Recibido: 27/04/2021. Aceptado: 14/09/2021.

A glance at the 21st-century livestock industry and breeding

Un vistazo a la industria ganadera y a la cría en el siglo XXI

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Cómo citar este artículo: Valmoria Ortega ADS. A glance at the 21st-century livestock industry and breeding. Revista Ciencias Agropecuarias. 2021;7(1):11-26 . DOI:

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Abstract

The livestock and poultry industry plays a significant role in providing food to the global population, which is a great and constant challenge for the said industry. The continuous rise in the global population threatens our natural resources and poses a great threat to food security and environmental sustainability. The excessive use of our natural resources and the increase of animal population to satisfy the ever-increasing demand for animal protein greatly contributes to climate change which then, in turn, jeopardizes the efficiency, reproductive performance, and productivity of food animals. Through the years, researchers in the field of animal nutrition and animal breeding constantly seek the best solution to mitigate these problems with due consideration to animal welfare. This led to the development of management tools and technologies such as precision livestock farming and biotechnology which improved

Revista Ciencias Agropecuarias
ISSNe 2422-3484
Volumen 7 No. 1 • 2021

Keywords: *Poultry, Livestock, Animal production, Reproduction trends.*

Palabras clave: *aves de corral, ganadería, producción animal, tendencias de reproducción.*

the efficiency and productivity of food animals. Although these technologies greatly influence the success of global animal production, problems associated with food animal production is still evident. Thus, it is the objective of this paper to summarize such problems and prospects associated with cattle, pig, and poultry production and trends regarding their reproduction.

Resumen

La industria ganadera y avícola desempeñan un rol significativo en la provisión de alimentos para la población global, lo cual representa un desafío permanente y constante para la industria. El aumento continuo de la población mundial amenaza los recursos naturales y representa una gran amenaza para la seguridad alimentaria y la sostenibilidad ambiental. El uso excesivo de nuestros recursos naturales y el incremento de la población animal para satisfacer la demanda cada vez mayor de proteína animal contribuye en gran medida al cambio climático que, a su vez, pone en peligro la eficiencia, el rendimiento reproductivo y la productividad de los animales destinados a la alimentación. A lo largo de los años, las investigaciones en la nutrición animal y la cría de animales buscan constantemente la mejor solución para mitigar estos problemas con la debida consideración en el bienestar animal. Esto promueve el desarrollo de herramientas y tecnologías de gestión como la ganadería de precisión y la biotecnología, que han mejorado la eficiencia y la productividad de los animales destinados al consumo. Aunque estas tecnologías influyen en gran medida en el éxito de la producción animal mundial, los problemas asociados con la producción de animales destinados a la alimentación siguen siendo evidentes. Por lo tanto, el objetivo de esta revisión es presentar los problemas y las perspectivas asociados con la producción bovina, porcina y avícola y las tendencias en cuanto a su reproducción.

Introduction

Living in the 21st century poses a lot of global concerns and challenges. Some of these are sustainability, climate change, continuous use of non-renewable resources depletion of fossil fuels, pollution, and natural hazards. These challenges are believed to be infinite and the only way to address them is to mitigate their effects. It can be said that all of these problems and challenges that we are facing today areas associated with the continuous rise in the human population and food security. Roser *et al*. (1) made some predictions based on the demographic data gathered in the past years that by 2050 human population will reach 9.7 billion from the current population of 7.7 billion. This would certainly lead to an increase in the demand for food. This situation creates a huge challenge to the agriculture sector. With the ever-increasing demand for food, many industries in the agricultural sector particularly, the poultry and livestock industry have shown increase in meat, egg, and dairy production (Table 1) led by the top producing nations (Table 2).

Table 1. **Volume of meat production worlwide by type in million tons (2001-2020).**

	Year						
Production	2001	2005	2010	2015	2018	2019	2020
Poultry	76.14	86.74	105.82	123.13	127.3	133.6	136.8
Pork	90.76	98.78	108.97	119.41	120.9	109.8	101
Ruminant	7.63	75.6	80.74	83.62	87.3	88.6	88.2
Others	2.39	2.48	2.63	2.81	6.7	6.9	7
Total	239.65	263.60	298.16	328.97	342.2	338.9	333
Percentage change	na	10	13.11	10.33	0.31	-0.96	-1.74

na: *not applicable.*

Source: *Ritchie and Roser, 2019 (2) and FAO, 2020a (3)*

Table 2. **Top 5 producing nations in terms of meat, egg and dairy (2020).**

Commodities and production					
Countries	Meat, tonnesa	Countries	Egg, tonnesb	Countries	Dairy, TT-MEc
China	88,156,383	China	28,453,871	India	194,800
EU	63,845,936	EU	10,739,427	EU	176,719
USA	46,832,946	USA	6,706,770	USA	101,251
Brazil	29,341,250	India	5,775,000	Pakistan	57,722
Russia	10,629,378	Indonesia	4,753,382	China	35,894

TT-ME: *in thousand tonnes - milk equivalent.*

Source: *a Kreshner, 2020 (4), b FAO, 2021a, (5) (data available 2019), c FAO, 2021b (6)*

In the early years of the 21st century (2001-2010), there was a 24.41% increase in the volume of meat produced worldwide, and has been progressive for the last 20 years with an over-all increase of 38.95%, despite the slight decline of production from 2019 (338.9 million tons) to 2020 (333 million tons) due to various challenges (COVID-19) related market disruptions and animal diseases such as African Swine Fever (ASF) and Highly Pathogenic Avian Influenza (HPAI). Despite the decrease, the Food and Agriculture Organization (FAO), still projects an increase in global meat supply by 2030 of about 374 million tons (2,3). This projected increase in meat production means a significant increase in the number of animals to be slaughtered in the years to come and increase in the global livestock animal population. As data shows that even in a period of 8 years (2010-2018) food animal population had a steady increase led by chicken, cattle and pigs from 20.24 billion, 1.41 billion, and 971.95 million, heads respectively in 2010 to 23.70 billion, 1.48 billion and 978.33 million, heads respectively in 2018 (7). So, it can be said that the increase in the human population also leads to the increase of livestock animals. This immediate solution performed by the agriculture sector is in the hopes to satisfy the human need for animal products (meat, milk, and egg). Many people around the world have a high preference for animal-derived protein than plant protein. In 2020 the global per capita consumption of meat was 34.44 kg in retail weight equivalent (r.w.e) and is expected to increase by 35.4 kg (r.w.e) in the year 2030 (8). However, livestock production and intensification to satisfy the global demand for animal protein carries uncertatinties and can have an impact on the environment and sustainability. Raising livestock involves excessive use of natural resources such as land and water. In some countries, forest lands are being converted into agricultural lands by which harms wild animals which can, in turn, disturb the balance in the ecosystem. The continuous growth in the animal population can give rise to a competition of resources that man needs. Mono-gastric animals such as pigs and poultry depend on grains such as corn as a source of food and it greatly affects food availability in developing countries. Moreover, the increase in livestock population also leads to the increase of greenhouse gasses (GHG) emission. Poore and Nemecek (9) said that the entire food supply chain contributes about 26% of the global GHG emissions. Out of the various sectors in the food supply chain crops and livestock and fisheries contributes the most with a combined percentage (52%) of GHG emissions (10). As mentioned, crops are important in the livestock industry as 6% of its total production usually goes to the livestock industry for animal feed. Among the various livestock species, cattle (beef, dairy, manure, and draft power) are responsible for the majority of the emissions (65%) of the livestock sectors' emissions followed by swine (9%), buffalo meat, and dairy (8%), chicken meat and egg production (8%) and small ruminants, raised for dairy and meat (6%). While other poultry species contribute to the rest of the GHG emissions (11,12). Thus, emphasis on the efficiency of production should be looked into.Furthermore, raising animals leads to the continuous use of energy to operate heavy machinery and to provide a favorable environment for those animals that are intensively raised. This can have a big impact on the usage of non-renewable energy sources such as fuel. These facts supports the contribution of livestock and poultry production to climate change of which the top producing nations in terms of animal production listed in Table 2 had significantly contributed and can be highly affected by its adverse effects. Moreover, with the high animal intensification to cope up with the demand, animal's health and welfare can be jeopardized, thus creating more concern

in the society especially when brought up by animal activists. Thus, it can be said that these things can lead to a "perfect storm". Fortunately, with problems arising from time to time, many people of science are continuously searching for practical and efficient solutions to these problems.

Amid these issues concerning the livestock industry, the hope lies in research and development to find ways to efficiently and ethically produce and raise livestock animals for human consumption. Although, management and production systems in mitigating the adverse effects of these issues have been in practice (for example, the creation and efficient utilization of carbon sinks to counter the GHG emission from livestock and poultry production) with the top producing nations in the industry as primary drivers (3,8). Most of these fall in the area of animal breeding. Genetic improvement through selective breeding and breeding intensification paved the way for the development of all livestock species. Animals now can grow faster and can efficiently produce more meat, milk, and egg compared to the past 30 years. However, we cannot deny the fact that there are also consequences and problems in animal breeding such as deterioration of other performance which is unintentional as well as cases of dystocia in breeding for large offspring, health, and welfare conditions of livestock animals. Through the years the intensification of livestock animals particularly pigs and poultry lead to efficiency of production as animals eat less and produce more meat and egg in a short period, however, consequences were observed as broilers showed metabolic problems and sows and cows showed reduced fertility during the high production period. In dairy cattle, the breeding for high production yield can lead to shortening of life expectancy as well as reduced fertility and compromised health (13,14). With these facts, this paper will explore the various issues, concerns, and prospects as well as trends in livestock breeding with emphasis on cattle, pigs, and poultry.

Issues and concerns in beef and dairy cattle breeding

Together with the continuous development of technologies and improvement of animal genetic lines for better production, issues, and problems that mainly concern the well-being of the animals, as well as the human population, are evident. Beef and dairy cattle combined had the 2nd highest animal population worldwide among the various food animals (7). This only shows that the demand for meat in milk worldwide is high and people deemed it essential in their diet. However, along with it is the increase in population growththat led to the increase in methane emission. Among the different livestock species cattle is the highest contributor of the greenhouse gasses mostly in the form of methane. In the livestock industry, methane emission is usually from enteric fermentation (40%) and manure left in the pasture which is about 16% (11,12). This is a big problem for both the dairy and beef cattle industry as GHG is the primary cause of climate change. One of climate change's direct effects on animals is heat stress (HS). When the ambient temperature exceeds the upper critical limit of cattle (25°C, beef cattle) and (24°C, dairy cow) HS is evident (15). HS greatly affects the breeding and reproduction of cattle. When cows are exposed to HS, reproductive efficiency declines. High possibility of a reduction in the duration and intensity of estrus, along with altered follicular and impaired embryonic development, can be experience by the animal when exposed to HS (16). The said reproductive failure is evident

as HS affects the animals' body homeostasis and it can alter secretion of hormones such as gonadotropins: luteinizing hormone (LH) and follicle-stimulating hormone (FSH) which are essential for reproduction (17). This shows that environmental factor is very important in animal breeding and it is a fact that climate change will still be a problem in the future if we will not do something for our environment today. Efforts from researchers, non-government, and government organizations lead to the development of technological advances in the hopes of addressing this situation. Most of it is done through proper nutrition and management (18). These mitigation strategies will only be effective if farmers are responsible for the way of raising their animals and thus in the future, uncertainties can still be expected and finding more practical and efficient ways of addressing these issues should always be a priority. Problems arising from various factors have a big impact on cattle breeding and should always be taken into consideration as they may also play a great role in addressing the key issues in animal breeding. Another issue in cattle breeding is how to sustain the desirable traits of the animal after breeding. This issue is relevant in intensive breeding and production as it can influence the farms' productivity and efficiency. With high intensification, the risk of breeding cattle susceptibility to diseases is also high which in turn can harm its breeding efficiency. Health is one of the most important factors to look into in animal breeding operations as it greatly affects the physiology of livestock animals. These concerns in livestock breeding, however, can be addressed and as time goes by, new development and technologies in the industry were made and paved the way for the improvement of the livestock industry.

Trends and prospects in cattle breeding

Through the years the livestock industry has faced a lot of challenges which gives rise to new solutions, technologies that are practical and can show promising results. In the past, simple crossbreeding is done to obtain a desirable trait for the preferred production (meat or dairy) as well as for the animal's adaptability to a certain environment (tropical or temperate) without jeopardizing its production potential. In animal breeding, it is always a priority to have a progeny that exhibits heterosis and within a short period, to select individuals with high breeding values for traits of interest as parents to produce the next generation (19). Modernization in animal breeding paves its way in determining the efficient solution in addressing animal breeding problems, producing more productive animals to lessen the use of resources in producing animal derived food products and in obtaining the said objective with the use of genetic tools. Genetic modification (GM) and genomics can be introduced as a expeditious solutions to various problems in the field of animal breeding and genetics (20). As defined by The European Food Safety Authority (EFSA), the animals' genetic modification involves alteration of its genetic material by adding, changing, or removing certain DNA sequences in a way that does not occur naturally. It aims to modify specific characteristics of an animal or introduce a new trait, such as disease resistance or enhanced growth (20,21). Bengtsson *et al.* (22) evaluated Nordic dairy cattle by looking into the data from virgin heifer genomically enhanced breeding values (GEBV) and parent average breeding values (PA) to predict future cow performance and they concluded that the said technology can be used effectively in the farmers' herd.

Aside from the female line the said technology also showed promising results in the sire line. Hutchison *et al*. (23); Mrode *et al*. (24) reported that in the USAgenomic selection improves the artificial insemination (AI) rates of activeyoung bull sires (Holstein and Jersey) from 28 and 25% of inseminations in 2007, increased to 51 and 52%, respectively in 2012. The progress in controlled genetic modifications of farm animals would not have been possible without the development and refinement of the various reproductive techniques including in vitro fertilization, in vitro cultivation of embryos, and cloning techniques (20). Embryo transfer technology in cattle has long been refined since 1951 and is an essential technology for efficient breeding today. Genetic modification is proven to be effective in addressing cattle breeding problems and can have a beneficial impact on the livestock industry. With the use of this technology, the time and the number of animals used in researches to produce proven progeny can be lessenedwhich can have a great impact on cattle producers as well as addressing ethical concerns. However, this technology has only been exploited in developed countries and some developing countries. The said technology is known but most developing countries have a small chance of practicing it as the cost of facilities and the technology's application is expensive. Thus, they continuously rely on the traditional way of animal breeding. The good thing is that there are non-profit organizations that can support these countries through research projects and thus opening an opportunity for exploitation. The progress in cattle breeding will continue as there is always a new issue that will arise in the years ahead and the quest for knowledge and solutions to uncertainties will be realized through research.

Problems in pig breeding

Pigs being the 3rd most-produced animal type in the world have always been exploited by researchers due to the impact of their meat in the market. A lot of people consume pork and the thing that's pulling its wide distribution in the market is the acceptance of its meat from various religions. The data from FAO (25) showed that in the year 2015 the per capita consumption of pork in the world and the developing countries were 15.3 and 12 kg, respectively. Although, the projections for 2030 shows varied trend on the per capita consumption of pork between the world (decreased, 15.1 kg) and the developing countries (increase, 12.2 kg). Still, it has the highest per capita consumption among the different meat that can be obtained from livestock animals. Thus, it is a fact that the said commodity will be on the list of the top priorities for continuous development in the livestock industry. With its global rise in production, problems always arise which concerns with the welfare and in its breeding. In developing countries, raising pigs intended for breeding following the animal welfare law is usually not being practiced, especially in intensively raise sows and boars. This is because most farmers in these countries do not have enough money to invest in advanced facilities as well as increase their space for the living comfort of the sows as this will increase their cost of production without any assurance of getting enough profit from the product they produce. Also, in times of disease outbreak such as ASF, many pig farmers experience a hugeloss and some do not get financial assistance from the government. Currently, the general response to prevent the spread of ASF particularly in developing countries is depopulation which greatly affects

the supply of pork in the market and leads to its price increase. In other cases, losses can also be experienced by farmers that raised pigs in a safe and uninfected area. As the price of live pig drastically drops due to the sudden change of consumers' preference in the fear of consuming pork and most middlemen take advantage of the situation creating a big problem for hog farmers, especially for small-scale or backyard farmers. With this, some farmers stop their operations as they felt that they have no assurance of getting back their investments, which is very sad because it can affect the availability of pork in the market.

Reproductive failure is a serious problem thatcan happen in gilts, sows, and boars. It can occur in all breeding farms and there can be a lot of causes that can lead to this problem. The said problem can be acknowledged when there is an observed significant decrease in the expected production and breeding performance of animals such as the low fertility rate of boars and sows as well as first service farrowing rates and litter size. In this case, a thorough investigation must be done in the breeding farm performance as the information obtained will serve as facts and a means to exploit possible solutions. Thus, it is very important to explore the possible causes of reproductive failure and to find ways to address it as it can be assured that upon its progress, the livestock breeding sector will get the benefits. In this case, management practices, nutrition, health, genetics, and environmental effects should be looked into. The genetic makeup of the animal is very important as it contributes about 30% of the animal's performance. In developing countries, the availability of improved breeding stocks is scarce as it is always expensive and is only available in commercial farms. However, due to the increase in competition in the pig market some companies sell semen for AI to small-scale farmers,and also government organizations made programs for the hybridization of stocks. But the concern is in tropical countries, most of these semen came from breeding stocks that are not well adapted to the said environmental condition and the expected performance of the progeny is usually not met. Climate change is also a big factor in pig breeding as these animals are sensitive to various changes in environmental temperature. When the ambient temperature exceeds the critical limit of boar and sows which is 25°C and 26°C, respectively (15), they will experience HS which can harm their reproduction. Studies have confirmed that HS compromises the fertility of sows by affecting their regular estrous cycle, conception rate, and farrowing rate. For animals to be bred they should be in a state of heat (estrus). Usually, when gilts and sows are exposed to high environmental temperature their body system is highly affected which can lead to anestrus (26). De Rensis *et al*. (27) said that anestrus is often experienced by sows during hot summer months where temperature rises above their thermal comfort which can lead to low ovulation rates and an increase in poorly timed insemination. HS harms the ovaries as it can inhibit the growth of follicles and deteriorateoocyte quality. Furthermore, it reduces inhibin levels by hastening the decrease in size of the first-wave dominant follicle and the emergence of the second dominant follicle (28). This could negatively influence the ovulation rate of the sow and can lead to a poor conception rate. HS can have a tremendous impact on pig breeding as pigs are more sensitive to heat compared to other livestock animals due to their relatively small lungs as compared to body size and inability to sweat. Thus, this is a very big concern in both tropical and temperate countries and a lot of researchers are putting their time and efforts to find the best solution which can be made available for all pig breeders and farmers. Environmental factors are always a big concern in livestock breeding even though this factor can

be controlled in livestock farming through the construction of tunnel ventilated housing, but in the concerns of having sustainable breeding and farming operations finding a sustainable way to mitigate the effects of climate changeis still the best and practical.

Trends and prospects in pig breeding

It is always a goal in pig breeding to produce a progeny with desirable traits (phenotypes) of interest and its exploration for improvement in a manner that is ethical, practical, and economical. Merks *et al.* (29) said that way back pig breeders aimed breeding goals according to the producers, processors, and consumers needs and have made remarkable genetic improvements in the trait of interest. However, satisfying the market needs and expectations of the consumers are becoming more challenging, which opens an avenue for additional traits and phenotypes to be included in the breeding goals. Phenotypes such as (a) vitality from birth to slaughter, (b) uniformity at different levels of production, (c) robustness, (d) welfare and health, and (e) phenotypes to reduce carbon footprintwithout jeopardizing production efficiency. He further stressed that advanced management, genomics, statistical models, and other technologies can provide opportunities for recording these phenotypes and can be of effective use for faster genetic improvement. Determining such goals about future challenges is vital for the improvement of the pig industry and thus being supported by new technologies to realize this aim is a significant breakthrough. With the improvement of vitality, there will be a higher rate of piglet survival during the prenatal period up to the finishing period and fewer sows to be culled after 1st parity. Improvement of uniformity can lead to better performance as it will guarantee ease in management and in providing the appropriate nutrition wherein no pig will be deficient. This can result in uniform growth and age at the required time of slaughter and gives more efficient utilization of dietary nutrients. The robustness of the pigs will improve their ability to adapt to various stressors, disease challenges, and extremes in temperatures (heat stress). Reduction of the carbon footprint of pork production can be realized by improvements in digestive efficiency and reductions in maintenance requirements which is a hot topic in nutrition and sustainability. Biotechnology plays a vital role in the development of pig breeding. Genetically modified pigs produced through cloning and genetic engineering (GE) show promising results in the selected desired traits and are believed to be effective in improving the efficiency of swine production as well as food quality, disease resistance, and environmental sustainability (30). GE of animals is a significant breakthrough in the livestock industry as it greatly contributes to the improvement of all food animals and without this technology, we will still be stuck on traditional breeding which can show a slower pace of results in genetic improvement. But there is always a question if the GE of animals is ethical as it can lead to uncertainties and a possible concern of animal welfare (31). As long as researchers and scientist that practice the said technology will not violate the ethics of animal use in science, which includes the principles of the three Rs; (a) reduction of animal numbers, (b) refinement of practices and husbandry to minimize pain and distress, and (c) replacement of animals with non-animal alternatives wherever possible (32), then it can be positively said that technology is ethical and is deemed necessary for the future of the livestock industry. The only thing that can jeopardize the said technology is when somebody abuses it and use it for personal gain rather than industrial gain.

Revista Ciencias Agropecuarias ISSNe 2422-3484 Volumen 7 No. 1 • 2021

Problems, prospects and trends in poultry breeding

With the continuous demand for poultry meat and egg worldwide, it is a fact that the said commodity has a very important role as one of the top animal protein sources. Various species of poultry render economic services to man (food), however, the most popular among the different species is chicken. In 2017, chickens accounted for 92% (23.2 million heads) of the world's poultry population and contributed 89% and 92% of the world's poultry meat and egg production, respectively (33). Ducks usually come in second followed by turkey in terms of production. With this, there is always an avenue for research and development for chickens, thus the said species will be given emphasis. Since the early 21st century, poultry meat and egg production from commercial flocks of broilers and layers has enormously increased with the help of genetic selection in the nucleus breeding flocks of breeding companies as well as genomics (34). Nowadays, through precise selection and breeding as well as genetic improvement layers can produce efficiently an average of more than 300 eggs per year and broilers can now grow at a very fast rate, reaching the recommended slaughter weight in only 28-35 days with a very good feed conversion ratio reducing the amount of feed consumed in their productive life thus reflecting a positive impact on the environment. Through the years, the introduction of these genetically improved lines of chicken helped in satisfying the demand for poultry meat and egg in the market. However, through the said technology some of the important traits are sacrificed such as the capacity of the hen for broodiness. Commercial-strain layer hens are not capable of natural reproduction, and their value in the village environment is thus quite limited. Another possibility that needs to be looked into is the danger that this breeding technology can reduce or even eliminate the indigenous breeds. In most developing countries, there are two parallel poultry industries: one using a high-performing commercial layer or broiler genotypes; and the other based on lower-performing, dual-purpose indigenous breeds (35). Most indigenous breeds cannot compete with high-performing commercial stocks in almost all of the production aspects. In raising indigenous chickens in developing countries like the Philippines, the period spent in feeding and rearing is very long (3 to 4 months) and only having an average weight of 1.2 kg. Despite its low productivity, many Filipino households still raise it in their backyard as this breed of chicken can survive with less feed and is a good forager. With the help of crossbreeding, the so-called improved type (dual-purpose, for meat and egg) is now being raised which shows the promising result and is gaining popularity in the market. But still, due to the high demand for meat and egg, the quantity of produce is always being prioritized and a lot of commercial farms are still investing in raising high-performing chickens. In 2019 the percentage of native and improved chicken raised in the Philippines is at its highest that comprised about 44.72% out of the 186.37 million birds, sadly as of January 2020, it dropped by 3.2% and on the other hand, there is an increase of 6.2% in the production of layer chickens (36). Looking at how the country's poultry industry responds to the consumers' needs it can greatly affect the genetic diversity of chickens. Then by looking into worldwide perspective it might be that the significant replacements of indigenous breeds with commercial strains of poultry could pose a great threat to poultry genetic resources. Table 3 summarizes the issues, concerns and prospects in livestock and poultry industry and rearing as well as the recent trends in breeding.

Table 3. **Summary of the issues, concerns and potential in livestock and poultry and breeding trends.**

Food animal	Issues and concerns	Prospects	Technological trends in breeding	Source
Beef and Dairy Cattle	Intensification and GHG emissions leading to climate change which is a major cause of HS which impair their reproductive and productive performance.	Increasing global demand for beef and dairy products. Solid international trade. High avenue for genetic improvement.	Genetic modification, genomics, in vitro fertilization, in vitro cultivation of embryos, cloning and embryo transfer.	(12-17, 20-24)
Pig	Setbacks of intensification such as animal welfare, disease outbreaks (ASF), and etc. Climate changes' induced HS which causes reproductive failure and jeopardise productivity.	Exploitation of genetic and production potential. Growing demand in the international market. Flexible to any kind of production system.	Genomics, cloning and genetic engineering.	(8, 15, 27, 29, 30)
Poultry	Vulnerable to climate change. Animal ethics in intensification and rapid production. Traits needed by the birds in the natural setting (broodiness) are sacrificed through genetic improvement as well as jeopardizing the indigenous chickens worldwide.	Projected to remain as the primary driver of meat production growth. Rapid improvements in genetics, animal health and feeding practices.	Genetic modification, genomics,	(8, 34,35)

GHG - greenhouse gasses, HS - heat stress

General perspective

Given the various challenges that the global livestock and poultry industry is facing, it is very important to find practical and sustainable solutions with consideration of the minimal risk of uncertainty in the future. The use of effective management tools and technological advances to optimize the performance of animals is a significant breakthrough in animal production. Moreover, incorporating the concept of sustainable breeding intensification and extensification could help increase the rate of production without any adverse effect in the environment and it can also prevent the conversion of additional non-agricultural lands as well as decreasing the depletion of natural resources by reducing the food nutrient loss through animals' excretion. In the European Union (EU) the concept of intensification and extensification is already in practice as the animal population in the EU is decreasing while the production of meat and milk remains high (37,38). This kind of approach is beneficial and is practical of which most of the developing countries like the Philippines are already starting to grasp this idea and areon the verge of development one step at a time.

Revista Ciencias Agropecuarias
ISSNe 2422-3484
Volumen 7 No. 1 • 2021

Conclusion

The livestock and poultry industry's progress are associated with the continuous global demand for animal protein. The increase in food animal population to satisfy such demand can have some drawbacks including conversion of farmlands and overutilization of natural resources which contributes to climate change. These then indirectly affect the animals' productive and reproductive performance leading to a poor supply of animal protein particularly in vulnerable countries (developing countries). Reproduction and rearing technologies, however, are an efficient tool to compensate for the said harmful effects of livestock and poultry production of which the developed countries have a full understanding of the system. Therefore, the full grasp of such technologies and their improvement can be a gateway to provide enough food for the next years to come and as there is a great deal of uncertainty in the future, a constant pursuit of effective measures should be a priority.

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Revista Ciencias Agropecuarias
ISSNe 2422-3484
Volumen 7 No. 1 • 2021

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