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DESIGNING LIVESTOCK PRODUCTION SYSTEMS THROUGH ENHANCED UTILIZATION OF LOCAL RESOURCES

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Summary

Efforts in agricultural development need priority setting and the direction for research and development in animal science concerning the use of locally available resources. Moreover, it should be within the context of prevailing limited land resources and poverty. Subsistence animal production systems with reference to limited land resource and feed availability open many opportunities for interventions of technology to increase animal productivity. Various crop-livestock production systems (CLS) apparently are good alternative approaches to meet food security, in which by-products and crop residues are utilized for animal production. Within the system, nutrient recycling in conjunction with effective utilization of processed manure and wasted feed as organic fertilizers for crop production was expected to maintain and/or preserve crop productivity and ultimately save the global environment.

Introduction

There is no doubt that the demand for food, including livestock products will increase along with the increase in human population; hence, more attention should be paid to facilitate small farmers that dominate the agricultural production supply. As in general case in developing countries, there are great movements in land use (for estate and industrial purposes) and land ownership that include fertile agricultural land, and consequently big agribusiness enterprises are mostly run by non-farmers. The traditional farmers often serve as farm labor of big agricultural enterprises, others look for off farm jobs in urban areas to gain income and this situation occurred in Indonesia (Husodo, 1999).

The poverty level in Indonesia is high (12%), while land ownership per farm household is relatively small (average 0.25 ha). Therefore, the vision of AARD (2002) is proactive and participative in creating competitive technology, community-based, sustainable and decentralized agribusiness system.

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Potential of Livestock Production

Rice is the staple food for Indonesians. In comparing the contribution of food crop, estate crop and livestock production to Gross Domestic Product (GDP - %) in Indonesia, livestock contribution has increased from 5.8% in 1970 to 12.6% in 2000, while food crop and estate crop contribution decreased from 61.3 to 50.7% and from 17.2 to 16.0%, respectively (Table 1).

Table 1. Proportion of Gross Domestic Products (GDP, %) of agriculture products in Indonesia over 1970-2000

Sub-sector	1970	1980	1990	2000
1. Food crops	61.3	60.7	60.6	50.7
2. Estate crops	17.2	18.8	16.7	16.0
3. Livestock	5.8	6.1	10.4	12.6
4. Fisheries	9.3	5.4	7.8	13.9
5. Forestry	6.4	9.0	4.5	6.9
% Agriculture.	41.2	30.7	15.4	16.9
% Man power	66.4	54.8	53.9	45.6

Source: DGLS (2002).

The consumption of animal products (meat and eggs) from 1995 to 2000 has decreased significantly with the monetary crisis (Table 2). Broiler, beef, mutton, pork and meat of other animal species have contributed to the supply of meat, while layers, native chicken and ducks mainly supply that of eggs. It is apparent that poultry products significantly contribute to the supply of animal protein for human consumption.

Domestic beef production has never met the national demand for meat, so that import of feeder cattle and meat has been in operation since late 1980's to balance the increasing domestic demand. It is known that Indonesia has experienced being a live cattle-exporting country from the 70's to late 80's when the rate of increase in demand for beef became faster and could not be reached by domestic production. The increased demand for beef has given a high pressure to the national existing stock and reduced off-take rates; therefore, import of either fresh or frozen meat (with or without bone) has become the only alternative to satisfy the national consumption. In contrast, export of broiler is increased each year, starting from 0.3 tons in 1991 to 703.8 tons in 2000 with trade values of US$ 8700 to US$ 1,298,500 respectively (Statistical Book, 2001).

Milk production meets only 35% of the national demand; hence the rest has to rely on imported milk. The Government of Indonesia has placed various regulations

for the dairy industry, such as import ratio, import tariff, import licensing and restrictions; however, with the latest Presidential Instruction (Inpres No.4/1998) in response to the 50 items commitment with IMF, all the regulations have been lifted out.

National egg consumption has been met by domestic production since 1980's, which indicates its potential for export. Export of eggs could be considered small and negligible, which started in 1996 with only 60 kg of eggs and jumped to almost 6 tons of eggs in the year of 2000. This was a good sign, however, that Indonesia has the potential to export chicken eggs, much better than the situation before 1984 during which Indonesia was a net importer of chicken eggs. At present chicken consumption and production has reached a higher level of the peak consumption and production level before crisis; while the total import of beef cattle is almost at the same level as that in 1996.

The global tendency of decreasing agricultural land area per capita has led livestock as an important asset for the poor in the developing countries as this is supplementary to a relatively low total income obtained from food crop production under limited agricultural land area. Therefore, livestock farming has become an important component for the agricultural sector, in which it has significant contribution to the family income (Haryanto et al., 1999). Livestock is raised by farmers but generally as an effort to avoid risk against crop failure and cash income especially for rural people, savings and other social status and its function such as in the religion ceremonial, food and nutritional security, drought power, transport and manure.

The slow population growth of livestock especially beef cattle tends to limit consumption of food from livestock products. Due to dramatic increases in price of livestock products with the increasing demand and limited supply, farmers are motivated to sell their animals including productive cows (DGLS, 2002).

Table 2. Meat, eggs and milk consumption in Indonesia 1970-2000 (thousand tons)

Year	Chicken meat	Total meat	Eggs	Milk
1970	40.0	321.5	29.4	209.4
1975	76.7	430.4	64.2	294.0
1980	151.9	552.9	189.0	597.3
1985	313.9	811.5	321.6	578.9
1990	511.5	1,036.6	412.5	696.5
1995	881.8	1,566,6	645.5	1,131.9
2000	753.1	1,419.7	629.7	1,233.2
Growth rate (%)	3.90	3.20	4.32	5.88

Source: DGLS (1998, 2002).

Livestock Production in Indonesia

Livestock population trend in Indonesia (Table 3) indicates a slow increase of dairy and beef cattle population with the low productivity. Moreover, the present state of the livestock sub-sector in Indonesia at monetary crisis condition is far from being satisfactory. However, this should not discourage further development efforts, as it is the most potential farming that affects directly the well being of the people. The majority of cattle are generally raised in small numbers (1-3 heads/farm-household) and widely distributed all over Indonesia. While those rose under feedlot systems for fattening are kept in large numbers (up to thousands) and are imported from Australia. The native chicken and ducks are generally raised under subsistence systems with minimum inputs whereas exotic poultry breeds are managed under intensive systems.

To face challenges in the simultaneous globalization and incorporation of profit and commercialization approach, it is important to elaborate further the operational steps towards livestock technology development. Improving location-specific farming systems involves not only technological problems, but also appropriate management systems; one of this is how to transfer the appropriate technology to the farmers.

The research and development (R&D) should start with the users' needs, continuing with users' participation in the field testing and ending with the technological results in the users' hand to gain wider acceptance in the community. The research planning and implementation should be designed to improve the economic well being of farmers. The concept of adoption technology means a conscious shift from commodity approach to become more contextual-oriented research that could fit production technology systematically to each unique agro eco-region.

In the early 90's, the beef industry in Indonesia grew very fast from initial number of only 5 feedlots in 1992 to 42 in 1997. The fast growth was supported by importation of feeder cattle (including meat product) because the domestic beef production could not meet the increasing demand. It is apparent that the monetary crisis in 1997 has had a large impact on livestock development and the closing of many beef cattle fattening operations and bankrupt of many feedlots, facing a huge loan burden.

At present, it is fortunate that although the rupiah exchange rate is still weak, beef cattle operations, and importation of live animals start growing rather slowly. However, in the future, with the improvement of national economic condition, and the growth of population and nutrition awareness of the people, the demand for beef will increase as experienced in other countries. Just to increase beef consumption by one kilogram per capita per year would mean additional supply of at least 1 million heads of cattle for over 217 million people.

Table 3. Livestock population in Indonesia (million)

	1997	1998	1999	2000	2001	2002*
Layers (including pullets)	68.8	38	48.7	57.6	70	73.5
Broiler	670	201	418	646	832	898
Beef cattle	11.9	11.6	12.1	12.4	12.4	11.5
Dairy cattle	0.334	0.322	0.334	0.343	0.334	0.387

Source: DGLS (2002). * = Preliminary figures.

Almost 99% of breeding practice to produce feeder cattle is still held by small holders, where livestock play an important role as an integral part of farming system. Consequently, cattle are also used as drought power for ploughing rice field or for pulling a cart. On the other hand, cattle under fattening schemes are almost never been used for drought power.

Low income from livestock farming led farmers to obtain additional income by producing compost from manure. The use of organic fertilizer for crop production in a crop-livestock system is important since it can be used to correct the imbalanced C/N ratio due to high inorganic fertilizer applied over the past two decades. Continuous supervision for utilization of organic fertilizers in food crop production, in particular for rice production, is needed (Diwyanto and Haryanto, 2001).

Livestock productivity under the present traditional management systems by farmers in developing countries is usually low. In addition, the limited genetic potential of breeding stock and impact of unconscious inbreeding, low quality and insufficient supply of feeds have resulted in a high neonatal mortality, reproductive disorders, and incidence of chronic, endemic diseases and parasitic problems. Inbreeding has drastically decreased livestock genetic quality. There is a clear perception that both the quality and quantity of beef cattle in Indonesia are falling. In some regions they are falling rapidly and in others marginally. There is evidence also that the weight of cattle at slaughter is lower than it used to be. Raising improved cattle breeds to perform its genetic potential is almost impossible, given locally low quality feed and management. Improved breeds are in fact likely to be less resistant to diseases and require more inputs, better feeding and preventive treatments. In addition, high level of management is needed if improved breeds are to be raised in Indonesia agro-climate situation.

Low calving rate because of delayed sexual maturity, long post-partum anoestrous period and low conception rate is also a problem that occurs in Indonesia. High quality feeds that are sufficiently supplied are needed to shorten the long calving interval (i.e. 50-60 days).

The fast development of industrial and recreational areas has resulted in land utilization changes. Decrease in public grassland areas since 1980 to 2000, was significantly high, from 78,100 ha to 42,100 ha (in Java) and from 3.4 million ha to

2.1 million ha (outside Java). Therefore, farmers have to look for public open lands in hilly areas or cut and carry forages from distant places (up to 10 km), which are impractical, time consuming and wasting labor.

In Sumatra or Kalimantan, it is possible to produce forages in selected agro-forestry systems, and under intercropping systems based on estate crops. However, the idea of grazing of animals under the trees of estate crops is often rejected due to safety reasons, and animal is generally considered as intruder. In Java, however, available crop residues such as rice straw, corn by-products, sugar cane tops and cassava leaves, are already used for feeding ruminant animals but in fact a large proportion is still wasted. In the dairy farming, the use of fibrous residues that have low feed conversion efficiencies requires the supply of good quality concentrate especially for high-producing cows.

Alternative Approach

The fact that agricultural fibrous residues are potentially available throughout the year is a challenge, but storage is a problem in conjunction with the 120 days harvest while daily feed supply is required. The present focus in irrigated rice production systems with the implementation of IP 300 (3 times a year planting scheme); the expected production is 7 tons dried rice (+ hulls) per ha and rice straw at the same amount. This rice straw is sufficient to feed 3-4 heads of cattle, as a basal diet for a whole year. In upland rain-fed areas only the IP 100 (one time a year planting scheme) could be implemented due to lack of water and, subsequently, the straw produced will only cover a year round feed required by 1-2 heads of cattle. Under the IP 100, the cropping pattern practiced is generally rice-corn-vegetables, thus by-products available are various such as corn leaves, vegetable leaves, peanut leaves beside rice straw.

Within the system, the animals utilize crop residues and by-products and in return contribute organic fertilizer in the form of manure to the crops following a low external input source approach (Low External Input Sustainable Agriculture - LEISA) to achieve optimal production from limited land resources. Animals should be raised in a communal barn in order to obtain sufficient amounts of manure for further processing. It is also important to determine the production target that meets the market requirements.

The present focus of the Crop-Livestock Systems approach is with irrigated land areas where water availability is not a problem. Rice productivity over the past three decades, especially in the northern part of Java, has declined due to soil fertility problems with the massive use of inorganic fertilizers and imbalanced organic matter replacement.

Most of the rice produced is taken away from the soil, either sold or consumed, and organic material was not returned to maintain soil fertility. The use of processed cattle manure was reported to recover rice production losses as one mature cattle could produce about 2 tons of organic fertilizer a year which is considered sufficient

for a year round rice production (Haryanto, 1999). In addition, the fermentation process gives additional benefits since most parasites are killed and weed seeds are also destroyed.

In Central Java, the available crop residues of corn and rice at harvest are already used as feed. The productions are 3.6 and 4.6 tons/ha, respectively (Prasetyo, 2001). Table 4 shows that there is a relatively better utilization of rice straw by domestic animals compared to improved breed or imported cattle.

Table 4. Response of different breeds of cattle to rice straw feeding

Parameter	Breeds of cattle			
	SO	PO	Brahman Cross	FH Cross
Weight gain (kg/d)	0.75	0.69	0.56	0.47
Dry matter intake (kg/d)	13.00	11.38	11.45	9.67
Feed conversion ratio	12.12	11.20	13.70	13.94

Note : SO = Sumba Ongole, PO = Ongole Crossbred from Surakarta, FH Cross = Friesian Holstein crossbred

Source: Haryanto *et al* (1999).

Furthermore, significant amounts of methane gas released from incomplete rice straw decomposition may affect the environment (Preston and Leng, 1989). In the Crop-Livestock Systems (CLS) applied in rice production areas, the use of rice straw as animal feed was strongly recommended, either with or without chemical or microbial pretreatment process. No doubt many social factors within the present systems have to be taken into account (Diwyanto, *et al.*, 2002), for example, labor force and time allocation to collect the straw, land area to keep the animals and storage of straw, etc. The principles of CLS should be socialized and determined globally to solve problems of low crop and animal productivity and environment

Research Priorities to Improve Livestock Production

Indonesia is well known as a country, which is very rich in its animal genetic resources. Indonesian animal genetic resources are: chicken (30 breeds); ducks (14 breeds); goats (11 breeds); sheep (5 breeds); cattle (13 breeds); buffaloes (9 breeds); pigs (16 breeds) and deer (4 breeds) and other native birds.

In majority livestock are raised on low land area, and 70-80% of the total livestock are raised in Java under traditional systems. Under these systems, a very small number of animals (2-3 heads/farm) are kept in a subsistence-oriented production system that gains less than 30% of gross farm product from the livestock. This type of system has dominated the production of livestock in most regions.

Indonesian domestic animals are well adapted to the hot tropic climate. The

animal reproduction activity was not influenced by climate. Indonesian thin tailed sheep was known as prolific breed and also highly resistant to parasites (*Fasciola hepatica; Fasciola gigantica* and *Haemonchus*) that could only be found in our local domestic animals. Because of its important characteristic, this breed is very important in developing high breed of sheep in the future. Madura and Bali cattle have been known to have very efficient reproductive characteristic (early calving age; fertile and short calving interval) in addition to its hardiness.

The major concern of development in the livestock sector is the "low productivity" of the indigenous breeds in Indonesia. Breed improvement schemes based on village production systems are not presently available. In the dairy and beef cattle business, Friesian-Holstein; Simmental; Brahman; Limousine; Angus semen and live animals from Australia, New Zealand; Europe and the USA have been imported to increase milk and meat production. The main approach to improve the indigenous breeds was through cross breeding the local indigenous breeds with improved breeds. Unfortunately most of the improved breeds that have been developed in temperate regions have limited adaptability and capacity to express their superiority when raised in tropical environments where feeds are limited. This practice has resulted in the diminishing number of indigenous livestock breeds in Indonesia. Besides, this approach is also limited by the present poor management conditions at village level. The introduced, improved breeds may not express their full genetic potential; hence, their performance does not exceed that of the locally available breeds.

Crossing with exotic breeds without thorough planning could produce the new breed with worse quality. Among Indonesian indigenous breeds that are considered to have "low productivity" are being extinct due to the cross breeding system. In fact most of these breeds are genetically valuable in developing future high-breed animal that has an optimum productivity, adapted to the hot and humid environment and less nutritionally demanding. Therefore, planning and implementation of a systematic genetic improvement program for livestock in Indonesia is the very important research priority to be recommended; it should be designed to improve the economic well-being of small holders, but at the same time it should ensure that the unique genetic diversity of these indigenous breeds are preserved.

Values for several traits of economic importance for livestock need to be established in order to set appropriate breeding objectives. A critical evaluation of published literatures on the breed should be undertaken as a starting point of determining these values, and before their adoption, scientists should agree upon the outcomes and suggestions of this review.

Priorities for the relative emphasis on traits of economic importance, are recommended as a starting point, and breeding objectives, once are set, should only be altered for sound reasons, following a review of the relative weighting of traits by a panel of experienced animal breeding scientists. Any breeding program adopted must be simple in structure, must involve farmers as key stakeholders in implementation, must be based on economic values as a key-driving factor, and should not involve expensive technologies.

In order to increase the chances of success of any new breeding program, current programs need to be critically re-evaluated in order to identify their advantages and disadvantages, and these matters taken into account in planning new programs; that a recommended approach is to commence with internal generation of replacements, and move toward a controlled nucleus herd(s) from which selected sires are generated, and that a selection index be developed for selection of replacement breeding stock.

It is recommended that, concurrently with the introduction of new breeding programs for livestock, additional research be implemented to determine a range of important genetic parameters; that a key part of the program be an ongoing genetic analysis and evaluation project; and that a five yearly cycle of program review be put in place to review the effectiveness of the overall program, with concentration on determining economic benefits to farmers.

For the success of the above program, however, research and development should be conducted through the LEISA approach and its application to rural poor farmers. Priority setting and direction for more effective utilization of locally available resources should consider two major issues: (1) concerning management and use of the locally available natural resources, and (2) opportunity for technology interventions to significantly increase crop and animal productivity. A market-oriented development approach is strongly recommended, and research for year-round food-feed system involving socio-economical problems is needed. Within the existing framework, a networking system involving concerned individuals and institutions would apparently be an advantage to learn from the experiences gained.

Conclusion and Recommendation

The major concern of development in the livestock sector in Indonesia is the "low productivity" of the indigenous breeds as local breed resources. A systematic genetic improvement program for livestock development is needed through enhanced utilization of local breed resources. The program should be designed to improve the economic well being of smallholder farmers. However, at the same time it should ensure that the unique genetic diversity of these indigenous breeds are preserved.

Since in majority of ruminants and native poultry are raised in Java under traditional systems with small number of animals and in limited land resources, low-external input sustainable agriculture approach is needed to achieve optimal production. Facing the limited land resources for agriculture development, and subsequent limited food-feed supply, requires heavy consideration in designing crop-livestock production systems.

For non-ruminants, the production of essential feed ingredients like corn and soybean may likely involve policies in regulating international trade and optimum use of land for corn production. For the future dairy production, the base feeding management on green pastures and cereal forages and silages with continuous

supply of concentrate feeds is strongly needed. On the other hand, beef cattle production is likely feasible to apply cereal and leguminous straw-based diets as the principles for implementing crop-livestock systems are feasible.

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