomes [14]. Increase the quality and quantity of products. People can produce more products and reduce processing time. Especially, in livestock management, we can control animal herds easily with technologies. Additionally, new technology and ICT (information and communication technology) can be used for facilitating livestock management methods that are more responsive to market signals. Besides, envisaged and real-time monitoring and control systems could dramatically improve the production efficiency of livestock enterprises [15]. Information was collected on farms that can be related to the welfare of animal via the documentary of living conditions emerged in livestock farms can be used for quality assurance purposes.

# 5. Condition of Livestock Farmers in Developing Country

In developing countries, livestock has played a significant role in livelihoods, incomes and economic development that provided a job for most rural people [16]. Smallholder livestock farmers represent almost 20 percent of the world population and steward most of the agricultural land in the tropics. Two-thirds of the world's domestic animals are kept in developing countries, where over 90 percent are owned by rural smallholders. They dominate crop-livestock systems, with livestock playing an essential role in highly diversified livelihood strategies that typically combine crops and livestock with off-farm activities [17].

# 6. Obstacles of Using Technology for Small Farmers

Livestock technology is necessary for smart farming in developing countries. However, the adoption of livestock technology has some obstacles. First, there is a lack of knowledge development. Small farmers do not know about the benefits of using technology and they also have a lack of skills in using technology. Besides, they have less knowledge, lacking of training and lacking of time spent on using new technology. Some farmers do not want to use new technology for their farm, it is a reason that they do not mention about innovation. Livestock technology usually imports from developing countries where they use their language to create methods to use it. When a farmer wants to adopt new technology, they face a language barrier. The second, there is a lack of knowledge diffusion [18]. Farmers have to know how to use livestock technology before buying and using it, yet adequate knowledge of livestock technologies is not accessible to small farmers. And sometimes, smallholders have no chance to use new technology because they already have their owned livestock instruments. The final obstacle is the lack of investment. Technology accommodation is insufficient. Price of technology is expensive while capital is not enough for buying and adopting new technology.

## 7. The Role of Extension in Livestock Development

Today, most livestock extension services in Asia and the Pacific moreover in developing countries are under the wings of the ministries or department of agriculture, as government services are concerned. The privatization of livestock extension service, however, has been in existence ever since in an informal way which means that distributors of veterinary products, feed or animals have actually been performing extension work in the promotion of their products and/or services [19]. Extension methods, as they recognized today in the Asian context, come in three major approaches: individual, group, and mass. The individual approach involves extensionist's visits to the individual farms usually by appointments or prearranged schedules. On the other hand, the group approach takes the other form of filed demonstrations, training courses, seminars, meetings, and group discussions [20]. The mass approach entails the production and dissemination of informational materials either through print, broadcast or computer media. Key extension service functions vis-as-vis National agricultural development goals [21], as it is described in **Figure 2**.

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Figure 2. Key extension service function [21].

There are some new extensions that can be adopted in developing countries such as participatory, demand-led, market-led approaches, pluralism of service providers, decentralized system of implementation and growing role of information communication technology. Besides, government and responsible agencies should increase the number of technology training, implement the promotion, especially in agriculture areas. And those who are seniors should find difficulties in using technology for breeding and give that information to other people. Moreover, we should first educate children and then they will show those to their parents. Also, we need to spend more time to make changes because technology adoption is very slow. There are some sectors that need to be required or changed when we want to do extension: a new mindset, new challenges, new agricultural service, new roles, new solutions, new models and new capacities.

#### 8. The Importance of Innovation

Innovation is the process by which new knowledge is generated, adapted and used (knowledge management framework). Agricultural innovation system encompasses an interactive network of organizations, enterprises, and individuals together with institution and policies. Addressing the global challenges requires an agricultural innovation systems approach with substantially enhanced use of knowledge and advisory systems by limited-resource smallholder farmers and other rural actors. This implies new roles for rural advisory service (RAS), which are fundamental to supporting people to deal with existing and new challenges and to improve the livelihoods of rural people worldwide. Innovation is fundamental to supporting family farmers, revitalizing rural areas, creating attractive job opportunities for youth, bringing prosperity to communities as a whole, and help achieve the zero hunger world we want [22].

We need to increase the pace of innovation to overcome the challenges of the 21st century. Accelerating and scaling up innovation in agriculture can trigger the transformation needed to respond to feeding a growing and increasingly urbanized population, climate change impacts and achieve the sustainable development goals [22]. In doing so extension needs to change its mind map so far, from; materialistic to realistic, participatory to a partnership, authoritative to democratic, trickle-down to bottom-up, clientele to partner, public to strategic, bureaucratic to dynamic, and passive to active. Major improvements in livestock productivity are possible and needed to assist economic growth in developing countries. Research can provide technologies to help achieve productivity increases but the transfer of technology is needed to achieve impact. The global research and development community is expanding and new functional modes are required to ensure coordination of the use of resources.

We should consider issues related to the role of research in the strategies making up an action framework to promote livestock development and especially effective linkage of research with technology transfer. The three most important necessities of humans are food, air, and water (of course after modern technology like smartphones and wireless technology). The increasing consumption need of a global population is expected to grow by 70% by 2050 as quoted by UN food. This means there has to be a production of 70 times more than we have it now. Heat waves, which are projected to increase under climate change, could directly threaten livestock. In 2011, exposure to high-temperature events caused over \$1 billion in heat-related losses to agricultural producers. High temperatures affect flowering and fruit because it damages the reproductive organs, and the pollen grains die so flowers drop. High temperatures increase insect activity and therefore virus and diseases, causingfarmers to apply pesticides every day. Flowers and fruits are sunburned and die [23]. Global climate change, estimates of cropland reductions from 10 to 50 percent. Food losses and waste amount to roughly US\$ 680 billion in industrialized countries and US\$ 310 billion in developing countries.

#### 9. Conclusion

Adoption of science and technology in livestock is a development trend to take advantages of science and technology to increase productivity and efficiency. We should make narrow gap between industry and farmer groups in using technologies, so the smallholders are not left behind to take opportunities to have more benefits. Smart Farming for farmers leads to the application of Precision Livestock Farming (PLF). The application of smart farming in Indonesia still requires a long process because it can be seen from the condition of the level of education of farmers that is still low so that it affects the lack of knowledge of farmers about raising livestock according to the principle of Animal Welfare. The level of adoption of innovations and technology of the farmers is still diverse and is limited to the basic aspects of livestock raising that have not yet led to the modernization of technology for smart farming. Therefore to be able to reach it, farmers must begin to be given knowledge and understanding related to Animal welfare and the development of technological modernization in the field of animal husbandry having to pay attention to the needs and convenience of farmers in using it.

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