

Strategies for Increasing the Productivity of Goat Farming Business in the Era of Industry 4.0 in Banyumas District

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Abstract. The development of goat breeding business needs to be done so that the business can compete in the era of industrial 4.0. The study aims to formulate the strategy to increase productivity in goat breeding business on the 4.0 industry era. The study used survey methods. Determination of the sample was done using stratified random sampling that took the region based on high land, moderate and low land. Then, on each level was taken by criteria of number of goats and the dominant species. Number of sample was determined using Nomogram Harry King and the total respondents was 322 farmers. The analysis used was Causal Loop Diagram modeling and Qualitative Descriptive. The results show that to increase the productivity of goat breeders can be done with optimize Information and Communication Technology (ITC) in production factors, utilization management system application and the innovation of feed technology, optimize smartphone as promotion and trading tools, share the information via social media, supply of information service based on website or application and transformation of extension to virtual extension.

Keywords: Business productivity, causal loop diagram, strategy, industry 4.0

Abstrak. Pengembangan usaha peternakan kambing di Kabupaten Banyumas di era industri 4.0 perlu dilakukan agar usaha dapat bersaing dengan usaha lainnya yang berbasis teknologi informasi. Pemanfaatan informasi dari dunia maya dapat mempercepat diseminasi inovasi dan informasi yang sangat membantu peternak untuk mengembangkan kapasitas diri dalam mengelola usahanya. Penelitian bertujuan untuk merumuskan strategi peningkatan produktivitas usaha peternak kambing di era industri 4.0 dalam menjalankan usaha ternaknya. Penelitian dilakukan menggunakan metode survei. Penetapan sampel wilayah menggunakan *stratified random sampling* yaitu mengambil wilayah berdasarkan topografi dataran tinggi (>100 – 500 m dpl), sedang (>25 - 100 m dpl), dan rendah (0 – 25 m dpl). Masing-masing strata diambil 1 kecamatan secara purposive sampling dengan pertimbangan daerah tersebut memiliki populasi ternak kambing cukup tinggi. Pengambilan sampel responden menggunakan *nomograf harrying* dan responden berjumlah 322 peternak. Analisis yang digunakan adalah analisis deskriptif dan pemodelan *Causal Loop*. Hasil penelitian menunjukkan bahwa peningkatan produktivitas usaha peternakan kambing di era industri 4.0 dalam menjalankan usaha ternaknya dapat dilakukan dengan pendekatan *Information and Communication Technology* (ITC). Kegiatan pemberdayaan peternak dilakukan dengan transformasi penyuluhan ke arah *cyber extension*. Penyuluh juga perlu mendampingi peternak dalam pengadaan faktor-faktor produksi, promosi dan penjualan produk dengan penggunaan aplikasi *smartphone*

Kata Kunci: Produktivitas usaha, *causal loop diagram*, strategi, industri 4.0

Introduction

Goat is livestock with promising development in Banyumas District in which the climatic condition with an average temperature of 26.3°C is perfect for goat breeding. In addition, most people in Banyumas district earn their living from the agriculture sector, so the agricultural waste provides abundant sources of cattle feed. According to Saria et al. (2016), agricultural waste is a potential local feedstuff to support the development of cattle breeding in the agriculture-based area as an alternative to forage for ruminant cattle. The agricultural

waste includes corn hay, rice straw, peanut waste, and cassava leaves. From a cultural perspective, goat breeding is relatively easy to manage and disease-resistant (Marhaenyanto et al., 2019). The fast reproduction rate and high adaptability to different agroecosystem conditions in Indonesia are the reasons for rural society to rear goats.

For the community of Banyumas District, goat is one of the most common cattle commodities in the rural area despite the fluctuating populations. Data of Statistics of Banyumas District (BPS, 2020), the population of

goat breeding in Banyumas District from 2017 through 2020 was 248,489 head, 15,646 head, 175,835 head, and 166,101, respectively. This fluctuated number is because the local people regard goat breeding as either saving in kind or side business, so they have not implemented professional management. As a result, it brings implications to the under-optimized productivity of the goats, both the number of kids and body weight gain.

The optimal productivity of goat breeding can be achieved by good breeding quality and proper breeding management supported by knowledgeable human resources of the farmers. In the era of industry 4.0, knowledge can be accessed through smartphones at any time anywhere. The year 2016 is the beginning of the new industrial era so-called Industry 4.0. The changes have significantly impacted every sector from agriculture to industry, services, information, and social life. The penetration of Industry 4.0 into the agricultural sector is marked by the introduction of Smart Farming, Smart Green House, Autonomous Tractor, and Smart Irrigation. Industry 4.0 has brought multiple benefits that include accelerated production, improved services to customers, and increased income, despite the challenges (Prasetyo and Sutopo, 2018). The penetration of the new industrial era in the agricultural sector must be encountered with preparedness so that stakeholders involved in cattle breeding can compete and be the actors in Industry 4.0. accordingly, this present study conducted qualitative approaches to formulate strategies to improve cattle productivity through quality development of farmers as breeding managers, especially in the face of the Industry 4.0 era that has permeated every aspect of life. As cattle productivity improves, it will in turn increase farmers' income and welfare (Sumartono et al., 2016).

Some socio-economic factors contribute to the development of goat breeding in Banyumas

District. One of these factors is the farmers' preparedness as the manager of cattle breeding to face the changing information system. Farmers may use their background knowledge and business experience to base their decision making on strategic developments for their goat breeding. One of the strategies to develop cattle business in Banyumas District is the modeling approach, simple qualitative modeling to illustrate the complex business model of cattle breeding (Setianto et al., 2018). The qualitative approach allows the exploration of every element that contributes to the performance of goat breeding.

Materials and Methods

The target of this research was the goat farmers in Banyumas District. The area of sampling was determined using stratified random sampling, namely selecting the area based on its topography. Area topography is divided into three: high land (>100 – 500 m dpl), midland (>25 - 100 m dpl), and low land (0 – 25 m dpl). From each stratum, we used purposive sampling to select one sub-district which has a high population of goat breeding of Ettawah and Jawarandu strains. The sample respondents were selected using Harry King's Nomogram to account for a total of 322 respondents (Sugiyono, 2013). While the primary data were collected from interviews, observation, and focus group discussion (FGD), the secondary data were obtained from institutions related to the present study. The data were subjected to the model of the Causal Loop Diagram to analyze the correlation between the elements of goat breeding and to formulate the strategic alternatives for goat breeding business in the era of Industry 4.0. The Causal Loop Diagram was made using Vensim PLE software (Ventana Systems, Inc., MA, USA) in a method by a previous study (Ismoyowati et al., 2022; Setianto et al., 2014)

Results and Discussion

Causal Loop Diagram Modelling for Goat Breeding Business

Goat breeding business is a complex business that involves multiple elements. The use of Causal Loop Diagram illustrates these elements and their correlations (Figure 1). The unidirectional relation is illustrated with positive symbol (+), and the non-unidirectional or opposite relation is the negative symbol (-).

Identification of Archetypes System in the Causal Loop Diagram

Limit to Growth

Limit to growth explains that a business may experience growth or setback. Setback may occur to a growing activity because of one limitation that makes a business activity is slowing down. Limit to growth in this study was illustrated by the archetype of feed availability and income from cattle business.

Figure 2 explains that cattle size is positively correlated with production. The number of cattle owned by the farmers may increase the production (calving), which then increases the number of cattle. However, the increased number of cattle may decrease feed availability, especially forage. Consequently, farmers who do not have land to grow forage must look for the source of forage in their neighborhood. A limited supply of forage has forced these farmers to sell their calves, which leads to the stagnant number of cattle owned by farmers. In addition, the workforce in the goat breeding business is mostly only farmers and their wives. The husbands are responsible for collecting forage feed and the wives are tasked with cleaning the cage and helping with goat calving. This limited workforce has made farmers unable to provide sufficient forage feed if they have more goats.

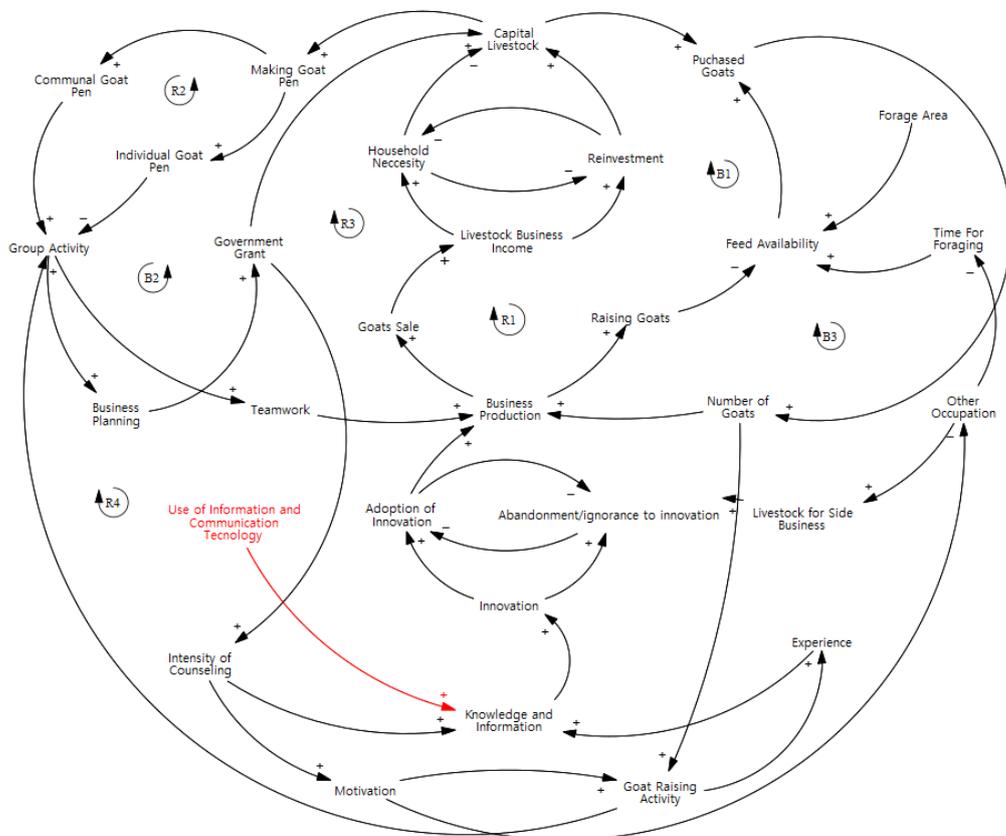


Figure 1 Causal Loop Diagram of Goat Breeding Business

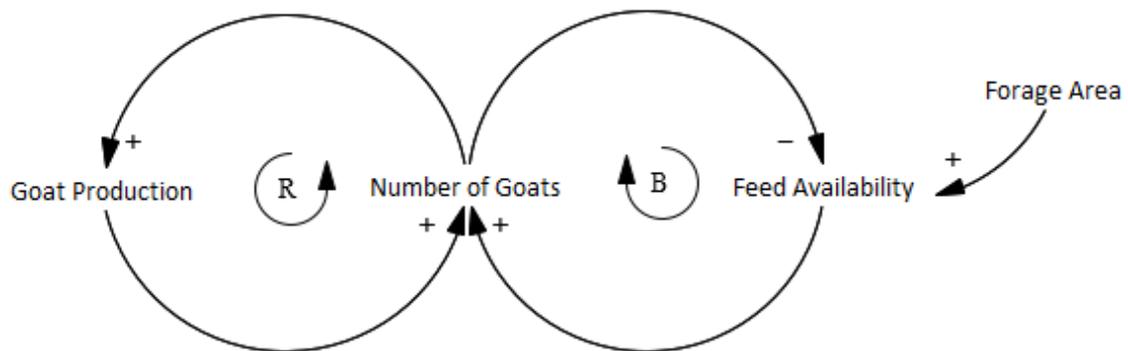


Figure 2 Availability of Archtype of Feed

The goat breeding business in Banyumas District is mostly a side business or saving in kind, and therefore, not profit-oriented. Nevertheless, it is undeniable that goat breeding has contributed to the household income of the farmers. According to Hutajulu and Tribudi (2019), goat breeding contributes around 31.4% – 39.9% to farmers' household income. It indicates that the more goats owned by farmers, the higher the family income. Figure 3 shows that goat breeding revenue is spent on household needs. Therefore, the higher the income allocation for investment (sale of goats), the higher opportunity for goat breeding income. In contrast, the higher the income allocation for household expenses, the lower the goat breeding income because farmers have no more funding allocation for purchasing goats.

Shifting the Burden

Shifting the Burden explains that problems can be solved with either short-term solutions or long-term solutions. The short-term solution is generally the easy alternative with a tangible result, so people will feel that it brings a positive impact. However, continual use of short-term solutions can make the long-term solution rarely used. Consequently, the problems can reoccur because the short-term solution only provides a temporary fix, and it needs long-term solutions

for a more permanent result. Shifting the burden in this study is illustrated by the other work of archetype. Figure 3 shows that every farmer desires to earn income which is made possible through improving the production of cattle breeding or performing other jobs. In general, farmers tend to prefer conducting other jobs from which they earn direct income because it takes time for goat breeding to produce revenue. In other words, the more time farmers spend doing other jobs, the fewer goats they have because they do not have enough time to manage their cattle. In fact, the declining number of cattle translates into lower cattle productivity that contributes to farmers' income from goat breeding. This has been the reason goat breeding remains a side business for farmers.

Figure 4 explains that feed is the main necessity for farmers. Farmers usually obtain cattle feed through a cut-and-carry system. Small land and small cattle size have made farmers choose not to dedicate specific land to grow forage plants. However, the longer farmers use the cut-and-carry, the more diminished their knowledge of feed and feed technology, which will decrease their skills in feed technology and their ability to adopt technology innovation for feed.

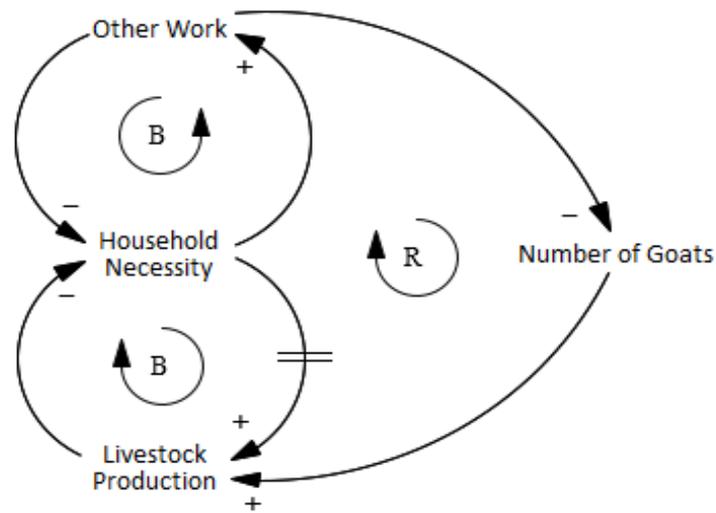


Figure 3 Archetype of other job

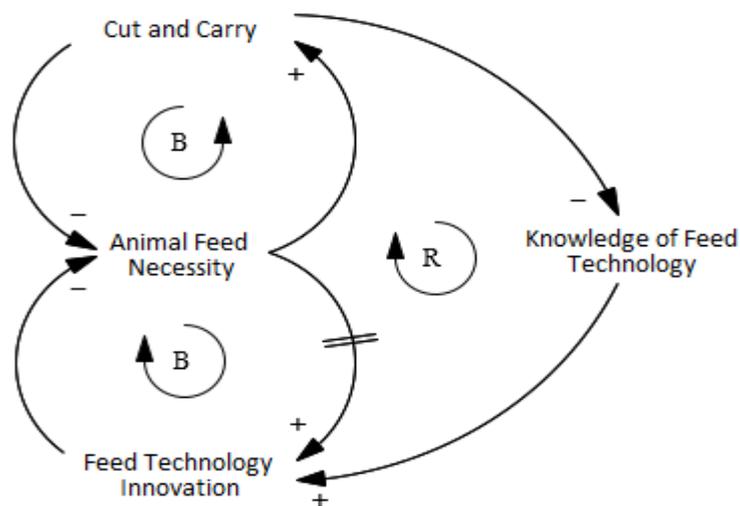


Figure 4 The archetype of feed necessity

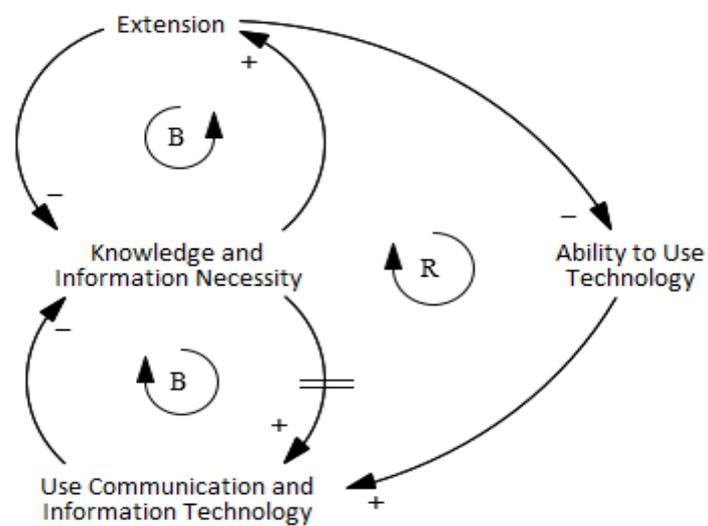


Figure 5. The archetype of the need for knowledge and information

Shifting the Burden to The Intervenor

Shifting the Burden to the intervenor is similar to shifting the burden by which providing a short-term, temporary solution that potentially decreases an individual's capacity to engage in a long-term solution. However, in Shifting the Burden to the intervenor, the short-term activities are performed by the external parties, so the internal parties lack practice in developing their capability which eventually costs them problem-solving ability. Shifting the Burden to the intervenor is illustrated by the archetype of the need for knowledge and information.

Figure 5 shows that farmers' need for knowledge and information can be met by extension programs provided by the extension agents. To date, farmers rely on extension agents as their source of knowledge and information; consequently, they only gain a little because the extension program is not regularly scheduled. In fact, the extension program is rarely conducted because of the limited number of agents involved in Banyumas District. In developing countries like Indonesia, the low frequency of extension services to farmers has affected the distribution of new technologies and problem-solving for farmers (Suratini et al, 2021). The extension acts as a bridge between researchers and farmers, connecting unidirectional processes of the latest developed technology, agricultural policies, and the utilization of technology by farmers (Margono & Sugimoto, 2011). The limited number of extension agents in Banyumas District can be overcome through the fast-developed use of online social media in this 4.0 era. Online social media (Google, Yahoo, Facebook, Twitter) has allowed easy access to information related to modern agriculture. Also, it provides an opportunity for both extension agents and farmers to access technical information or the economy in an instant and use them effectively and efficiently to decide (Destrian et al., 2018).

The extension agents teach the farmers how to use their smartphones to follow the extension program. Then, the agents will simply present extension messages (with demonstration) that are easy to understand by the farmers. However, the extension programs have not been incorporated into online social media, so the farmers cannot harness social media. As a result, farmers cannot utilize information technology to solve their problems related to the livestock business. To perform their duties in the field, agricultural extension agents need information on research findings related to the problems faced by their extension targets. Syam and Widjono in Kushartanti (2001) stated that agricultural information /technology and research findings should be relevant to issues faced by farmers. According to Mulyandari (2011), Dasli et al. (2015), and Elian et al. (2014), the contributing factors that drive the extension agents and farmers to utilize information which includes social media are age, formal education, income, ownership of information technology, motivation, behavior in utilizing information technology, types of training been undertaken, and involvement in the group.

Strategies to Improve Productivity of Goat Breeding Business Based on the Archetypes System

The Archetypes Systems in the Causal Loop Diagram allow observation of the problems in the goat breeding business, which include feed availability, the need for cattle feed, the revenue of cattle business, the purpose of goat breeding as farmers' saving that has driven the farmers to find other jobs, and farmers' limited knowledge and access to information. Accordingly, the recommended strategies based on the Archetypes System in the era of Industry 4.0 are as follows:

Strategies to overcome the need for and availability of feed

The open access to the information system in Industry 4.0 era provides both opportunities and

challenges to the husbandry sector in Indonesia. People who manage livestock businesses are forced to remain active in keeping up with the development of information technology, which includes information on feed. Feed availability and feed technology have been crucial issues in the livestock business because both are the determining factors in the sustainability of the livestock business. For this reason, farmers are obligated to be able to use the internet to obtain the information they need. The strategy to overcome problems in feed availability is by utilizing waste or by-products of agricultural business without competing with food ingredients for the community. A goat is a type of cattle that can consume different kinds of feedstuff. Goats' curiosity and their feeding habit that wants to try any kind of feed have allowed goats to many kinds of feedstuff, especially those with high fiber content. Therefore, farmers may provide feedstuff other than forage based on the available sources in their neighborhood. The provision of feedstuff without competing with human food is a form of actualizing sustainable bio-industrial agriculture in the era of Industry 4.0. Another effort to overcome feed availability is by utilizing the marginal land for planting quality forage feed or establishing partnerships with the Department of Forestry to grow forage plants under the teak trees.

Cattle feed in form of forage is easily obtained during the rainy season, but difficult during the dry season. Forage availability is one of the determining factors of the success of the ruminant cattle business to accelerate cattle growth and development (Rusdiana and Hutasoit, 2014). Efforts to address low availability of forage can be done through feed processing technology (silage). Hidayat (2014) stated that agricultural waste like tapioca residue, bran, and molasses can be incorporated into silage making. Cattle breeding in the future will need efficient, practical, and sufficient

infrastructure and feed. Making feeds with long shelf life can answer this problem.

Strategy to overcome issues related to cattle management pattern as side business and additional income

The recommended strategy to improve the breeding system to adopt a revenue-oriented approach is by empowering farmers to raise their awareness and increase their motivation. This mission is actualized by playing videos on YouTube about opportunities in the livestock business, partaking in internship or field trip programs, and forming or activating breeder institutions. The other effort is by engaging farmers' children in breeding activities. Young people who can use their smartphones are given guidance to help their parents look for the information they need. Human empowerment through extension programs not only provides knowledge and information but also assistance to farmers so that they want to and can change their behavior, one of which is through using smartphones as the media to find information.

Research findings reported by Permana (2020) stated that empowerment through extension and training programs by engaging in direct communication and interaction may significantly affect the improvement of the agricultural pattern. The improved cattle business is expected to make farmers switch from perceiving cattle breeding as merely side jobs to the main business with an economic orientation. The extension programs in the era of 4.0 must engage Information and Communication Technology (ICT) to embody cyber extension. It can be actualized by overcoming the limited number of extension agents and facilitating farmers' learning through improved infrastructure, materials, digital content, and information access. As a result, an efficient service of extension and an extended scope of empowerment will come true.

The Regulation of the Ministry of Agriculture (Deptan) No 273 of 2007 stipulated that the

function of the farmers' group is as the learning class, production unit, and space to build a partnership. The formation of a farmer group is directed at the creation of a farmer corporation. Farmer corporation aims at strengthening the business system of farmers from upstream to downstream, from production to marketing, to establish the pioneer of one-stop breeding development to face Industry 4.0. Corporations, knowledge dissemination, information, capital, and production facility are some efforts to develop livestock businesses. It is expected that farmer corporations can boost farmers' motivation so that they change their perspective of goat breeding from merely side business to main business. In addition, farmers can improve the quantity and quality of breeding production in a consistent and sustainable manner using information technology, improved synergy with different stakeholders, and efficiency of the supply chain system to the consumers in order to face the challenges in Industry 4.0.

Strategy to improve knowledge and information

The recommended strategies to improve farmers' knowledge and information are with information and technology infrastructure in form of smartphone or other gadgets that is connected to the internet and the provision of technology-based service provider of information and communication. The Internet is an innovation in the world of technology that becomes the starting point of industry transformation. Today, the internet has been a basic need of most societies because it allows people to connect to access knowledge and information. Meanwhile, information from the printed media has rarely been outreaching to farmers because they can easily find it on the internet (Mulatmi *et al.*, 2016). Accordingly, farmers must have a gadget that is connected to the internet to get easier access to information that helps them in the production and marketing process.

The government must provide information and communication services to allow dissemination to the community and farmers. In era 4.0, all things must run quickly and effectively with the help of information technology (IT). Public services provided through the website or applications from the government can be the source of fast, correct, and accurate information, thus assisting farmers to obtain information for their livestock business. Information technologies play a crucial role in developing goat-sheep breeding because they help farmers access their communications, information, and decision-making (Muhlisin *et al.*, 2015). Although it does not guarantee that all farmers can access the technology due to their limitations, the technology-based services for cattle breeding allow much ease of business to farmers who can access the information.

Findings in the field showed that many farmers are not familiar with the internet and its facilities, and therefore, farmers need an extension program to introduce the internet to them and how to access all facilities offered by the internet.

Strategi to Improve Productivity of Goat Breeding Business in the Era of Industry 4.0

Industry 4.0 has significantly impacted many sectors, including cattle breeding. The cattle breeding sector in the future is expected to develop cattle production more efficiently and sustainably with technology and information. According to Soeparno *et al.* (2020), the concept of agriculture in the era of 4.0 is known as smart farming, which refers to the concept of agricultural management using modern technology to improve the quality and quantity of agricultural products. Smart farming has a tangible potential to produce more productive and sustainable agricultural products through a

proper approach and efficient utilization of resources.

Some developed countries have implemented 4.0-based agriculture due to the developed science and modern technology. Meanwhile, cattle breeding in Indonesia is still dominated by small-scale breeding. Therefore, developing cattle breeding 4.0 must be oriented towards developing small-scale livestock businesses. One of the efforts to enable small-scale breeding to survive in industry 4.0 is area clustering based on specific livestock commodities (Soeparno *et al.*, 2020). Accordingly, the development of the goat breeding industry in the era of industry 4.0 must focus on developing a particular typology based on the regional potency and the characteristics of livestock business in the rural area.

Goat farming businesses with different typologies in different areas must use advanced technology in their business in the era of industry 4.0. Information and Communication Technology must be implemented in the procurement of production factors (upstream), production process (on-farm), and marketing livestock production (downstream). Some technologies that can be applied are communication technology, feed processing technology, and the internet. The use of these technologies may increase the efficiency and quality of production and support business sustainability.

The recommended strategies in the upstream sector (input) of goat business in the era of Industry 4.0 are, 1) provide production factors (calves, female cattle, feed, capital) by utilizing information technology to expand the business network, and 2) improve partnership with different partners to achieve availability of materials for production and livestock breed. Communication technology allows farmers to extend their partner network in order to streamline and expand their business. The availability of raw materials for production is one

of the pillars of sustainable livestock business in the era of Industry 4.0.

The recommended strategies in the production sector of goat breeding business in the era of industry 4.0 are 1) the use of management system and 2) innovation in feed technology. Business production in 4. Era must be sustainable and secure the quality and quantity. Accordingly, it takes innovation in feed technology so that livestock business may survive any seasons, especially dry season. Therefore, farmers must utilize different applications for management system to input the data so that they have the production record which makes their business easy to control. Additionally, considering the old age and low-level of education of the first generation of farmers, the second generation, or farmers' children should assist their parents in running their livestock business.

The recommended strategies in the production sector of goat breeding business in the era of industry 4.0 are 1) the use of a management system and 2) innovation in feed technology. Business production in 4. Era must be sustainable and secure the quality and quantity. Accordingly, it takes innovation in feed technology so that livestock business may survive any season, especially the dry season. Therefore, farmers must utilize different applications for the management system to input the data so that they have the production record which makes their business easy to control. Additionally, considering the old age and low level of education of the first generation of farmers, the second generation, or farmers' children should assist their parents in running their livestock business.

The recommended strategies in the downstream sector (output) of goat breeding in the industry of 4.0 are 1) processing of livestock production technology and 2) utilizing smartphones for marketing. Farmers can cooperate with business partners to create livestock products that have undergone the

processing stage in order to increase the selling power of the product. Several processed livestock products are frozen meat, goat milk in packages, kefir, beauty products such as goat milk face masks, beauty soap, and others, which are the alternative business that farmers may consider. Farmers need to use communication technology in form of smartphones as a means of promotion through social media or e-commerce applications. In this way, smartphones enable farmers to shortcut the long supply chain and make their products reachable to consumers and extend their marketing network to many areas.

The development of farmer resources in the era of 4.0 can be done through 1) dissemination of information through social media, 2) provision of website- or application-based services, and 3) digitalized extension (cyber extension). Social media can be utilized by farmers by joining a certain chat group that allows them to receive information disseminated within the groups about goat breeding. The government or private sectors must also facilitate the dissemination of information by providing applications or websites related to goat farming. Also, as the frontline of the agriculture sector, the extension agents need to transform in establishing digital extension systems. Farmers' lack of understanding and utilization of the internet has forced the extension agent to socialize the ease and benefits of the internet to access information. Then, to enable effective and well-managed extension programs, it takes a development towards cyber extension, namely extension that involves a technology network that includes hardware, software, and data.

Conclusions

Improving the productivity of goat breeding business in the era of Industry 4.0 can be done through the utilization of Information and Communication Technology (ITC) in the provision of production factors, the use of applications for management systems and

innovation of feed technology, the use of smartphones for product promotion and selling, dissemination of information through social media, provision of information services based on website or application, and transformation towards cyber extension.

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