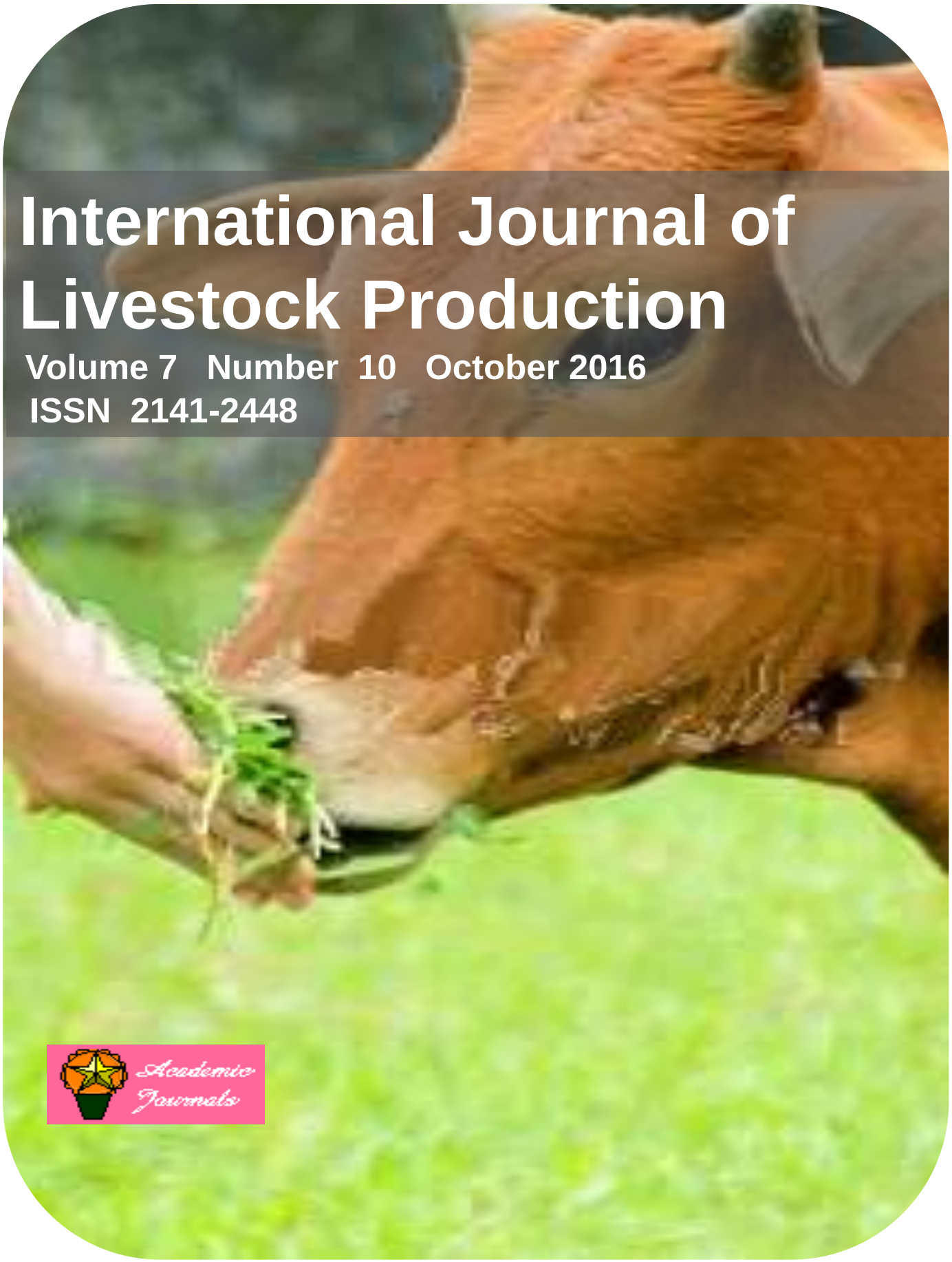

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Table of Contents: Volume 7 Number 10 October 2016

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Full Length Research Paper

Comparative study of Indigenous pig production in Vietnam and Sri Lanka

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Smallholder pig farming is an important livelihood source in many rural communities of countries in Asia region such as Vietnam and Sri Lanka. The indigenous pig population is diminishing over the years and it requires a better attention for conservation and sustainable utilization. The objectives of this study were to identify the pig farming system characteristics and investigate the effect of these characteristics on keeping pigs for livelihood in Vietnam and Sri Lanka. A total of 725 households were surveyed including 264 keeping pigs and 461 without pigs. Farming system characteristics were analyzed by descriptive statistics. The effect of farming system characteristics on keeping pigs for livelihood was determined by logistic regression models (Models I and II). The results revealed that majority of famers (>80%) kept indigenous pigs as an income source in both countries. Free range pig rearing system with low cost feeding (mainly the kitchen waste) was predominant in Sri Lanka whereas confined pigs and providing commercial concentrates was mainly practiced in Vietnam. The average herd size was significantly ($p<0.05$) different in Vietnam (8) and in Sri Lanka (4). Age at first farrowing, farrowing intervals and number of piglets per farrow were higher in Vietnam than in Sri Lanka. The results of model-I showed that family size, availability of piped water, keeping other livestock than pigs, watering pigs adlibitum, positively influenced keeping pigs for home consumption, whereas feeding kitchen waste, availability of water connection in working condition and livestock income negatively influenced for the same attribute. The results of model-II revealed that availability of river water and livestock income have positive impacts while availability of piped water and watering pigs adlibitum have negative impacts on keeping pigs as a income source. These findings will be useful in formulating policies to conserve the gene pool of indigenous pigs and facilitate the indigenous pig production. Increasing indigenous pig production will contribute in considerable level to ensure the food security and income generation of rural families.

Key words: Indigenous pigs, livelihood, Sri Lanka, Vietnam

INTRODUCTION

Small-scale pig farming plays an important role in livelihood of many rural farm families in developing countries (Lanada et al., 2005; Ayalew et al., 2011). In the Asian region, Sri Lanka and Vietnam are two countries

countries among many where pig farming contributes at different levels but in many ways to rural livelihood particularly in income generation and household food security. Pig populations in Vietnam and Sri Lanka are 27 million (FAO, 2011) and 82 030 (DAPH, 2011), respectively. Vietnam possesses the largest pig herd in South East Asia and among the top five countries that raise pigs in the world (Dang-Nguyen et al., 2010). Hence, it is inevitable that a large proportion of the population (42%) of farm households own pigs and pork accounts for about 74% of all livestock products (Duong and Giao, 2012). In contrast, Sri Lanka possesses one of the smallest populations among the pig producing countries of the region where it contributes only 4% to the total meat production of the country (Dematawewa et al., 2009). Similarly, the level of pork consumption also varies in two countries; 34.9 kg in Vietnam (Duong and Giao, 2012) and 0.309 kg/year (DAPH, 2011) in Sri Lanka.

Despite the operational differences in two countries, both show many commonalities in its role play as pork has been recommended as a good source of cheap, high quality animal protein and fat for human. In addition, pigs also have high production potential, high prolificacy and high carcass yield (Ironkwe et al 2008). Therefore, improving small-scale pig production is a remedial action in both the countries in the respective endeavours towards alleviating the animal protein and calorie deficit in rural families.

The indigenous pigs are still reared under smallholder farming systems even though exotic pig breeds and their crosses are more popular in both countries. The indigenous pigs possess valuable traits such as adaptability to poor feed quality, resistance to diseases and ability to thrive through a wide range of environments. Moreover, indigenous pig industry only requires minimal inputs in terms of family labour and feeding. Hence, they sustainably exist in rural setup compared to exotic pig breeds. However, due to the pressures for high production efficiency, the indigenous pig population has gradually been decreased with the introduction of exotic pig breeds such as Landrace and Large white in breeding strategies in respective countries, and in particular in Sri Lanka, where indigenous pig farming is always receives a least priority in livestock production endeavours under present policy, economic and social regimes. Given the unique features of indigenous pigs and their role play in rural economy and household food security, it is highly required to formulate policies to support conservation and sustainable utilization of indigenous pigs in both the countries. However, very little information is available on indigenous pig production, especially in Sri Lanka. In this context, this study attempts to describe the characteristics of pig farming systems and to quantify the effect of these characteristics on keeping pigs as a livelihood function by rural farmers in Vietnam and Sri Lanka, where pig farming is operated in two different operational scale but similar social strata.

MATERIALS AND METHODS

Study sites

This study was conducted between 2009 and 2011 in Sri Lanka and Vietnam. Two study sites were selected in each country on the basis of the availability of the indigenous pigs and their diversity. The selection of study sites and data collection arrangement in this study was conducted in the larg framework of the multi-country regional project (GEF-UNEP-ILRI FAnGR Asia Project) that is being conducted South Asian region. Maps showing the location of the selected sites can be accessed on the projects website http://fangrasia.org/

Sampling

The household survey followed a stratified random sampling method. Stratification was done based on ownership of species of interest (pigs). The sampling process involved the field teams visiting (with the assistance of village chiefs and/or elders) and producing a full list of households categorized into 'species owning' and 'non-species' owning for the species of interest (pigs in the case of this study) in the selected villages. A detail description of the sampling process is given in the household reports of respective countries on project websites http://fangrsl.com/ and http://fangrvn.com.vn of Sri Lanka and Vietnam, respectively. From the list of households in each of the categories, the team then randomly selected the number of households' required. Five additional households were also selected in each category as replacements for households refusing to participate in the survey. A summary of the households selected in each country; Sri Lanka (317) and Vietnam (408) are given in Table 1. A total of 725 households, 264 keeping pigs and 461 without pigs, participated in the household survey. In Sri Lanka, indigenous pig rearing activities was limited to only one project site and also two villages out of the seven villages surveyed in total (Table 1).

Data management

Database design and data entry of the surveys were done in Microsoft office (MS Access). MS Access is a user friendly software which provides sufficient data validation tools to support high-accuracy data entry and requires limited data cleaning requirements. Similar databases were used across the two countries for data management.

Data analysis

Quantitative data were analyzed using descriptive and inferential statistical procedures in the STATA software (www.stata.com). Tests of statistical significance or otherwise of particular comparisons were done with *Chi-square* (χ^2) tests, and *Marascuillo*

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Table 1. Total number of households (HHs) selected for survey in Sri Lanka and Vietnam.

Country	Site	Villages	HHs keeping pig breeds				HHs not keeping pigs
			All pig breeds	Indigenous breeds only	Exotic/ crossbreds only	Both Indigenous and Exotic	
Sri Lanka	Thirappane	Alagollawa	30	08	22	--	10
		Labunoruwa	03	01	02	--	29
		Ooththupitiya	--	--	--	--	40
		Dematagama	--	--	--	--	40
	Karuwalagaswewa	Thabbowa	--	--	--	--	55
		Thewanuwara	--	--	--	--	55
		Kudamedawachchiya	--	--	--	--	55
Vietnam	Son La	Co Chia	46	44	0	2	12
		Cho Long	59	54	2	3	11
		Ban Dan	49	47	0	2	17
	BacNinh	Lac Tho South	33	13	17	3	38
		Ho Town	22	15	5	2	49
		Lac Tho North	22	20	1	1	50

procedure in Minitab for comparisons of multiple proportions (www.minitab.com). The *Post-Hoc Turkeys HSD test* was used for multiple comparisons of means. The significance levels considered were *P<0.01*, *P<0.*05 and *P<0.10*. The effects of farming system characteristics on the reason for keeping pigs as a source of income (Model I) and for home consumption (Model II) were determined using logistic regression models. The explanatory variables used for these models are listed in Table 2.

RESULTS

Results of the study are presented in this report across countries facilitating the comparison between the two scales of operations. However, owing to the difference in popularity of indigenous pig farming in two countries, the number of observations made in two sites varied widely.

Pig farming system characteristics across countries

Pig breeds and their preference

The percentage of households keeping the different pig breeds in Sri Lanka and Vietnam are presented in Table 3. The number of pig breeds kept and their preferences varied from country to country. The commercial pig breeds (27%) and their crosses with village pigs (46%) were predominantly kept in the study area in Sri Lanka while the local Ban pigs (46%) were kept mainly in the study area in Vietnam. Between two countries, Vietnam (7 breeds/crosses) had a high number of pig breeds (including crosses) compared to Sri Lanka (4 breeds/ crosses).

Production systems, feeding and breeding practices

Production systems were defined based on the management and housing regimes. Two systems of production; free range and confined were identified in both countries. Confined was further split into two, those with roof and without roof in their houses. Accordingly, all three production systems were represented in both the countries. In Sri Lanka, majority of the households kept pigs under the free range system both during the day and at night, while in Vietnam, pigs were mainly confined (with roof) during the day and at night (Table 4). Within country comparison (χ^2) of the number of households practiced different pig production systems showed significant differences only between free range and confined (with roof) during the day (19.13, *P<0.01*) and at night (7.52, *P<0.01*) in Vietnam. Between the two countries, the number of household practicing different systems of production was significantly different (*Marascuillo procedure*).

Since pigs were mainly confined in Vietnam, commercial feeds were purchased by majority (54%) of the farmers (Table 4). Kitchen waste and straws / grains / fodders were also used as feeds for pigs. A significantly high number of households use commercial feeds for pigs compared to the use of kitchen waste (135.83, *P<0.01*), grains (83.31, *P<0.01*) and other pig feed resources (64.58, *P<0.01*). In Sri Lanka, Kitchen waste (48%), straws / grains / fodders (24%) and commercial feeds (24%) were used as pigs feed where the proportional use of kitchen waste as a feed resource differed significantly from commercial feeds and grains (17.22, *P<0.01*). Across country comparisons showed the

Table 2. Description of variables for the logistic regression models.

Variables	Description	Variable type
Dependent		
Pigs for home consumption (Model I)		0/1
Pigs as a source of income (Model II)- Vietnam only		0/1
Independent		
Country[a]	Country name	Categorical
Gender	Gender, 1 if the household is male headed	0/1
Age	Age	Continuous
Farm-exp	Farming experience	Continuous
HHsize	Family size	Continuous
Educ	Number of years of schooling	Continuous
Farmincome	Farm income (not including livestock)	Continuous
Liv-income	Income from livestock and livestock products	Continuous
Offfarm-income	Off-farm income (including remittances)	Continuous
Liv-other	Keeping other livestock other than pigs	0/1
House-day[b]	Housing system (Day)	Categorical
House-night[b]	Housing system (Night)	Categorical
Feed-kitchen	Feeding - kitchen waste	0/1
Feed-grains	Feeding - straws / grains / fodders	0/1
Feed-conc	Feeding - commercial concentrates	0/1
Health	Animal health services	0/1
ChickenTLU	Chicken Tropical Livestock Units	Continuous
Information	Source of information	0/1
Primary[c]	Primary activities	Categorical
Waterown	Watering frequency (animals get on their own)	0/1
Wateronce	Watering frequency (once a day)	0/1
Watertwice	Watering frequency (twice or thrice a day)	0/1
Wateradlib	Watering frequency (throughout the day)	0/1
Waterother	Watering frequency (other)	0/1
Source-piped	Water source-piped	0/1
Source-river	Water source - river/streams/pond/Waterfall	0/1
Source-well	Water source; well/tube/hand pump/electric pump/canal	0/1
Breeding 1	Natural uncontrolled	0/1
Breeding2	Natural controlled	0/1
Greater-3rms	Household has <=3 roomed house	0/1
Nb-rms	Number of rooms in the house	Continuous
Conn-water	Water connection in working condition	0/1
Conn-elec	Electricity supply in working condition	0/1

[a] Country: 1=Sri Lanka; 2=Vietnam; [b] Housing system: 1= free range only/no housing at all; 2= No roof only/free range and no roof; 3= roof only/Free range and roof/No roof and roof. [c] Primary activities: 1= on farm; 2= civil servant/employee/business/off-farm/rickshaw/teaching/workerbuild/wage/timber/private; 3= Retired/Housewife/leader/work at home/home/not defined

Table 3. Percentage of households keeping different pig breeds in Sri Lanka and Vietnam.

	Breeds	Number of households	Percentage (within country)
Sri Lanka	Village pig	9	24
	Wild crossed with village pig	1	3
	Village crossed with commercial pig	17	46
	Commercial pig	10	27

Table 3. Contd.

	Unknown	-	-
Vietnam	Mong Cai / I	27	10
	Ban	129	49
	Landrace (exotic)	5	2
	Local x Exotic*	34	13
	Mong Cai Cross	1	0.4
	Ban cross	9	3.4
	Cross breed - unknown combination	61	23

level of use of all the three pig feed resources were significantly different (*P<0.01*).

Natural controlled breeding was practised predominantly in both the countries. Comparison between natural controlled and natural uncontrolled breeding practices across countries showed significant differences (χ^2) at 19 (*P<0.01*) and 1349 (*P<0.0*), respectively.

Reasons for keeping pigs

Pigs in Sri Lanka and Vietnam were mainly kept as source of income by over 80% of the farm households. In addition, about 33% of the households kept pigs for home consumption in Vietnam while 14% kept pigs for home consumption in Sri Lanka. Keeping pigs for home consumption and for other purposes including ceremonial/religious/sacrificial roles differed significantly across the two countries (*Marascuillo procedure*). The proportion of households keeping pigs for other purposes, that is, ceremonial activities related to religious occasions or sacrificial role in Sri Lanka was comparatively higher than in Vietnam. Pigs were hardly kept for social/ wealth status in both countries. The χ^2 tests performed for two countries separately showed that both the countries have significant differences between the reason for keeping pigs as a source of income against other roles- including ceremonial/religious roles (21.23, *P<0.01*) and social/wealth status (6.8, *P<0.05*) for Sri Lanka, and home consumption (49.35, *P<0.01*) and ceremonial/ religious/sacrificial roles (8.76, *P<0.01*) for Vietnam.

Pig herd sizes and Tropical Livestock Units (TLU)

The average size of the pig herd for Vietnam was twofold of that of Sri Lanka, estimated as 8±9.86 and 4±3.45 heads, respectively. The corresponding TLUs were even higher in Vietnam (0.44±0.78) than in Sri Lanka (0.05±0.13). This indicates pig herds in Vietnam had higher live weights and they are more mature animals than those in Sri Lanka. The TLU concept provides a convenient method for quantifying different pig weights/ sizes and in a standardised manner, compared to the use of average herd sizes as it is. Comparison of herd sizes and TLUs between Sri Lanka and Vietnam showed significant difference between each other in both parameters (*Post-Hoc Turkeys HSD test*- results not presented).

Off-take and mortality rates

The off-take and mortality rates correspond well to the number of pigs and TLUs reported in both countries. More off-take than mortality rates was expected because the former accounts for all exits of pigs due to any cause in the last 12 months prior to the survey where mortality rate include only the deaths. The difference between the two values provides estimates of exits for others purposes (sale, slaughter, gifts etc.) other than deaths due to diseases and other causes. The results indicate that exits due to losses of pig mortalities were lower than the exits for other purposes such as livelihoods (sales and income), food and nutrition. The off-take and mortality rates were not significantly different across the two countries (*Post-Hoc Turkeys HSD test*).

On-farm pig productivity

The average pig productivity parameters for all the breeds in the two countries are presented in Table 4. Estimates for individual pig breeds are presented elsewhere. Comparison of these parameters across countries indicates that the age at first farrowing (months), farrowing intervals and number of piglets per farrow were higher in Vietnam than in Sri Lanka. However, only the age at first farrowing was not significantly different between the two countries (*Post-Hoc Turkeys HSD test*). As expected, animals with higher age at farrowing and farrowing interval had higher number of piglets per farrow in Vietnam. Weight at maturity of males was slightly lower than that of females in Vietnam whereas the opposite was observed among Sri Lankan pigs. But these estimates were not significantly

Table 4. Pig farming system characteristics in Sri Lanka and Vietnam.

Characteristics		Sri Lanka		Vietnam		Total	
		N	Proportion/ Mean	N	Proportion/Mean	N	Proportion/Mean
Production systems							
Day	Free range	25	0.35	19	0.04	44	0.08
	Confined (no roof)	2	0.03	1	0.00	3	0.01
	Confined (with roof)	8	0.11	241	0.49	249	0.44
Night	Free range	18	0.25	7	0.20	25	0.04
	Confined (no roof)	2	0.03	2	0.01	4	0.01
	Confined (with roof)	14	0.20	252	0.51	266	0.47
Feeding practises	Kitchen waste	28	0.48	90	0.21	118	0.24
	straws / grains / fodders	14	0.24	60	0.14	74	0.15
	Commercial feeds	14	0.24	236	0.54	250	0.51
	Other *	2	0.03	48	0.11	50	0.10
Breeding practises	Natural uncontrolled	4	0.21	18	0.13	22	0.14
	Natural controlled	15	0.79	116	0.87	131	0.86
Reasons for keeping pigs	Home consumption	1	0.03	76	0.33	77	0.29
	Source of income	31	0.86	204	0.88	235	0.88
	Social/Wealth status	1	0.03	3	0.01	4	0.01
	Other (incl. religious/sacrificial)	5	0.14	6	0.03	11	0.04
Production and survival	Average herd sizes	36	4.00±3.45	231	8.00±9.86	267	7.00±9.38
	Tropical Livestock Units (TLU)	36	0.05±0.13	231	0.44±0.78	267	0.39 ±0.74
	Off-take rate	19	1.10±1.00	180	4.50±10.42	199	4.20 ±9.96
	Mortality rate	19	0.10±0.24	180	0.40±1.68	199	0.30 ±1.60
	Age at first farrowing (months)	34	6.40±4.84	204	8.40±4.55	238	8.10 ±4.64
	Farrowing interval	33	3.50±2.81	203	4.70±2.29	236	4.60 ±2.40
	Number piglets / farrow	33	6.00±4.16	202	8.00±4.07	235	7.70 ±4.14
	Male weight at maturity (kg)	26	71.90±17.61	92	53.6±18.42	118	58.3 ±19.84
	Female weight at maturity (kg)	26	63.70±15.40	160	56.20±22.67	186	57.3±21.52
	Male age culling	3	1.30± 0.39	166	0.30±1.30	169	0.40 ±1.29
	Female age culling	3	3.50±3.91	194	2.70±3.17	197	2.70 ±3.17

*Cassava, sweet potato roots, vegetables, soybeans, distiller grains.

different from each other.

However, male mature weights were significantly different when the two countries are compared. Culling age of males were much lower in males than females in both the countries where Vietnam showed the comparatively very low age at culling (0.3 years). The number of households that filled the questionnaire in Sri Lanka was very low to make any conclusions on this observation.

Effects of socio-economic and farming system characteristics on the reason for keeping pigs for home consumption and as a source of income

Several socio-economic and farming system characteristics were found influencing either positively or negatively, and at different levels of significance on the reasons for keeping pigs for home consumption (Model I) and as a source of income (Model II), (Table 5). The income level, wealth status and resource/ facilities available for farming were considered as determinants on the decision between rearing pigs for home consumption and as a source of income. Among the resources/ facilities available, the frequency and means of water supply was taken as a determinant that measure easy accessibility of available resources for farming. In Model I, family size (*HHsize*) and piped water (*Source-piped*) influenced significantly and positively for households keeping pigs for home consumption ($P<0.01$).

In addition, households keeping other livestock (*Liv-other*) and providing water for pigs throughout the day

Table 5. Results showing the effects of farming system characteristics on the reasons for keeping pigs for home consumption (Model I) and as a source of income (Model II).

Variables	Model I		Model II	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
Constant	-2.99	1.02***	1.60	0.84*
HHsize	0.31	0.11***	-	-
Liv-income	-0.37	0.15**	0.41	0.16**
Liv-other	1.08	0.48**	-	-
Feed-kitchen	-1.14	0.43***	-	-
Wateradlib	1.22	0.49**	-1.14	0.56**
Source-piped	1.16	0.38***	-1.37	0.48***
Source-river	-	-	2.39	0.76***
Greater- 3rms	1.36	0.80*	1.42	0.75*
Nb-rms	-	-	-0.27	0.21
Conn-water	-1.32	0.43***	0.35	0.48
Number of observations	242		242	
LR chi2(7)	102.45		31.93	
Prob> chi2	0.0000		0.0000	
Pseudo R2	0.3419		0.1723	
Log likelihood	-98.5836		-76.6634	

(***) significant at 1% level, (**) significant at 5% level and (*) significant at 10% level. As presented in Table 1 for explanation of variables.

(*Wateradlib*) showed positive and significant effects (*P<0.05*) towards rearing pigs for home consumption. However, feeding pigs with kitchen waste (*Feed-kitchen*) and water connection in working condition (*Conn-water*) had negative and significant effects (*P<0.01*). Source of income from other livestock species *(Liv-income)* also influenced negatively (*P<0.05*) on the home consumption of pigs.

In Model II, sources of water from the river/streams/ pond/waterfall (*Source-river*) for pigs and generation of income from other livestock species *(Liv-income)* influenced positively on the reasons for keeping pigs as a source of income (*P<0.05*). However, piped source of water (*Source-piped*) and watering of pigs adlibitum (*Wateradlib*) had negative and significant effects on keeping pigs as a source of income (Table 5).

DISCUSSION

Challenges and opportunities to indigenous pig production systems

Sri Lanka

The results of this study revealed that the rural small-holder indigenous pig production system in Sri Lanka is characterized by free range system of rearing where pigs are allowed to roam-around during both day and night time. Under this system, pigs are reared mainly with kitchen waste and undergo natural controlled breeding. Role of the farmer in the whole production is very limited and the input level to the production system is negligible. As depicted in these findings the indigenous pig production system in Sri Lanka totally operates on low-input basis. Similar findings have been recorded by Dematawewa et al. (2009) and Subalini et al. (2010) in their studies on pig rearing systems in Sri Lanka. The sustainability of the low-input pig production system in the study area at present is facilitated by the considerable extent of landholdings sufficient enough for the pigs to move freely and to pick their own feed within the home-yard. However, diminishing of resource base that is required for the free range rearing system of pigs, particularly the land and feed resources is a major constraint in indigenous pig farming.

Natural controlled breeding is practised to obtain offspring with economically favourable traits. This observation very well justifies the market-oriented purpose of rearing pigs. Majority of farmers hire good boars from neighbouring farms for breeding of pigs to improve the economically important characteristics. Even under the free range system of rearing the farmers manage the breeding activities accordingly. Hence, the low input pig production system in the study area depends purely on locally available simple inputs supplied through a short market chain. Nevertheless, there is no social and cultural affiliation with pig rearing activities in Sri Lanka as in the

case of some other Asian countries (Ayalew et al., 2011), and pig farming depends totally on independent decision of the respective farmer. Therefore, the indigenous pig farming activities exist as a sustainable livelihood activity of rural livestock farmers in Sri Lanka. Hence, efficient utilization of limited resources is important to remain the indigenous pig farming as a sustainable livelihood activity.

Vietnam

In Vietnam, indigenous pigs are kept mainly under confined system with roof, and bred mainly by natural controlled breeding. Pig production under this system of rearing serves mainly as an income generation activity in rural communities, and represents a low-input system. In addition, it plays socio-cultural functions too. Pig farmers practice mainly natural mating, and occasionally artificial insemination (AI). For exotic and crossbreds, AI is being conducted by the officer of nearby boar station or private veterinarians as pigs are kept mainly for commercial purposes. As clearly indicated in the present study, mostly the natural mating is been practiced for local Ban pigs under controlled condition. Ban pig owners drove their boar upon request to the sows in heat. However, it is found that in this natural breeding system the sire being the son or father of the sow was the most common phenomenon, which maintain the kinship. Though this is a direct form of inbreeding, farmers tend to continue this traditional breeding practice. The existing population of Ban pigs could be highly inbred as this has been the traditional breeding plan for the history. However, the inbreeding depression, especially on reproductive parameters measured is not shown in the present population in the project site. In fact, those reproductive parameters are comparable to parameters observed on indigenous pigs in the region. This could be due to directional selection of pigs for high reproductive performance under the prevailing production objectives depicted by the market oriented production strategies of farmers in the project area. The recourse-driven and market –driven situation and its sustainability in local Ban pig production system has been discussed widely in previous studies as well (Lemke et al., 2002; Lemke et al., 2005; Madzimure et al., 2012).

Pig breeds, characteristics and attributes

As revealed by the analysis, the predominant pig types kept by the Sri Lankan farmers are commercial pig breeds and their crosses with village pigs, between which crosses are the most popular. Due to slow growth rate and low mature body weight of indigenous animals (Subalini et al., 2011; Silva et al., 2004; Goonewardene et al., 1984), the farmers prefer crossing the indigenous pigs with commercial breeds in order to enhance the growth and body weight while preserving some level of desirable meat qualities of indigenous animals in the market product. This observation is clearly justified by the controlled breeding that the farmers practice to cater to the demand-driven market opportunities. Besides, cross-breds are also preferred because locally adopted genotypes could survive better under the existing low input production system and harsh environments than the pure commercial pig breeds, which demonstrate on the other hand the resource-driven nature of farming operation.

The analysis on size of the herd and TLU revealed that farmers kept only small pig herds in Sri Lanka. The reason may be the limitation of major inputs (lands and feeds) in free range system of rearing. Also being a small nation island, Sri Lanka has a characteristic small-scale farm production system scattered throughout the island and pig farming show no deviation. Low mortality rates of indigenous pigs in Sri Lanka could be partly attributed to their disease resistance. This characteristic of indigenous pig was highlighted by Subalini et al. (2011) as well. Average of six piglets/farrow is consistent with the findings of previous studies done on Sri Lankan village pig production (Subalini et al., 2011; Rajamahendran & Fernando, 1982; Goonewardene et al., 1984). The litter size of indigenous pigs recorded in some other countries for example were: 7.9 in Zimbabwe, 7.2 in South Africa, 6.5 in Nigeria (Holness, 1991), and 8.0 in Nepal et al. (2011). Age at first farrowing (6.4 months) and the farrowing interval (3.5 months) recorded for Sri Lankan indigenous pigs in the present study is lower than the values reported by Subalini et al. (2011) (9.5 and 8.9 months, respectively) for the Sri Lankan indigenous pigs in eastern and western parts of the country. The age at first farrowing and farrowing interval of local Kenyan sow were 12.1 and 2.7 months respectively (Mutua et al., 2011), and it was 12.3 and 4.5 months respectively for Nepal indigenous pigs (Nidup et al., 2011). Particularly, lower age at first farrowing recorded in the present study could be attributed contribution of genetic makeup of indigenous population and their crossbreds, as well as mating opportunities provided in free range small scale farming system. Mean maturity weights for male and female pigs reported were 71.9 and 63.7 kg respectively. However, these values were larger than the male and female maturity weights of indigenous pigs in Sri Lanka reported by Subalini et al. (2011) (50.62 and 44.00 kg for male and female pigs, respectively) and Nepal pigs reported by Nidup et al. (2011) (40.7 and 71.8 kg for male and female pigs, respectively). The higher productivity performance recorded in the current study compared to previous studies done in Sri Lanka may be due to the presence of considerable number of crossbred animals in the study site considered in the present study.

In Vietnam, the average herd size and TLU of pigs were higher than that in Sri Lanka. This reveals the operational differences and diverse orientations in pig production in two countries. Rearing pigs in confinement with commercial feeds is a common practice in Vietnam,

whereas free-range system of rearing with scavenging type feeding is common in Sri Lanka. In addition, pig farming is quite widely practiced and highly demanded operation where commercial opportunities are high in Vietnam compared to Sri Lankan conditions in the study sites. With regard to the pig production parameters in Vietnam, previous studies done on local Ban, MongCai and exotic pigs (Lemke et al., 2005; Drucker, 2006) showed that, average, sows farrowed 1.3 litters year with 9.2 piglets born alive and 6.7 piglets weaned. Further it was shown that, Ban sows had smaller litters and longer farrowing intervals than improved genotypes, and farrowed the lowest number of litters per year. These production standards are similar to those reported for indigenous pigs in the region (Nidup et al., 2011; Aylew et al., 2011, Mohanty and Nayak, 1986). The mortality rate observed in the present study was 0.4, which is a comparatively higher rate than that reported for Sri Lanka. Given the fact that most of the pigs are reared in confinement, the high mortality rate could be due to poor feeding, poor or unsuitable housing facilities and lack of knowledge in raising pig as pointed out by Rodriguez and Preston (1997). Given the fact that pigs are raised under small scale operation characterized by low input system, the pig farmers do not pay attention on vaccination program for their pigs. Nevertheless, in the instances when piglets get disease the farmers hardly use medicine. As described by Cuong et al. (2012) the efforts of crossbreeding and directional selection of indigenous pigs for lean percentage and high-growth rate in the Vietnamese pig herd has also resulted in a decrease in some economically important traits such as adaptation to the indigenous ecologies, meat quality (pork becomes tougher and is low in taste) and disease resistance.

The age at first farrowing, farrowing interval and number of piglets/farrow recorded for all the pig types in the study area were 8.4 months, 4.7 months and 8 piglets, respectively. The previous studies have reported that 6 to 7 piglets born per litter and 1 litter per year for Ban and 9.5 to 12.5 piglets born per litter and 1.5 to 2.1 litters per year for MongCai (Thuy, 1999, 2001). These two pig breeds are the main indigenous pig breeds used in the present study representing more than 50% of the pig population evaluated. A comparable litter sizes have been recorded by some other unimproved breeds in the region and elsewhere, for example, native pigs of the hill-tribes in Thailand with 7.1 piglets born per litter (Falvey, 1981), native pigs in Nepal with 7.9 piglets born per litter (Gatenby and Chemjong, 1992), and Mukota pigs in Zimbabwe with 7.3 piglets born per litter in an on-station trial (Ncube et al., 2003). Further, those studies done on Ban and MongCai pigs (Thuy, 1999, 2001) reported 1 litter/ year and 1.5 - 2.1 litters/year for Ban and MongCai pigs, respectively. However, the farrowing interval recorded in this study is shorter than those values reported earlier, whereas it is similar to Nepal indigenous pigs (4.5 months) as reported by Nidup et al. (2011). When compared with the value in Sri Lankan pigs (3.5 months), Vietnam pigs showed a little high farrowing interval. As mentioned earlier this could be due to the restricted movements and less chances Vietnamese pigs get in their confined system of rearing compared to Sri Lankan pigs get under the free-range management conditions. Though the age at first farrowing was higher in Vietnam pigs (8.4 months) than what was reported for Sri Lankan pigs (6.4 months), Vietnam pigs showed a lower age at farrowing than those reported for other local pigs in the region and elsewhere, for example, Nepal pigs showed 12.3 months and Kenya pigs showed 12.1 months (Wabacha et al., 2004). In contrast to the observation made with regards to the Sri Lankan pigs, mean maturity weight of a female pig (56.2 kg) was slightly higher than that of male pig (53.6 kg) in Vietnam. However, a high body weight in males has been reported in most of the previous studies done elsewhere (Essien and Fetuga, 1986; Nidup et al., 2011). The lower body weights of the male pig in Vietnam could be the characteristic of breeds considered in the present study.

Effect of farming systems characteristics on pig production

The common characteristics of farming system of both the countries were used in combined analysis of two countries to determine the influence of those characteristics on the decision of purpose of rearing of pigs. The results of model I (Table 5) depicted that family size, availability of piped water, keeping other livestock other than pigs, providing water throughout the day positively and significantly influenced keeping pigs for home consumption. In contrast, feeding pigs with kitchen waste, availability of water supply connection in working condition, livestock income negatively and significantly influenced the keeping pigs for home consumption. Accordingly, large families tend to fulfil their nutrition requirement by rearing pigs since it is a cheap and a good protein source. Those farmers might be looking for the income generation by keeping other livestock (Cattles, Buffaloes, Goats and chicken), which may be more profitable and readily marketable. Adequate availability of water and pipe water supply could be considered as indicators of the wealth status as well as organization level of farming. Large family size and availability of other livestock also could be attributed to the wealth status and the organized farming in the farming community hence, the mode of water supply and availability show the similar influence on pig production. The farmers who expect direct income from the sales of pigs always try to maximise their profit in every management practice. This is well reflected by the negative association between feeding pigs with kitchen waste and keeping pigs for home consumption. Profit oriented farmers generally try to maximise the profit by lowering the cost of production. Feeding pigs with material with low or no monitory value is one of the strategies in this

context (Nidup et al., 2011; Madziure et al., 2012). When a high income is generated by farming, livestock farmers tend to increase it further by reducing the income generating farm items for home consumption (Weerahewa, 2010). Similar phenomena was reported by Lemke and his group (Lemke et al., 2005) in describing the socio-economic features of indigenous pig rearing systems in Vietnam where demand-driven and resource-driven farming practices have been highlighted. According to the present comparison, it was revealed that such phenomena are featured in the indigenous pig rearing systems irrespective to the scale of operation and orientation of farming.

The results of model II (Table 5) indicated that availability of river water as the main water source (in Vietnam) and livestock income are the factors that positively and significantly related to keep pigs as a source of income. In pig farming, the availability of river water makes zero cost for water and hence the cost of production will be reduced. This was particularly shown in Vietnam context. Therefore, farmers can maximize the profit of rearing pigs as explained above. This may be the reason to increase the probability of keeping pigs as a source of income by the farmers who have access to river water. Farmers are more likely to keep livestock as an income source when they earn a higher income through selling animals and their products. Therefore, as expected the livestock income showed a positive effect on probability of keeping pigs as a source of income.

Conclusions

Indigenous pig farming has considerable economic, genetic and cultural significance to many rural communities in Vietnam and Sri Lanka. Pig production helps enhancing income, improving living standards of farmers and increasing nutritional level of rural families in both countries. Though productivity and efficiency of indigenous pigs remain critical constraints in economic point of view, the role play of pig farming in both demand-driven as well as resource-driven situations ensures its sustainability. Keeping indigenous pigs either for home consumption or as an income source is significantly influenced by several farming system characteristics related to social and economic attributes, irrespective to the operational differences. These factors should be considered in formulating policies to conserve and sustainably use indigenous pigs and also in designing programmes to enhance indigenous pig production.

Conflict of Interests

The authors have not declared any conflict of interest.

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