



Nutritional Constraints and Possibilities for Pig Production on Smallholders Farms in Central Vietnam

Pham Khanh Tu*, Nghia Duyet Hoang, Ngoan Le Duc, W. H. Hendriks¹ and M. W. A. Verstegen¹

Department of Animal Sciences, Hue University of Agriculture and Forestry, Hue City, Vietnam

ABSTRACT : This study aimed to evaluate the nutritional situation of pigs kept in three ecological zones of central Vietnam: Upland, Lowland and Coastal Area. An interview-based questionnaire was made and surveys were conducted in 27 villages and data were collected from 1,200 participating households. The current study showed that amounts of feed and crude protein content in the diets for fattening pigs and sows are deficient for all three regions. Amounts of feed as DM (kg/d) fed to growing pigs of 20-50 kg BW was deficient by 0.54 kg (29%) in Lowland, 0.53 kg (28.6%) in the Coastal area and 0.42 kg (22.4%) in Upland. The deficiency in CP in the diets of growing pigs in this period (20-50 kg) was largest at 20.7 g/d (62.1%) in Lowland, following by 22.1 g/d (66.4%) in Coastal and 23.2 g/d (69.7%) in Upland. Amount of feed as DM (kg/d) fed to growing pigs of 50-90 kg BW had a deficiency of 1.26 (48.9%), 1.25 (51.2%) and 1.14 (51.5%) kg/d in Lowland, Coastal and Upland, respectively. The deficiencies in crude protein in the growing diet during this period in Lowland, Coastal and Upland regions were 27 g/d (68.3%), 29 g/d (71.9%) and 30 g/d (74.6%), respectively. The deficiency in DM intake (kg/d) of pregnant sows in the Lowland area was 0.3 kg (15%), 0.33 kg (16%) in the Coastal area and 0.47 kg (23.5%) in the Upland area. Crude protein content in the diet of pregnant sows raised in Lowland was 8 g/d (32.0%) deficient, in the Coastal region the deficiency was 11 g/d (42.7%) and in Upland this deficiency was 15 g/d (61.2%). The deficiency in DM intake (kg/d) of lactating sows raised in Lowland was 1.47 kg (31.1%), in the Coastal area this was 1.69 kg (39.2%) and in Upland it was most deficient at 2.46 kg (57.1%). The lack of crude protein content in the diets of sows raised in Lowland was 45 g/d (63.4%), in the Coastal region it was 46 g/d (65%), and in Upland it was 55 g/d (78.9%). The low input of feed in these areas is especially due to low quality and to the insufficient intake of nutrients by the pig. As a result, production and income of farmers are low. (**Key Words :** Household, Pig, Feedstuffs, Nutritive Value, Village)

INTRODUCTION

Vietnam is situated along the Southeast margin of the Indochina peninsula. It has a total land area of 330,541 km² and the length of 1,600 km lasting from 23° Northern latitude to 6° Northern Latitude and from 103° 11 to 109° 27 Eastern Longitude. About three fourth of the land area is occupied by hills, mountains and high land. The agricultural land occupies 23.8% (7,907,207 ha) of the land. The natural pasture occupies 1% (330,000 ha) and forest occupies 30% (9,650,000 ha). The rest of the land is un-cultivated or open lands (GSO, 2006).

Central Vietnam consists of 14 provinces located from the 20° to the 11° North latitude. Its surface area is about

97,000 square Kilometers and it has about 17 million inhabitants. A common feature of these provinces is the presence of Truong Son Mountain and a narrow coastal zone. Compared with other regions of the country, Central Vietnam is a poor and agriculturally, it is not well developed. This is mainly due to climatic conditions which can be hard and the upland is not very fertile. The annual average temperature is about 25.9°C. During winter time, the lowest temperature sometimes falls under 15°C with more than 95% humidity. During Summer time, temperature can go up to 39°C with lower than 60% humidity. These conditions combined with western hot winds cause a very high rate of water evaporation. As a result, water shortage can be a serious problem. The complicated weather and climatic conditions are not always ideal for thermal comfort of animals (NAP, 1981; Hatfield, 2008).

Vietnam is an agricultural country with over 80% of the population living in rural areas and their livelihood is

* Corresponding Author: Pham Khanh Tu. Tel: +85-54-3539518, Fax: +84-54-3524-923, E-mail: p.khanhtu@gmail.com

¹ Animal Nutrition group, Department of Animal Sciences, Wageningen University, Wageningen, the Netherlands.

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mainly based on agriculture. In Central Vietnam, mixed farming system (the mix of animals and crops) is mostly applied and pigs are one of the most-important livestock species raised by smallholder farmers. Pigs are raised for sale, home consumption, festivals and financial security. These animals can convert concentrated food to meat efficiently, produce large numbers of offspring after a relatively short gestation period. Pigs have a short generation interval and can grow rapidly. Hence, these animals are of great interest for studies on smallholder farms and for possible developments of these smallholders farms. Descriptive observation studies about smallholder pigs have been conducted in Nepal by Gatenby and Chemjongg (1992) and in the Solomon Islands by de Fredrick (1977).

Smallholder farmers keep pigs in small numbers. They use family labour and locally available feedstuffs. Pigs are also of considerable importance in customs and in traditions in many developing countries (Bantugan et al., 1992). Many constraints are known to limit improvement of the productivity of pigs on smallholder farmers. Animals are frequently fed household waste complemented with a small amount of other feedstuffs. According to De Fredrick (1977), these feedstuffs include: i) Carbohydrates resources such as cassava, rice bran, sweet potato and fruits. ii) Leaf green materials and occasionally. iii) Protein resources such as fresh fish, ensiled fish and shellfish. Central Vietnam has the potential for further animal production development, if the constraints of low nutritional quality and quantity of feedstuffs, which are the main limitations to husbandry and management, can be overcome. Obviously, the economic contribution of pig productions as yet is not very high.

This study aimed to survey the situation of pig production on smallholder farms in Central Vietnam with special emphasis on nutrition. It is expected that based on the results of this survey specific nutritional investigations may be needed to study possibilities for improvements in the feeding situation.

MATERIAL AND METHODS

Study design

The interviews were held with 1,200 pig raising smallholders and conducted in the three ecological zones of Central Vietnam. The distinction between the farmers in the zones was with regard to their main crops:

- Upland area with cassava and upland rice (UL)
- Lowland area with paddy rice cultivation and vegetable (LD)
- Coastal area with sandy land rice and aquaculture (CT)

Questionnaire survey

This study was carried out by means of an interview-

based questionnaire. Households chosen for survey were selected based on the following criteria:

- Location (from different villages in commune and from different regions in provinces)
- The pig raising situation (at least one fattening pig and /or one sow present)
- The wealthy ranking (Rich, Average and Poor households)

These households have the main characteristics of their respective group in the household socio-economic classification group which is annually certified by The Ministry of Labor War Invalid and Social Affairs (MOLISA 2003).

In general, the aspects covered in the farm questionnaires included farm-management practices, type of feeds and feeding practices, housing, preventive medicine and production constraints encountered in pig production.

General information was collected on farm and household characteristics such as family size, age, education, sex, occupation, farm size, number of parcels, household assets, etc.

The production system included cropping and the livestock systems included information on by-product use. Furthermore information on household revenue and income was obtained and on main constraints as they are perceived by farmers.

All selected farmers had at least one sow or one fattening pig. If the selected farmers were not present on the pre-arranged day of the interview, arrangements were made for another day or mutually convenient meeting. If the selected farmers proved ineligible or was not present on the pre-arranged day of the interview, an additional farmer was randomly chosen immediately from the other farmers. At the three Agro-ecological zones, information about each selected pig farmer was collected before the start of the interviews. Interviews were only conducted with farmers who meet our definition of a smallholder pig farmer (at least one pig present at the farm visit).

The interview questionnaire that was used for this study contained three sections: i) about pig farmers, ii) about the number of pigs, iii) about the kind of feed resource they used and iv) years of relevant experience. For our study only the pig farmer and the feed resources are relevant. The pig feedstuffs section also covered information about the caretaker.

The question was about major feedstuffs for non-pregnant pigs, for pregnant sows, for lactating sow and for fattening pigs resp. Besides, questions about the use of available feed resources, commercial concentrated high protein foodstuffs, uncooked green feed, kitchen waste and pre-mixed vitamin-mineral additive; methods of feed processing were asked on the questionnaire. We also asked

about the amounts of feed used to feed the non-lactating sows, the lactating sows, and the fattening pigs respectively. The interviewer weighed the animals, feeds and feedstuffs (uncooked) on the day of the interview.

Data sources

Primary data were collected by interviewing the farmers. The secondary data are collected from yearly statistical books published by the General Statistical Office (GSO2006).

Provincial and district level : A review of the current agricultural production and farming systems in the Lowland, Coastal and Upland. The provinces involved in these survey are Nghe An, Quang Binh, Quang Tri, Thua Thien Hue, Quang Nam, and Binh Dinh. The data were collected from provincial animal husbandry departments and divisions in district from reports, statistical books, development strategies and open-ended interviews.

Commune level : To determine the present major animal production systems and animal feeding in the commune

Data from commune level was collected as follows:

- PRA (Participatory Rural Appraisal) work in communes and villages which included commune leaders, organization mass and village leaders.
- The direct interviews and observations were carried out by 10 staff members of the Department of Animal Science and Department of Agriculture and Rural Development of Hue University, by 20 final years Student of Animal Science and by the chiefs of 27 villages.
- The smallholder pig raisers were selected for inclusion in the study by the use of a multistage stratified random sampling process.

Necessary informations related to social, economic and agricultural topics are recorded.

Food sample analysis

Feed ingredients were analyzed in triplicate for DM, GE and CP at the Animal Nutrition Laboratory of Department of Animal Nutrition of Hue University, Vietnam. Determination of DM content, feed was freeze-dried and DM determined according to Vietnam Standard (TCVN) 6952: 2001 (ISO 9498: 1998). Crude protein content was determined as Kjeldahl N \times 6.25 according to Vietnam Standard (TCVN) 4328: NIAH 2001 (ISO 5983: 1997). Other values (Ca and P) were calculated from NRC (1998) and NIAH (2001).

Farm income

The income of households was estimated from animal income, crop income and off-farm income. This was

grouped in relation to different types of households and types of animals. An animal income level was estimated from the ratio of measured weight and reported age of each fattening pig and the same for each sow. Data on pigs in each smallholder unit was used to calculate pig population and performance in each specific zone.

Off-farm income : Typically refers to money or wage received when labor is provided to other farms. This includes payment in cash or in kind (such as paddy and food) and other non-wage types.

Non-farm income is defined as non-agricultural income sources. The common non-farm income sources identified are non-farm wage or salary, non-farm rural self-employment (business income), rental income obtained from leasing land or property, remittance from both internally (rural-urban immigration labor) and international labor

Data analysis : In order to reach research objectives the households are divided into different categories. Firstly, based on ecological region. There are three ecological zones: namely Lowland, Coastal and Upland. Theoretically, ecological ranking is intended to analyze the different farming systems among smallholders and among pig production categories. This gives especially the assets and situation of the pig nutrition. Secondly, it is classified based on type of pig production: Fattening or breeding pigs.

Data analysis is done by a model with region as factor by using SPSS software version 11.5 and excels 2003. Descriptive information about pig production at the three ecological zones were compared to test for categorical and continuous data.

RESULTS

Characteristics of households in Central Vietnam

Smallholders are a heterogeneous group whose resources, livelihood patterns and income sources are very diverse. The farm-level categorical variables of the 300 smallholder pig raiser enrolled for the cross-sectional study are as shown in Table 1.

The mean family size in Lowland, Coastal and Upland was 5.6, 6.1, 6.7 person respectively. The mean farm size was bigger in the Upland and Coastal areas compared to the Lowland area. On average, the cultivated area is about 0.62 ha/farm in the Lowland, 0.88 ha/farm in the coastal and 1.17 ha/farm in the Upland.

Traditional farming is an integrated system of rice, root crops, fruit tree, vegetables and livestock. The specified character of multi-purpose in Central Vietnam is the diversity of animal species used on the farm. Livestock raised by smallholders in Central Vietnam consists of pigs, cattle, poultry (especially duck) and fish. The number of

Table 1. Number of households and mean size standard deviation within region in Central Vietnam

Characteristics	Region	Lowland	Coastal	Upland	SEM
No. Interviewed Households		400	400	400	-
Size of family		5.6 ^a	6.1 ^{bc}	6.7 ^c	0.37
Farm size (m ²)		6,163 ^a	8,618 ^b	11,772 ^b	907
Number of ruminants		1.39 ^a	1.60 ^b	2.27 ^{bc}	0.34
Number of pigs/HH ¹		3.3 ^a	3.1 ^b	2.3 ^b	0.43
Number of poultry/HH		14.32 ^a	21.67 ^b	19.7 ^b	1.20
Total income (1,000 VND) ²		16.41 ^a	12.44 ^{bc}	17.56 ^b	0.25
Crop income (1,000 VND)		5.06 ^a	3.76 ^c	4.99 ^{ab}	0.45
Animal income (1,000 VND)		6.10 ^a	8.48 ^c	8.62 ^{bc}	0.43
Other income (1,000 VND)		1.97 ^a	5.72 ^c	4.18 ^{bc}	0.47
Experience for pig husbandry (year)		7.5 ^a	6.2 ^b	4.5 ^b	1.04
Interviewed farmer was trained on pig husbandry (%)		10	7	2.5	-

¹ HH: as Households. ²VND: as Vietnamese dong.

^{a, b, c} Means with different superscripts within rows differ ($p < 0.05, 0.01, 0.001$).

ruminants per household was higher in Upland whereas the number of pigs per household was higher in Lowland.

The majority of the income of the farmers in the country as well as in Central Vietnam comes from both crops and animal production. The total income of households in Lowland and Upland were higher than in Coastal area. Household income from animal production was higher compared to income crop production and other income (Table 1).

Performance of animals

A detail survey was conducted for the farmers who are raising only fattening or only reproductive sows were presented in Table 2. Table 2 shows the number of

fattening/farm for lowland, coastal and upland areas were 4.15, 2.97, 1.95 pigs/farm and number sows raised by smallholders in that area was 1.35, 1.27 and 0.90 sows/farm respectively. Smallholders in the Lowland have the highest number sows per farm and those in upland have the lowest number. The sows raised by smallholders in different ecological zones have different performances. Sows raised in the Lowland and in the Coastal area have the largest litter size. Sows raised in Lowland and Coastal areas also have the highest number of weaned piglets and the highest weaned piglet's weight after a 60-day lactation period. Table 2 also shows that fattening pig raised by smallholder in Upland grew slower than to that ones in the Lowland and Coastal areas.

Table 2. The performance of sows and fattening raised by smallholders in Central Vietnam

Variable	Region	Lowland	Coastal	Upland	SEM
No. interviewed farm		150	150	150	-
The performance of sows					
No. observed sows		130	120	100	-
Average no sow/farm		1.35 ^a	1.27 ^c	0.90 ^{bc}	0.01
Number of piglets born alive		10.5 ^a	9.13 ^b	8.41 ^b	0.02
Piglets weight at birth kg		0.53 ^a	0.67 ^b	0.6 ^b	0.03
Number of weaned piglets		9.5 ^a	8.55 ^b	7.25 ^b	0.02
Weaned piglet's weight		9.8 ^a	9.1 ^c	8.2 ^c	0.04
The performance of fattening pigs					
Number of fattener		4.15 ^a	2.97 ^c	1.95 ^c	0.01
Average starter's weight (kg)		10.66 ^a	9.55 ^b	7.15 ^b	0.02
Average fattening time (months)		6.05 ^a	6.75 ^b	8.25 ^b	0.03
Average selling weight (kg)		85.5 ^a	77.2 ^b	67.98 ^b	0.02
ADG (g/d)		436 ²	344 ^b	235 ^c	0.08

^{a, b, c} Means with different superscripts within rows differ ($p < 0.05, 0.01, 0.001$).

Situation of pig husbandry in Central Vietnam

Swine breed : The pig genetic resource in Vietnam is based on three groups of breeds, the local breed and the exotic breeds and crossbreds. The local pig breeds consist of Mong Cai, Thuoc Nhie, Ba Xuyen and Co breed and they constitute around 26% of national pig herd. Among them, Mong Cai pigs are raised widely in all regions of the country. Compared to exotic breed, Mong Cai pigs have lower carcass weight and a much lower lean meat percentage and a much higher back fat thickness compared to exotic breeds (Nguyen et al., 1996).

In recent years, the number of pigs belonging exotic breeds like Large White, Landrace and Pietrain has increased. The mature age of these pig breed is about 6 to 8 months. The mature weight male animal are from 190 to 260 kg and mature weight of female pigs are from 180 to 240 kg. The lean percentage of Landrace, Yorkshire and Pietrain pigs range from 47 to 56%.

The F1 crossbred (Large White×Mong Cai or Landrace ×Mong Cai) is the most comment type of fattening pig in rural areas throughout the country. The main characteristics of crossbreds are better growth rates and higher carcass lean than indigenous breeds and better adaptation to poor feed and management conditions than purebred exotic one. Lean percentage of two way crossed (Landrace, Yorkshire×Mong Cai) is about 43 to 45% and three ways crossed ((Yorkshire×Mong Cai) Landrace)) is about 45 to 48% (Nguyen et al., 1995; Nguyen et al., 1996).

Pig populations and cattle/ poultry populations throughout Central Vietnam are expanding rapidly. Production is increasing steadily in all agro-ecological zones, Lowland, Upland and Coastal areas. Production is carried out at three levels; state, private companies and smallholders. Among them smallholders pig production

take the highest proportion (GSO, 2006).

Feed sources for pig production in central Vietnam

Feed sources, which are available for pigs, vary greatly among agro-ecological zones in Central Vietnam. Feed composition for pregnant, lactating sows and fattening pigs raised in smallholder farms is presented in Table 3. Table 3 shows that sows are fed mainly rice bran, cassava meal, fresh sweet potato vine and a small amount of salted fish. During the survey we found that are only very few smallholder in the Lowland area use supplemented feed (with Premix) in their pig's diet. Almost all farmers use sweet potato vine for the sows. Farmers especially the older ones mention that they provide sweet potato to prevent constipation in the sow and to facilitate the sow's farrowing. Table 3 also presents the amounts of feed components given to fattening pigs in different zones. The main protein feed sources in Central Vietnam are fishmeal and seafood by-products like fish heads and shrimp heads. Other sources include coconut, sesame, and soybean, but the use of these ones are minimal. Fishmeal is produced mostly from salt-water fish and from animals or the part of the animal that are not suitable for human consumption.

Nutrition and feeding : Table 3 presents results of our estimates of energy value given as Digestible Energy value (DE) Crude protein (CP) and in the diets for fattening pigs and sows raised in smallholder farms in different zones of Central Vietnam. The average crude protein content in the pig's diet is about 10%. Restricted feeding is practiced in all the herds and commercial feeds that are not specifically formulated for pigs. Table 3 also shows that feeds for fattening pigs and sows are not very complicated and contains insufficient amounts of energy and protein. Ensiled fish is used as supplement is but it is available only in small

Table 3. Amount feed given for pregnant, lactating sows and fattening pigs in different ecological parts of Central Vietnam

Variables	Pregnant sows				Lactating sows				Fattening pigs			
	Lowland	Coastal	Upland	SEM	Lowland	Coastal	Upland	SEM	Lowland	Coastal	Upland	SEM
Number interviewed Households	150	150	150	-	150	150	150	-	150	150	150	-
Rice (kg) ¹	0.66 ^a	0.59 ^b	0.25 ^{bc}	0.02	1.10 ^a	1.3 ^{bc}	0.5 ^c	0.02	0.44 ^a	0.34 ^b	0.10 ^{bc}	0.02
Rice bran (kg) ¹	0.68 ^a	0.59 ^b	0.50 ^b	0.03	0.6 ^a	0.8 ^{bc}	0.7 ^{bc}	0.02	0.35 ^a	0.34 ^{bc}	0.55 ^c	0.03
Cassava meal (kg) ¹	0.41 ^a	0.45 ^b	0.60 ^b	0.02	0.25 ^a	0.5 ^{bc}	0.6 ^{bc}	0.03	0.2 ^a	0.30 ^b	0.40 ^b	0.02
Sweet potato vine (kg) ¹	0.05 ^a	0.07 ^b	0.1 ^b	0.04	0.8 ^a	0.5 ^b	0.2 ^b	0.05	0.12 ^a	0.1 ^{ab}	0.08 ^b	0.03
Banana stem (kg) ¹	0.1 ^a	0.2 ^b	0.4 ^b	0.2	0.2 ^a	0.3 ^b	0.6 ^b	0.25	0.1 ^a	0.2 ^b	0.4 ^a	0.25
Salted fish (kg) ¹	0.1 ^a	0.15 ^b	0.05 ^b	0.35 ^b	0.1 ^a	0.05 ^b	-	0.15	0.01 ^a	0.02 ^b	-	0.03
Pre-mixed feed (kg) ¹	0.1	-	-	-	0.15	-	-	-	0.05	-	-	-
Amount feed (kg DM /pig/d)	1.92	1.77	1.53	-	2.84	2.22	1.8	-	1.31 ^a	1.33 ^a	1.44 ^b	0.03
Crude protein/sow (g/d)	17.3	14.5	9.8	-	28.4	24.6	14.8	-	12.66	11.21	10.12	-
DE intake/sow/d (kJ)	24,673	22,757	21,514	-	38,454	34,727	25,705	-	17,395	17,804	19,765	-

¹ As amount of kg of product intake/d.

NRC 1998: Nutrient requirement for gestation sow 125 kg BW: Feed intake: 1.96 kg DM/d, Energy: 27,865 kJ DE/d; Protein: 25.3 g/d. Nutrient requirements for lactation sows of 125 kg BW: Feed intake: 4.31 kg DM/d, Energy: 58,827 kJ DE/d, Protein: 70.3 g/d. Nutrient requirement for fattening 50-80 kg BW: Energy: 36,654 kJ DE; Feed intake: 2.575 kg DM/d, Protein: 39.9g/d.

^{a, b, c} Means with different superscripts within rows differ (p<0.05, 0.01, 0.001).

Table 4. Deficiency of energy and nutrients intake for fattening pigs as % of requirements

Item	Region	Lowland			Coastal			Upland				
		Sufficiency	Shortage %	Amount	Sufficiency	Shortage %	Amount	Sufficiency	Shortage %	Amount		
Growing Pig of 20-50 kg BW												
ME (kJ)	No	34.2		8,678	No	32.6		8,251	No	25.1		1,522
DM intake (kg)	No	29.1		0.54	No	28.6		0.53	No	0.42		22.4
CP (g)	No	62.1		20.7	No	66.4		22.2	No	69.7		23.2
Ca (g)	No	54		4.1	No	64		4.86	No	66		5.0
P (g)	No	31		4.96	No	39		6.24	No	41		6.5
Lysine (g)	No	59		7.5	No	55		5.93	No	70		6.0
Fattening pig of 50-90 kg BW												
ME (KJ/d)	No	52.6		4,424	No	51.4		4,322	No	46.1		3,872
DM intake (kg)	No	48.9		1.26	No	51.2		1.25	No	51.5		1.14
CP (g/d)	No	68.3		27	No	71.9		29.	No	74.6		30
Ca (g)	No	61.42		9.8	No	54.35		8.7	No	40.3		6.45
P (g)	No	29.33		3.9	No	13.05		4.4	No	27.55		3.69
Lysine (g)	No	49.35		7.2	No	34.65		5.0	No	68.95		6.44

NRC 1998 requirement: DE content of diet (kJ/kg): 14,230 kJ. Growing pig of 20-50 kg BW: Estimated feed intake as 1.855 kg DM/d, Energy: 26,397 kJ DE, Crude protein: 33 g/d. Fattening pig of 50-80 kg BW: Estimated feed intake as 2.575 kg DM/d, Energy: 36,642 kJ DE; Crude protein: 39.9 g/d. Amount of insufficient feed of Nutrient requirement (as kJ and g DM intake/d), Shortage in %.

quantities. Amino acids and fatty acids are not added to pig feed.

Nutritive value of foodstuffs : The contents of energy, protein and minerals given per day are compared with the national standard requirements. NRC (1998) and Vietnam NRC-NIAH (2001) of fattening and reproductive sows were presented in Table 4 and 5.

From the determinations of feed given to pigs and estimation of DM in feed (kg/d) supplied to growing pigs of 20-50 kg BW. The shortage of DM in growing diet was for

29.1% in Lowland, 28.6% in Coastal area and highest with 42% in Upland. The shortage of DM food (kg/d) fed to growing pig of 50-90 kg of body weight in three zones: Lowland, Coastal and Upland were 48.9, 51.2 and 51.5%, respectively. Crude protein content fed to growing and fattening pig were deficient for all regions. The shortage of crude protein supply in the growing diets in this period was 62.1% in Lowland, 66.4% in Coastal and 69.7% in Upland area. The shortage in crude protein in the fattening diets in lowland, Coastal region and Upland were 68, 71.9 and

Table 5. Deficiency of energy and nutrients intake for pregnant sows raised in Central Vietnam

Item	Region	Lowlands			Coastal			Upland				
		Sufficiency	Shortage %	Amount	Sufficiency	Shortage %	Amount	Sufficiency	Shortage %	Amount		
Gestation sows												
ME (KJ/d)	No	29		1,864	No	14.0		878	No	23		1,463
DM intake (kg)	No	15		0.3	No	16		0.34	No	23.5		0.47
CP (g/d)	No	32		8.0	No	11.0		42.7	No	61.2		15
Ca (g)	No	6.5		0.78	No	32.0		3.9	No	32.0		3.9
P (g)	No	30.0		4.77	No	39.0		3.6	No	29.0		2.3
Lysine (g)	No	18.0		2.10	No	34.0		4.04	No	34.0		4.04
Lactation sows												
ME (Kcal)	Lack	37		5,249	Lack	43.		6,104	Lack	58		8,174
DM intake (kg)	Lack	31.1		1.47	Lack	39.2		1.69	Lack	57.1		2.46
CP (g)	Deficit	59.6		42	Lack	65		46	Deficit	78.9		55
Ca (g)	Deficit	34.51		7.4	Lack	40.		6.45	Lack	42.		6.65
P (g)	Deficit	22.86		3.8	Deficit	28		3.2	Deficit	38		5.3
Lysine (g)	Lack	26.78		5.4	Lack	69		6.44	Lack	70		7.10

NRC 1998 requirement: ME content of diet (kJ/kg): 13,660, Gestation sows: Estimated feed intake as 1.96 kg DM/d, Energy: 26,740 kJ/d, Crude protein: 25.3 g/d. Lactation sows Estimated feed intake as 4.31 kg DM/d, Energy: 58,616 kJ/d, Crude protein: 16.3%.

* Shortage of feed compared to Nutrient requirement (as kJ and g in DM intake/d).

74.6%, respectively.

Similarly to the composition of feedstuffs given to fattening pigs, we also estimated data for Nutritive value of feedstuffs for pregnant and for lactating sows. Data in Table 5 showed that feed fed to pregnant and lactating sows were not only low in amount and but also in nutritive value.

The shortage of DM intake (kg/d) of pregnant sows raised in three zone Lowland, Coastal and Upland were 25, 16 and 23.5% respectively. The shortage of crude protein content in diet of pregnant sows in these three zones were 32, 42.7 and 61.2%, respectively.

The shortage of DM intake (kg/d) of lactating sow raised in Lowland, Coastal and Upland were 31.1, 39.2 and 57.1%, respectively. The shortages in crude protein content in the diets of sows in these areas were 63.4, 65 and 78.9%, respectively

Pig housing of smallholders in Central Vietnam

Most of pig houses in Central Vietnam are simple and shows a great variation. Pig housing in Upland, Van Kieu, Taoi, Muong minorities keep pigs as scavengers, occasionally confine them in paddocks; in wooden or bamboo-made pens. Pig housing in Lowland and Coastal areas are often in enclosed pens with a concrete floor. Walls between the pens and in the slatted floor manure collection pit are made from brick, the roof is mostly made from iron sheet, clay tiles or fibro-cement on a framework of timber or bamboo stems. Almost all farmers keep the gilts and sows in the same place from pregnancy, farrowing and lactation until weaning of piglets and manure is not stored.

Natural ventilation of pig housing system in Central Vietnam that is associated with micro-climate and the animal's welfare. The average temperature in Lowland, Coastal and Upland areas is about 25.9, 25.3, 24.5°C and relative humidity is about 82.6, 83.4 and 84.2% respectively. In the wet season, the mean minimum temperature for Lowland, Coastal and Upland area was about 19.5 18.2 and 17.3°C and the mean maximum temperature in that one was about 26.2, 25.3 and 23.4°C respectively. Mean minimum relative humidity in that one was 71.5, 72.7 and 75.83% and mean maximum relative humidity was 92.7, 95.3 and 95.7% respectively. In the dry season, the mean monthly minimum temperature for Lowland, Coastal and Upland area was 25.9, 24.5 and 23.7°C and mean monthly maximum temperature were, 35.2, 33.5 and 31.7°C respectively. Mean monthly minimum relative humidity in three zone were 57.83, 58.7 and 61.5% and mean maximum relative humidity was 84.7, 87.7 and 86.3% respectively.

Farmers were asked to identify the constraints responsible for their fragile pig production situation and to suggest possible solutions to alleviate these constraints. Obviously, many factors contribute to poverty of family farmers. And pigs breed, nutrition and housing do not

contribute much to their wealth.

As a conclusion, our survey stresses on the need of an integrated approach to improve pig production and living standards of rural smallholders in Central Vietnam. Scientific, technical, social and economic research involving all aspects of animal production systems (animal genotypes, nutrition, human and environmental condition interactions) is a great challenge for researchers.

DISCUSSION

In the context of social science, peasant societies are described as communities rather than as single individuals or households. Communities are halfway between the traditionally agricultural and industrial society. In the peasant society the household is an important social unit because within it the decisions concerning individual members' activities and their consumption (and thus their welfare) and their social status are made (Ellis, 1993).

The median farm size of 0.62 to 1.17 ha was small and this was attributed to the natural ecological zone of the study sites and the land-tenure system of inheritance (with subsequent subdivisions). In common with other reports on smallholder farming systems (Gitau et al., 1994; Simon et al., 1999), the smallholder pig farmers also kept other livestock and grew cash and subsistence crops. Most farms depended on family labour for pig production and had an off-farm income activity as has been observed previously on smallholder dairy farms (Schaik van et al., 1996).

The great importance of pigs in customs and in traditions was probably brought about by scarcity. Fish, vegetable and fruit were relatively plentiful, available and provided every day and these pigs are reserved for great occasions. The keeping of Village pigs is still a non-commercial activity illustrated by the small size of herds, the frequent change in ownership, and generally poor nutrition.

The results of our study show a low production output for different zones in Central Vietnam. This is clearly related to low input. Feeding just a small amount in an unbalanced way causes a low performance of sows and of fattening pigs raised in smallholder farms in Central Vietnam. The most common factor is the insufficient supply of nutrients with the feed. This makes it impossible to reach a good production level. The differences between high and low quality-feeds are mainly with regard to energy and protein supply. This low supply of energy and nutrients is undoubtedly the greatest limit to production of pigs in Central Vietnam. Also the pigs are fed the same materials as people eat, so the are in direct competition with humans for food (paddy rice).

The availability and utilization of feedstuffs varies very much according to geographical region. Farmers tend to use

whatever is available and reasonably palatable, including commercial feed, crop products and by-products, kitchen waste and fresh forages.

From two surveys of Tran et al. (2003) and Hoang (2003), it is clear that in rural areas, the use of by-products from crop production as feedstuffs is common in particular rice bran is used. The use of rice bran is very common because wet and rain-fed rice cultivation is practiced throughout the country.

The production system used throughout the country and thus also in Central Vietnam is a traditional one with a pig local breed that is fed crop by-products, crop residues and or/ any green material produced in home garden or nearby areas (Vo et al., 1995). Costs and net returns are both very low in this system. Green forage is also provided as a significant part of the pig's diet by many smallholders, particularly in upland area. Forage provides up to 25% of the energy (ME) for fatteners and 40% for pregnant sow in these areas (Le et al., 1998). Since premix-vitamin is not applied by farmer in daily pig diets, green forage is the major source of vitamins for village pigs. There are shortages of nutrient in pig feed and the higher the body weight is, the larger the shortage of DM is. Particularly, more than 50% in DM (kg) and CP is lacked in the lactation diets.

There was close similarity between pig breed and pig feeding regimen seen in three regions during this study. There is a great importance of pigs in customs and in traditions and this was probably brought about by the scarcity according to de Fredrick and Osborne (1977). Central Vietnam has a variety of pig breeds of which some lean breed like Large White, Landrace and some are not considered lean breeds like local breeds as Mong Cai, Co, VanPa. The indigenous breeds survive well in local conditions but they show a low productivity (Pham et al., 2007).

The pigs in the farms were local pigs and F1 that were mainly the crossbred of (Large White or Mong Cai) or (Landrace×Mong Cai) and only a few farmers possessed more than one sow (Pham et al., 2007). Such breeds perform well under tropical conditions if they are properly managed (de Fredrick and Osborne, 1977; Kunavongkrit and Heard, 2000). Most farmers in the current study do not keep a breeding boar because their sows are served by artificial insemination. Similar observations have been made in other tropical smallholder farms (Gatenby and Chemjong, 1992; Lanada et al., 1999). Most pig raisers did not seek extension information on pig farming and this might explain the poor pig-management practices observed.

During investigation, we found that pig houses on smallholders in Central Vietnam are simple and great variation. The pig housing are constructed by local available materials and in a traditional way. According to

Astroem (2000), the prevailing systems in rural areas are free-range systems or housing in simple pens, both with a minimum of inputs.

The constraints to pig production as perceived by the farmers in the current study were largely in accordance with findings in other tropical smallholder pig-production systems (de Fredrick, 1977; Kambarage et al., 1990; Gatenby and Chemjong, 1992; Lanada et al., 1999; More et al., 1999; Kunavongkrit and Heard, 2000). The production constraints might hinder improvement to productivity of pigs raised by the smallholder farmers.

When conducting the detail the survey for 150 farmers who are raising only fattening and 150 farmers who are raising only reproductive sows in three zones, we found some differences on the number of fattening and number of sow/farm (compared to average number of pig/households for three zones was 3.3 animal/households). The questions about the reason of these difference were answered by the interviewed farmers. Pigs are raised in Lowland and Coastal more than Upland because the main areas of rice and cassava which are feed sources for pig production. The farmers of the regions responded with different emphasis on cash money, meat consumption and also practical experience of animal husbandry. That is also differences about the way they think that pig prices will go and if they can sell surplus at a good price.

During this study, we observed that in practice, only a few farmers kept written records. All survey data, except objective measurement such as weight or other measures that enable us to estimate weight, weight food were based on information provided by each participating pig raiser. Because a few farmers kept any written records about management or production, these data were generally based on recall. Although no verification could be made of the data provided by each farmer, but we assumed that the accuracy of dataset is likely to be reasonable.

Firstly in common with the principles underpinning participatory rural appraisal (Young, 1993), we have considered smallholder farm to have substantial knowledge about the few animals they have under their care. Secondly, although recall of some questionnaire issues (Notably: the birth dates of growing animal) may be subject to considerable error, misclassification has been minimized by dichotomizing continuous variables wherever appropriate. This approach is particularly reflected in our analytical method. Although statistical power was reduced we elected to use logistic (with the outcome being dichotomized weight-for age) rather than multiple regression to minimize misclassification that may have resulted from inaccurate estimate of age. Most of the data collected during the cross-sectional study (such as level of ownership, piglet management procedures) were likely to change a little (if at all) over time. Relevant question were phrased to specific

period of interest.

Similarly with previous studies (Slater et al., 1992; Wilesmith et al., 1992; Wittum et al., 1994) there is a problem with accurate assessment of some nutritional information. During this study we collected those data about diets that likely influenced weigh-for-age. These data include basal feedstuffs (the feed that forms the large part of diet weight) and the use of commercial feeds, green feeds and any protein sources. These data were collected from all farms. And we considered that the use of commercial feeds or not and the inclusion of some source of protein was indicative of a long term trend.

The key problems in feed supply considered may be i) inadequate supply of amounts of protein and or amino acids. ii) No knowledge of fatty acid composition of feeds. iii) Little understanding of the level concentrate or supplement required in a diet. iv) appropriate level of feed energy for pigs at each age. To improve the quality of feeding the pigs it is needed that farmers first know the requirements of the animals. So it will be best to train the farmer on this aspect of pig husbandry. A number of opportunities have been identified for improvement of the production of smallholder pig farms in a sustainable way. The formulation of appropriate and cost effective diets proved problematic, particularly because of considerable overlap in feedstuffs eaten by pigs and people (de Frederick and Osborne, 1977). Nonetheless, significantly improved growth rate have been achieved if more attention was paid to the nutritive value of locally grown feedstuffs and to the value of added vegetable protein, fish and shrimp -by product and sources rich in energy e.g. carbohydrate rich feeds like Cassava and Sweet potato.

The strategies to promote increased pig production by providing more nutrient-rich feeds would be more effective when combined with a nutrition education intervention. This ensures that increased household food supply and income translates into improved pig's dietary quality. Pig nutritional interventions generally focus on increasing knowledge, changing attitudes, and improving practices related to the three pillars of good nutrition, namely health care, and dietary intake. Our result show that very few farmers were trained on pig husbandry, especially the farmers in the upland area. It is thought that swine nutrition education can stimulate the demand for certain foods, but the farmer must have the means and opportunities to act on that knowledge.

In a previous study of Honeyman (1991) several opportunities were given to enhance sustainability, including i) feeding with increased use of forage and by products, ii) nutrient cycling through improved handling of manure, iii) low capital but higher quality of animal houses that offer a better environment for operator and animals iv) preventative approaches to reduce swine health risks v) also

use of a broader genetic base.

Over the long term a sustainable pig production system should ; maintain or enhance the environment and natural resources (land, water, human, and feedstuffs); increase welfare for producer; should serve the market, pork consumer, and social aspects.

We concluded from our survey that the small scale in the pig production system in Central Vietnam is not only due to small farm house but according to interviewed farmers it is also due to the lack of capital for investment. Lack of technical knowledge and husbandry experiences were reasons of making feed which does not have a proper feed composition for the animals. Low amounts of capital for housing and for the provision of sufficient feeds and thus the situation of deficiencies in nutrient supply by feeds provided to the animal are considered by the farmers a main reason for low yield of animal production and the low income of farmers in Central Vietnam.

IMPLICATION

Increased feed supply will undoubtedly help to develop pig production in Central Vietnam and this will result in increasing income for farmer and better nutrition for people in rural area. To solve the situation of low quality of pig feeding in smallholder pig farms, there are some possibilities to improve food quality for pig production on smallholders:

- Allow animals to eat a longer time of the day so they can ingest more energy and protein
- Feeding semi-*ad libitum* will contribute to this: the animal can consume un-limited from two or three diets per day.

The optimum feeding for smallholder pig production would be rationed feeding with a balanced ration: Animal receives a limited quantity of feeding according to the age and stage of animals. The method of rationing is better economic effect. The improving is clearly when rationing is applied during growing of animals. It is recommended to supply a balance of amino acids and fatty acids in the ratio at the various stages of the fattening and the sows.

Education to farmers should be given a high priority and linked with supply of financial mean to apply this. Better understanding of nutrition requirement is essential to raise production.

Basic cost-efficient housing for small-scale farm should be study with emphasis on heat control and disease prevention. Farmer requires simple units; use available materials for cheap solution to be demonstrated. Hence, it can be concluded that the animal clearly need to be given the most cost effective nutrition as well as good housing. People should have a good general knowledge on pig

husbandry. This is very important to develop pig production on smallholder in Central Vietnam.

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