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MECHATRONICS AND PRECISION LIVESTOCK FARMING IN MEXICAN ANIMAL PRODUCTION

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ABSTRACT

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For México, the base projection shows that the demand for this meat grows at rates faster than the production, reason why an increase in the imports in the long term is expected. The base projection shows that purchases abroad will reach a level close to 390 thousand tons in 2018. In Mexico, the deficit in the milk market is complemented by imports. For 2009, an import of 1.0 billion liters is estimated and in 2018 these are hoped to fall to 946 million liters [1]. According to these projections makes it necessary to analyze the pressure for increased food production of animal origin, leading to review technologies applied in the rest of the world to carry out such an increase, a technology is the application of mechatronics to animal production, which is also known as livestock farming precision. Being the objective of the present article the revision of the state of the art in the world and in Mexico of this technology. In Mexico it is possible to increase the productivity of Livestock Farming, if the decision to guide and formed human capital and training are taken at all three levels ; Bachelor , Masters and Ph D , to the research and application of livestock mechatronics, results in developed countries so it evidence Mexico cannot be left behind in this regard , besides that is the only way to increase food production, applying mechatronics in animal production .So previously treated the perspectives for the precision animal production in the country are very big.

Contribution/ Originality: The Precision livestock farming is important in the social and economic environments of Mexican animal production and has been Kept in oblivion for many years . Being that at present, as verified by the mentioned references is the only way to alleviate the needs of animal food in the country. This paper provides the first overview of the Precision Livestock Farming and the application of mechatronics to animal production in Mexico.

1. INTRODUCTION

Mexico covers some 2 million square kilometers of territory, 11% of which is used for agriculture, 57% for pasture and fallow land, 26% for forestry use and the halting 6% for other uses .Some 58% of the territory's approximate 19 million hectares (47.5 million acres) is dedicated to Mexico's primary economic activity: cattle ranching, in its different modalities. Livestock is domesticated animals embossed to produce aliment for person consumption. Different foods elaborate from cattle provide essential nutrients, contributing 15% of the total dietary

energy and 25% of all proteins in the human diet. Moreover, the cattle ranching sector is one of the rapid increasing constituent of the universe's agriculture and livestock sector. In Mexico, the major livestock production enterprise comprise beef and dairy, hogs, sheep, goats, poultry, horse and mule ranching. Beef and dairy ranching was popularize into Mexico during the Colonial Era, limited pre-Hispanic animal husbandry being spotlight on turkey and xoloitzcuintle (Mexican hairless dog) breeding and the cultivation of the cochineal (an insect producing a crimson-colored natural dye) and some beekeeping activities [2].

In 2008 a request for meat of 1.9 mtons is forecast, while for 2018 an estimated demand of 2.1 mtons is estimated. Likewise, there was a slowdown in imports from 2007 to 2009, from 302 to 290 thousand tons of meat, respectively. However, the base projection shows that the demand for this meat grows at rates faster than the production, reason why a growth in the imports in the whole is expected. The base projection shows that purchases abroad will reach a level close to 390 thousand tons in 2018 [3]. In Mexico, the deficit in the milk market is complemented by imports. For 2009, an import of 1.0 billion liters is estimated and in 2018 these are perspective for decrease to 946 million liters. This is in replay to an growth in domestic production that is motivated by the recovery of the cost of this food at the end of 2018 [3]. According to these projections makes it necessary to analyze the pressure for increased food production of animal origin, leading to review technologies applied in the rest of the universe to carry out such an increase, a technology is the application of mechatronics to animal production, which is also known as livestock farming precision. Application of automatic technologies is a growing trend in the cattle industry and plays an sustantial part in the forthcoming prospects [4]. Being the objective of the present article the revision of the state of the art in the world and in Mexico of this technology.

2. MATERIALS AND METHODS

For data collection searched in printed data bases, Internet, magazines scientific, professional and postgraduate university thesis, newspaper articles, etc.

2.1. State of the Art

Precision livestock production (PLP) is the augmentation of precision agriculture (PA) notions to include all components of agro ecosystems, particularly animals and plant-animal interactions. Soil, plants and soil-plant interactions are the subjects of PA or site-specific farming, where the main principle is to exploit natural spatial heterogeneity to increase efficiency and reduce environmental impacts. For the most part, PA has been studied and developed for intensive cropping systems with little attention devoted to pastoral and agro pastoral systems. PLP focuses on the animal component and exploits heterogeneity in space and among individual animals towards more efficient and environmentally friendly production. Within PLP, precision grazing consists of the integration of information and communication technologies with knowledge about animal behavior and physiology to improve production of meat, milk and wool in grazing conditions [5].

The aim of Precision cattle production is to manage individual animals by continuous real-time monitoring of health, welfare, production/reproduction, and environmental impact [6]. Precision cattle production involves the measurements, predictions and data-analyses of animal variables. Offers totally new possibilities to collect and analyze data from farm animals in a continuous and fully automatic way. We cannot only replace the farmers "eyes and ears" to each individual animal as in the past, but several other variables (infections, physiological variables, stress, etc.) will soon be measurable in practice. The bottleneck to apply this technique is in the opportunity of accurate sensors and sensing systems, since it has been shown that the required mathematical algorithms can be exposed. The application of this scientific knowledge offers new possibilities to realize nutriment safety and quality, competent and feasible animal production, fine animals, guaranteed animal well-being and acceptable environmental impact of livestock production.

Therefore, efforts should be increased for bringing this challenging approach of Precision cattle ranching to practice. This is only possible when teams from different research disciplines, such as physiology, ethology, nutrition, hygiene, engineering, etc. join their research efforts [7].

Some elements of accuracy cattle ranching are already not unusual on livestock farms, i.e. sensing systems for milk yield in dairying, and their use should be part of livestock production heedless of the greater potential to manage livestock automatically. If the assurance of PLF is to be realized then three barriers need to be overcome before commercial uptake occurs: i) PLF technology needs to be advanced that is based upon robust, low cost sensing systems and data-based models with consequential parameters that enable control of two or more collaborating physical and/or biological processes; ii) appropriate implementations must be identified with purpose and trajectories specified for the main candidate processes; and iii) development and demonstration must be completed at a commercial scale to demonstrate that any asset will have a reasonable return and that the technology is reliable. Given the scale of these challenges and the timescale needed to overthrow them, then current effort should focus on the evolution of monitoring systems for livestock that satisfy the request of purchasers and buffers for safe, healthy food produced from cattle ranch's of secured standard of health within acceptable limits of environmental emissions [8].

Accuracy Livestock Farming is an embryonic technology with great potential to convert intensive livestock production by efficient utilization of nutrients, early warning of ill health, reduction in pollutant emissions and arrangement of useful information to skilled stockmen. However, in our opinion a careful procedure is needed to Research & Developed if the promise of the technology is not to be scamper against the rocks of poor product design and marketing [9].

In order to be able to produce secure, uniform, cheap, environmentally- and welfare-friendly food products and market these products in an increasingly complicate world agricultural market, cattle producers must have entry to timely production related information. Especially the information related to feeding/nutritional issues is relevant, as feeding related costs are constantly significant part of variables costs for all types of cattle production. In consequence, automating the collection, analysis and use of production related information on cattle ranches will be imperative for improving livestock productivity in the forthcoming. Electronically-controlled livestock production systems with an information and communication technology (ICT) focal point are required to guarantee that information is collected in a cost effective and timely appearance and readily acted upon on farms. New electronic and ICT related technologies insert on ranch's as part of Precision Livestock Farming (PLF) systems will facilitate cattle management methods that are more tender to market signals. The PLF technologies circumscribe methods for electronically measuring the critical components of the production system that indicate the performance of resource use, interpreting the information captured and controlling processes to ensure optimum efficiency of both resource use and livestock productivity [10].

Precision Livestock Farming (PLF) is potentially one of the most powerful developments amongst a number of interesting new and approaching technologies that have the potential to revolutionize the cattle ranching industry. If properly accomplished, PLF or Smart Farming could (1) enhance or at least objectively document animal welfare on farms; (2) decrease greenhouse gas (GHG) emission and improve environmental performance of farms; (3) supply product segmentation and better marketing of livestock products; (4) reduce illegal trading of livestock products; and (5) enhance the economic stability of rural areas. However, there are just a few examples of effective commercialization of PLF technologies insert by a small number of commercial companies, which are actively involved in the PLF commercialization methods. To guarantee that the potential of PLF is taken to the industry, we need to: (1) create a new service industry; (2) check, display and divulge the benefits of PLF; (3) better arrange the efforts of different industry and academic organizations interested in the development and promotion of PLF technologies on farms; and (4) encourage commercial sector to assist with professionally managed product development [11].

'Precision Livestock Farming' (PLF) technology is an arise research field that develops management tools aimed at continuous automatic monitoring of animal production, which includes real-time monitoring of growth, health and welfare. PLF intends to support farmers in making daily management decisions with extra 'senses', and to make farmers less dependent on human labor. Many PLF concepts have been emerged in recent years, but the uptake of most of these technologies on commercial ranches has been slow. Reasons for this slow uptake include that these PLF technologies generate considerable amounts of data but that this data is not converted into profitable information for decision administration. A further reason is that investments in PLF technologies can be significant, while the economic benefits of the inversion are unknown.

The application of mechatronics in cattle farming is found through the use of biosensors and miniaturized electronic mechanics , developing data collection and allowing more precise decision making actions. Nääs [12] presents some cases of the use of this technique in particular areas related to livestock farming. The approach of biosensors technology applied to cattle ranch, mainly based on the miniaturized electronic mechanics has being used from the mid 70s into several stages of production, such as feeding, detection of metabolic testing in animal husbandry, as well as to individual identification and monitoring, which is an important step towards tracking of actions and application of traceability of episode and processes in the animal protein production chain . The precision breeding involves the technological innovations that monitor the animal and its environment where it pastures. The knowledge of the digestive behavior of the animal in milk or meat production is fundamental to perform grazing management actions of the production system, nowadays as Information will be used by modern technologies is still a unknown. Being that these new technologies applied to the cattle industry can help to integrate the heterogeneity in the pastures, and it is proposed to the bit as the basic unit of the process to be monitored, concluding that creating environments with precision bites is like constructing grass structures to designate bits [13].

The benefits of using precision dairy technologies include increased system efficiency, reduced costs, improved end product, minimizing negative environmental impacts, and improved animal health and welfare. Such technologies have a greater impact in the areas of health, reproduction and quality of milk. Technologies have modified milk production systems and are generally variations of those already used in industries such as automotive or electronics. Precision livestock technologies enable farmers to make informed decisions quickly and based on better information, resulting in increased productivity and profitability . Precision livestock technologies enable farmers to make informed decisions quickly and based on better information, resulting in increased productivity and profitability [14].

The livestock sector faces the challenge of optimizing natural resources and those applied to the environment for animal production, such as agricultural inputs and pesticides, for example. For if it is produced with quantity and quality, the productive chain of ruminant livestock must be efficient within a restricted area of action. In this scenario, precision farming tools combined with animal production were developed from the advent of microcomputers, robotics and microelectronics. Measurements began to be carried out with the minimum of human intervention. The researcher is currently concerned not only with the field measurements, but with the planning, design and interpretation of the analyzes. Today's farmer is an information manager, who comes to him in countless digital forms and with speed in real time. Through applications, smartphones, tablets and ultra books, all this in the face of increasingly fast internet connections, there is a range numerical and computationally intensive methods that facilitate the accuracy of multifactorial responses. Applied to animals and agro ecosystems are a wide range of wireless sensors, actuators and controllers capable of recording signals, storing and interpreting them. From there, it aims to allow automated and accurate decisions to improve the use of environments and provide the balance between the sustainability and profitability of agricultural activities [15].

And thus, the traditional problem of mechanization of agriculture can be solved by the Agricultural-Mechatronization or Agrotronics. Similarly, problem solving of the breeding science passes through Mechatronics

technology forward Breeding-Mechatronization or Breedtronics, and the fisheries difficulty may be overcome through this emerging engineering technology, forward Fishery-Mechatronization or Fishtronics [16].

2.2. Precision Animal Production in Mexico

In Mexico the pressure for food is increasing, as in other countries, so there is no way to make use of modern technologies for providing food for the growing population, these technologies are precision breeding, automation and robotics, which were based on Mechatronics, which is an integrative discipline in the areas of mechanics, electronics and computer science which aims to provide better products, processes and systems [17]. The country needs these technologies to rapidly increase food production. This is possible because it has the infrastructure and human capital in sufficient quantity, one study estimates that in Mexico every year around 2,500 students graduate mechatronics of more than 150 schools that offer this specialty, at all three levels (bachelor's, master and Ph.D.) [1] which have the capacity to investigate on subjects of Precision animal production.

Guerrero, et al. [18] Conducted a review to determine the image processing importance as an automation tool for assigning a Body Condition Score (BCS) of dairy cattle, this factor is one of the most important criteria for dairy farmers, with his knowledge they can prevent health problems, feeding, breeding and production. The use of new technology in the milk industry has given rise to a new era of automated and non-invasive production systems giving the main result a greater production the majority of studies acquire the images in weighing aisles. In these corridors, although the animals are enclosed, they tend to remain in motion, making it difficult to acquire the images. The time of milking, since it has been observed that it is when they remain longer. As the processing of images is applied to other industries, the costs of these technologies will continue to decline; On the other hand the limitations of computer storage for the data collected are no longer a major concern. Once the technical difficulties mentioned above have been overcome, the assignment of an automated QC rating can become an integral part of modern dairy farms. Dorantes [19] conducted an investigation with the objective was to design an automatic quick assessment system of mastitis that applying fuzzy logic relates electrical conductivity and volume to determine and prevent mastitis in dairy cattle. It was implemented an animal identification system using Radio Frequency boluses with a Reading frequency of 134.2 KHz, also we designed the system that is implemented in the milking, with this system we can analyze the electrical conductivity and the milk production per cow. To determine the presence of mastitis cases, we implemented a fuzzy logic model having as input the parameters of electrical conductivity, production, standard deviation of electrical conductivity and standard deviation of production, both deviation as the result of moving average from ten previous data and the actual measurement.

Galicia, et al. [20] carry out an investigation that promotes a system of remote monitoring of the temperature and heart rhythm of a sow, that allows to predict the moment of the birth, and with this: to help reduce the mortality rate of piglets, to improve the welfare of the sows in childbirth when the delivery is attended individually and in a timely manner; as well as helping to increase the profitability of the pig production system. A diadem-type device was designed to always position and maintain contact with the skin of the sow to two non-invasive sensors, on the back of the ear of the sow; Generating the minimum of discomfort for its easy adaptation and acceptance. The headband is made of flexible and soft leather that provides resistance to rough use and rigidity to keep in contact with the skin of the sow to the sensors, has two adjustment systems for different sizes of the head of the sow and not to generate discomfort. The test animals were six sows. Two in their second delivery, two in their fourth delivery and two in their sixth delivery. Race, physical dimensions and temperament at the time of delivery are aspects that were not considered in the present study. Sensors record changes in body temperature and heart rate hours before delivery. The temperature sensor was placed behind the right ear and the heart rate on the left. The device or headband is installed without sensors to the sow in turn, when it is taken from the gestation area to the maternity area and a period of adaptation of 24 h is given, to minimize the effect of the stress generated by the change of room and use Device. Subsequently, the sensors are installed in the device, taking care of the

continuous contact of the sensor with the surface of the sow and starts recording the behavior of temperature and heart rate. Records are analyzed and searched for behavior patterns that can be used as benchmarks in decision making to help predict the time of delivery.

1. Placing non-invasive sensors in the transition of the ear pavilion and dorsal on the head of a sow, allows the identification of behavioral patterns of their temperature and heart rate, characteristic of the proximity of labor.
2. Introducing electronic devices or gadgets, which facilitate everyday work and enhance the livestock production sector, is the contemporary challenge of livestock engineering.
3. The application of the device or headband allows management personnel to remotely consult the body condition of the sow, temperature and heart rate, predict the time of delivery and make necessary decisions to reduce the mortality rate of piglets, improve the welfare of the bristles in the childbirth when being attended individually and at the appropriate time

3. DISSCUSION

The situation despairs in the country as far as the animal production in Mexico obliges to explore all the possibilities to remedy that situation, at the moment one has an abundant skilled workmanship in as much as mechatronics technology alone must guide its application of its investigation To the country's primary needs, such as the primary sector of providing animal products, thus avoiding that the leakage of foreign exchange increases by having to import these in a recurring manner, the review reveals really incredible data that only Queretaro Autonomous University and Chapingo Autonomous University, and only some research applying mechatronics to livestock . This situation must change, being this work a call of attention in this respect so that researchers in the area are willing to change that situation.

4. CONCLUSIONS

In Mexico it is possible to increase the productivity of Livestock Farming, if the decision to guide and formed human capital and training are taken at all three levels ; Bachelor , Masters and PhD , to the research and application of livestock mechatronics, results in developed countries so it evidence Mexico can not be left behind in this regard , besides that is the only way to increase food production, applying mechatronics in animal production .So previously treated the perspectives for the precision livestock farming in the country are very big.

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