

CHARACTERISTIC PERFORMANCES OF THE MAIN FOUR PIG FARMING SYSTEMS IN MANOKWARI, WEST PAPUA

(Karakteristik Performa Babi pada Sistem Pemeliharaan yang berbeda di Manokwari, Papua Barat)

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui kemungkinan perbaikan sistem pemeliharaan ternak babi pada daerah perkotaan maupun pedesaan di Manokwari, Propinsi Papua Barat, Indonesia. Penelitian ini dimulai dengan mengeksplorasi perpektif dan persepsi peternak melalui diskusi kelompok. Sebanyak 386 ekor babi ditimbang dan ditentukan skor kondisi tubuhnya. Peternak babi papua terdiri atas suku Jayapura, Biak, Ambai, dan Ansus (Serui), Mee (Nabire), Arfak (Manokwari) dan Ayamaru (Sorong). Peternak babi non-papua terdiri atas suku Batak, Toraja, Manado dan Flores. Jumlah babi terbanyak dipelihara oleh peternak dengan sistem *semi-pen*, diikuti oleh peternak dengan sistem *pen*, dan *restrained*. Sekitar dua jam per hari dialokasikan oleh peternak untuk bekerja masing-masing pada sistem pemeliharaan model *restrained*, *semi-pen*, dan *pen*, sementara peternak dengan sistem pemeliharaan *free range* hanya mengalokasikan waktu bekerja selama 1,5 jam per hari. Pada daerah perkotaan, bahan pakan utama yang digunakan ialah sisa dapur dan restoran, sementara pada daerah pedesaan bahan pakan yang digunakan ialah hijauan dan sisa hasil tanaman pertanian. Pakan tambahan dan konsentrat yang digunakan hanya dalam jumlah terbatas. Sisa hasil pertanian yaang digunakan ialah ubi kayu, pisang, kentang, jagung, dedak dan sisa sayuran. *Litter size* dari keempat jenis sistem pemeliharaan rata-rata 6 ekor anak/kelahiran/induk. Skor kondisi tubuh babi lebih tinggi pada sistem *pen* (2,9 - 3), diikuti *semi-pen* (2,1 - 3), sistem *free-range* (2,1 - 2,8) dan *restrained* (1,8 - 2,5) dengan tingkat umur yang berbeda. Analisis ekonomi dan sosial dari masing-masing sistem pemeliharaan masih perlu dikaji lebih lanjut.

Kata kunci: Performa babi, *Free-range*, *Restrained*, *Semi-Penned*, *Penned*, Papua Barat

ABSTRACT

This research aimed to investigate opportunities for improving pig farming systems both in urban and rural areas of Manokwari, Papua Barat province-Indonesia. The research started by assessing the perspectives and perceptions of farmers in group meetings. A number of 386 pigs in cummulative was weighing and measured for life body weights and body condition scores. Papuan pig farmers were represented by Jayapura, Biak, Ambai and Ansus (Serui), Mee (Nabire), Arfak (Manokwari) and

Ayamaru (Sorong) tribes. Non-Papuan pig farmers identified with ethnic groups of Batak, Toraja, Manado and Flores. The highest numbers of pigs kept were by semi-penned pig farmers, followed by pen and restrained pig farmers. About two hours per day was devoted to work in the restrained, semi-penned and pen pig keeping systems, while less than 1.5 hours per day was allocated by free-range pig farmers. In urban areas, feeding sources were kitchen and restaurant waste, and likewise crops and agriculture residues were in rural areas. Supplements and concentrates were used on a limited scale. Agricultural residues used were cassava, banana, taro, corn, grain and vegetable wastes. Litter sizes in the four pig farming systems were in average of 6 piglets/farrow/sow. Body condition scores were higher in pen pig keeping, i.e. 2.9 to 3, followed by semi-pen pigs, i.e. 2.1 to 3, free-range pigs, 2.1-2.8 and restrained pigs, i.e. 1.8 and 2.5 at different age levels. Economical and social quantitatives need further studies.

Key words: Pig performance, Free-range, Restrained, Semi-penned and Penned systems, West Papua

INTRODUCTION

In developing countries, factors influencing pig farming systems are poverty, social functions and average income of farmers. Poverty causes that farmers do not have access to the necessary inputs to increase their production. Social functions of animals can be very important in areas such as South Pacific, Papua New Guinea (Perkins, 2002) and the outer islands of Indonesia. Provinces in Indonesia where smallholder pig keeping systems are important are North Sumatra, Bali, Borneo, South and North Sulawesi, East Nusa Tenggara and Papua. Papua is the easternmost island of Indonesia. It consists of two provinces, i.e. Papua and West Papua.

Papua comprises of more than 250 Papuan ethnic groups. There are other Indonesian ethnic groups such as Batak, Java and Sulawesi, Flores, and Ambon, which are called non-Papuan. Papua has unique pig farming systems which can be found at coastal, lowland and even highland areas. One example is the sweet potato-based farming systems in the central highland Wamena (Peters, 2001; Berkmann, 2006), Paniai and Kebar valley (Pattiselanno, 2004b). Sweet potato-based pig keeping is practiced when sweet potatoes are harvested and the pigs eat the residues in the sweet potato fields. Pigs then have two functions, i.e. as bulldozer (Pattiselanno, 2004a) and providers of manure for soil fertility. The last function is not known yet. Another pig keeping system (PKS) is the 'platform' pig keeping system along the coastal line of Manokwari (Ropa, 2001; Warastuti, 2001; Pattiselanno and Iyai, 2005). Swill is the main source of offered feed (Iyai, 2008). Papuans, both in lowland and upland areas, use local resources and traditional knowledge in their pig keeping. The local breeds, feeds, and housing materials sustain traditional pig keeping.

Pigs are playing vital roles in Papua to support Papuan livelihoods and social activities. Warastuti (2001) and Ropa (2001) stated that pigs in coastal areas of Manokwari constitute additional sources of income and savings. Simanungkalit (2001) stated that traditional pig keeping contributes into family consumption, savings and social activities in the highlands of Kebar valley and in Manokwari. Social functions

include using pork for marriages, funerals, anniversaries, and other social activities (Pattiselanno and Iyai, 2005). Although pigs are highly valued, this is not shown in the way pigs are kept.

In Manokwari regency, both in rural and urban areas, pigs are raised in extensive, semi-intensive and intensive ways (Pattiselanno, 2004a). Pens are made of cut wood and roofs are made of aluminum sheets or leaves. Pens can be opened during the day and closed at night (Pattiselanno and Iyai, 2005). Information concerning pigs' production and reproduction performances (Phookan *et al.*, 2006; Kanis *et al.*, 2008) is hardly available.

In developing animal production systems for smallholder farmers, the farming household is the center (Perkins, 2002). Thereby, innovation in terms of messages and technical issues has to be based on farmers' needs, experiences, values and opinions. This can determine priority needs, main constraints (Dessie and Ogle, 2001) and opportunities in pig keeping. How farmers see, perceive and conduct their pig keeping can stimulate to promote effective innovation for pig farmers. Focus given in this research was on investigating opportunities of innovations for farmers in pig keeping in Manokwari regency in West Papua province. Understanding characteristics of pig keeping systems and pig performances are the basis for further improvements. The main aim of the study therefore was to investigate characteristic performances of the current pig keeping systems in Manokwari, West Papua province.

MATERIALS AND METHODS

Materials

General information of Manokwari

Manokwari regency, which has a total area of 14.445 km² and possesses a population of around 161.000 inhabitants with a density of 11.51 inhabitants km⁻¹, is located at 132°30' - 134°45' East Meridian and 0°20' - 2°25' South latitude. Manokwari has relatively dense population of around 228 inhabitants per km². The population in Manokwari is growing in both urban and rural areas, especially in transmigration areas, such as Prafi and Masni districts.

Manokwari regency is a source of agricultural production for both animals and crops. Animals are kept in rural areas in particular in areas used for transmigration by both local people and immigrants. Immigrants settled in Manokwari in 1983. Most of them came from Java and East Nusa Tenggara. They are called non-Papuans. They were given a piece of land, usually two hectares per household, to grow rice and other crops. The government distributed also livestock such as cattle, goats and poultry. Some local farmers had been given land, crops and livestock too. Both local and immigrant farmers are also involved in palm plantations.

Manokwari has a wet climate. The average monthly temperature ranged from 26.4 °C up to 27.7 °C and monthly humidity ranged from 81% up to 86% in 2006. The average annual rainfall was 2.688 mm, with average number of annual rainy days of 123 or 124 days of dry season.

Field research areas

The study was done in Manokwari regency and involved six districts, i.e. Northern Manokwari district, Eastern Manokwari district, Western Manokwari district, Warmare district, Prafi district and Masni district (Figure 1). Respondents chosen, guided by local extensionists, came from 15 villages. In urban areas selected farmers were lived in Anggrem, Borobudur, Fanindi, Wosi, Amban and Susweni. While, in rural areas selected farmers were lived in Tanah Merah, Nimbai, Waseki, Aimasi, Mokwan, Mimbowi, SP-8 Masni, Breimi and Warbefor. Three urban villages, Anggrem, Fanindi and Wosi, are situated at coastal areas of Manokwari as well as the two rural villages, i.e. Breimi and Warbefor, which are located in the Northern coastal line of Manokwari. Anggrem, Fanindi and Wosi are located at less than 5 m above sea level. Amban and Susweni are located at 110 m above sea level. The rural villages Breimi and Warbefor, are located less than 5 meter above sea level. While most villages in Prafi valley, such as Tanah Merah, Waseki, Nimbai, Aimasi, Mokwan, Mimbowi and SP-8 are located at about 20 to 25 meter above sea level.

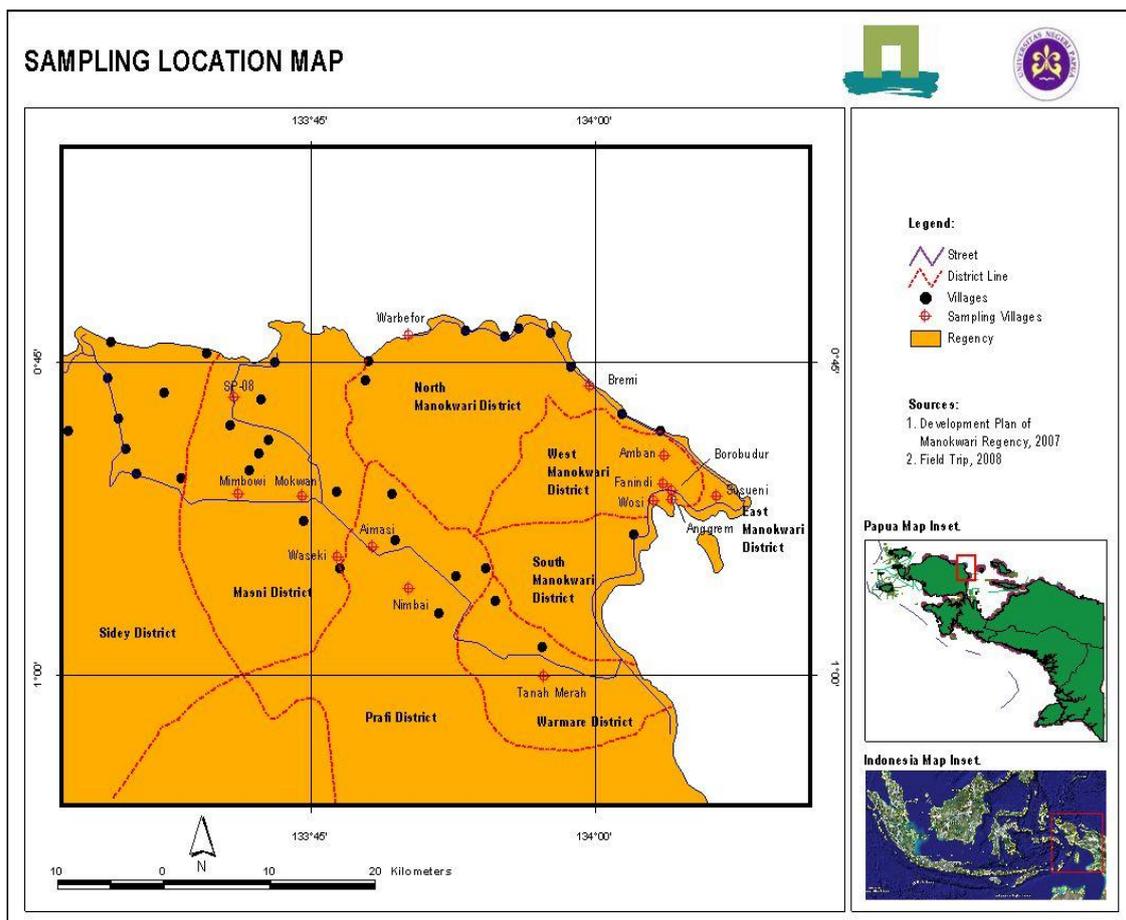


Figure 1. A map of research location in Manokwari, West Papua province-Indonesia.

Methods

A participatory situation approach (Conroy, 2005) was employed during the field research. Group meetings and individual farmer interviews were done. A farming household is defined as a household, headed by man or woman, for whom agriculture is their main source of livelihood. Selected households were grouped into urban and rural pig farmers. The respondents were grouped because farmers in urban and rural areas were expected to have different household or farm characteristics. Fifty farmers, consisting of 20 urban and 30 rural farmers, were interviewed. The interviews included farmer's household characteristics, pig keeping systems, pig performances and perception of opportunities in pig keeping. Household physical performance during field observations in terms of household wealth, owned land, educated family members, and furniture, was used to estimate wealth status. It was then categorized as 'poor', 'normal' and 'well-off'. Educational levels in Manokwari were categorized as 'no education', 'primary education' that was grouped as basic, junior and senior schools and 'university' grouped as 'diploma' and 'university'. The interviews took on average 45 minutes.

Data analyses

All collected data were entered into a database in Microsoft Excel 2003. The statistical analyses (Ott and Longnecker, 2001) were performed using SPSS for Windows version 15.0 (SPSS, 2006). A one-way Anova test for more than two independent samples were used to compare different groups of pig farming systems for the above mentioned parameters. Mathematical formula is $Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$, where Y_{ij} is variable responses, μ is overall mean, α_i is effects of pig farming systems, and ε_{ij} is errors with normal distribution, $N(0, 1)$. Qualitative data resulting from the interviews such as characteristics of pig farmers, characteristics of pig keeping systems, pig productivities were analyzed with Chi-square (χ^2). A t-test for two independent samples was employed. A Post-hoc analysis using LSD was performed for pair wise comparisons.

RESULTS AND DISCUSSIONS

Pig farmers' characteristics in urban and rural areas

Of the field research in urban areas, 19 of 20 farmers were males and in rural areas 26 of 29 farmers were males (Table 1). The participation of female farmers in raising pigs was low. Women can be a headed pig farmer if they are the head of the household. Similar finding of women (gender equitability) was also reported in hillside Thailand (Nakai, 2008). The pig farmers' ages did not differ significantly between urban and rural locations, i.e. 49 and 43 years, respectively. Household sizes were relatively similar in urban and rural areas ($P > 0.05$), i.e. 6.6 persons and 5.8 persons, respectively. Similar finding reported by Tra (2003) in Colombia and Vietnam in which 5 persons/hh living in the same family of pig farmers.

In both locations Papuan and non-Papuan farmers were found. The Papuan pig farmers were of different tribes, i.e. Arfak (Manokwari tribe) origin, Biak origin, Ambai and Ansus (Yapen) origin, Jayapura origin, Ekagi or Mee (Nabire) origin and Ayammaru (Sorong) origin. Non-Papuan ethnics were represented by Batak (North Sumatra), Toraja (South Sulawesi), Bali, Manado (North Sulawesi) and Flores (East Nusa Tenggara) ethnic groups. Javanese pig farmers were not found during the research.

Table 1. Pig farmers' characteristics in urban and rural areas.

Farmer's characteristics	Location of households			
	Urban (n=20)		Rural (n=29)	
	Mean	%	Mean	%
Sex (%)				
Male	19	95	26	90
Female	1	5	3	10
Age (y)**	48.9 ± 9.3		43.1 ± 12.9	
Household size (n)**	6.6 ± 3.5		5.8 ± 2.6	
Ethnics (%)				
Papua	17	85	18	62
Non-Papua	3	15	12	38
Land size (%)*				
landless	12	60	1	3
≤1 ha	4	20	2	7
≥1 ha	4	20	26	90
Educational level (%)*				
No education	6	30	17	59
Primary	11	55	7	24
University	3	15	5	17
Income source (%)				
State officer	6	30	8	28
Farmer	8	40	17	59
Private	6	30	4	14
Wealth status (%)				
Poor*	6	30	18	90
Normal	11	55	8	27
Well-off	3	15	3	10

*There was association between urban and rural pig farmers (Chi-square test, P< 0.05)

**There was no significant differences (p>0.05).

Mean ± Standard Deviation

Most pig farmers in rural areas (90%) had land sizes larger than 1 ha, while in urban areas most farmers (60%) were landless (P<0.05). Urban farmers with land (less than 1 ha), were living in Susweni village and used this land for cropping. The four urban farmers with more than 1 ha were Arfak tribe landlords.

Table 1 shows that educational level of pig farmers was different (P<0.05) between urban and rural areas. Most pig farmers that had no education (59%), were living in rural areas, whereas in urban areas many farmers (55%) went to high school

compared to only 7 rural pig farmers who did so. Both areas had farmers that were relatively well-educated, i.e. 3 and 5 in urban and rural areas, respectively. Effect of educational levels was reported in Kenyan small-scale pig farmers also by Kagira *et al.* (2010).

Income sources did not differ between urban and rural farmers. Most pig farmers in rural areas (59%) considered themselves as farmers, as “pure” pig farmers or crop farmers. Three out of eight urban pig farmers with penned pigs worked as fisherman, private airplane officer and one received a pension. The private sector was one of the alternative jobs for less educated persons in urban areas such as working as labourers. Some pig farmers in rural areas looked occasionally for seasonal jobs in the city.

Most pig farmers (90%) in rural areas had “a poor” status ($P < 0.05$), while for urban pig farmers this was only 30%. “Normal wealth” status was found in 55% of the urban pig farmers and for rural areas this was 27%. In both areas, three farmers were found to be “well-off”. In general rural pig farmers had higher pressure and lower general resources compared to urban pig farmers. Effects resulted from each component need to be separately studied.

Pig farming systems

Pig keeping systems in Manokwari can be categorized into four pig keeping systems, i.e. free-range-, restrained-, semi-pen- and penned pig keeping systems. Performances and visual appraisals of these four pig keeping systems are explained in subsequent pages. In rural areas, with 29 participating farmers, 17 households (58%) were free-range pig keepers, 4 households (13%) were farmers with restrained pig keeping, 3 households (10%) were with semi-penned farmers and 5 households (17%) were farmers with penned pig keeping. The free-range scavenging pig keeping system is the oldest pig keeping systems in Manokwari. Changes and appearances of other pig keeping systems in Manokwari are being shaped from this traditional system. The characteristics of these pig keeping systems will be explained below.

In the free-range pig keeping system, farmers do not provide housing and feeding on a regular basis. Pigs have to cater for their own needs such as feeds and spaces. Feeds are provided when farmers want to call or approach their pigs. This system is still found in both urban and rural locations. It is the traditional pig keeping system in rural areas. In urban locations, it implies that pigs scavenge in waste disposals and gardens, and roam around urban houses. In restrained pig keeping, farmers tie the leg or neck of sows and boars, while the piglets and weaners are not being tied. The restrained pig keeping system was mainly found in transmigration areas and was done by non-Papuans (East Nusa Tenggara in SP-8 Manokwari). Crops and their residues were most used as feed, such as cassava, banana, taro, maize, grains and vegetables.

Fresh crops were bought in the local markets. In addition, crops sometimes are obtained by collectively buying it from crop farmers. This was usually done once a month by using a truck. In the rural areas, farmers grow their own crops for feeding their housed pigs.

In the semi-penned pig keeping system, farmers provide housing and feeding but pigs have the opportunity to scavenge during the day. In this system pigs kept

were mostly crossbreds, either imported with local or local with wild pigs. Farmers in urban areas, in particular in southern coastal areas, provide docking houses, which means that the pens built have slatted floors and are placed over land and/ or water, while farmers staying more in-land provide fenced housing. In the pen pig keeping system, pigs are housed completely. Feeding is done routinely, i.e. in the morning and in the afternoon. In urban areas, pig farmers that raise pigs in pens feed wastes from kitchens, restaurants and hotels and in small amounts crops and agriculture residues.

Overall, pig farming systems were classified into three different systems (Muys and Westenbrink, 1998), i.e. free-range scavenging pig keeping, semi-intensive- and intensive pig keeping. Pig production systems in developed countries are mainly commercial-intensive pig keeping systems. In developing countries, such as in Papua New Guinea (Berkmann, 2006), Vietnam (Lemke *et al.*, 2006), India (Deka *et al.*, 2007), and in Africa (Lekule and Kyvsgaard, 2003), different production systems co-exist due to different resource availabilities, values and functions, knowledge and traditions.

Pig farming characteristics

Table 2. depicts an overview of pig farming characteristics: experience, herd size, breeds, labour and work hours for the four pig keeping systems. Experiences in keeping pigs differed between the four pig keeping systems ($P < 0.05$). On average free range pig farmers had 31 years of experiences in keeping pigs. Whereas, on average, restrained and pen farmers had 14 years and 15 years of experience in keeping pigs, respectively. Semi-pen pig farmers had 24 years of experience in raising pigs.

Table 2. Overview of pig keeping characteristics for the four pig keeping systems.

Pig farming characteristics	Pig keeping systems							
	Free-range (n=19)		Restrained (n=4)		Semi-Pen (n=11)		Pen (n=15)	
	Mean	%	Mean	%	Mean	%	Mean	%
Experience (y)*	31.0±14.2 ^a		14.3±6.1 ^b		23.7±13.3 ^a		15.2±16.4 ^b	
Herd size (n)*	5.5± 4.1 ^a		7.3±1.5 ^a		12.3±12.1 ^b		7.3±6.1 ^a	
Breed (%)**								
Local	5	26	0		4	36	5	33
Import	0		0		0		3	20
Local x import	7	37	3	75	5	45	6	40
Local x Wild pig	11	58	1	25	2	18	2	13
Labor(%)								
Father	9	47	3	75	10	91	8	53
Mother**	19	100	4	100	9	82	8	53
Children	6	32	3	75	5	45	7	47
Hired	0		0		0		2	13
Work hours (h/day)*	1.32± .45 ^a		1.50±.71 ^a		2.09± .83 ^b		2.21±1.13 ^b	

*There was a significant difference between the four pig keeping systems, One-Way Anova test ($P < 0.05$).

**There was a significant difference between the four pig keeping systems, Chi-Square test ($P < 0.05$).

Mean ± Standard Deviation

Herd size differed between the four systems ($P < 0.05$). The number of pigs kept by semi-penned farmers, with an average of 12 pigs kept, was significantly higher than in the other systems. Restrained and pen pig farmers were only keeping 7 pigs per household. Free-range pig farmers were only keeping 5 pigs per households. Twenty three farmers (47%) kept 1 to 5 pigs. The numbers of 6 to 10 pigs were kept by 14 farmers (29%) and more than 10 pigs were kept by 12 farmers (24%). This finding was in between of the finding of Tra (2003) at Vietnam, where number of population was ranged of 5-10 heads/hh and lower than that of Northern Thailand, i.e. 4 heads/hh (Kunavongkrit and Heard, 2000; Nakai, 2008).

Local breeds were mostly used by free-range pig farmers (26%), semi-pen pig farmers (36%) and pen pig farmers (33%). Only pen pig farmers kept imported breeds although only in few numbers of farmers (18%). Local \times imported breeds were used by 37% of the free-range pig farmers, 75% of the restrained pig farmers, 45% of the semi-pen pig farmers, and 40% of the pen pig farmers. A considerable number of free-range pig farmers (58%) kept local \times wild pigs, while only 25%, 18% and 13% of the restrained, semi-pen and pen pig farmers, respectively, kept local \times wild pigs. Local pigs are mainly kept by farmers in developing countries (Lekule and Kyvsgaar, 2003; Chiduwa *et al.*, 2008; Phookan *et al.*, 2006; Lemke *et al.*, 2006). Local pigs are suitable for smallholder farmers. In Asia, many different native pigs and local breeds can be found (Oliver *et al.*, 1993; Anil *et al.*, 2006). Other important traits that can be economically and socially adapted are needed to be selected (Kanis *et al.*, 2008).

Labour is a primary production factor for raising pigs. Men were similarly involved in the workload in these pig keeping systems ($P > 0.05$). Women labour in keeping pigs differed between these pig keeping systems ($P < 0.05$). Children were involved similarly in these pig keeping systems. Mostly the mother was doing the work in keeping pigs, followed by the father and children. Only in penned systems pig keeping hired labor were used.

Work hours in raising pigs differed ($P < 0.05$) amongst pig keeping systems. On average, work hours allocated in pen systems were 2.2 h d⁻¹ followed by semi-pen system with 2.1 h d⁻¹, restrained pig keeping with 1.5 h d⁻¹ and free-range keeping with 1.3 h d⁻¹. Work included cleaning houses and pigs, and giving feed to the pigs. In free-range pig keeping, only occasionally feed was given by the farmers, pigs obtained the majority of their feed requirements by scavenging around waste disposals, gardens and communal land. Raw feed materials such as cassava were often given by chopping it in small pieces. Free-range pig farmers spent considerable time in inspecting their pigs and approaching them to get contact and an emotional bond with their pigs.

Characteristics of feeds

Pig feed characteristics consisted of feed types, residue uses and feed sources (Table 3, 4 and 5).

Feed types

Table 3 shows that almost half of the farmers (43%) used a combination of feeds. A combination of kitchen wastes, crops and residues was used by 21 farmers (43%),

followed by 6 farmers (12%) using a combination of crops, agriculture residues and 5 farmers (10%) using crops, agriculture residues and concentrates.

Table 3. Overview of feed types given in the four pig keeping systems.

Feed types	Pig keeping systems				
	Free range (n=19)	Restrained (n=4)	Semi-Pen (n=11)	Pen (n=15)	Total (n=49)
	(%)	(%)	(%)	(%)	(%)
1,3	0	0	0	1 (6)	1(2)
1,3,4	14 (74)	0	4 (36)	6 (40)	21(43)
1,3,4,5	0	0	1 (9)	0	1(2)
1,3,4,6	0	0	0	3 (20)	3(6)
1,5	0	0	0	1 (6)	1(2)
2,3,4	0	0	1 (9)	2 (13)	3(6)
2,3,4,5	0	0	3 (27)	0	3(6)
2,3,4,6	0	0	0	1 (6)	1(2)
3,4	3 (16)	1 (25)	0	2 (13)	6(12)
3,4,5	0	0	0	1 (6)	1(2)
3,4,5,6	1 (5)	0	0	0	1(2)
3,4,6	1 (5)	3 (75)	2 (18)	0	5(10)

1=Kitchen, 2=Kitchen & Restaurant, 3=Crops, 4=Agriculture residues, 5=Supplement (salt, antibiotics, fish bone) and 6=Concentrates.

Figures in parentheses are percentages of respondents.

In the four pig keeping systems, more than half of the free-range farmers (74%) were using a combination of kitchen waste, crops and residues. Most restrained pig farmers (75%) were depended on crops, agriculture residues and concentrates. Semi-pen and pen pig keeping farmers used a wide variety of feeds, mostly a combination of kitchen wastes, crops and residues, restaurant wastes and supplements, and concentrates. Higher variability of feeds were applied by the two traditional intensive pig keeping systems, i.e. semi-penned and penned systems compared to the rest, i.e. free-range and restrained systems.

Crop residue types

Table 4, shown that 15 farmers (31%) used crop residues fed to the pigs, mostly cassava, banana, taro, grain and vegetable wastes, followed by 31 % of farmers who were using cassava, banana, grain and vegetable residues. Cassava, grain and vegetable residues were used by 7 farmers (14%). All kinds of combinations were found and applied by the semi-pen and pen pig farmers.

In the free-range pig keeping system, a combination of cassava, banana, grain and vegetable residues was fed to pigs. Other crops products were also offered to pigs such as palm kernel (Amaufule *et al.*, 2006).

Grain residues were mainly fed by farmers with rice fields. Restrained pig farmers depended on a combination of cassava, banana and vegetable residues. Semi-pen and pen pig farmers used a wide variety of feeds including complete crops. Similar finding also reported in application of residues. Higher variability of residues were

applied by the two traditional intensive pig keeping systems, i.e. semi-penned and penned systems compared to the rest, i.e. free-range and restrained systems.

Table 4. Overview of residues used in the four pig keeping systems.

Residue types	Pig keeping systems				
	Free range (n=19)	Restrained (n=4)	Semi-Pen (n=11)	Pen (n=15)	Total (n=49)
	(%)	(%)	(%)	(%)	(%)
1,2,6	2(10)	3(75)	1(9)	1(6)	7(14)
1,2,3,6	1(5)	0	0	2(13)	3(6)
1,2,3,4,6	0	0	0	2(13)	2(4)
1,2,3,4,5,6	0	0	2(18)	0	2(4)
1,2,3,5,6	5 (26)	0	5(45)	5(33)	15 (31)
1,2,5,6	11(58)	0	2(18)	3(20)	15 (31)
1,3,5,6	0	0	0	1(6)	1(2)
1,6	0	1(25)	0	0	1(2)
2,3,5,6	0	0	1(9)	0	1(2)
2,3,6	0	0	0	1(6)	1(2)
5,6	0	0	0	1(6)	1(2)

1=Cassava, 2=Banana, 3=Taro, 4=Corn, 5=Grain, 6=Vegetable wastes.

Figures in parentheses are percentages of respondents.

Feed sources

Places where pig farmers collected feeds varied. High numbers of farmers (n=16) depended on kitchen and garden (n=16), followed by kitchen, garden and disposal (n=15), garden, disposal and market (n=5) and kitchen, garden and restaurants.

Table 5. Overview of feed sources in the four pig keeping systems.

Feed sources	Pig keeping systems				
	Free range (n=19)	Restrained (n=4)	Semi-Pen (n=11)	Pen (n=15)	Total (n=49)
	(%)	(%)	(%)	(%)	(%)
1	1(5)	0	0	0	1(2)
1,2	9(47)	0	0	7(47)	16(33)
1,2,3	0	0	0	4(27)	4(8)
1,2,3,4	0	0	2(18)	0	2(4)
1,2,3,4,5	0	0	1(9)	0	1(2)
1,2,4	9(47)	0	4(36)	2(13)	15(31)
1,2,4,5	0	0	2(18)	1(6)	3(6)
1,4,5	0	0	1(9)	0	1(2)
1,5	0	0	0	1(6)	1(2)
2,4,5	0	4(100)	0	1(6)	5(10)
2,5	0	0	1(9)	0	1(2)

1=Kitchen, 2=Garden, 3=Restaurant, 4=Disposal, 5=Market.

Figures in parentheses are percentages of respondents.

Free-range pig farmers (47%) depended on kitchen, garden and disposal sources. Restrained pig farmers (100%) depended on feed from harvested gardens, disposal and market sources. Restrained pig farmers used concentrates as additional feed bought from local markets. This source of feed was used with other types of livestock and poultry farmers in Manokwari. Semi-pen pig farmers (36%) were feeding pigs with feed collected from kitchens, gardens and disposals. A small number of farmers bought feeds from a local market (9% and 18% of crops and concentrates, respectively). Pen pig farmers were depended on kitchen and gardens (47%). A quarter numbers of pig farmers (27%) used feeds obtained from kitchens, gardens and restaurants.

The herd size in the semi-penned pig keeping system higher than in the free-range and restrained pig keeping systems. Breeds used were local and imported (crossbreeds) types. Semi-penned pig farmers used swill feeds. Concentrates were hardly given to the pigs. Raw ingredients were occasionally given. Chopped swill feed was cooked before offered. Pigs also had chances to scavenge around. Outputs were sold fatteners, piglets and pork. Manure and tillage of the land had no market values. In this system, no findings of gifts were recorded.

Pig characteristics' measurements for the four pig keeping systems

Pig performance characteristics

Performances of pigs in the four pig keeping systems are depicted in the Table 6 and 7. Table 6 shows that there was no significant difference in litter size amongst pig keeping systems. The average litter size was 6 piglets. Similar report was also found by Wabacha *et al.* (2004) at Kenya pig farming system, i.e. 4 heads of born piglets/hh. Number of farrowing/y was 2 times. The number of farrowing was also not significantly different among the four pig keeping systems. It ranged from 1.5 to 1.7 farrowing per year. Similar findings were reported in India by Kumaresan *et al.*, (2007) and in Vietnam by Lemke and Zarate (2008) and Lemke *et al.* (2008) and Roessler *et al.* (2008).

Table 6. Overview of pig characteristics for the four pig keeping systems.

Pig characteristics	Pig keeping systems							
	Free range (n=19)		Restrained (n=4)		Semi-Pen (n=11)		Pen (n=15)	
	Mean	%	Mean	%	Mean	%	Mean	%
Litter size (<i>n</i>)	5.61±1.19		6.0±1.15		7.0±2.28		5.69±1.97	
Farrowing frequency (<i>n</i> year ⁻¹)	1.50±0.51		1.75±0.50		1.73±0.47		1.61±0.51	
Boar uses (%)								
Own*	2	10	2	50	6	55	9	60
Rent*	0	0	0	0	1	9	6	40
Natural mating*	13	68	2	50	4	36	0	0
Wild pig	4	21	0	0	0	0	0	0

*There was a significant difference between pig keeping systems' households, Chi-Square test (P< 0.05). Mean ± Standard Deviation.

There were significant differences in using boars between the four pig keeping systems. Nine of 15 penned pig farmers, six of the 11 semi-penned pig farmers, two of the 4 restrained pig farmers and two of 19 free-range pig farmers used their own boars. Rented boars were found in semi-pen and penned pig systems. Most farmers in free-range pig keeping were using “natural” mating, which means that mating occurs in the field without presence of the owners. Four (36%) farmers of 11 semi pen pig farmers applied natural mating, although they had their own boars. This was simply because they did not know when sows had to be mated.

Body condition score, body weight, and hearth girth

Table 7 shows that there were significant differences in pig body condition scores ($P < 0.05$) between pig production systems. On average, pigs had normal body condition scores (BCSs). BCSs of piglets, weaners and growers in the pen pig keeping system were higher than in the other pig keeping systems. Restrained growers had a low BCS. Sows had a lower BCS in the restrained pig keeping system than in the other systems. The BCSs based on types of breed were not recorded.

Table 7. Body condition scores and body weight for different categories of pigs for the four pig keeping systems.

Pig characteristics	Pig keeping systems							
	Free range		Restrained		Semi-Pen		Pen	
	Mean	n	Mean	n	Mean	n	Mean	n
BCS (<i>n</i>)								
Piglets*	2.3 ^a ± 0.6	23	2.4 ^a ± 0.9	8	2.1 ^a ± 0.7	53	2.9 ^b ± 0.3	22
Weaners*	2.1 ^a ± 0.4	23	2 ^a ± 0.0	7	2.1 ^a ± 0.6	29	2.9 ^b ± 0.3	15
Growers*	2.5 ^a ± 0.5	28	2 ^b ± 0.0	7	2.7 ^{a,d} ± 0.5	22	2.9 ^{c,d} ± 0.3	46
Sows*	2.8 ^a ± 0.5	24	1.8 ^b ± 0.4	6	2.8 ^a ± 0.4	16	2.9 ^a ± 0.3	23
Boars*	2.8 ^a ± 0.4	6	2.5 ^a ± 0.7	2	3.0 ^{a,b} ± 0.0	7	3 ^{a,b} ± 0.0	15
Body weight¹(kg)								
Piglets(kg)*	2.9 ^a ± 0.6	23	3 ^a ± 0.7	8	2.8 ^a ± 0.7	53	3.5 ^b ± 0.5	22
Weaners(kg) *	2.5 ^a ± 0.7		2.9 ^{a,b} ± 0.6		3.3 ^{a,b} ± 1.1		3.8 ^b ± 0.6	
Growers(kg)* ²	11.6 ^a ± 1.9		13.5 ^a ± 1.3		14.4 ^a ± 5.9		16.6 ^b ± 7.2	
Sows (kg)*	48.7 ^a ± 13.7		55.4 ^{a,b} ± 3.1		65.8 ^{a,b} ± 18.6		87.2 ^b ± 52.7	
Boars (kg)	58.4 ± 14.5		65.2 ± 5.4		65.6 ± 14.3		100.3 ± 83.5	
Body length (cm)*								
Weaners	32.1 ^a ± 2.3	23	34.5 ^b ± 2.4	7	35 ^b ± 3.5	30	35.8 ± 2.1	14
Growers	52.4 ^{a,b} ± 3.1	26	49.8 ^a ± 2.1	7	57.3 ^{b,c} ± 9.6	2	61.5 ^c ± 7.1	48
Sows	88.1 ^a ± 8.3	23	92.9 ^a ± 2.8	6	100.8 ^b ± 13.6	24	107.1 ^b ± 13.4	19
Boars	91.2 ^a ± 6.1	6	97 ^a ± 0.6	2	99.7 ^a ± 7.5	7	109.7 ^b ± 22.3	13
Hearth girth (cm)								
Weaners*	32.6 ^a ± 3.5	23	34.2 ^b ± 2.3	7	35.5 ^b ± 4.3	30	38.3 ^b ± 2.2	14
Growers*	51.3 ^a ± 4.2	26	52.7 ^b ± 2.5	7	58.3 ^b ± 10.8	22	60.8 ^b ± 9.8	4.8
Sows*	86.3 ^a ± 8.1	23	90.6 ^a ± 1.5	6	93.5 ^a ± 10.4	24	101.5 ^b ± 20.7	19
Boars	93.2 ± 8.3	6	96.3 ± 4.3	2	94.5 ± 7.9	7	107.8 ± 25.1	25.13

¹Formula = (L*G*G)÷13781.

²There was a significant difference between pig body weights in pig keeping systems, One-way Anova test ($P < 0.05$) and Kruskal Wallis test ($\chi^2=9.8$).

Table 7 shows that in general there were significant differences in body weights of pigs between different production systems for different growth phases. Body weights of piglets were significantly different in the four pig keeping systems ($P < 0.05$). The higher piglets' body weights were obtained in the penned pig keeping system. The body weights of weaners, growers, sows and boars were estimated by using body length and hearth girth.

Higher weaner body weights were obtained in the penned pig keeping system, i.e. 3.8 kg, followed by semi-penned system with 3.3 kg, restrained pig keeping with 2.9 kg and free-range pig keeping with 2.5 kg. In gilts and sows, highest body weights were recorded also in the penned pig keeping system. There was no difference of body weights in boars between pig keeping systems. Similar finding was also reported in Manokwari by Randa (1994).

Table 7 also shows that body lengths differed between different categories. The body lengths were significantly different ($P < 0.05$) between pig production systems. Weaners body length was higher in the pen pig keeping system than in the free-range system. The pig body lengths of other age groups were significantly different ($P < 0.05$) between the pig keeping systems in growers, sows and boars with the highest body length measurements in the pen pig keeping system ($P < 0.05$).

Hearth girths were also significantly different ($P < 0.05$) between pig production systems. Weaners and growers hearth girths in the free-range system were lower than in the three other pig keeping systems. In sows, hearth girth of penned pigs was higher than in the other three pig keeping systems.

CONCLUSIONS

Pig farmers can be grouped into urban and rural farmers. Performances of both farmers slightly similar except for land size, educational level and wealth status. Rural farmers are having lower general resources compared to urban pig farmers. There were four types of pig keeping systems identified, i.e. free-range, restrained, semipenned and penned pig keeping systems. These systems differed in herd sizes, breed used, women-labour, work hours, reasons of keeping pigs (income and cultural reasons), BCS (piglets, weaners, gilts, Sows) and body weight (piglets, weaners, gilts, sows). Semi-penned system contributes significantly on farmers and pig farm, and pig performances followed by penned, free-range and restrained pig systems. In details, pigs were not solely kept for production purposes; they also had a social function. Herd sizes and reproduction performances were slightly below averages for tropical conditions. Pig productivities in terms of body weight and body condition scores were relatively promising. Economical and social quantitatives need further studies.

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