

Monogastric Animal Production Systems in Small Farms in Tropical Countries^a - Review -

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ABSTRACT : Like other livestock, monogastric animals are essential components of the farming systems in the tropical countries. Pigs, chicken and ducks are by far the most important animals in the culture of the peoples of developing countries in the tropics. Traditionally these animals are raised in small farms and they are also the bulk producers of meat, eggs etc. in the tropics. In many countries the farmers of these small farms are unable to meet the requirement set by financial institution and other loan giving agencies for agricultural loan. Thus, the small farmers can get neither the opportunity to generate sufficient income to support the family nor to extend the livestock activities. The production systems are characterized by small number of animals with no or minimal inputs, low outputs and periodic destruction of animals by disease. Typically the litter size or flocks are small in number with each household containing 5-6 pigs and 7-10 poultry. Animals are owned by individual households and mostly maintained under a scavenging systems with little or no inputs for housing, feeding or health care. Because of the nature of this production system, productivity of these animals is rather low. The low level of inputs is due to a lack of capital and a low risk oriented outlook. The feed resource base for monogastric is scavenging and consists of household waste, roots and tuber, grain by-products and anything edible found in the immediate environment. Usually farmers select breeding gilts from their own female piglets or to a lesser extent, buy them from neighbors for natural mating. As regards poultry attempts have been made to increase egg and meat production by improving local poultry birds by upgrading and crossbreeding with exotic germ plasma in the tropics. Animal disease present a major constraint to animal production in the tropical region and the extent of the losses due to disease is very high. (*Asian-Aus. J. Anim. Sci.* 2000. Vol. 13, No. 3 : 401-412)

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INTRODUCTION

In tropical countries of the less-developed world, animals are an integral part of the farming systems and perform a variety of roles, either supplying products for household, for sale or providing inputs for crop production. Animals also figure as living savings that can be converted into cash when the need arises. The species of animals are buffaloes, cattle, goats, sheep, poultry, pigs, and ducks, but seldom of all these animals are maintained together. The value of animals in this context is also related to their multi-purpose use. Large ruminant are used to provide draught power, meat and milk and the supply of manure for fuel and fertilizer. Small ruminant are valued for meat, milk, fibre and skin production. Likewise monogastric animals especially, pigs, chicken and ducks are also essential components and used for more than one purpose. These small farmers largely depend on livestock for their existence. They are not commercial producers of specialized animal products

and usually own 1-2 large ruminant, 4-6 small ruminant, few indigenous pigs, chicken and ducks. Animals are owned by individual households and mostly maintained under a scavenging systems with little or no inputs for housing, feeding or health care. Because of the nature of this production system, productivity of these animals is rather low. The small size of the holdings is one of the characteristics of small farm systems. The production systems are characterized by small litter size (5-6 pigs) or flocks (7-10 poultry), no or minimal inputs, with low outputs and periodic destruction of animals by disease.

CHARACTERISTICS OF SMALL FARM IN THE TROPICS

A number of definition have been proposed to describe both small farmers and small farms. In general terms, a small farmer owns a tiny parcel of land and animal,, suffers chronically from scarcity of capital and he has limited access to credit and inputs. In addition, he faces unstable markets and prices, he receives very little technical support and because of his lack of economic clout, his participation in the control and operation of agricultural institution is limited (Dillon and Hardaker, 1980). A more precise definition of small farms that they are complex

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interrelationships among animals, crops, fish and farming families, involving, small land holdings, minimum resources of labour and capital from which small farmer may or may not be able to derive a regular and adequate supply of food or acceptable income and standard of living.

Small farm holdings

Since the majority of the rural population in developing countries in the tropics made up of small farmers, many national, regional and international institutions have shown some interest during the past few years, and made efforts to study the small farmer and his agricultural production systems, in order to improve the well being of the farm family. In this regard, Wharton, (1969) suggests that, about 50% of world population depends on subsistence agriculture; that almost 40% of cultivated land is in the hands of the small farmer, that he represent 60% of the total number of farmers and produces less than 40% of total agricultural output. The small size of the holdings is one of the characteristics of small farm systems. The actual size of the farm varies from one country to another. Table 1 illustrate differences between countries with in the Asian region (Devendra, 1993). The smallest farm size occur in Bangladesh (<0.4 ha), while households cultivating paddy in Sri Lanka have average holding of 0.3 ha of land.

Table 1. Variation in size of the of small farms in some countries in South East Asia and East Asia

Country	Landholding	Definition
Bangladesh	<0.4 ha	Subsistence farmer
	0.4-0.8	Viable and potentially viable owners
India	2-4 ha	Small farmer
	0.8-2 ha	Marginal farmer
	< 0.8 ha	Agricultural labour
Indonesia	0.66 ha	Java
	1.2 ha	Average size
Korea	< 1 ha	Small farm
Malaysia	< 1 ha	Small farm
Nepal	1.6-1.6 ha	Rice farm
	2.1 ha	Rubber
Philippines	2.5 ha	Terai
	1.0 ha	Hills
Sri Lanka	2.5 ha	Terai
	1.0 ha	Hills
Thailand	2.8 ha	Average
	1.2 ha	Agri-household
	0.3 ha	Rice farm

In South East Asia, the average size of small farms is about 1-2 ha. Recent report from Bangladesh indicated that eighty five per cent of the small farmers fall bellow the 5 ha size land and 60% is bellow 3 ha size land (BBS,1996). The household size ranges from 5-6 members. The variation in size of the of small farms in some countries in South East Asia and East Asia is not so much different from each other.

Production systems in small farm

Agricultural production systems specially those involving both crop and animal components, are complex. The systems of integration of different types of animals with crop in the farming system in South East Asian countries have been described by Devendra (1993), as follows:

a) Systems combining crops, non-ruminant and fish: Pigs and ducks are the prevalent animal species found in mainly annual cropping systems. This systems are very important in countries as China, Vietnam, Indonesia, Thailand. Important crops that generate feed are sugar cane, cereal crops and multipurpose trees.

b) Systems combining crops and ruminant: The system is potentially important in those regions where tree are important such as in South East Asia, Asia Pacific and East Asia and Africa.

The importance of crop-animal systems lies in their positive contribution to sustainability and economic growth. A central goal is to generate a minimum target income. There are many examples of integrated farming systems. McDowel and Hilebrand (1980) have identified 10 each for Asia and Africa and 4 for Latin America in which animals are important. These systems refer to all categories of animal based enterprises, such as lowland rice and intensive livestock rearing in Asia, pastoral herding in Africa and extensive and intensive livestock production in Latin America. However, Devendra 1993, stated that the best examples of integration are found in the rainfed areas of South East Asia. He observed that each species, production objective is related to type the of cropping systems (table 2). In the last column of the table 2, current importance of the system is asses in terms of high, medium or low rating. The rating is based on animal ownership.

Animal population and small farm ownership

Based on FAO, Agrostat, 1991 the annual growth rate of cattle, pigs, chicken and ducks for the period of 1971-'80 and 1981-'91 of different geographical region in the world is shown in table 3. From the table it appears the annual growth rate of cattle, pig and chicken is higher in Asia than other continent

Table 2. Animal-based small farm systems in South East Asia

Species	Production objectives	Type of mixed cropping	*Current importance
1. Large Ruminant	Draught	Rice and field crop cultivation	High
	Beef	Rice cultivation/Homestead/tree plantation	High/Medium
	Dairy	Rice cultivation/Homestead/tree plantation	High/Medium
2. Small ruminant	Meat	Homestead garden/tree plantation	Medium/High
	Milk	Homestead garden/tree plantation	Low
3. Non-ruminant			
<i>Pigs</i>		Intensive vegetable production	Medium/High
<i>Chicken & ducks</i>	Meat/eggs	Homestead garden/Intensive vegetable production	Medium/low
	Meat/eggs	Homestead garden/Intensive vegetable production	Medium/low

* Based on ownership by small farmer.

Table 3. Growth of rate (%) of animal population in different geographical groups of the world

Species	Average growth rate from 1971-'80				Average growth rate from 1981-'91			
	Cattle	Pigs	Chicken	Ducks	Cattle	Pigs	Chicken	Ducks
Asia	0.29	3.41	3.48	3.81	1.21	2.11	7.29	3.27
Africa	1.49	3.27	3.06	0.65	0.86	5.90	4.16	3.38
Europe	0.65	2.23	1.24	-0.91	-0.94	0.54	0.40	4.07
South America	3.06	1.24	6.78	1.13	1.23	0.86	2.91	3.56
North America	0.10	0.62	7.23	6.73	-1.25	-0.78	3.58	1.81

Table 4. Animal population in and ownership in small farms (%) in some selected countries of South East and East Asia

Country	Buffaloes	Cattle	Goats	Sheep	Chicken	Ducks	Pigs	Small farm
	('000s)	('000s)	('000s)	('000s)	(mln)	('000s)	('000s)	Ownership
Bangladesh	445	19850	7608	498	16	70000	-	90
Combdia	760	1560	-	-	7.7	3500	1610	95
Indonesia	3500	10350	1130	5750	590	29500	6800	90
Laos	1100	865	143	-	8.0	310	1390	95
Malaysia	190	658	315	200	148	5000	2400	70
Myanmar	2080	9310	1040	280	24	3566	2250	95
Philippines	2710	1677	2107	30	65	8268	8007	80
Thailand	4743	6052	140	178	114	17300	5000	76
Vietnam	2929	3282	300	-	81	28600	12583	95

even the previous period from 1971-'80 indicating importance of this animal in this region.

Animal population in of selected countries of and ownership in small farms in South East and East Asia is shown in table 4 (Devendra, 1993). From the table it appears that 80-95% of the farm in this region is owned by the farmer of small farm categories.

Values of small farm production system

Small farm systems combining crop and animals are the important categories specially in South East Asia and East Asia. The value of crop-animal systems lies in their positive contribution to sustainability and

economic growth. A central goal of the small farm is to generate a minimum target income and a sustainable systems which widely practiced in South East Asia and East Asia as for example China, Indonesia, Vietnam, where pig production is integrated with fish farming, poultry raising and vegetable production. Advantages of these systems have identified as follows:

- Efficiency of scarce resource use in small farm
- Reduced dependence on purchased concentrates for pigs, ducks and fish,
- Reduced cost of production,

- Reduced pollution, and
- Bio-energetic efficiency
- Increased self reliance and Sustainability

Trends in the population growth rate of monogastric animals

The trends in the growth rate of livestock in selected countries is shown in table 5 (Agrostat, FAO, 1991). The highest growth observed for poultry in Indonesia and Malaysia (12.4 & 12.5%) followed by Cambodia and Vietnam. With pigs, very high annual growth rates were noted in Cambodia (16.6%) followed by Indonesia (8.6%) during the same period.

Table 5. Trends in growth rate of monogastric animals population in selected countries in South East and East Asia

Country	Average growth rate from 1981-'91 (%)			
	Cattle	Pig	Chicken	Duck
Bangladesh	0.7	-	2.8	-3.07
Cambodia	-	16.6	8.4	8.7
China	4.9	2.1	8.7	3.8
Indonesia	3.5	8.1	12.5	2.1
Laos	7.5	1.2	3.3	3.4
Malaysia	3.4	2.0	12.4	12.4
Myanmar	1.6	1.1	2.0	-4.1
Philippines	-1.8	0.2	1.3	5.0
Thailand	2.56	2.7	5.3	2.8
Vietnam	7.6	2.0	4.9	2.7

Contribution of monogastric animals in small farms

Livestock and poultry are important contributors to total food production. It has been reported by Sensoucy (1995) that the animal contribution increases at a higher rate than that of cereal (table 6).

Table 6. Trends and projection in the growth rate of food production in developing countries

Product	Growth rate (%)	
	1970-1990	1990-2010
Wheat	3.8	2.1
Rice	3.0	2.0
Milk	3.5	2.5
Meat	4.6	3.8

Recent increases in animal production appear to be even spectacular than those achieved for cereals from green revolution. Most notably, egg production has increased by 331% over the last two decades, compared with 127 % for meat production, 78% for cereal and 113% for fish (figure 1). He further reported that by the 2,010 animal products are expected to contribute proportionally much more to the

food supply than they do at present, since income determines the protein intake of people, particularly in urban areas. From the figure 2 it appears that, contribution of different animal species in respect of total meat production. It appears from the figure that meat production from monogastric animals (poultry and pigs) has increased at a much higher rate than that from either large or small ruminant. small ruminants (sheep & goats) or large ruminants (cattle and buffaloes). While in 1970 ruminant and monogastric meat production were approximately equal (figure 2), it has been projected that by 2010 monogastric may produce 2.4% more meat than ruminant, providing that feed is available and affordable (figure 2).

Production in million MT

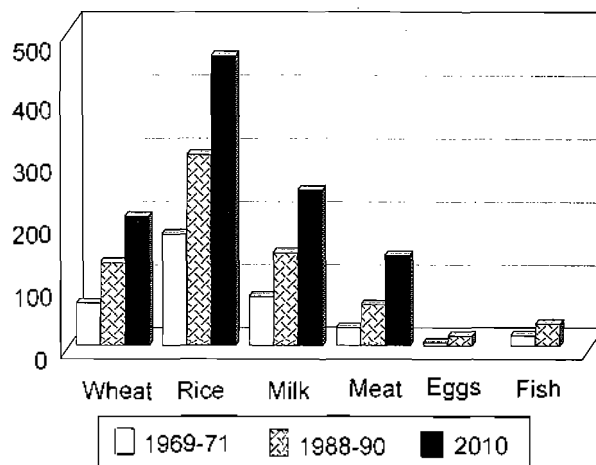
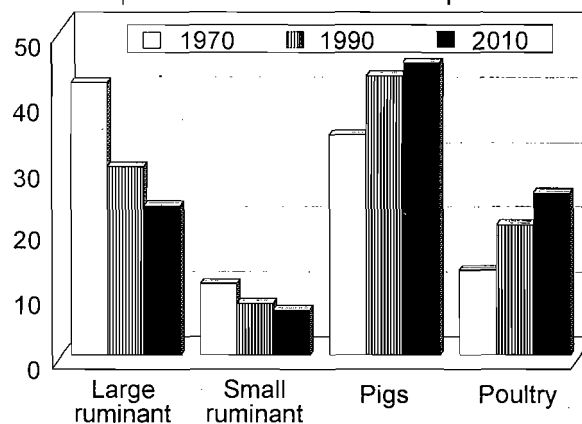


Figure 1. Food production in developing countries

Meat production in % of total meat produced



Note: Total meat production in developing countries (MT) 1970: 28.5, 1990: 64.8 and expected 2010: 143

Figure 2. Species contribution of total meat production of developing countries

Devendra (1993) reported that total meat produced in South East Asia, pig meat accounted for 44.3% followed by poultry meat (33%), beef and veal (11.9%), buffalo (5.5%), duck meat (2.9%), goat meat (1.6%) and lamb meat (0.8%) (table 7). With the exception of duck meat, and in comparison to all meats, poultry and pig meat production grew the fastest. Further he reported that in the case of poultry meat, double figure growth rates were recorded in Malaysia (12.9%), Cambodia (10.4%) and Indonesia (10.3%). The growth rate of pig meat production was highest in Cambodia (14.1%) followed by Indonesia (8.4%) and the Philippines (5.5%). From last column of the table 7 it appears that the production of meat from non-ruminant (pigs and poultry) is increasing faster than that of meat from ruminant in South East Asia

Table 7. Meat production from different animals in South East Asia

Species	Of the total meat produced (%)	Growth rate of meat production (%)
Beef	11.9	2.9
Buffalo	5.5	2.0
Goat	1.6	2.1
Mutton	0.8	5.6
Pig	44.3	5.6
Chicken	33.0	6.2
Duck	2.9	1.4

Constraints of production

Following factors associated with the low level of inherent input resulted low level of economic efficiency of the total enterprise. Besides these factors, there are lot problems of high cost of handling and collection, lack of managerial and technical skills to utilize the feeds in situ and lack of institutional support. Both the scale of operation and feeding technologies applied are not conducive to high economic returns. There are also problems of seasonally, processing and storage facilities and marketing of the products. The primary limitation to raising their level of productivity is high quality protein and energy food. Factors associated with the low level of production are :

- a) Lack of economical technology for better utilization of local resources
- b) Non-availability feed resources (quality & quantity)
- c) Climate and disease constraints particularly for chicken
- d) Uneven income distribution which limits growth in demand to a small farm segment of the population
- e) Environmental constraints, particularly urban piggery
- f) Intense competition for land resources which will

push up the cost structure for animal production

PRODUCTION SYSTEMS OF MONOGASTRIC ANIMALS

Various monogastric animal production systems have been described by a number of authors (Huchzermeyer, 1967; Aini, 1990; Cumming, 1992; Devendra, 1993 and Dessie and Ogle, 1996). Pigs, chicken and ducks are by far the most important animals in the culture of the peoples of the tropics specially in South East Asia and East Asia. The production systems are characterized with small litter size or flocks, no or minimal inputs, low outputs and periodic destruction of animals by disease. Typically the litter size or flocks are small in number with each household containing 5-6 pigs and 7-10 poultry. Animals are owned by individual households and mostly maintained under a scavenging systems with little or no inputs for housing, feeding or health care. Although collecting feed and raising animals, are male dominated activities, female play a vital role in monogastric animal production activities. Furthermore, children also play a major role in raising livestock and poultry usually who spent about 4 hours a day (Paul and Saadullah, 1991). Diversification is the backbone of small farm systems. Farmers consciously diversify the use of their resources to produce a mix activities which are economically rewarding and highly stable. As such in small scale farms in the tropical countries, goats, sheep, chicken, ducks are commonly reared in combination with mixed cropping.

Pig production system in small farm

Small Scale Pig Production in the tropical region play an important in the farming systems as they are commonly the major source of cash income. Majority of the pigs raised by small farmers are local type. Generally, the pig production systems can be grouped into three categories namely

- a) Commercial production system
- b) Medium scale production system
- c) Small Scale production system

Small scale pig raisers in rural areas can be roughly divided into 3 categories with regard to their roles in rural pig production systems.

- a) Those who produce piglets
- b) Those who buy the piglets and feed them to market weight and
- c) Those who keep servicing boars for hire.

In this system pig raisers who produce piglets and feed them to market weight are rarely found. The

majority of pig raiser in rural areas are those who buy weaned pigs and raise them to market weight. Interrelationship among the different types of small scale pig raiser in rural areas is shown in figure 3. In this cycle, pigs are bought either from neighbors or local dealers, who earlier have bought them from other villages. Usually raiser seldom go out of their villages to buy piglets themselves because considerable time is spent in the search of right stock. Since most of the piglet producers keep only one or few sows and cannot afford to have a service boar of their own, those who raise service boars for hire are very essential to the system. Under this systems, the gilts, the sows and the boars are raised in yards of the farmer. The yards of the household may be fenced, but in most cases, they are not, when the yards are fenced, pigs are either in sties or just allowed to roam freely around the yards. In cases where the yards are not fenced, the pigs are allowed to roam around freely to forage for themselves. Although at present in Thailand, in view of higher buying process, most pigs are confined in the yards or in pens or sties. (Na-lampang, 1986). Roughly 83% of the pig population in the Philippines are taken care of by small holders (Posas, 1986) with average increase of 3% per year. Small scale production system: This is the traditional system of raising and maintaining one or two pigs in the household in combination with other animals. In Indonesia efforts is being made for the development of native monogastric animal production through improved feeding and health management (Setioko, 1991). The animal combination pattern in Philippines of carabo+ pig+ chicken and pig+chicken are the commonest (Posas 1986). A small number of exotic breeds are kept by some well-off farmers for breeding purposes. In Bangladesh black native pigs are raised, also in a small number, by some ethnic groups.

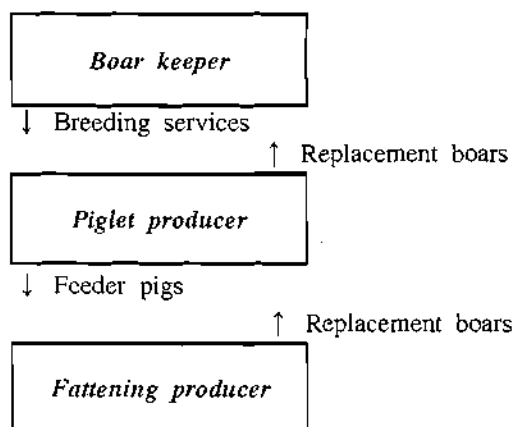


Figure 3. The relationship among the different types of small scale pig raiser in rural areas

Chicken and ducks

The backyard poultry raising in tropical countries have been practiced for centuries and will continue to exist in the years ahead. In an estimate, it was found that about 96% of eggs and 98% of poultry meat are produced from backyard production (Ahmed and Huque, 1991). This system has not only become an old practice, but also has an economic importance to the small scale farms, who keep them to supplement their income and also keep these animals as saving to be utilized in case of emergency. Nielsen (1997) and Salek and Mustafa (1997) stated that about 89% per cent of rural households in Bangladesh rear poultry and the average number per household is 6.8 ownership of backyard poultry is almost in the hands of women. It has been reported by Saadullah et al (1997) that all species of animals are mostly in the hand of small farmers (82.4%) in Bangladesh. However, Dessie and Ogle, 1996 reported that the proportion of population raised by the small farm household (subsistence) in Ethiopia vary greatly between species namely 1% for broiler, layers and dairy cattle; between 1 to 5% for horses, buffaloes and pigs; 15% for draft cattle and 17.6% for goat and sheep; whereas the highest is for native chickens (56.7%). Typically the flocks are small in number with each household flock containing birds from each age group with an average of 7-10 mature birds in each household, consisting of 2-4 adult hens, a male bird and a number of growers of various ages. Gunaratne et al (1992) and Cumming (1992) also described village poultry flocks in Asia as including 10-20 of birds of different ages per household. According to Sonya (1990), the average flock size in Africa ranges from 5-10 birds. A whole village study in Bangladesh on weekly basis over a year showed an average 8 chicks, 6 pullets and 3 hens per family. The average production of eggs per hen per year was only 42. Egg lay peaked at 27% during the rice harvest. Of the eggs produced 55% were set under a hen for further chicken production, 40% were eaten and 5% were sold. Of hens and pullets or cockerels grown, 56% and 44% respectively, were sold or eaten (Saadullah et al 1993). In Bangladesh, chickens are the most widespread species of backyard poultry and ducks are second. The backyard poultry production system in Bangladesh can be divided in two production subsystems:

a) Traditional Backyard scavenging poultry Production: Where indigenous or crossbred between indigenous and pure bred birds are raised under scavenging feeding systems. This system is a self-sustained system of production in the rural areas. This system relies primarily on local foodstuff as well as local replacement of breeding stock. There is no systematic

brooding and male and female are grown together. The available males are used for breeding with all hens in a house. The chicks are naturally hatched by mother-hen. Eggs are set with ash, husk and small pieces of straw in a pot. The mother hen brood the chicks and spend a larger percentage of their time in rearing chicks after natural hatching.

b) Intensive Backyard (confinement) poultry production: where pure breeds like white leghorn, RIR, Fayomi or crosses between two pure-breed birds are raised under intensive system. In this production system, birds are reared with complete balanced ration prepared from locally available feed ingredients. Pure breeds birds are available in the country at public sector farms. Management of intensive backyard poultry production are mostly based on confinement system with complete balanced ration with available feed ingredients. Small poultry houses are made with bamboo, CI sheet etc. Feeders and drinkers are also made locally. As the birds are collected from private hatcheries a systematized breeding programme is used for chick production. Some time eggs are collected from model raisers are used for hatching under indigenous broody hens. Raising poultry is one of the effective technology to alleviate the poverty in small farm and improve nutritional status in the Bangladesh context. Women and children usually take care of the chicken and ducks. The income generated from raising poultry in small farm is used for their food, clothing and to meet other requirement in household. Saadullah et al 1993 described village flocks in Bangladesh including 10-15 birds per households and the production level of these scavenging hens is generally low, usually with 40-60 eggs produced per bird per year under small farm management conditions. A number of authors, including Vcluw (1987), Salek (1995) have outlined that rural poultry play a significant role through their contribution to cultural and social life of rural people in tropical countries. This is also confirmed by Dessie and Ogle (1996) in Ethiopia. They found that the main objectives of poultry production in three villages were eggs for hatching (51.8%), sale (22.6%), sacrifice (healing ceremonies) (25%), replacement (20.3%) and home consumption (19.5%) in Ethiopia.

There are various systems of duck production in the tropics. The one extreme is the extensive duck raising with 10-100 birds per family through free grazing in paddy field after harvesting, on pond, and lake. The other extreme is the intensive duck production systems with the scale of producing few hundreds to thousands ducks annually. The traditional systems of duck rearing in small farm of South East Asian and East Asian countries including Indonesia, Vietnam, Thailand, Malaysia, Bangladesh, is the seasonal grazing system combining with the scavenging on fish pond, lake

river and coast. This system depends on rice harvesting and other naturally available feeds. More ducks are being raised during harvesting season and lesser during the long period of dry season. Ducks are scavenged for around seven hours a day in the pond or household areas and are supplemented with rice polish, fish waste, snail and meat oyster. Fish and Ducks are common features of small scale farms in tropical region of the world. Both fish and duck production are largely extensive i.e. dependent on natural food that can be scavenged, and both are minor parts of the farming system. They sell birds and eggs in the local market or trades. The traditional role of ducks in the agro-ecology of wet rice cultivation is to scavenge and extract food from flooded rice fields without damage to the growing crop and retrieve spent grain after harvest. Their controlled use in the management of many different rice field pests is traditional in southern China (Fuan, 1986) and analysis of crop contents indicates the importance of insects and molasses in the diet of ducks herded through rice field in Indonesia (Setiako et al 1986). By scavenging in aquatic and semi-aquatic areas in an around of the farm such as weed infested canals, lakes and reservoirs ducks could harvest and provide nutrients for the fish pond systems that would otherwise be unavailable to the farmer. The potential for integration of duck and fish production in which the wastes of the ducks are used as the main input for fish pond has been promoted for small scale farmers. to obtain high yield of fish at low cost. The system of duck production on fish pond and lake provides farmers with high economic return. With this system, ducks can be kept all year round This systems is very popular in China, Vietnam, Korea, Thailand and Indonesia. In this duck raising system, after the initial period of 1-21 days of age, ducks are shifted to paddy fields and kept there until slaughter age. The results from duck and fish production system is shown in table 8 (Dong, 1991).

Table 8. Comparative production yield of fish and duck (kg/ha)

	Lake without duck	Lake with duck
<i>LAKE 1</i>		
Natural fish production	498	1,185
Duck meat production	0	3,200
<i>LAKE 2</i>		
Fish production	300-500	950-1,400

FEEDING MONOGASTRIC ANIMALS

Feed resources

Feed resource base for pigs, and poultry is mostly

scavenging in the small farm and consists of household waste, fruits by-products, roots and tubers and small amount of grains, grain by-products and anything edible found in the immediate environment. The portion that comes as a grain varies with activities such as land preparation and sowing, harvesting, post harvesting and season of the year. In pig feeding the sources of protein which have high potential for use by the small scale farms are the leaves from water plants and multipurpose trees. Water plants such as duckweed (*Lemna minor*, *Spirodela punctata*) and azolla (*Azolla anabaena*) are proving to be the most useful alternative sources of high quality protein. Almost without exception most of these feed resources are very low in protein (less than 5%). The cereal grains used in temperate pig production are high in protein (8-10%). Preston (1995) suggested that the future feed resources in small farm for monogastric animals in the tropics will not be cereals, but rather locally available feed resources that can be produced on the farm with comparative advantage in sustainable, non-subsidized production systems. In contrast in the temperate regions of the world, cereal production exceed what is needed for human consumption. The surpluses are fed to livestock and considerable amounts are exported. On the other hand, most tropical countries import part of their needs of cereal grains for human consumption and many of them also import grain for feeding to livestock. In this situation the primary limitation to raising their level of productivity is high quality protein and energy.

Feeding systems

The conventional system of feeding grains or other protein rich feed like grains, fishmeal is rarely feasible for small scale farmers. The systems of feeding in small farms are generally not intensive and these systems are based on available cereal by-products non-conventional feed and also kitchen waste. As such feeding monogastric animals (pig, chicken and ducks) is inefficient process on small farms. Although improved feed both in quality and quantity should be to increase their productivity. However, whilst good quality commercial feeds are available, they are not popularly being used by small farms simply because they are expensive. Three broad categories of feeding systems are identifiable.

- Scavenging (Backyard)
- Semi-intensive (partly confined)
- Intensive

Feeding pigs

The traditional sources of protein in the diets of monogastric animals are the by-product from oil seed milling and the processing livestock and fishmeal.

Although the village based processing system is still the norm in some countries in the tropics. Considerable advances have been made in the development of feeding systems using the products and by-products of sugar cane (FAO, 1988, and Perez, 1995) and the African oil palm crops that with appropriate management have proved to be sustainable. Much work has been done with the cassava plant, designed to promote its use in pigs in many countries. However, the major emphasis has been on producing a dry meal from the roots that could be used in conventional mixed feeds. This suited the interest of exports and feed millers and compound feed mixer the developed countries, but the added processing costs usually put the dry product out with the financial means of small-scale farmers, who were usually the original growers of the crop. Future research with cassava and other tuber crops should be directed to simple ways of on-farm processing and conservation (FAO, 1992), so that the growers can also be the major beneficiaries. The most promising alternative to cereal grains for intensive feeding of pigs in the tropics are sugar cane juice (Sarría et al., 1990, Speedy et al., 1991), sugar cane molasses, juice from the sugar palm tree (Rodriguez and Preston, 1995), oil, whole fruit and byproducts of the African oil palm, cassava roots and by-products and organic waste from urban households, restaurants and canteens (Devendra, 1992 and Dominguez, 1992). Other products and by products from tree, roots and tuber crops are included in tropical pig diets but mostly on ad hoc basis and not as the basis of the feeding system (Preston, 1995). In the farming systems in Colombia, in unfertilized ponds, yield of azolla filiculoids were equivalent of 3-4 tones protein/ha/year. It was shown that it could be sole source of protein in diets of pregnant sows fed on sugar cane juice (Rodriguez and Preston, 1995). Like the duckweed and azolla, the foliage of most trees is rich in protein, minerals and vitamins. The limitation of leaves from trees as dietary supplements are the presence of non-nutritional factors which negatively influence digestibility and intake. *Gliricidia sepium*, *Leucaena leucocephala* and *Erythrina fusca* are in this category and as a result they are used mostly in the diets for ruminant. An exception is the foliage of *Trichanthera gigantea* which is readily consumed by pigs and can be used to replace up to 30% of the protein in diets of pregnant sows with significant reduction of feed costs. (Sarría, 1991).

Feeding chicken and duck

Duck meat is emerging as important in a number of countries where relatively high growth rates have been noted. It has been reported by Yeong (1992) duck meat production in Malaysia is based on pekin ducks with minor from local itik jawa, muscovy and spect

laying ducks. He also reported that 58% of the total ducks are broiler followed by layer (21%) and breeder (6.3%). Feeding of is usually ad libitum to obtain maximum growth and shorten rearing period for marketing. The growth rate of ducks is faster and lay bigger eggs than chickens. Generally, all the cereal sources which are used for chickens can also be used for feeding ducks. As protein sources, fishmeal, soybean meal are commonly fed besides broken rice. Certain agr-industrial by-products such as palm oil sludge and cocoa bean shell have been tried in Malaysia and Indonesia. In the coastal and flood prone areas meat and layer ducks rearing make use of trash fish as cheap protein source. The use of local feed resources can be compared to those using snail and prawn peel for laying ducks in Bangladesh. Fresh water snail (*Sinotia ingallsiana*) which are also available also in south east Asia for feeding duck. However, feeding snail alone with a supplement of rice bran seems to be insufficient in nutrients to support sustained egg production among the local ducks in Bangladesh (table 9).

Table 9. Comparison of egg production between compound feed and snail feeding with feed supplement (7 weeks average)

Item	Compound feed	Snail+ 55 g feed
% egg production	68.1	70.1
Average egg weight, g	58.8	59.5
Daily egg mass, g	40.0	41.7
Yolk colour index	2	12

BREEDING OF MONOGASTRIC ANIMALS

Pig

For many reasons, whether historical, cultural, biological, scientific or economic, the conservation of animal genetic resources of tropical country is important at both national and international level. The fundamental ways of establishing gene reserves are live breeding stocks, conservation of gnomes (semen, embryo, cells or oocytes) and isolated chromosomes or genes. Most farmers employ natural mating because the artificial insemination service carried out by the artificial insemination station far away from the villages. The farmers usually select breeding gilts from their own female piglets or to a lesser extent, buy them from neighbors instead of buying from commercial or government farms since these are cheaper and more convenient. More over facilities for artificial insemination in the villages are not well established. It has There is one or few boar raisers in a village. A great majority of breeding boars used in rural areas are selected from the same locality. Only

in such areas sow raisers can pay more for breeding services, a few boars are purchased from commercial or government farms.

Poultry

The major portion of chickens in the small farm of the tropics are indigenous type (table 10) and unfortunately little research and development work has been carried out on these chicken (Dessie and Ogle, 1996). These bird are reputed for their broodiness character. Comparatively Rural farmers exploited this characteristic in a positive way and eggs (ducks and chicken eggs) are hatched naturally by broody mother hens. The hatching practices are that the farmers manage a nest which is made by straw or hay in bamboo or earthen pot. Besides earthen pot, any other vessels of wood or tin can also be used. The nest with the broody hen is placed in a quiet corner in the house where she will not be disturbed. Generally, the chickens are reared by mother hen from one day old to 8 weeks. The farmers supplies small quantities of feed to these chicks and broody hen. Attempts have been made to increase egg and meat production by improving local poultry birds in small farm by upgrading and crossbreeding with exotic germ plasma in many countries in the tropics. In this direction scientist and the government of many tropical countries have promoted schemes in which cockerels from selected strains are reared upto 15-20 weeks of age in the government farm and then exchanged for local cockerels own by the rural subsistence farmers. The farmers are advice on improved feeding and housing and also asked to remove all remaining cockerels. In few countries improved hens are also replaced by local hen.

Table 10. Percentage contribution of local birds in selected African and Asian countries to the poultry population

Country	% contribution
Bangladesh	99
Cameroon	65
Ethiopia	99
Gambia	90
Kenya	80
Malawi	90
Nigeria	91

COMMON DISEASES OF MONOGASTRIC ANIMALS

Animal disease present a major constraint to animal production in the tropical region and the extent of the losses due disease is very high (table 11 and table

12). Chick mortality represent a major loss in scavenging system of production and reports from different countries show that 50-70% of chicks die between hatching and the end of brooding. Kingston (1980), Kingston and Cresswell (1982) in Indonesia; Roberts (1992) in Sri Lanka and Matthewmann (1977) in Nigeria calculated mortality rates of chicks as being 53-69% upto 6 weeks of age. Roberts (1992) reported that in Indonesia losses were due to a combination of poor nutrition, predators and various diseases. New castle disease is the most important disease recognized in tropical countries in small farm production system. Salek and Mustafa (1996) reported that the prevailing diseases in Bangladesh are Newcastle, fowl pox, fowl cholera, coccidiosis and worm infestation. He also reported that without interventions, the mortality rate of the poultry in scavenging system is high (30-80%) due to disease and predators Post weaning diarrhoea is known as one of the main problems for pig production in small farm in the tropical countries (Srinongkote et al 1992).

Table 11. Reported baby chicks mortality in small farm

Country	% mortality	References
Sri Lanka	65	Gunaratne et al. (1992) pp. 81
Indonesia	79	Kingston & Cresswell (1982)
Ethiopia	61	Dessie, T. & Ogle, B. (1997)
Bangladesh	80	Jensen (1996)

* Under control situation

Table 12. Reported Mortality in small farm due to various diseases of bird

Country	% mortality	Reference
Nigeria	70	Nwosu (1990)
Ethiopia	80	Alamargot (1987)
Bangladesh	30-80	Salek & Mostafa (1996) pp. 41
Bangladesh	19*	Jensen (1996)

* Under control situation

It has been reported by Magor (1986) from a village based study in Bangladesh that even all the birds in five selected villages the chick mortality was 50%, hens 14% and pullets and cockerels was 25%. In contrast during the same period mortality of pullets and hens in a neighboring village was above 50%. Among vaccinated birds coccidiosis and vitamin A deficiency were the primary causes of mortality. He also concluded from this study that poultry care in small farm was a women's activity, egg production was low with the dominant output being meat

production, contagious disease placed any poultry rearing risk and nutritional disorders specially vitamin deficiency contributed to mortality. Research in supplement feeding and separation of chicks and hens has been found to reduce mortality, increase egg production and growth rate. Dissemination of results/know how together with vaccination services need to be implemented at small farm level.

FUTURE OUTLOOK

There is no doubt that individual and collective, the obstacles facing the small farmers in tropical countries are formidable. They are not, however, insuperable. Most of the forces creating poverty in small farms are allocation that the society makes, and as such they can be reversed. The farmers in small farms are not idle, they work. From this perspective, overcoming poverty means helping the poor to be more productive. Below is outlined potential guidelines for poverty alleviation and to improve the life style of small farmers-centered growth in monogastric animals in the tropics:

Small farm monogastric animal production systems

Agricultural systems specially those involving both crop and animal components, are complex. The feed base together with the disease challenge, determines the potential animal production systems that may develop. Any modification in the components of these systems often leads to unexpected effects, which are sometimes unfavorable, for the functioning and productivity of the total system. These improvement usually benefit both the farmer and consumer. The goal often conditioned by the need to preserve non-renewable resources in order to guarantee the capacity to continue efficient production. For instance, to maintain a sustainable system.

The backyard systems raising monogastric animals in tropical countries have been practiced for centuries and will continue to exist in the years ahead. There are a range of factors associated with the development of back-yard monogastric animal management. To improve the management system that is pertinent to pig and poultry production on small farm, a specific approach and analysis of the existing problems is required. Expanded 'Backyard' meat production using such animals as rabbits, pigeons and other micro livestock. This could provide significant employment, meat and some income from excess production. Research is needed in this direction.

Promoting rural small-scale enterprise

Small scale enterprise and small-scale processing units by the rural poor have to be encouraged through appropriate policy and institutional support. Such

activities could increase the added value accruing to the rural poor as well as create links with the outside economy that will provide a new dynamic to rural development and overall growth.

Supporting rural women as producers

Women constitute more than half of the total population in most of the tropical countries. Given the crucial role, women play and will increasingly play in agriculture especially livestock and pig and poultry rearing, any effort at poverty alleviation must address the needs of women as producers and income earners than merely as consumer of social services. There should continued research on the judicial and legal situation that affects women in their activities as rural producers.

Feeding systems

Feeding monogastric (pig, chicken and ducks) is inefficient process on small farms. Although improved feed both in quality and quantity is essential to increase their productivity. However, whilst good quality commercial feeds are available, they are not popularly being used by small farms simply because they are expensive. The option left therefore appears to be the need to develop economically effective feeding systems based on on-farm available non-conventional and indigenous feed resources. It would also be desirable if the technique used in making such feeds would be commensurate with existing on-farm technologies and would socially acceptable.

Research and technology development

Research relevant to small farm production has been shockingly deficient. For small holders, technological change must serve to increase resource productivity as well as labour productivity. It should be characterized by low cost and low external input requirements to facilitate its adoption by small farmers. Research approach needs to be directed to the improvement of feed technologies and storage facilities.

Education extension training

Extension training services that increase the farm productivity and the improvement of farmers access to education must also be ensured.

Conservation of on farm genetic biodiversity

The animal genetic resources are characterized by their great diversity in the tropic. A wide range of resources are found on small farms in the tropical countries of the less-developed world and their conservation is essential. The development of native monogastric animal production needs also to be directed towards both feeding and health management. Native animals require comparatively little inputs and

therefore research on this animals should be directed towards the management with least cost/minimum inputs. This type of study needs to be evaluated economically at on-farm level.

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