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THE WISDOM OF USING INSECTS AS ANIMAL FEED ON DECREASING COMPETITION WITH HUMAN FOOD

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Abstract

This article presents a brief study on a wisdom of using insects in animal livestock especially as animal feed to reduce competition with human need. The aim of the study is to find out the recent situation of development conditions using insects as animal feed in relation to human food supply. The method used is a comparative study using primary and secondary data from various sources. The growth in the human population in many countries is relatively very fast, which means an increasing in human food needs. This increase in needs is absolutely necessary, followed by efforts to increase food production. On the other hand, the expected increasing in human population from 6.9 billion in mid-2011 to 9.3 billion in 2050 requires various breakthroughs in preparing sufficient food. The use of insects as animal feed is not functioning only as an alternative feed but is an option that could contribute to decreasing competition of food need in relation with human population numbers in the world that are raised in various parts of the world today. Livestock business like this is not only oriented to business but on efforts to build and have insight into the environment. The conclusion is that the development of good insect cultivation needs to be developed even with simple methods to be applied in farms today by considering environmental management aspects.

Key words*: insect, animal feed, human, competition.*

INTRODUCTION

The use of insects for livestock is progressing as appeared in various countries today. In line with these changes, this use for livestock activities is mainly related to benefits as animal feed, besides that it is also convenient as immunogen as well as bio-degradation agents for livestock waste.

The beneficial insect species have begun to be used as alternative feeds (Toar et al., 2018) and were proven to improve livestock production performance, for example by using maggot from various species ofDiptera Order such as *Hermetia illucens* and *Musca domestica* (Sogbesan et al*.,* 2006; Veldkamp et al*.,* 2012) and the Order Coleoptera for example *Rhynchophorus phoenicis* f. from the family Curculionidae (Omotoso and Adedire, 2007).

The content of nutrients, especially protein, makes this alternative feed material attract an attention in the world of animal husbandry. Another reason of this resource is not commonly used as a human food source, even its utilization in livestock will reduce the use of feed ingredients which are also human food ingredients such as corn, soybeans, fish and so on. The policy of applying insects as food in Europe has progressed. Fernandez (2016) states that: "recent changes to European regulations may be a sign that insect protein will soon be entering the animal feed market". This policy could be considered as entry point for insect rearing to fulfil the need of protein insect as animal feed in Europe and as its consequence is to minimize the use the feed raw material as human food.

MATERIALS AND METHODS

A comparative study approach by using primary and secondary data from various literature sources was used to review the current conditions for application of insect cultivation in livestock development, which affected an impact on reducing the use of

animal feed ingredients that competed with human food needs.

RESULTS AND DISCUSSIONS

Global challenges in improving the quality and quantity of livestock production to meet world food needs, especially in Asia and Africa (Van Huis A, 2013) moreover the consumption of livestock products will increase up to 70%. The use of insects for livestock can be one of the keys to the development of food from animal products in terms of nutrition and fodder (Stammer, 2105), health livestock (Rumokoy et al., 2015).

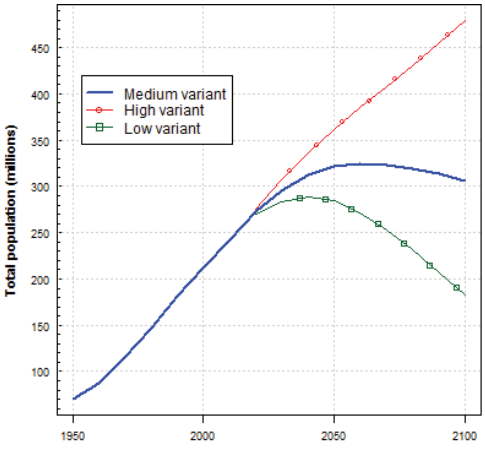

Figure 1. The population in Indonesia.
Sources: World Population Prospect in Indonesia (United Nation, 2017)

Population growth in many countries continues to grow strongly, for example in Indonesia. As shown in Chart 1 in 2019, it reached 260 million, an increase of about 40 million over 2000, but less than 220 million. Even though Indonesia is an agrarian country, to meet national food needs, it is necessary to import foods such as rice from abroad (Rahayu, 2018), even if national food security experiences positive changes (Tarigan, 2018). In a situation where a country still has a poverty rate whose number cannot be ignored, various policies must be applied to anticipate food problems.

The important effort in reducing hunger and malnutrition could be realized by promoting food production. The graph in Figure 2 shows that the population in China has been estimated to reach around 1.4 billion habitants in 2018 according to the United State (2017) followed by various strategies and policies to meet their food needs following the development of the population which tends to increase, among others develop livestock activities and production as reported by McMillan (2018).

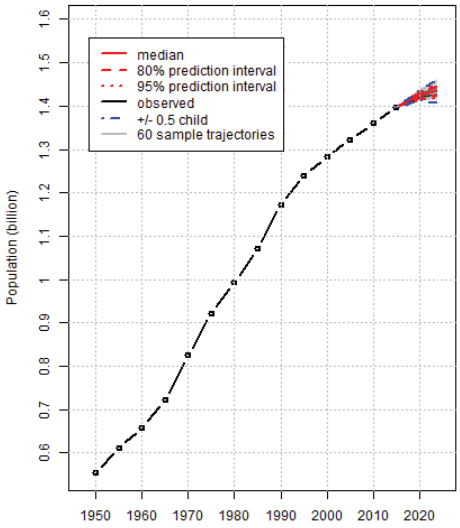

Figure 2. The Total Population in Chine.
Sources: United Nation (2017)

Other sources stated that medium variant of the 2010 Revision of World Population Prospects, the world population was expected to increase from 6.9 billion in mid-2011 to 9.3 billion in 2050 and to reach 10.1 billion by 2100 (United Nation, 2011).

The use of insects as an alternative food contributes to replacing conventional ingredients, thus minimizing the use of food products as livestock feed, such as types of cereals for example maize, rice, wheat and sorghum.

In addition, fishmeal, which is used as the main source of protein for animal feed, can be replaced by insect meal proteins.

The Altech Global Feed Survey, released in January 2017reported that world feed production for the first time exceeded one billion tonnes.

These numbers are related to the number of animals raised. The larger the human population, the greater the number of animal livestock to meet the food consumption needs of these farms.

Table 1. Livestock Slaughtered Number in Indonesia

Livestock	2013	2014	2015	2016	2017
Beef cattle	1.326.395	1.088.140	1.207.170	1.163.459	1.114.748
Buffalos	41 974	36 145	34 960	37 797	32 909
Horses	3 368	3 358	3 292	3 162	3 094
Goats	274 943	211 590	212 589	186 628	193 649
Sheep	142 736	93 578	99 987	93 342	107 704
Pigs	538 101	458 153	474 277	546 650	518 602

Source: BPS (2018)

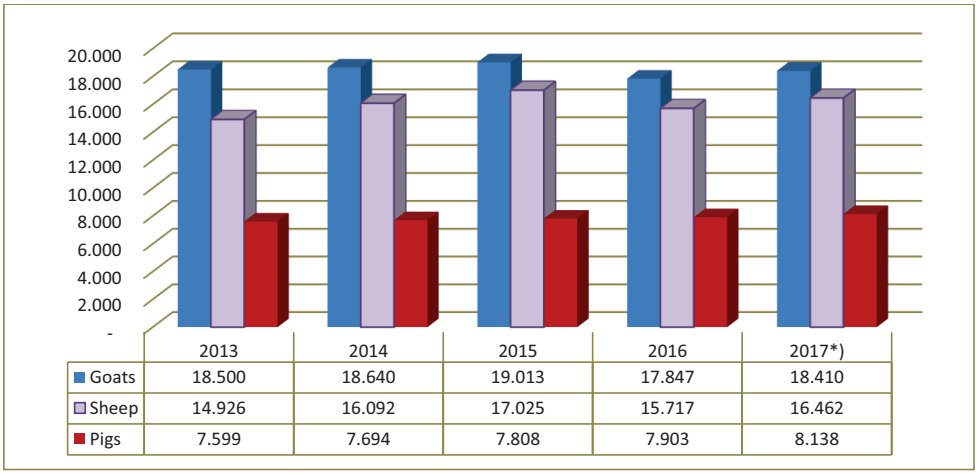

Figure 3. Population of Small Livestock (x 1,000 heads) in Indonesia.
Source: Direktorat Jenderal Peternakan dan Kesehatan Hewan (2017)

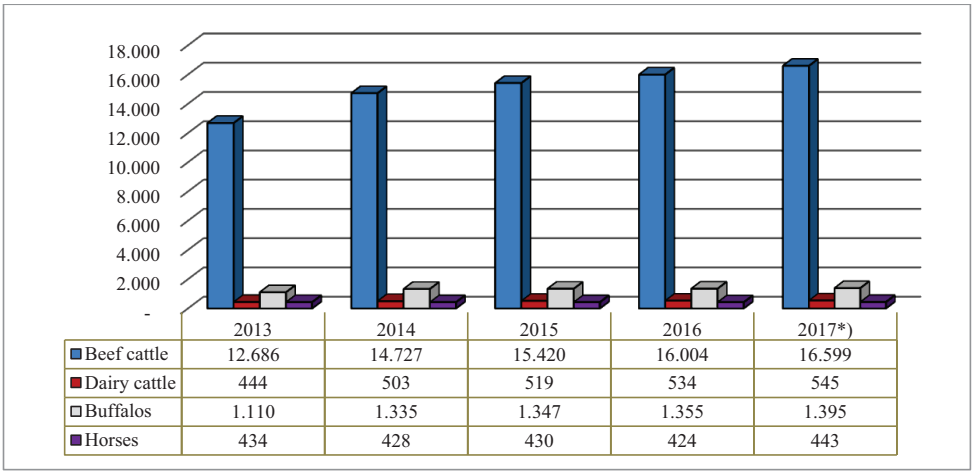

Figure 4. Population of Large Livestock (x 1,000 heads) in Indonesia.
Source: DirektoratJenderalPeternakandanKesehatanHewan (2017)

Insect rearing technology can produce high-quality alternative feeds to eliminate some feed ingredients that compete with human food needs (Rumokoy et al., 2018), for example by utilizing various types of insects: black soldier fly *(Hermetia illucens),* common house cricket *(Acheta domesticus)*, field cricket *(Gryllus bimaculatus),* bamboo caterpillar *(Omphisafus*

cidenttalis) pupae silkworm *(Bombyx mori),* Palm weevil larvae (*Rhynchophorus ferrugineus),* South American palm weevil *(Rhynchophorus palmarum),* Oriental migratory locust *(Locusta migratoria)*, house fly *(Musca domestica)* and termites *(Isoptera).* Furthermore, van Huis (2013) reported various insect orders that can be used as animal feed as shown in figure 5 below.

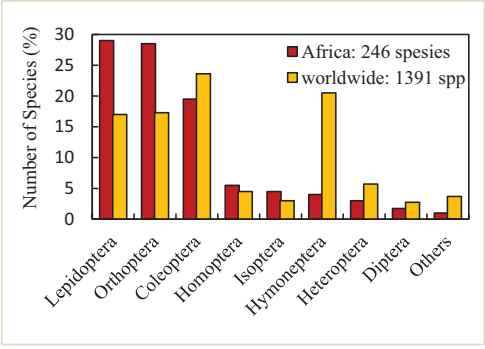

Figure 5. Several insects orde which are potential to be used as alternative feed. Source: van Huis (2003)

A promising prospect in the use of insects because it is easy to breed to be cultivated with relatively low prices can be carried out in larger quantities to be used as animal feed. In various African countries are known as edible insects for animal feed (Ayieko et al., 2010; Hanboonsong et al., 2013).

Various results of research have proven that maggot meal has a significant influence on weight gain and broiler feed conversion value. Insect larvae cycles as animal feed should be carried out at the moment when accumulated insect biomass and metabolic regulation are in the highest range to obtain maximum nutritional benefits, for example those sourced from BSF (Liu et al*.,* 2017). The use of insect larvae for organic livestock can be given fresh to poultry and in the form of flour. The role of the entomology field in alternative feed aspects becomes more complete if accompanied by the development and application of rearing technology in producing larvae or maggots ranging from small scale to large scale.

The results of insect cultivation development studies involve the rearing process to produce quality and continuously available maggots for livestock (Hussein et al*.,* 2017) have raised a business of black soldier fly *(Hermetia illucens)* to large-scale insects in various countries. This BSF cultivation does not require special facilities that are expensive, moreover the organic waste that exists in the livestock environment or from household kitchen waste can be converted into a BSF mass.

The role of insects is not just to be used as animal feed but has other advantages: as decomposers in livestock in relation to livestock waste management. The ability of BSF *(H. illucens)* to degrade livestock waste organic matter can overcome the problem of pollution generated from these wastes (Nguyen et al*.,* 2015).Other insects that can be used as decomposers for livestock waste, for example, are various species from the families of Scarabaeidae, Geotrupidae, Hydrophilidae, Histeridae (Pimsler, 2007) and Calliphoridae namely *Chrysomya megacephala* (Mendonça et al*.,* 2009). Wang et al. (2018) reported that *C. megacephala* fly larvae can significantly reduce the population of pathogen bacteria in the cow manure while being able to degrade and to reduce methane (CH_4) emissions and dinitrogen monoxide (N_2O) from manure.

A big challenge in animal husbandry is facing potential parasitic infections (Rumokoy et al., 2018b), as well as pathogenic microbes originating from the environment when insects can enhance the immune system in livestock (Rumokoy and Toar, 2015). The use of manufacturing antibiotic substances growth promoters in livestock is not allowed anymore because various considerations, especially the potential of microbial resistance even though antibiotics at GP level give a positive response to growth.

The livestock which born in hypo-gammaglobulinemia conditions are at high risk of passive immunoglobulin transfer or FTP (passive failure of transfer) failure, and become complex when they have to be exposed to pathogenic micro-organisms in the environment that can result in death (Rumokoy and Toar, 2014). In a situation like this another alternative is needed in an effort to minimize the risk. The function of immunogens substances derived from insects in enhancing animal immunity becomes a great force to minimize the economic loss risk in the development of organic livestock production.

CONCLUSIONS

The development of the human population in the world has increased so sharply that it requires various efforts to fulfil the food supply in accordance with its population. The policy of using insects as animal feed can contribute to this effort.

Other benefits of insects as well as slag feed, can be used to improve the livestock immunity system and environmental management of livestock.

It is wise to promote the use of insects as natural resources for animal feed in supporting sufficient food supplies to face a very rapid increase in the human population.

REFERENCES

Alltech (2017). *World feed production exceeds 1 billion metric tons according to 2017 Alltech Global Feed Survey*. Press Releases. https://www.alltech.com/press-release/world-feed-production-exceeds-1-billion-metric-tons-according-2017-alltech-global.

Ayieko, M.A., Ndong'a, M.F.O., Tamale, A. (2010). Climate change and the abundance of edible insects in the Lake Victoria Region. *Journal of Cell and Animal Biology*, 4(7), 112-118.

BPS (Badan Pusat Statistik) (2018). Data Peternakan 2000 - 2017. Retrieved 20 December 2018. *https://www.bps.go.id/*

Direktorat Jenderal Peternakan dan Kesehatan Hewan (2017). Livestock and Animal Health. *http://ditjenpkh.pertanian.go.id.* Retrieved 20 September 2018.

Fernandez, L. (2016). Insect protein for animal feed considered in EU. Wattagent. *https://www.wattagnet.com/articles/25457-insect-protein-for-animal-feed-considered-in-eu.*

Ghose, B. (2014). Food security and food self-sufficiency in China: from past to 2050. *Food and Energy Security*, 3(2), 86-95.

Hanboonsong, Y., Jamjanya, T., Durst, P. (2013). Six-legged Livestock: Edible Insect Farming, Collecting and Marketing in Thailand. FAO, Bangkok. *http://www.fao.org/3/a-i3246e.pdf.*

Hussein, M., Pillai, V.V., Goddard, J.M., Park, H.G., Kothapalli, K.S., Ross, D.A., Ketterings, Q.M., Brenna, J.T., Milstein, M.B., Marquis, H.,. Johnson, P.A., Nyrop, J.P., Selvaraj, V. (2017). Sustainable production of housefly (*Musca domestica*) larvae as a protein-rich feed ingredient by utilizing cattle manure. *DOI:10.1371/journal.pone.0171708.*

Liu, X., Chen, X., Wang, H., Yang, Q., urRehman, K., Li, W., Cai, M., Qing, Li, Mazza, L., Zhang, J., Yu, Z., Zhen, L. (2017). Dynamic changes of nutrient composition throughout the entire life cycle of black soldier fly. *https://doi.org/10.1371/journal.pone.0182601.*

Mendonça, P.M., Queiroz, M.M.C., Almedia, M.J. (2009). Rearing *Chrysomya megacephala* on artificial diets composed of varying concentrations of albumin. *J. Braz. Archive Biol Tech*., 52(2), 421 – 426.

McMillan, T. (2018). How China Plans to Feed 1.4 Billion Growing Appetites. *Magazin (National Geographic)*. https://www.nationalgeographic.com/magazine/2018/02/feeding-china-growing-appetite-food-industry-agriculture. Retrieved 10 February 2019.

Nguyen, T.T., Tomberlin, J.K., Vanlaerhoven, S. (2015). Ability of Black Soldier Fly (Diptera: Stratiomyidae) Larvae to Recycle Food Waste. *Environ Entomol*., 44(2), 406-10. doi: 10.1093/ee/nvv002.

Omotoso, O.T., Adedire, C.O. (2007). Nutrient composition, mineral content and the solubility of the proteins of palm weevil, *Rhynchophorus phoenicis* f. (Coleoptera: Curculionidae). *J Zhejiang UnivSci B*., 8(5), 318–322.

Pimsler, M.L. (2007). *A survey of the dung beetles in cattle manure on pastures of an organic and a conventional dairy farm in New York state*. Thesis. College of Agriculture and Life Sciences, Department of Entomology of Cornell University.

Rahayu, Y.A. (2018). Ironis, pemenuhan kebutuhan pangan Indonesia dipenuhidari impor. *Merdeka.* https://www.merdeka.com/uang/ironis-pemenuhan-kebutuhan-pangan-indonesia-dipenuhi-dari-impor.html. Retrieved 9 February 2019.

Rumokoy, L., Toar, W. (2014). The equine colostrum of milk treatment against pathogen agent. *Scientific Paper. Series D. Animal Sci.*, 58, 174-177.

Rumokoy, L., Toar, W.L. (2015). The Paradox of Nutrient Fulfillment and Immunity Challenge on Chicken Livestock Development in Tropical Humid Regions. *Agriculture and Agricultural Science Procedia*, 6, 259 – 264.

Rumokoy, L.J.M., Najoan, M., Nangoy, M.J., Manangkot, H., Assa, G.J.V., Toar, W.L. (2018a). Quantitative assessment of S. calcitrans infestation in cows suffered skin defects, grazed on two pasture types. *Scientific Papers. Animal Science. Series: Lucrări Ştiinţifice – Seria Zootehnie*, 70(23), 120 – 125.

Rumokoy, L., Posangi, J., Toar, W.L., Lopez-Aban, J. (2018b). An expectation of bio resources function against parasite infection on animal health. *Scientific Papers. Series D. Animal Science*, LXI(1), 216 - 219.

Stamer, A. (2015). Insect proteins-a new source for animal feed: The use of insect larvae to recycle food waste in high-quality protein for livestock and aquaculture feeds is held back largely owing to regulatory hurdles. *EMBO Rep*., 16(6), 676-80.

Tarigan, E. (2018). Ketahanan Pangan Indonesia Semakin Kokoh. *RMOL*. https://www.rmol.co/read/2018/11/17/366673/Ketahanan-Pangan-Indonesia-Semakin-Kokoh-. Retrieved 9 February 2019.

Toar, W.L., Tulung, M., Memah, V., Pudjihastuti, E., Rumokoy, L., Untu, I.M. (2018). The presence insects in animal farm in North Sulawesi. *Scientific Papers.Series D. Animal Science*, LXI(1), 220-224. http://animalsciencejournal.usamv.ro/pdf/2018/issue_1/Art39.pdf.

Toar, W.L., Warouw, J., Tulung, M., Najoan, M., Rumokoy, L. (2013). The Landing Periodicity of *Stomoxyscalcitrans* in rations, supplemented with citronella and papain on broiler health. *Lucrări Științifice Universitatea de Științe Agricole și Medicină Veterinară, Seria Zootehnie*, 59, 325-328.

United Nation (2011). Population Facts. Department of Economic and Social Affairs. 2011/2. http://www.un.org/en/development/desa/news/population/2015-report.html. Retrieved 09 December 2018.

vanHuis, A. (2003). Insects as food in sub-Saharan Africa. *Insect Science and its Application*, July–September, 23(3), 163–185.

Wang, X., Wang, W., Gao, Q., Wang, X., Lei, C., Zhu, F. (2018). *Chrysomya megacephala* larvae feeding favourably influences manure microbiome, heavy metal stability and greenhouse gas emissions. *Microb. Biotechnol*., 11(3), 498-509.