

Nutrition, feeds and feeding for pig production in Vietnam: Current status and future research – A review

La Van Kinh, Tran Quoc Viet, Vuong Nam Trung, Dinh Van Cai, Nguyen Thanh Van
National Institute of Animal Sciences, Vietnam

www.livestockfish.cgiar.org




April 2014

CGIAR is a global partnership that unites organizations engaged in research for a food secure future. The CGIAR Research Program on Livestock and Fish aims to increase the productivity of small-scale livestock and fish systems in sustainable ways, making meat, milk and fish more available and affordable across the developing world. The Program brings together four CGIAR centres: the International Livestock Research Institute (ILRI) with a mandate on livestock; WorldFish with a mandate on aquaculture; the International Center for Tropical Agriculture (CIAT), which works on forages; and the International Center for Research in the Dry Areas (ICARDA), which works on small ruminants. <http://livestockfish.cgiar.org>

© 2014



This publication is licensed for use under the Creative Commons Attribution-Noncommercial-Share Alike 3.0 Unported Licence. To view this licence, visit <http://creativecommons.org/licenses/by-nc-sa/3.0/>. Unless otherwise noted, you are free to copy, duplicate, or reproduce and distribute, display, or transmit any part of this publication or portions thereof without permission, and to make translations, adaptations, or other derivative works under the following conditions:

-  **ATTRIBUTION.** The work must be attributed, but not in any way that suggests endorsement by the publisher or the author(s).
-  **NON-COMMERCIAL.** This work may not be used for commercial purposes.
-  **SHARE ALIKE.** If this work is altered, transformed, or built upon, the resulting work must be distributed only under the same or similar license to this one.

ilri.org
better lives through livestock
ILRI is a member of the CGIAR Consortium

Box 30709, Nairobi 00100, Kenya
Phone: +254 20 422 3000
Fax: +254 20 422 3001
Email: ILRI-Kenya@cgiar.org

Box 5689, Addis Ababa, Ethiopia
Phone: +251 11 617 2000
Fax: +251 11 617 2001
Email: ILRI-Ethiopia@cgiar.org

Contents

Executive Summary	3
Chemical composition and nutritive value of feedstuffs	3
2. Study on digestibility for pigs.....	6
3. Nutrient requirements for pigs.....	7
3.1. Suckling piglets	7
3.2. Weaned piglets.....	7
3.3. Growing pigs	7
3.4. Pregnant sows	8
3.5. Lactating sows	8
3.6. Other related studies.....	8
3.7. Nutrient requirements for pigs: Recommendation	9
4. Better use of local and available feedstuffs.....	11
5. Feed and feeding methods	17
6. Future research in nutrition, feed and feeding for pigs.....	20
References	21
Tables.....	31
Part 1. Chemical composition and energy.....	31
Part 2. Amino acid composition	44
Part 3. Total tract and ileal digestibility.....	49
Part 4. Nutrient requirements	69
Part 5. Local and available feed resources for pigs	93
Part 6. Feeding methods	164

Executive Summary

This review paper was done by the National Institute for Animal Science (NIAS) and the Institute for Animal Science for Southern Vietnam (IASSV). The paper has reviewed the previous research results on the chemical composition and nutritive value, and digestibilities of nutrients and amino acids of Vietnam feedstuffs; Nutrient requirements for sucking piglets, weaned piglets, growing pigs, and pregnant and lactating sows; The use of unconventional feed resources; Feeding methods for pigs; and suggestion on the future research on nutrition, feed and feeding for pigs in Vietnam. The paper consists of five main parts: (1) chemical composition and nutritive value of feedstuffs; (2) Study on digestibility; (3) Nutrient requirements, (4) The use of local and available feedstuffs; and (5) Future research in nutrition, feed and feeding for pigs; and 143 tables.

Chemical composition and nutritive value of feedstuffs

For the last 20 years, approximately 1,000 feeds collected throughout the whole country have been chemically analysed. This work has been undertaken by the National Institute for Animal Husbandry (NIAH) in Hanoi and the Institute of Animal Sciences for Southern (formerly, Institute of Agricultural Science in Southern Vietnam - IAS), and some laboratories in Agricultural Universities. At the beginning stage, a proximate composition, Ca and P were analysed. The first publication on chemical composition and nutritive value of animal feeds was completed in 1962 and updated in 1983, followed by a major update and revision in 1992 and again in 2001 by NIAH supported by SINAO (Soviet Union) and others such as INRA (France), Queensland University, Ajinomoto Company, and the Vietnam Government.

The IAS had calculated the correlation equation estimated value of the amino acids, based on the crude protein content of the main raw material such as fish meal, corn, rice bran, rice bran, and cassava bran. This helps farmers formulate balanced amino acid pig diets without analysing the amino acids in the raw material.

During 2002-2012, the IAS analyzed approximately 16,500 feed samples from seven agro-ecological zones in the country for DM, CP, CF, ADF, NDF, EE, total ash, NaCl, Ca, P, trace mineral (Cu, Fe, Mn, Co, Hg, Cd, Pb), sugar, starch, DE, ME. In which, about 1,600 samples were analyzed for amino acids prior to formulating the correlation equations for the amino acid composition estimates. In total, 450 samples were analyzed for trace minerals, vitamins, toxins, and antinutrients.

The second book on the composition of amino acids and energy values of livestock feeds in Vietnam, including proximate and amino acid compositions was published in 2003 with the effort of IAS. In the publication, more than 1,000 feedstuffs from different agro-ecological zones were clearly defined, sensorily described, and chemically and nutritionally characterised. This analysis is summarized as:

Leaves, tubers and fruits: had low nutritive values and are a good source of vitamins, usually used in fresh form and available in rural areas of Vietnam. They are mainly used by smallholders in order to reduce feed costs, especially for pig production. Data are shown in Tables 1.1, 1.2, 1.3, 1.4, and 2.1.

High energy feedstuffs: had a low protein content but are rich in energy (Tables 1.5, 1.6, 2.1, 2.2 and 2.3) and of course, the main energy sources for livestock. They are available in rural areas and produced by farmers.

Plant protein feedstuffs: included legume seeds and their byproducts, and leaves; have high protein content (Tables 1.7, 2.1, 2.2, 2.3 and 2.4) and therefore, are locally available and cheap protein sources, particularly in rural areas. Cakes from oil seed extraction are the dominant feedstuffs. They contain a high crude protein content, and of course, high ANFs that may cause toxicity. Their protein contains normally imbalanced amino acid composition that may induce nutritive values and their utilisation.

Animal protein feedstuffs: are mainly fishmeals and soybean cakes (Tables 1.8, 1.9, 2.1, 2.2, 2.3 and 2.4). They have a high protein content but are costly. Traditionally, these feedstuffs are used in combination with the plant protein and energy sources to balance nutritive values, especially amino acids in diets.

Based on proximate composition, correlation equations were made for estimating DE and ME for pigs and poultry as the following:

For pigs:

$$\text{DE (kcal/kg)} = 52,8 \text{ CP} + 69,7 \text{ EE} - 11,5 \text{ CF} + 34,7 \text{ NFE} + \text{K}; \text{ R sq} = 87,8\% \text{ (1)}$$

$$\text{ME (kcal/kg)} = 46,6 \text{ CP} + 65,9 \text{ EE} - 12,4 \text{ CF} + 34,6 \text{ NFE} + \text{K}; \text{ R sq} = 86,6\% \text{ (2)}$$

For poultry:

$$\text{ME (kcal/kg)} = 38,6 \text{ CP} + 66,2 \text{ EE} - 14,1 \text{ CF} + 36,4 \text{ NFE} + \text{K}; \text{ R sq} = 85,9\% \text{ (3)}$$

In which, K is a correction factor that depends on the type of feed (Table 1.12).

In general, the chemical composition and nutritive value of Vietnam feedstuffs were varied and are dependent on the original sources and their processing methods. The variation in nutritive value causes difficulty for the database users. Nutritive values of grains and their byproducts are more stable.

In late 1990's, amino acid compositions of many feedstuffs also were reported by different studies (La Van Kinh et al., 2003; Ninh Thi Len et al., 2010). Data on amino acid compositions of feedstuffs reported by different authors are presented in Tables 2.1, 2.2, 2.3 and 2.4. The database of these came from individual studies and it is hard to compare with each other because of different analysis methods and/or variations in sample collection methods.

Generally, lysine and methionine are the two limiting amino acids in almost all feedstuffs for pigs. Amino acid compositions of feeds are varied and largely depend on their processing methods, and perhaps the analysis methods.

Besides energy, the equations for estimation of amino acids in feeds were also built based on a study by La Van Kinh et al (2003). Table 2.5 shows all equations.

General comments on this section

For over 20 years, almost all of Vietnam's feedstuffs were chemically analysed, mainly for proximate composition, some macro-minerals and essential amino acids, and energy value estimations. These databases are useful not only for scientists but also for animal raisers, who use this information for diet formulation. However, data on micro-elements, vitamins and nonstarch polysaccharides (NSP) were missed.

Moreover, data on mycotoxins and antinutritional factors (ANF) are limited. Data on aflatoxin (B1, B2, G1, G2) are restricted in some feedstuffs, but not other mycotoxins such as Ochratoxin A (OTA); Zearalenone (Zon); Trichothecenes (T2 toxin DON) and Fumonisin (FUM). In tropical climate conditions, availability of mycotoxins data in feeds are very important. These points may require further consideration in the near future.

It is important to note that almost all feedstuffs were collected in the North, Central and Southeast but not much in the Central Highlands and Mekong Delta, where pig production plays an important role in terms of pig population and income for the country.

Discussion on the use of existing essential amino acid profile

The balance of a mixture of AA in the diet is very unlikely to exactly meet the requirements of each of the animal's tissues. A deficiency of an AA is likely to cause a reduction in performance and excesses of AA can also be deleterious (Buttery and D'Mello, 1994). It has therefore been suggested that the most important single factor affecting the

efficiency of protein utilisation for meat production is the dietary balance of AA (Cole and Van Lunen, 1994). In order to compare the pattern of AA in diets for pigs in particular, the ideal protein provides a simple and effective approach. The development of an ideal protein in pigs has received considerable attention in recent years.

The ideal protein is conceived as providing the essential amino acids in the proportion required by the pig and of having the correct balance between EAA and NEAA. In the ideal protein each EAA is equally limiting for growth in the actual feeding situation and there is a minimal surplus of N (Boisen, 1997). The basis for ideal protein has been discussed by several authors, including the ARC (1981), Baker and Chung (1992), and Cole and Van Lunen (1994).

It has been suggested that the ideal protein pattern changes during growth, and three different amino acid patterns for pigs at live weight 5 – 20 kg, 20 – 50 kg and 50 – 100 kg, respectively, were recommended (Chung and Baker, 1992; Baker et al., 1993). However, there seems not to be sufficient experimental evidence for a change in the ideal protein pattern during the live weight period from 20 to 100 kg, and therefore, the composition of ideal protein for growing pigs is assumed to be constant (Boisen, 1997).

In Vietnam, the ideal protein concept has not been paid much attention in many previous studies. Therefore, the use of existing EAA profiles has not been efficient in feed evaluation and as well in pig diet formulation, leading to a probable increase in the level of crude protein in the diet.

2. Study on digestibility for pigs

In the 1980's, under Soviet Union-supported programs, studies on total tract digestibility of DM, CP, EE, and CF of common feedstuffs were carried out by NIAH (Nguyen Van Thuong et al., 1992). Of course, the number of experiments is limited due to a lack of research facilities such as cages, chemical analyses, and funds. Available data on digestibility were effectively utilized for estimation of energy value by using Bo Gohl (1982) recommendation equations. These energy values were presented in the book on chemical composition and nutritive value of Vietnam feedstuffs in 1991.

Total tract apparent digestibilities of common feedstuffs have been determined by using traditional total collection methods (Thuy and Ly, 2002; Vuong Nam Trung and La Van Kinh, 2010; Ninh Thi Len and et al., 2010). Total tract apparent digestibility of a number of common feedstuffs were reported by Thuy and Ly (2002) on rubber seeds; Vuong Nam Trung and La Van Kinh (2010) on maize meal, broken rice, rice bran, cassava bran, soybean cake, soybean seed meal and fish meal; Ninh Thi Len et al. (2010) on maizes, rice brans, soybean meal and fishmeal; and Dao Thi Phuong et al. (2013) on maizes, rice brans, cassava and its byproducts among others. All information on total tract digestibility of common feedstuffs are presented in Tables 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6.

In 1999, the post-valve T-caecum cannula technique (PVTC) method developed by Van Lueewen et al. (19991) was introduced to Vietnam by Prof. Lindberg and his group. Since then, the PVTC technique has been widely applied in many digestibility studies on pigs (Le Van Tho, 2000; Phuc, 2000; Ngoan, 2000; Len et al. 2010).

Bui Huy Nhu Phuc and Lindberg (2001) and Ngoan and Lindberg (2001) reported that values of ileal digestibility of amino acids could be accurately used in the pig diet formulation. Therefore, the determination of ileal protein and amino acid digestibilities of a number of feedstuffs were formulated by this method.

Ileal digestibility of amino acids of a number of feedstuffs were reported by Le Van Tho (2000) on soybean meal and soybean cake (Tables 3.6 and 3.7); Phuc and Lindberg (2001) on protein leaves (Table 3.8); Ngoan and Lindberg (2001) on shrimp byproducts (Table 3.9); Ngoan et al. (2001) on common protein sources in the Central region (Table 3.10); Phuc (2003) on protein leaves (Table 3.11); An et al. (2004) on sweet potato vines; and Nguyen Thi Hoa Ly et al. (2007) on cassava leaves and sweet potato vines in silage and in dry form (Table 3.17). Further, ileal digestibility of amino acids of feedstuffs were also reported by Ninh Thi Len et al. (2010) on maize meal, broken rice, cassava root meal, rice bran, fish meal and soybean meal (Tables 3.12, 3.13 and 3.14); and Dao Thi Phuong et al. (2013) on maizes, rice brans, cassava and its byproducts (Tables 3.15 and 3.16).

Besides in vivo methods for digestibility, the enzyme method has been used (Nguyen Cong Oanh et al., 2013). The authors have used pepsin and pancreatin enzymes (following Dierick, 1985; Lowgren, 1989) to determine digestibility of DM, CP, NDF and GE of banana flower and fruit. This method is recently been tested.

General comments

In last 10 years, studies on the digestibility of nutrients and amino acids have been very much encouraged. Different methods have been applied. Some thousand samples of more than 100 feedstuffs have been collected and had their nutrient digestibility in growing pigs determined. This means that approximately 100 common feedstuffs have been nutritively evaluated and had their DE and ME calculated accordingly. These values can be utilised in pig formulation.

However, the work is still in its infancy as the number of analyzed feedstuffs are still limited (about 100 feedstuffs vs potential 1,000). On the other hand, the almost all studies have mainly been using the total tract collection method for the determination of the digestibility of crude protein and amino acids, while the advantages of ileal digestibility methods are obviously recognised. A number of different types of studies have been undertaken to determine the usefulness of ileal digestibility values. Comparisons have been made between ileal and total tract values (Van Barneveld et al., 1991). Just et al. (1985) reported that digestible crude protein and AA determined from ileal digesta were better correlated to protein deposited in the carcass than digestible protein and AA determined from faecal analyses. Buraczewska et al. (1997) observed higher nitrogen retention and higher daily gain in pigs fed diets balanced according to pig requirements for ileal digestible, rather than total AA during the first fattening period. Furthermore, a higher correlation has been demonstrated between daily gain in pigs and ileal rather than total tract digestibility ($r = 0,76$ vs $0,34$), particularly with unconventional protein sources (McDonald et al., 2002).

Currently, we still rely on overseas results to formulate diets for all pig types.

3. Nutrient requirements for pigs

In Vietnam, so far, the nutrient requirements for pigs have been applied by NRC or ARC, or modified from these sources. The feeding method has been used in most studies.

3.1. Suckling piglets

La Van Kinh and Vương Nam Trung (2000) reported that, requirements of ME and lysine for a suckling piglet are 3,300 kcal ME kg⁻¹ feed (ranging 3,200 – 3,400) and 5 mg lysine kcalME⁻¹ (ranging 4.5 - 5.5). Data are presented in Tables 4.1 and 4.2. On the other hand, the authors also reported replacing up to 40% whey powder by lactose improved a feed expenditure but not growth performance.

Ton That Sơn et al. (2010) reported that, optimum CP and lysine requirements for a suckling piglet are 23% and 1.5%, respectively (Table 4.3).

3.2. Weaned piglets

For weaned piglets, La Van Kinh and Vương Nam Trung (2001) indicated the requirements of CP and lysine at 28-42 and 42-56 days old are 22% and 1.5%, and 20% and 1.35%, respectively (Table 4.4).

Similarly, Tran Quoc Viet and Le Minh Lich (2001) reported the DE and lysine requirements for weaned piglets (Yorkshire x Yorkshire x Mong Cai) are 14 MJDE kg⁻¹ feed and 0.9 g lysine MJDE⁻¹, respectively (Table 4.5).

Also, Nguyen Thi Luong Hong and Bui Quang Tuan (2001) have found the optimal levels of ME and lysine for weaned piglets (Yorkshire x Mong Cai) of 7-14 kg LW are 3,200 kcal ME kg⁻¹ feed and 1.3% (as DM) lysine (Table 4.6). In another study, the authors reported optimal levels of ME and lysine for weaned piglet of 5 – 10 kg LW as 3,100 kcal ME kg⁻¹ feed and 1.1% (as DM) lysine (Table 4.7).

Tran Quoc Viet et al. (2003) indicated the DE and lysine requirements for F1 weaned piglets are 14 MJDE kg⁻¹ feed and 0.9 g lysine MJDE⁻¹ (Table 4.8). Meanwhile, Hoang Toan Thang et al. (2005) reported that optimum lysine and ME ratio for weaned piglet (Landrace x Yorkshire) was 3.88g per 1,000 kcal ME. Dang The Nhung et al. (2006) determined the optimal DE and lysine requirements for Mong Cai weaned piglet of 5 – 17 kg LW are 13.5 MJDE kg⁻¹ and 1.1% digestible lysine (Table 4.10). Ta Van Dung et al. (2008) found that the optimal crude protein and ME ratio in Landrace weaned piglet was 59.5 g CP per 1,000 kcal ME.

Tran Dinh Phung et al. (2004) have found that the optimal protein level in a weaned piglet diet was 18% CP (Table 4.9). In addition, Tran Dinh Phung et al. (2004) reported that the essential amino acid profile for weaned Landrace piglets fed an 18%CP diet is Thr: 65; Met + Cys: 55, Trp: 19, Arg: 42, Iso: 50, Leu: 100, His: 33, Phe + Tyr: 100 and Val: 70% as lysine concentration. Also, Tran Dinh Phung et al. (2007) reported that the use of a balanced amino acid diet for weaned piglets can reduce the CP requirement from 20 to 18%.

3.3. Growing pigs

Do Van Quang (2001) reported the optimal lysine and DE ratio in diets for (Yorkshire x Landrace x Duroc) growing pigs of 20-95 kg LW was 13.5 MJDE kg⁻¹ feed and 0.65 g lysine MJDE⁻¹(Table 4.11).

Tran Quoc Viet (2003) found the ME and lysine requirements for (Yorkshire x Yorkshire x Mong Cai) pigs of 15-30; 30-60; and 60-100 kg LW were 3,100; 3,000 and 2,900 kcal kg⁻¹, and 0.95; 0.75 and 0.55% (as DM) lysine (Table 4.12). Meanwhile, Hoang Nghia Duyet (2003) reported that ME and lysine requirements for (Yorkshire x Mong Cai) pigs of 15-30; 30-60; and 60-90 kg LW were 3,250; 3,000 and 3,000 kcal ME kg⁻¹ feed, and 1.1; 0.95; and 0.70% (as DM) lysine (Table 4.13).

Tran Dinh Phung et al. (2008) reported that in a balanced (Lys; Me + Cys; Thr and Try) amino acid diet, the CP content of 17% was optimal for Landrace growing pigs of 20-50 kg LW. And, Tran Dinh Phung et al. (2004) reported the Met + Cys requirement for maintenance for (Landrace x Large White) growing pigs was 46.1 mg/ W0,75. Tran Hue Vien et al. (2004) reported the histidine requirement for maintenance for (Hampshire x (LD x LW) growing pigs was 13.5 mg/ W0,75.

Pham Thi Hien Luong et al. (2006) reported that the optimal lysine and DE ratios in diets of pigs at 10-30; 30-60 and 60 kg LW to slaughter were 0.82; 0.59; 0.52g MJDE⁻¹, respectively.

Bui Thi Thom et al. (2008) reported the optimal protein level for (Landrace x Yourshire) pigs diet with balanced (Lys; Me + Cys; Thre and Try) amino acid was 17% CP (Table 4.14).

Tran Van Phung et al. (2008) determined the optimal lysine and ME ratio in growing (LW x LD) pigs was 3.437 g lysine Mcal ME-1.

Bui Thi Thom et al. (2010) reported the optimal crude protein and lysine levels in diets for pigs of 18-50 and 50-90 kg LW were 170 g CP and 11 g lysine kg-1, and 150 g CP and 9 g lysine kg-1, respectively.

Ninh Thi Len et al. (2011) have observed the effects of energy density, protein and lysine concentrations, and seasons on growth performance of growing crossbred pigs with different blood levels. The authors reported that the optimal ME and CP levels in diets of 4-blood crossbred pigs of growing and finishing phases were 3,050 kcal and 160 g kg-1, and 2,950 kcal and 130 g kg-1, respectively; while the optimal digestible lysine levels were 3.2 and 2.8 g Mcal-1 in summer, and 2.9 and 2.5 g Mcal-1 in winter season. For 2-blood crossbred pigs, the optimal ME and CP levels were similar to those for 4-blood crossbred, but lower digestible lysine levels; The optimal digestible lysine level in summer were 2.9 and 2.5 g Mcal-1, and 2.6 and 2.2 g Mcal-1 in winter for growing and finishing phases, respectively (Tables 4.16 and 4.17).

3.4. Pregnant sows

La Van Kinh and Nguyen Van Phu (2002) reported the optimal ME density energy and lysine concentrations in diets for of crossed pregnant (Yorkshire x Landrace) sows were 3,100 kcal ME kg-1 feed, 13% crude protein and 0.65% lysine (Table 4.18).

La Van Kinh and Nguyen Van Phu (2002) also found that a thin pregnant sow required 260 g CP and 6,300 kcal ME per day for the first pregnant period, and 390 g CP and 9,450 kcal ME per day for the 2nd period. Whereas, a fat pregnant sow required 234 g CP and 5,670 kcal ME per day for the first period; and 351 g CP and 8,505 kcal ME per day for the second period (Table 4.19).

Tran Quoc Viet and Ninh Thi Len (2003) reported the optimal ME, CP and lysine levels for local-breed pregnant sows were 2,900 kcal ME kg-1 feed, 12% CP and 0.6% lysine. Feed allowance was 1.4 and 1.5 kg/sow/day in the 1st period and the 2nd period for 1st and 2nd parity sows and 1.1 and 1.2 kg/sow/day in the 1st period and the 2nd period for 3rd and over parity sows (Table 4.20).

Nguyen Thi Kim Loan et al. (2008) determined the effect of fiber levels in pregnant sow diets and found that increasing crude fibre levels from 10 to 12% in the pregnant sow diet did not effect the sow's productivity but improved the ADG of piglets (Table 4.21).

3.5. Lactating sows

La Van Kinh and Pham Tat Thang (2003) determined the optimal ME density, CP and lysine levels in diets of lactating crossed (Yorkshire x Landrace) sows were 3,100 kcal ME kg-1 feed, 18% CP and 0.95% lysine (Table 4.22).

Tran Quoc Viet and Ninh Thi Len (2003) reported the optimal ME density, and CP and lysine levels in diets of local Mong Cai lactating sows were 3,000 kcal ME kg-1 feed, 14% CP and 0.85% lysine with a daily feed intake of 3.0 - 3.5 kg (Table 4.23).

3.6. Other related studies

Bùi Huy Nhu Phuc (1996) determined the optimal ME density and CP level in diets of crossed growing pigs. The results showed that the optimal ME density and CP level were 2,965 kcal kg-1 feed and 14-16%, respectively.

Nguyen Nghi (1995) reported that (LW x LD x DR) pigs at growing and finishing phases fed a diet balanced in amino acids with 16 and 14% CP, had similar growth performance to those fed high CP diets with unbalanced amino acids (16 and 18% CP).

For pregnant sows, Nguyen Nghi (1994, 1995) suggested that crossed (Y x L) sows in southern Vietnam, with a mating weight of 140 kg should have 5,500 kcal ME and 247g protein intake and 6,550 kcal ME and 299g protein intake per day in the 1st and 2nd pregnant periods respectively (diet contained 13 % protein and 2900 kcal ME / kg feed). They also suggested that sows in northern Vietnam, with a mating LW of 160-180 kg should have daily intakes of 6900 kcal ME and 299 g CP, and 7500 kcal ME and 325g CP in period 1 and 2, respectively (diet contained 13% CP and 3000 kcal ME kg-1 feed). According to Nguyen Thien (1996), F2(Yx(YxMC) pregnant sows fed 1.7 to 2.3 kg feed day-1 in phase 1 (4760-6440 kcal ME; 243-328 g protein) in 5 firts parity without affecting the number of piglet/litter. Increasing the feed amount by 0.3-0.4kg in period 2 would increase the birth weight by approximately 50g/piglet. Nguyen Nhu Pho (2001) suggested that pregnant sows required 6,000 kcal ME per day in the 1st period and 7,500-9,000 kcal ME per day in the 2nd period, depending on the sow's body condition score.

Similarly to lactating sows, the studies focused on exotic and crossbred pigs. Nguyen Nghi (1994) suggested that optimal diets for F1 crossbred (Landrace x Mong Cai) sows were 3,049 kcal ME/kg feed, 16.12% CP and 0.75% lysine. Pham Nhat Le (1994) suggested that 3,131 kcal ME kg-1 and 16.14% CP were suitable for exotic sows.

Meanwhile, studies on nutrient requirements for adult boars were very limited. According to Vu Duy Giang (1997) a level of 445g protein day-1 was suitable for boars in Vietnam conditions. Nguyen Nghi (1995) concluded that a boar required 18-19% CP, 0.90-1.0% lysine and 0.51-0.56% Met + Cys in diets, and a daily feed intake estimated at 400-450 g CP. According to Pham Nhat Le (1994), increasing CP in boar diets from 17.1 to 20.9% (equivalent 458 and 560 g CP day-1) improves reproductive performance.

3.7. Nutrient requirements for pigs: Recommendation

Nutrient requirements for pigs can be summarized in Table 1.

Table 1. Summary of nutrient requirements for pigs

Type	ME (kcal kg ⁻¹)	CP (%)	Lys (%)	Met (%)	Met+ Cys (%)	Thr (%)	Trp (%)
Sulking piglets	3,300	22.5	1.65	0.44	0.94	0.99	
Weaned piglets							
Exotic breeds							
Southern							
- 28-42 days old	3450	22	1.50		0.84	0.92	0.26
- 42-56 days old	3300	20	1.35		0.74	0.82	0.24
Crossed F ₂	3200	19	1.26		0.75	0.81	0.22
Crossed F ₁	3200	20	1.3				
Local MC breed	3100	18	1.1				
Exotic growing pigs							
- < 60 kg	3100		0.88		0.48	0.59	0.15
- > 60 kg	2900		0.69		0.38	0.46	0.12
Growing F ₂ pigs							
- < 30 kg	3100	16	0.95		0.57	0.62	0.17
- < 60 kg	3000	14	0.75		0.49	0.50	0.13
- > 60 kg	2900	12	0.55		0.38	0.38	0.11
Growing F ₁ (YxBX) pigs							
- < 60 kg	2900	14	0.75	0.47			
- > 60 kg	2900	12	0.60	0.45			
Growing F ₁ (YxMC) pigs							
- < 30 kg	3000	16	1.10				
- < 60	3000	14	0.90				
- > 60 kg	3000	12	0.70				
Pregnant sows							
Exotic	3100	13	0.65	0.23	0.46	0.53	0.12
Local	2900	12	0.6		0.38	0.46	0.11
Farrowing sows							
Exotic	3100	18	0.95		0.53	0.61	0.15
Local	3000	14	0.85		0.32	0.56	0.15

Source: La Van Kinh et al. (2003)

General Discussion

Results on nutrient requirement studies

In recent years, we have undertaken several trials to determine the optimal nutrient requirements for pigs including exotic breeds, crossbred pigs between exotic and local breeds as well as local breeds in the different production stages. These trial results have contributed greatly to building the optimal diet for pigs, the efficient use of feed resources, improving productivity and lowering production costs. However, we have only determined the basic nutrient requirements such as protein, total amino acids, macro minerals, and calculated DE and calculated ME. There are almost no studies on the apparent amino acids digestibility requirement, the ideal amino acid digestibility requirement, the trace minerals and vitamins requirement, and the optimal ratio between digestible amino acids and DE or ME. These weak points limit the optimization of diets and the genetic potential of production. Recently, the productivity of pigs in Vietnam have been 10-15% and 20-25% lower compared to regional Southeast Asian countries and other developed countries respectively. This leads to increasing production costs and reduced competitiveness.

Determining EAA requirement using “ideal protein” concept – Method of determination of nutrient requirements

As mentioned above, the ideal protein concept has been used not only in protein evaluation but also in amino acid requirement determination. In the ideal protein profile, lysine is of particular interest because it is the EAA found in the highest concentration in the muscle, egg and the carcass of many fish species (ARC, 1981, Wilson & Cowey 1985; Wilson & Poe 1985; NRC 1993). Moreover, lysine is the first limiting AA in most cereal grains and grain by-products, and plant protein sources used to manufacture commercial feeds (Akiyama, Oohara & Yamamoto 1997; Montes-Girao & Fracalossi 2006). However, lysine can be used as the reference AA for estimating the requirements of other EAA, using the ideal protein concept (Baker & Han 1994).

In previous studies in Vietnam, determination of nutrient requirements has usually been done in dose-response studies, which are costly and time consuming, especially when determining the requirement for all EAA. Therefore, the use of ideal protein concept to estimate the requirements for EAA for pigs in particular and monogastrics in general, should be emphasised in future studies in the country.

4. Better use of local and available feedstuffs

In the last 10 years, several studies have been undertaken to utilize and evaluate the nutritive values of local and available feedstuffs for livestock herd in which pigs are dominant. Ngo Huu Toan and Preston (2007) evaluated uncultivated vegetables for pigs and reported that a variation of accepted uncultivated vegetables, according to wealth ranking of pig raisers, and the use of local feedstuffs could reduce feed costs and therefore increase net income from pig production (Table 1.2).

Bui Hong Van et al. (1997) indicated that Duckweed (*Lemna* spp) can be used as protein supplement in an ensiled cassava root diet for (Yorkshire x Landrace x Baxuyen) fattening pigs (Table 5.1).

Le Thi Men et al. (1997) investigated the effect of dietary protein level and duckweed (*Lemna* spp) on reproductive performance of Ba Xuyen sows fed a diet of ensiled cassava root or cassava root meal. They concluded that a diet of ensiled cassava root or cassava root meal, with 75 g CP per day in pregnancy and 200 g per day during lactation, plus fresh duckweed ad libitum, can completely replace a conventional cereal-based diet for sows (Table 5.2).

Nguyen Thi Loc et al. (1997) indicated the importance of protein supplements in traditional diets for crossbred pigs under village conditions in Central Vietnam. Growth performance significantly improved with supplements of fishmeal and groundnut cakes in diets of (LW x MC) growing pigs (Table 5.3).

Le Thi Men et al. (2000) used water spinach (WS) as a protein source for BaXuyen and Large White sows and concluded that fresh chopped WS can replace 30% of the DM of concentrate diets for gestating sows and 15% of the diet of lactating sows of both local and exotic breeds, resulting in the improvement of reproductive performance and welfare (Table 5.4).

Vo Thi Kim Thanh et al. (2000) studied the use of ensiled groundnut vines for growing pigs and concluded that the feed cost was improved by 22% (Table 5.5).

Nguyen Nhut Xuan Dung (2005) nutritionally evaluated duck weed, para grass and water spinach in growing (Yorkshire x Ba Xuyen) pigs, and found that using locally available vegetables in diets could improve nutritive values and get more profit in village pig production (Table 5.6).

Nguyen Ba Trung (2006) determined the effect of using cooked fresh leaves and stems of water hyacinth (WH) as a supplement in commercial concentrate diets of growing Yorkshire pigs. The results showed that the use of WH could improve daily weight gain as compared to the concentrate diet and processing methods had no effect on daily gain and feed intake (Table 5.7).

According to Le Thi Men (2006), for medium and small household production, water hyacinth supplementation in LY growing pigs from 30 to 90 kg attained profits and backfat thickness also improved as compared to the traditional diet (16.8 mm for pigs fed WH vs 19.4mm in traditional diet) (Table 5.8).

Hoang Nghia Duyet (2003) has studied the effects of fresh sweet potato vines (SPV) levels in sow Mong Cai diets on reproductive performance and concluded that the optimal levels of SPV in pregnant and lactating sow diets were 20% and 50%, respectively (Table 5.9).

Du Thanh Hang et al. (2009) evaluated sweet potato vine (SPV), duckweed (DW), cassava leaves (CL) and Stylo foliage (SV) on F1 (Large White x Mong Cai) and found total tract apparent digestibility of CF did not differ among the diets (Table 3.6).

Pham Sy Tiep et al. (2005) reported on the processing methods to reduce the calcium oxalate content in *Alocasia macrorrhiza* roots fed to growing crossbred pigs in mountainous household conditions. It was determined that after processing, the *Alocasia macrorrhiza* root meal can be included at levels of up to 50% in the diets of growing pigs (Table 5.10).

Ngo Huu Toan and Preston (2007) tested processing methods (cook and silage vs fresh) and found that for F1 (Yorkshire x Mong Cai) (FL), ensiled taro leaves was the appropriate method (Table 5.11).

Pham Sy Tiep et al. (2007) studied the use and processing methods of *Alocasia macrorrhiza* (Giant taro) leaves in diets for Mong Cai sows and growing F1 (LW x MC) pigs under mountainous conditions, and found no negative effects on pig performance but benefits were improved (Table 5.13).

Du Thanh Hang and Preston (2007) studied the effect of processing methods of taro leaves in growing (MC x LW) pigs and found higher N retention in ensiled taro leaf diet. In conclusion, taro leaves need to be ensiled before feed to pigs (Table 3.6).

Nguyen Thi Hoa Ly et al. (2010) studied the use of taro leaves (*Colocasia esculenta*) and cassava (*Manihot esculenta* Crantz) leaves as silage additives; and evaluated digestibility and N retention in local Van Pa pigs. In conclusion, the mixture of taro and cassava leaves ensiled with molasses was the appropriate method and N retention in the ensiled Taro-cassava diet was low due to the reduced feed intake (Table 5.15).

Similarly, Pham Sy Tiep et al. (2010) evaluated the use and processing of giant taro (*Alocasia macrorrhiza*) for raising pigs in northern mountainous households of Vietnam. In conclusion, ensiling taro leaves with 7% rice bran and 2% molasses reduced 78.8% oxalate calcium content, and could replace 10% FM in the diet for growing (LW x MC) pigs.

Hoang Nghia Duyet (2010) reported that replacing soyabean meal by ensiled taro leaves slightly reduced reproductive performance of Mong Cai sows but improved economic benefits (Table 5.17).

Du Thanh Hang and Preston (2010) noted that oxalate content ranged from 1326-3567mg/100g DM for taro stem and 770-2531 mg/100g DM taro leaf. Processing methods such as air-drying, soaking, cooking or ensiling could reduce oxalate content, by as much as 50% by cooking and ensiling.

Hoang Nghia Duyet (2010) evaluated taro biomass in the coastal region of central Vietnam and the effect of taro protein on reproductive performance of MC sows. It was concluded that the boiled leaves of the Giant taro can be a complete replacement for soybean meal in the diets of MC sows with only a slight increase in time to re-mating (from 7.2 to 12.7 days) and a reduction of 3.5% in litter weight at weaning.

Nguyen Tuyet Giang and Preston (2011) compared a basal diet with a diet supplemented with 34.5% taro silage, 34.5% water spinach or a mix of taro silage 17% and water spinach 17.5%. There were no significant differences in terms of feed intake, protein and dry matter digestibility and nitrogen retention among the diets.

Tran Thanh Hai (2012) studied the effect of replacing FM by a mixture of ensiled taro leaves and sweet potato vines on reproductive performance of local Van Pa sows in Central Vietnam. It was concluded that there were no significant dietary effects, meaning that mixing ensiled TL and ESPV can applied in sow diets (Table 5.19).

Similarly, Hoang Nghia Duyet (2013) studied the effect of replacing rice bran with a mixture of ETL and banana pseudo-stem on reproductive performance of MC sows. The study concluded that areplacemet level of up to 50% has no effects on the reproductive performance of MC sows (Table 5.20).

Du Thanh Hang and Nguyen Trung Kien (2012) reported the effects of taro varieties on chemical composition and oxalate content, and digestibility of inclusion of ETL level in diets in F1 (MCai x LW) pigs. Apparent digestibility of OM was lower, but that of crude fibre was higher when ensiled Taro foliage replaced 50% of the maize-rice bran. Nitrogen retention and biological value of the dietary protein increased with the inclusion of ETL in the diet, and by the addition of a rice wine by-product (Table 5.21).

Du thanh Hang et al. (1997) studied N retention in Mong Cai pigs fed sugar cane juice with different foliage (ensiled cassava leaves, fresh foliage of cowpea, fresh duckweed, and silage mixture of cassava and trichantera (*Trichantera gigantea*) leaves) supplements as protein sources. N retention increased linearly as the proportion of leaves in the diet increased and was highest for ensiled cassava leaves.

Du Thanh Hang (1998) carried out a study on digestibility and nitrogen retention in fattening pigs fed different levels of ensiled cassava leaves as a protein source and ensiled cassava root as energy source. DM and CP digestibilities and N retention decreased with increasing level of ECL in growing pig diets. There were no indications of cyanide toxicity on any of the diets (Table 5.22).

Lam Quang Nga et al. (2000) studied the effect ofcassava leaf meal (CLM) and water spinach (WS) on reproductive performance of local MC and F1 (MongCai x Yorkshire) sows. The total litter weight at weaning (65.2 and 67.2 kg) was slightly lower for the sows given the cassava leaf meal/water spinach diet. The weight loss during lactation was higher ($P=0.03$) and time from weaning to oestrous was longer ($P=0.02$) for the cassava leaf meal/water spinach diet compared with the control (13.7 vs 11.7 kg and 21.7 vs 12.7 days, respectively) (Table 5.23).

Nguyen Thi Loc et al. (2000) evaluated the effects of cassava leaf silage on Mong Cai sows in Central Vietnam. Inclusion of up to 15% ECL in gestation and lactation diets for Mong Cai sows had no effects on litter size, but piglet weaning weights were significantly higher (Tables 5.24 and 5.25).

Nguyen Duy Quynh Tram and Preston (2004) determined the effect of cassava leaves processing method on intake, digestibility and N retention by Ba Xuyen pigs. The actual intake of cassava leaves and total DM were similar between the two treatments ($P>0.05$). Average values for DM, OM and N digestibility did not differ between treatments ($P>0.05$), and there was also no treatment effect ($P>0.05$) on N retention (1.93 and 2.16g/day for fresh and wilted cassava leaves). It was concluded that fresh cassava leaves can safely be fed to growing pigs at levels up to approximately 25% of the diet (Table 5.26).

Du Thanh Hang and Preston (2005) carried out two experiments to determine the effects of simple processing methods of cassava leaves on HCN content and intake by growing pigs. The fresh cassava leaves were readily consumed, providing 38% of the dietary DM and over 70% of the dietary protein with no effect of processing method on total DM intake. Levels of HCN were reduced slightly (16%) by washing and substantially (82%) by wilting, resulting in intakes of HCN between 6.0 and 15 mg/kg live weight. There were no apparent symptoms of HCN toxicity. The results indicate that fresh cassava leaves, chopped and washed before

feeding, can be included in ensiled cassava root / rice bran diets for growing pigs at levels of up to 40% of the diet DM, and as the sole source of supplementary protein (Tables 5.27 and 5.28).

Nguyen Thi Loc and Le Khac Huy (2003) studied DL-methionine supplementation in ensiled cassava root-based diets on the performance and economic efficiency of F1(LW x MC) growing pigs. The level of DL-methionine (0.3%) slightly reduced daily gain when compared with the 0.2% level. Feed costs for growth were reduced by 9% by 0.2% DL-methionine supplementation. Supplementation with DL-methionine at 0.2% in ensiled cassava root-based diets gave the best results on performance and economic efficiency (Tables 5.29 and 5.30).

Du Thanh Hang and Preston (2006) reported the effects of cassava leaf processing methods on HCN, and DL-met supplementation in ECL-based diets in growing F1(MC x L) pigs. The HCN level in cassava leaves from a high-yielding variety was reduced by 19% by washing, 74% by wilting for 24 hours and 76% by ensiling for 21 days. Adding 0.2% DL-methionine to a diet with 50% cassava leaves improved the live weight gain and feed conversion ratio (Tables 5.31 and 5.32).

Bui Huy Nhu Phuc and Brian Ogle (2005) evaluated the effects of cassava-leaf meal levels in sow diets on reproductive performance. It was concluded that up to 30 % of cassava leaf meal can be included in the diet of pregnant sows without any detrimental effects on reproduction (Table 5.33).

Du Thanh Hang (2009) carried out a feeding trial to evaluate the effect of different levels of DL-methionine supplementation on growth performance of pigs given diets with cassava leaves and cassava roots. The results indicated that daily weight gain of pigs fed fresh cassava was higher than that of pigs fed cassava-leaf silage (0.657 vs 0.578 kg/day). Increasing DL-methionine supplementation in the basal diet decreased backfat thickness while daily weight gain increased. Therefore, using cassava leaves with 0.2% DL-methionine to replace part of the fishmeal and rice bran component of the basal diet generating a greater profit for the household producer (Table 5.34).

Bui Huy Nhu Phuc (2005) studied levels of cassava leaf meal supplementation in sow diet on reproductive performance. It was concluded that up to 30% of cassava leaf meal can be included in the diet of pregnant sows without any detrimental effects on reproduction (Table 5.35).

Nguyen Thi Hoa Ly and Le Duc Ngoan (2005) determined the effects of DL-met and Lys supplementation on growth performance of growing (LW x MC) pigs. The results showed that daily weight gain gradually increased with increasing amino acid levels. Supplements of 0.2 % L-lysine and 0.1 % DL-methionine for 20-50 kg growing pigs' diet and 0.1 % L-lysine and 0.05 % DL-methionine for 50-90 kg growing pigs' diet gave the highest economic efficiency (Table 5.36).

Nguyen Thi Hoa Ly (2006) studied the effect of ECL on growth performance of growing (LW x MC) pigs. It was found that the inclusion of up to 20% (of DM) of ECL in the diet did not affect the animals' health or performance but reduced feed costs by 13.8% (Table 5.37).

Bui Huy Nhu Phuc and Brian Ogle (2005) studied the effect of the inclusion of cassava leaf meal (CLM) in diets on performance of growing (Yorkshire x Duroc x Landrace) pigs. With increasing CLM levels (up to 15% CLM) in diets, the DWG declined, FCR increased, the backfat thickness decreased and the loin eye area increased, although not with statistical significance. In Experiment 2, the live weight gains were slightly improved with increasing CLM inclusion level (up to 12% CLM), backfat thickness decreased and loin eye muscle increased with increasing CLM in pig diets. It was concluded that cassava-leaf meal could be included to a level of up to 12% for growing-finishing pigs (Tables 5.38 and 5.39).

Nguyen Thi Loc (2007) determined the effects on performance and economic return of ECL in a sweet potato vines-based diet, and of *Trichanthera gigantea* foliage in a SPV-based diet of F1(LW x MC). There were no effects of ECL and foliage on growth performance but feed costs were reduced (Tables 5.40 and 5.41).

Tran Thi Thu Hong (2013) studied the improvement of CP content of cassava root meal, rice bran and tofu byproducts by *Aspergillus oryzae* (AS) or *Aspergillus oryzae* in combination with *Saccharomyces cerevisiae* (AS + SC) or *Aspergillus oryzae* in combination with *Saccharomyces cerevisiae* and *Lactobacillus fermentum* (AS + SC + LB). At day 21 of the incubation process, the CP content of cassava meal, rice bran and tofu byproducts were 12.2%, 17.9% and 33.8% compared with day 1 levels of 3.52%, 13.9% and 11.3% respectively. The results showed that the additions of yeast have a significant effect on cassava residue, followed by tofu byproducts and finally rice bran (Table 5.42).

Nguyen Van Phong (2013) studied the effects of protein enriched cassava byproduct *Aspergillus niger* on the growth rate of F1(LW x MC) pigs and found that the enriched cassava byproduct improved growth performance (Table 5.43).

Le Van Lien et al. (2000) studied the ensiling technique for fish by-products and the use of EFB for growing (LD x LW) pigs. It was concluded that further studies are needed to improve the palatability of the silage and determine the optimum level of replacement. High-protein fish byproducts can be ensiled by using molasses as an additive; and EFM can replace 50% FM in diets (Table 5.44).

Le Thi Men (2010) studied the effect of replacing catfish byproduct meal with coconut cake on the performance of growing F1(Yorkshire x Ba Xuyen) pigs and concluded that coconut cake could replace up to 50% CP from catfish byproduct meal (Table 5.45).

Nguyen Thi Thuy and Preston (2012) studied the effects of oil-extracted fish products on the quality of sow milk and found that increasing oil-extracted fish byproducts by up to 9% in diets results in increased fatty acids (C18:2 and C18:3) in the sow's milk (Table 5.46).

Le Thi Men (2005) studied the effect of replacing fishmeal with catfish by-product meal on pig growth and concluded that catfish meal could replace up to 100% of FM in diets of growing pigs (Table 5.47).

Tran Thi Thu Hong et al (2003) studied the effect of replacing FM with tofu byproduct on digestibility and N retention in growing pigs and found that the increasing tofu byproduct levels slightly increased N digestibility but had no effect on BV (Table 5.48).

Le Thi Men (2012) studied the effect of replacing FM with a mixture of catfish byproduct meal and coconut cake on growth performance and fat quality in F1(LW x Ba Xuyen) pigs, and concluded that the mixture of catfish meal and coconut cake could replace up to 100% of FM in diets (Table 5.49).

Nguyen Thi Thuy (2010) found no effect on digestibility and N retention in growing pigs of replacing 100% FM with catfish byproduct and ensiled catfish (Table 5.50).

Nguyen Thi Thuy and Ly (2002) found there was an effect of genotype on DWG and FCR but not on digestibility in growing MC or LW pigs fed rubber seed meal in diets (Table 5.51).

Le Duc Ngoan et al (2000) developed the silage process for shrimp by-products using molasses, cassava root meal (CRM) as additives, and ensiled shrimp byproduct (ESB) for feeding growing pigs. In conclusion, shrimp byproducts could successfully ensile with molasses or CRM at 20% W; and ESB can replace up to 10% FM in diets (Table 5.52).

Luu Huu Manh et al. (2000) reported the nutritive value of rice distillers' by-product (hem) where CP contents ranged from 17 to 33% (mean of 23%) in dry matter. Also, Luu Huu Manh (2003) studied the effect of replacing fishmeal with hem on growing Yorkshire pig performance. It was concluded that for growing-finishing pigs, a diet based on broken rice and rice bran, the rice distillers' waste can be the sole protein supplement supporting performance levels comparable with the use of fish meal (Table 5.53).

Luu Huu Manh (2003) reported the effect of the inclusion of grain brewers (byproducts from beer processing) in diets on performance. Daily gains tended to decrease and FCR increased when brewers increased in diets, although a level of up to 30% brewers did not affect growth performance but improved economic return (Table 5.54).

Dao Thi Phuong (2010) studied the effect of wort on growth and intestinal microbial characters. Results showed that weight gain of piglets was not greatly effected when the level of grain brewers was up to 30%, but FCR was lower in diets which contained grain brewers as well as the number of intestinal bacteria *E. coli*. The height of the villi in ileum was 237, 423 and 334 mm for the control diet, diets with 15 and 30% grain brewers (Table 5.55).

Summary of other relevant studies

Bui Hong Van and Le Thi Men (1990) studied on the use of "A" molasses in diets for growing F1(LD x LW x DR) pigs. Average daily liveweight gains were slightly lower for the molasses fed pigs, but as total daily dry matter feed intakes were lower than for the control pigs, feed conversion efficiency was better for the molasses fed group (Table 5.56).

Bui Huy Nhu Phuc (1993) used sugar cane juice and molasses in the diet of growing F1(LW x LD) pigs. There were no differences in daily gains and FCR (Table 5.57).

Hoang Nghia Duyet and Nguyen Thi Loc (2000) determined the effect of dietary protein level on the reproductive performance of Mong Cai sows. It was concluded that the optimum levels of CP are 12% in gilt rearing diets, 10% in gestation, and 14% in lactation diets (Table 5.58).

Nguyen Nhut Xuan Dung (2005) reported the inclusion of up to 5-7.5% corn cob silage in diets of growing pigs improved growth rate.

Bui Huy Nhu Phuc (2003) found no effect of using wheat bran, soya hush or cassava leaves in diets for 21-day-pregnant sows on reproductive performance.

Nguyen Thi Hoa Ly et al. (2003) determined the effect of dietary protein content supplied by fish meal and sweet potato leaf meal on the performance of growing pigs under village conditions in Central Vietnam. There were no treatment effects on final live

weight, daily live weight gain and feed conversion ratio, but the cost of feed per kg live weight gain was significantly higher for the very high protein level, because of the high cost of fish meal. Dietary protein levels of 14% CP for pigs of 20-50 kg and 12% CP for pigs of 50-90 kg (as DM) with the protein supplied by fishmeal and sweet potato leaf meal, can be recommended as they resulted in reasonably good growth performance and gave the best economic efficiency (Table 5.59).

Nguyen Nhut Xuan Dung (2010) stated that we could mix diets including syrup from 4-6% daily weight, decrease the feed conversion ratio without affecting backfat thickness. According to Tran Thi Dan (2002), the diets of final stage pregnant sows with the addition of 5% fish oil or coconut oil led to improved weight gain, piglets' health and economic efficiency. The atrophy of lactating sows was significantly reduced when fat was added to the diets. The addition of coconut oil or fish oil to the diet for lactating sows increased the milk fat content.

Le Duc Ngoan and Thai Thi Thuy (2006) studied the effect of mulberry leaves in diets of growing pigs on digestibility and N retention. N retention was slightly higher in mulberry leaf meal than in ensiled leaves and higher than that in FM diet. Therefore, ensiled mulberry leaves and meal could be used to completely replace fishmeal.

Hoang Nghia Duyet (2005) evaluated the effect of cassava leaves, spinach leaves and sweet potato vines in diets of pregnant sows and lactating sows on reproductive performance. The results indicated that the use of up to 50% protein from a mixture of forage in the diet for pregnant and lactating MC and Y did not affect piglets' weight, and the mother reproductive performance, therefore feed costs were reduced feed costs.

Le Thi Men (2003) studied the effect of fish oil supplement in cassava byproduct-based or cassava meal-based diets on growth performance of growing pigs. The results showed that the inclusion of up to 5% fish oil in cassava byproducts could improve backfat thickness and loin area (Table 5.61).

Hoang Huong Giang et al. (2010) evaluated the effects of microbial enzymes and a complex of lactic acid bacteria and *Saccharomyces boulardii* on growth performance and total tract digestibility in weaned pigs. There were no differences in performance or digestibility between diet LY and LYE ($P>0.05$) (Table 5.62).

Pham Hong Son et al. (2003) tested a local medicinal herb (*Achyranthes aspera*) as dietary supplement to sows to prevent diarrhea in piglets. The analysis of the data indicated that "co xuoc" supplementation to sows decreased diarrhea prevalence in piglets and increased their growth rate but decreased the litter size. There was no apparent effect on the immune response of piglets and on their gut microbial flora (Table 5.63).

Nguyen Nhut Xuan Dung et al. (2010) determined the effects of turmeric (*Curcuma longa*) and garlic on growth performance, feed conversion and blood fat components of growing-finishing pigs. The studies indicated that fresh or dried garlic and garlic with turmeric might be used as a feed additive in the diet and have great potential in reducing the blood cholesterol and LDL cholesterol (Tables 5.64 and 5.65).

Long et al. (2010) determined the influence of phytase (PHY) supplementation in rice bran-based diets on the digestibility and phosphorus excretion in growing pigs. The results show that the diets had no impact on the feed intake ($P>0.05$). There were significant differences in the digestibility of DM, OM, CF, NDF and P among diets ($P<0.05$), with the exception of CP digestibility ($P>0.05$). The diets with supplemented phytase had higher P retention and lower total P excretion than the diets without phytase supplementation ($P>0.05$). In conclusion, enzyme supplementation improved the digestibility of dietary components and P and N retention (Table 5.66).

Tran Thi Bich Ngoc et al. (2010) determined the effect of dietary fiber level on gut environment and bacteria development of Mong Cai and F1(Landrace x Yorkshire) pigs of different ages. The results showed that the high fiber level resulted in decreased pH and increased content of total organic acids in all segments of the intestine ($p < 0.05$). Furthermore, the high fiber level resulted in an increased ($p < 0.05$) molar proportion of lactic acids (of total OA) in the ileum, cecum and colon and a decreased molar proportion of acetic acids (of SCFA) in the ileum and ceacum. MC pigs had a higher molar proportion of lactic acids in the ileum and lower molar proportion of lactic acids in the ceacum and colon than LY pigs ($p < 0.05$), whereas the reverse was true for molar proportion of short chain fatty acids (SCFA) at these sites. In conclusion, diets containing different fiber levels resulted in differences in the development of lactic and cellulolytic bacteria, and pH, lactic acid and short chain fatty acids in the intestinal segments of MC and LY pigs.

Le Thi Men (2006) determined the effect of replacing coconut meal with fishmeal on growth performance. It was determined that up to 50% protein of coconut meal being replacing by fish meal had a negative effect on growing and finishing pigs (Table 5.67).

Bui Huy Nhu Phuc (2010) evaluated the chemical composition of cashewnut cake (CC) and its usage in swine rations. The chemical composition of CC is 86.7% DM, 29.7 - 31.0% CP, 12.7 - 16.4% EE, 2.5 - 2.82% CF and 4:40 - 4.61% ash. Essential amino acids accounted for 28.7% with levels of Thr, Met + Cys, Lys, Try were 1.05, 1.08, 1:29, 0:38% respectively. The results were that daily weight gain increased and metabolic coefficients decreased with increasing levels of CC in diets. The use of CC didn't affect the

quality of pig meat. Experiments using CC for pigs after weaning: 240 pigs (weighing 9.5 kg/each) were arranged in randomized rations containing 0, 5.6, 11.0 and 16.8% CC. The results showed that CC could replace dried soybean meal in diets of weaned pigs at an optimum level of 11%. Experiments using CC for lactating sows: 44 LY sows at 15 days before laying were randomly arranged into 4 diets that contained level of CC 0, 11.65, 23.3 and 35%. Results show that CC with up to 67% protein can be used to replace dried soybean.

Nguyen Thi Tuyet Le et al. (2010) studied using Gac byproduct after oil extraction (*Momordica cochinchinensis* Spreng) in pig diets. Gac byproducts were treated with 2% molasses or 3% and 5% cassava byproducts or 3% and 5% maize meal or 10% taro leaves. Fresh Gac byproducts have a low dry matter content (10.59% \pm 0.93) and soluble sugar (0.35% in DM). It was concluded that good quality silage was obtained by ensiling the Gac byproducts with 5% maize or 10% taro leaves.

Doan Thi Hoang Mai et al. (2010) studied the use of ensiled cabbage by-products in pig diets. The conclusion stated that cabbage by-products successfully ensiled with rice bran, cassava meal, or molasses and can be preserved for at least 56 days, and molasses seems to be a better additive than others. Inclusion of up to 10% (as DM) of ECBP had no significant effect on nutrient digestibilities and N-retention for growing pigs.

Nguyen Thi Hong Nhan et al. (2011) studied the characteristics of *Tithonia diversifolia* and *Colocasia esculenta* silage and the effects of silage mixture on growing pigs. Lactic acid decreased with increased levels of *Tithonia* and increased with ensiling time, the relative increase being less marked as *Tithonia* levels were raised. In all cases the lactic acid concentration was higher with the addition of molasses. There were only slight decreases in digestibility of DM, CP and NDF (range of 4-5%) as the ensiled *Tithonia*: Taro was increased from 0 to 20% of the diet. It is concluded that ensiled *Tithonia*:Taro is of relatively high nutritive value, in terms of digestibility of the DM, NDF and crude protein for pigs (Tables 5.68 and 5.69).

Nguyen Thi Tinh et al (2002) studied the effect of ensiled sweet potato vines (ESP) in diets on growing pigs performance. The inclusion of up to 30% ESP for pigs of 15-30 kg LW, 20% ESPU for 30-50 kg LW and 10% for 50 -90 kg LW resulted in the best performance (Table 5.70).

Nguyen Ba Mui et al (2007) used pineapple pulps for piglets. Using pineapple pulp to feed pigs, there was a 30-42% reduction in urea excretion in the urine, compared with the diets of rice bran and cassava meal. The loss of nitrogen from the pineapple pulp diets is 36-68% lower compared with the cassava root meal and rice bran diets after 1 month storage (Table 5.71).

Bui Quang Tuan et al (2007) reported the use of cassava meal and the green bean for pigs. LW gain of pigs fed cassava meal and beans was significantly improved and feed costs were reduced.

Pham Sy Tiep et al (2010) used soybean oil in the diets of exotic lactating sows in summer. With the addition of up to 7% soybean oil into the diets of sows in summer, DWG survival rate of piglets was improved (Table 5.72).

General discussion

Studies on the use of available local feed resources as well as by-products to replace common feeds as well as imported ingredients has contributed greatly to improve the available feed efficiency resources, reduce feed costs, increase economic efficiency and gradually reduce the pressure on raw material imports. However, recent research determined only a suitable rate in the diet rather than enhancing efficiency of these resources. We need to promote the study of engineering materials to preserve feed and ingredients to extended usage time and minimize mold growth to reduce the loss of nutritional value and minimize the production of harmful toxins. We need to research processing techniques to reduce anti-nutritional factors in feed and increase digestibility of nutrients as well as absorption.

5. Feed and feeding methods

Nguyen Nhut Xuan Dung et al. (2007) evaluated the effect of different techniques for fermenting liquid feed on performance and Enterobacteria counts of grower and finisher pigs. The live weight gains of pigs fed FLFBR24h were significantly higher than for the BS diet ($P=0.04$) and those of the other diets were slightly improved (NS). Enterobacteria counts in the feeds and faeces for diets FLFBR12h, FLFBR24h, FLFBS12h and FLFBS24h were significantly lower than those in diets BS and NFLF. Coliforms were totally absent in FLFBR12h, FLFBR24h, FLFBS12h and FLFBS24h. Feed cost of the treated diets was lower than that of the BS diet. The study showed that non-fermented feed or fermented liquid feed improved live weight gain, and significantly reduced the numbers of Enterobacteria and coliforms in feeds and faeces (Table 6.1).

Nguyen Nhut Xuan Dung et al. (2007b) found the effects of fermented liquid feeds (FLF) and Lactobacillus subtilis and phytase supplementation (BS) on pig performance. Live weight gain, feed conversion ratio of pigs fed FLF and BS were slightly improved as compared to the BS diet. Total phosphorus excretion was significantly reduced in FLF, BSLAC and BSPHY as compared to the BS diet. Fermented liquid feed and the diets supplemented with Lactobacillus and phytase tended to improve weight gain and feed efficiency of pigs, and reduced Enterobacteria and phosphorus excretion into the environment (Table 6.2).

Vuong Nam Trung (2010) studied feeding regimes and conducted an experiment with a free feeding regime in stage 1 (20-50 kg) and limited feeding in stage 2 (51-100 kg) for gilt Yorkshire saved 12.5% of consumptive feed, improved 7.8% back fat density and had no influence on genital hormone via growth stage as well as reproduction productivity in topswarm in swine (Table 6.3).

Nguyen Thi Kim Loan (2006) investigated the effects of time and form of feeding on sows performance. LW loss and daily feed intake of lactating sows and weaning-mating interval, and daily weight gain of piglets were improved in groups of sows fed 5 times per day, and in groups of sows supplied wet feeds. Regarding economic efficiency, when the group fed 3 times per day was rated 100%, and the groups fed 4 or 5 times per day were rated as 116.28% and 139.04% efficiency respectively. When the group supplied dry feed was rated 100%, the group supplied wet feed was rated as 110.95% efficiency.

Nguyen Nghi (1993) showed that lactating sows fed free feed account for 2.8 – 3 kg DM for paternal sow and 4 kg for breeding sow with 16% crude protein.

Phung Thi Van et al. (2000) studied on restricted feeding regimes in gilts such as Landrace, Yorkshire, and breeding female YL, LY to reproductive yield of themselves via 3 litters. The authors stated that pigs of 30 – 65 kg were fed Ad libitum with diets contained 3000 kcal ME and 15% CP; and up to 65 days before mating, pigs were fed the diet contained 2900 kcal ME/kg and 14% protein. However, results showed that exchange energy needed as well as the nutritional density of the diet is lower than the recommendations of NRC (1998).

Pham Duy Pham et al (2008) added ultracid lactic acid and adimix butyrate into the diets for weaned piglets of 60 days old and found that Butyrate Adimix added at 0.1% was best for performance, FCR decreased by 11.4%, DWG increased by 8.3%, and economic return was increased by 13.2%.

Pham Duy Pham et al (2010) used Adimix butyrate and All-zym to replace antibiotics in feeding pigs. Using Adimix butyrate and All-zym did not affect feeding efficiency and growth rate.

Nguyen Hung Quang et al (2010) used Amoxy-comby and SELKO-pH in weaned pigs' diets. Using Selko-pH increased growth rate and reduced FCR and the incidence of diarrhea.

Bach Quoc Thang et al (2006) used Orgacid prophylactic preparations to prevent white pig feces disease. The addition of organic acids in diets for pregnant and nursing sows reduced the incidence of diarrhea in pigs and increased the growth of piglets compared to the control experiment.

Nguyen Thi Tiet et al (2002) compared the ability of Pancreatin digestive enzymes preparations (CPP) with DPS enzyme preparations on pigs. The addition of CPP preparations markedly increased digestibility.

Dang Minh Phuoc et al (2006) used the preparations of organic acids in the diet of pigs after weaning. Addition of organic acid preparations into lactic, formic and phosphoric acids with 0.3-0.5% in weaned piglets' diets improved growth rate and FCR, and reduced diarrhea rates.

Nguyen Thi Kim Loan et al (2007) used the preparations of garlic and ginger in diets for weaned piglets. The addition of 0.15 to 0.2% ginger and garlic preparations improved growth rate, FCR and reduced the incidence of diarrhea.

Dang Thi Hoe et al (2009) used Bio Elemon preparations - alternative antibiotic for piglets. The addition of BIO Elemon preparations for piglets 1-21 days old reduced the incidence of respiratory, gastrointestinal; stimulated growth rate, and can be used to replace antibiotics.

Pham Sy Tiep et al (2008) used herbal products for growing pigs. The addition of organic acid preparations into lactic, formic and phosphoric acid with the rate of 0.3-0.5% improved growth rate and FCR, and reduced diarrhea rates.

Pham Sy Tiep et al. (2011) added glucose of 2, 4 and 6% to piglets' diets. The addition of 6% glucose in diets improved LW of weaned pigs and LW of piglets 60 days old.

Tran Quoc Viet et al. (2006) studied Zeolite (trace minerals) in growing pig diets. Zeolite supplementation in diets without inorganic mineral premix at the levels of 3-5% did not affect daily intake, growth rate and FCR, and also reduced the residue of heavy metals in some lean meat. Using at the level of 3% resulted in the greatest economic efficiency.

Tran Quoc Viet et al. (2010) added Bentonite in diets for growing pigs, and pregnant and lactating sows. Using 3% Bentonite improved growth and reproductive performances and resulted in better economic return.

Tran Quoc Viet et al. (2010) added Zeolite into diets for growing pigs, and pregnant and lactating sows. The addition of 3% Zeolite improved economic return but not performance.

Vu Thi Khanh Nguyen et al. (2012) evaluated the effect of CP and CF levels in diets on N and P excretion from weaned (Duroc x (Landrace x Yorkshire) pigs. N and P excretions were not effected by CP and CF levels in pigs of 15 to 35kg LW. However, N content (% as DM) in pig wastes was different among CP levels.

Vu Thi Khanh Nguyen et al. (2012) studied the effect of CP and CF levels in diets of (Duroc x (Landrace x Yorkshire) pigs of 15-35 kg on NH₃, H₂S and other greenhouse gas emissions. NH₃ and H₂S emissions were not effected by CP and CF levels. While CP level in diets did not affect CH₄ and CO₂ emissions, however, increasing CF levels in diets resulted in a increase in CO₂ emissions.

Nguyen Thi Kim Lan et al. (2004) studied early weaning at 7 and 21 days of age. Early weaning at 7 days old resulted in better performance than at 21 days of age.

Nguyen Ngoc Phuc et al. (2011) evaluated the effect of feeding style (liquid and dry) and the types of pen (closed and open) on growth performance. Feeding liquid feeds resulted in higher LW gain and FCR improvement. Pigs in closed pens grew faster than those in open pens. Seasons affected growth but did not affect the efficiency of food after weaning stage.

Nguyen Ngoc Phuc et al. (2011) evaluated the effect of feeding style (liquid and dry) and the type of housing (closed and open) on growth and meat quality of growing pigs. Pigs in closed pens had reduced fat percentage. Housing type did not affect carcass and meat quality. Carcass percentage of pigs fed liquid feeds was reduced. Seasons affected lean and fat percentages. Lean meat was higher in autumn than in summer, fat percentage was lower in spring than in autumn, and backfat thickness in summer was higher than in winter (Tables 6.7 and 6.8).

Truong Huu Dung et al. (2004) evaluated the effect of Ad lib and restricted feeding on growth performance and carcass composition of crossbred (D x (LR x Y), (D x (Y x LR) pigs with two feeding models in indoor conditions. In village conditions , pigs can grow 664. 5g/, FCR of 3,27kg feed/kg weight gain and rate of lean meat /carcass of 56,5%. With dietary restrictions of 20% in comparison with free feeding in Phase 2, growth reached 3.42% and was prolonged by 5 days, but the feed costs reduced by 5.8%, carcass dressing increased 1.1% (Table 6.9).

Tran Thi Bich Ngoc et al. (2013) added enzymes, organic acids and Bentonite in diets for growing pigs. The addition of enzymes, organic acids and their mixture reduced NH₃ and H₂S emissions from 23.1 to 69.3% compared to the control (Table 6.10).

General discussion

In this area, our studies were relatively limited and discrete and the efficacy of the feeding method as well as feed allowance on pig productivity was unclear and with conflicting results. In the future, it is necessary to research the technology of using liquid feed and fermented feed technology before feeding. It is necessary to have thorough research on feed effectiveness, digestibility and economic efficiency when applying different methods of feeding.

Conclusion

In Vietnam, pig production plays an important role and pigs are dominant livestock. With breedings, studies on nutrition, feeds and feeding pigs are paid much attention. More than 1,000 feedstuffs are nutritively characterised and chemically analysed mainly for proximate composition, some macro-minerals (ie. Ca and P) and their DE and ME are estimated. Less than 100 common feedstuffs are analysed essential amino acids and some micro-elements (ie. Fe, Cu, Co, Mn). These databases are useful not only for scientists but also for animal raisers, who use this information for diet formulation. However, only few feedstuffs are analysed aflatoxin (B1, B2, G1, G2) and many others such as Ochratoxin A (OTA); Zearalenone (Zon); Trichothecenes (T2 toxin DON) and

Fumonisin (FUM) are not known. The research on this kind had been started by Institute of animal sciences for southern Vietnam but not much and still unpublished (the Institute had equipments to analyze these toxins such as HPLC, GC-MSMS, LC-MSMS).

Besides chemical analyses, studies on the digestibility of nutrients and amino acids have been very much encouraged. Different methods have been applied such as total tract collection, the PVTC technique and in vitro using enzyme. More than 100 feedstuffs have been collected and determined their nutrient digestibility and DE and ME value accordingly. However, the work is still in its infancy as the number of analyzed feedstuffs are still limited (about 100 feedstuffs vs potential 1,000).

In recent years, number of trials was carried out with using dose-response method to determine nutrient requirements of energy (DE and ME), protein (CP) and lysine (total and digestible) for suckling and weaned piglets, growing pigs, and pregnant and lactating sows. However, the requirements of essential amino acids in total or in digestible as well as essential fatty acids, trace minerals and vitamins for pigs are not determined yet. This may lead to increase feed efficiency and to reduce the animal performance.

Studies on better use of available local feed resources including feed evaluation, processing methods and feeding trials have significantly contributed to improve feed efficiency and to reduce feed costs, particularly for small scale farmers. However, anti-nutritional factors and toxicity in unconventional feeds in particular as well as feed processing technology have not been determined.

In feeding methods, the studies are relatively limited and results are unclear message. In tropics, however, feeding strategy is important to improve animal performance by restriction of effects of environmental conditions.

6. Future research in nutrition, feed and feeding for pigs

Based on previous achievements, some thoughts about future studies on nutrition, feeds and feeding for pigs in Vietnam conditions are following:

1. Study on sustainable feed supply - looking local and available feed resources

In Vietnam, pig production is still play an important role and is increasing annually about 8% since 2003, and an estimated 80% pigs kept in householders at medium and small scale. In 2013, pig's population reached 28 million that require about 30 mill tons of feeds.

According to Department of Animal Husbandry of MARD (2012), maize, wheat and soybean meal productions have been used as animal feeds were 8,600; 1,500 and 2,420 thousand tons in 2011; in which, 80% of maize were produced in the country, and wheat and soybean meals were totally imported. In 2011, revenue from rice exports was 3.7 million USD, while feed imports costed 3 million USD (Vu Duy Giang, 2012). Therefore, looking sustainable feed supply is necessary.

Discussion is now underway in central government circles on encouraging a shift from food to animal feed production as feed security for livestock (and reduction of feed import costs) may be just as important as food production in the livelihood and food security of a rural population looking for new ways to diversity.

A consideration is also being given to encourage the use of poor quality rice and agro-byproducts for feeding animals as well as shifting less productive rice areas to maize production for fodder and seed meal.

Therefore, study on better use of local and available feed resources including unconventional feedstuffs, paddy rice and rice byproducts are emphasized. By doing so, (1) an evaluation of nutritive values including proximate composition, non-starch polysaccharides, amino acids, micro-nutrients and essential nutrients as well as anti-nutritional factors and toxicity (aflatoxins) will be concentrated. Chemical compositions, and faecal and ileal digestibility of nutrients will be carried out to improve the existing database on Vietnam feedstuffs. The PVTC methods should be widely applied to study on ileal true and apparent digestibility of protein and essential amino acids. (2) Improving nutritionally and optimizing available and local feed resources particularly industrial and/or agro-byproducts such as cassava byproducts, low-value paddy rice, fishery byproducts as shrimp and catfish, etc.

2. Study on nutrient requirements in Vietnam climate conditions

As known, number of previous studies on nutrient requirements for pigs has been done, especially for exotic and crossbred pigs, with using dose-response studies, which are costly and time consuming, especially when determining the requirement for all EAA. Therefore, the use of ideal protein concept to estimate the requirements for EAA for pigs in general and in local or local crossed with exotic breeds in particular should be emphasized in near future study.

As above mentioned, pigs are mainly raised by householders in their own conditions, particularly natural conditions. Therefore, animal performance will be affected by many environmental factors, in which temperature and humidity are an important. Many studies have been done in other countries (Srikandakuman et al., 2003; Bhatta et al., 2005; Herig et al., 2006; Marai et al., 2010) but few in Vietnam (Le Van Phuoc et al, 2005; Đoàn Đức Vũ et al., 2008; Nguyễn Thạc Hòa et al., 2009). Study on effect of temperature and humidity (THI) on nutrient requirements for pigs should be paid much attention. Study on exploiting and using locally available feedstuffs to decrease pressure on the importation of ingredients. To increase energy feed sources, a study on using paddy rice is extremely necessary (by cross-breeding a new high-yield variety, building a special region of rice production as animal feed and determining suitable rice processing methods and inclusion level in the pig diet). Focusing on used cassava and its by-products, especially by-products from ethanol production, in pig diets.

3. Intensifying research activities, production and use of microbiological protein based on the salvage of agro-industrial by-products and crop residue which are readily available in Vietnam.

4. Research and application of advanced technology aims to combine commercially effective feed and traditional feed at householders and small-medium type farms to decrease feed cost and increase economic efficiency of pig production.

References

- Ankedianye, D., Radeny, M., Kristjanson, P. and Herrero, M. 2009. Assessing returns to land and changing livelihood strategies in Kitengela. In: Homewood, K., Kristjanson, P. and Chenevix Trench, P. 2009. Staying Maasai? Livelihoods, conservation and development in East African rangelands. New York: Springer: 115–149.
- Bach Quoc Thang, Huynh Thi My Le. 2006. Using Orgacid on piglets to prevent white faeces disease at Camp Hung Chi - Thai Nguyen. *Journal of Agriculture and Rural Development*, 2006. No. 5/2006. Page 52-53.
- Bo, G. 1982. Les aliments du bétail sous les tropiques, FAO, Rome. Reference of National Institute of Animal Science “ Vietnam feedstuffs chemical composition and nutrient value”. Ha Noi Agricultural publisher
- Bui Hong Van and Le Thi Men 1990. "A" molasses in diets for growing pigs. *Livestock Research for Rural Development*, Volume 2, Number 2
- Bui Hong Van, Le thi Men, Vo Van Son and T R Preston 1997. Duckweed (*Lemna* spp) as protein supplement in an ensiled cassava root diet for fattening pigs. *Livestock Research for Rural Development*, Volume 9 Number 1
- Bui Huy Nhu Phuc 1993. The use of sugar cane juice and molasses in the diet of growing pigs. *Livestock Research for Rural Development*, Volume 5, Number 2
- Bui Huy Nhu Phuc and Brian Ogle. 2005. Effect of inclusion levels of cassava leaf meal in the diet on the performance of growing-finishing pigs. *Workshop of Making better use of local feed resources. Mekarn-CTU.*
- Bui Huy Nhu Phuc. 2003. Determination of some nutrient and ileal amino acid digestibility of coconut meal, rubber seed meal, peanut meal and sesame meal for pig. *Journal of Science and technology in Agriculture and Forestry N03, Nong Lam University.* Pp. 76-83.
- Bui Huy Nhu Phuc. 2003. Effect of high fiber such as wheat bran, soybean hull and cassava leave in pregnant sow. *Journal of Science and technology in Agriculture and Forestry N04, Nong Lam University.* Pp. 62-69
- Bui Quang Tuan. 2007. Using by-products to create tapioca (black powder) and green bean (bran embryo) to feed meat pig in Duong Lieu, Hoai Duc, Ha Tay. *Journal of Agricultural Science and Technology. Hanoi University of Agriculture.* Episode 4. No. 4/2007. Page 50-54.
- Bui Thi Thom, Tran Van Phung and Hoanh Toan Thang. 2008.). Research on using low protein diet with amino acid balanced (lysine, methionine, tryptophan and threonine) for F1 pig (1/2 exotic breed) in stage of 18-50 kgs. *Journal of Animal Husbandry Sciences and Technics.* Vol 4/2008, pp. 9-15.
- Bui Thi Thom, Tran Van Phung and Hoanh Toan Thang. 2010. Research on effects of reducing crude protein on the basis of balancing essential amino acid to growing and feed conversion ratio of growing-fattening pigs. *Journal of Agriculture and Rural Development.* Vol 13/2010, pp. 52-57.
- Bui Van Chinh, Nguyen Huu Tao and Do Viet Minh 1993. Growing and ensiling soybean forage between rice crops as a protein supplement for pigs in north Vietnam. *Livestock Research for Rural Development*, Volume 5, Number 1
- Dang Minh Phuoc, Duong Thanh Liem. 2006. Research of using organic acid on food supplements to stimulate growth and prevent diarrhea in weaned piglets (part 1). *Journal of Animal Science and Technology - Livestock Association*, 2006. No. 9/2006. Page 4-7.
- Dang Thi Hoe. 2009. Using Bio Elemon instead of antibiotic in prevention and treatment of respiratory, gastrointestinal, growth hormone replacement for piglets. *Journal of Animal Science and Technology - Livestock Association*, 2009. Number 12 episode 2/2009. Page 24-27.
- Dang Thi Hoe. 2009. Using Bio Elemon instead of antibiotic in prevention and treatment of respiratory, gastrointestinal, growth hormone replacement for piglets. *Journal of Animal Science and Technology - Livestock Association*, 2009. Number 12 episode 2/2009. Page 24-27.
- Dang Thuy Nhung, Bui Quang Tuan. 2006. Determination of energy and lysine requirement for Mong Cai weaned piglet. *Journal of Agricultural Science and Technology* 6 (1). University of Agriculture, Ha Noi, Vietnam

- Đào Thị Phương, Ninh Thị Len, Trần Quốc Việt, Lê Văn Huyền, Trần Việt Phương, Ninh Thị Huyền, Vũ Chi Cường. 2013. Digestible energy (DE), Metabolizable energy (ME) and ileal digestibility of essential amino acid in some feedstuffs for swine in Vietnam. *Journal of Animal Husbandry Sciences and Technics*. Vol 41/4, 2013
- Đo Văn Quang. 2002. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry. Library of Institute of agricultural science for southern Vietnam.
- Đoàn Thị Hoàng Mai, Lê Đức Ngoan and Đỗ Thanh Hằng (2010). Ensiling techniques for cabbage by-products and their nutritive value for pigs. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Đỗ Thanh Hằng 1998. Digestibility and nitrogen retention in fattening pigs fed different levels of ensiled cassava leaves as a protein source and ensiled cassava root as energy source. *Livestock Research for Rural Development*, Volume 10, Number 3
- Đỗ Thanh Hằng and Nguyễn Trung Kiên 2012. Taro (*Alocasia odora* (C) Koch, *Xanthosoma nigra* (Vell) Stellfeld and *Colocasia esculenta* (L) Schott) in Central Vietnam: biomass yield, digestibility and nutritive value. *Livestock Research for Rural Development* 24 (12)
- Đỗ Thanh Hằng and T R Preston 2005. The effects of simple processing methods of cassava leaves on HCN content and intake by growing pigs. *Livestock Research for Rural Development* 17 (9)
- Đỗ Thanh Hằng and T R Preston. 2006. The effects of simple processing methods of cassava leaves on HCN content and intake by growing pigs. Workshop of Making better use of local feed resources. Mekarn-CTU.
- Đỗ Thanh Hằng and T R Preston. 2010. Effect of processing Taro leaves on oxalate concentrations and using the ensiled leaves as a protein source in pig diets in central Vietnam *Livestock Research for Rural Development* 22 (4)
- Đỗ Thanh Hằng, N Q Linh, T R Preston, H Everts and A C Beynen. 2007. The effects of simple processing methods of cassava leaves on HCN content, intake and performance by growing pigs Workshop on Forages for Pigs and Rabbits Workshop-seminar, 21-24 August 2007, MEKARN-CelAgrid
- Đỗ Thanh Hằng, Nguyễn Quang Linh, H Everts and A C Beynen. 2009. Ileal and total tract digestibility in growing pigs fed cassava root meal and rice bran with inclusion of cassava leaves, sweet potato vine, duckweed and *Stylosanthes* foliage. *Livestock Research for Rural Development* 21 (1) 2009
- Đỗ Thanh Hằng, Nguyễn Quang Linh, H Everts* and A C Beynen* Ileal and total tract digestibility in growing pigs fed cassava root meal and rice bran with inclusion of cassava leaves, sweet potato vine, duckweed and *Stylosanthes* foliage. *Livestock Research for Rural Development* 21 (1) 2009
- Đỗ Thanh Hằng, Nguyễn Văn Lai, Lylia Rodriguez and J Ly* 1997. Nitrogen digestion and metabolism in Mong Cai pigs fed sugar cane juice and different foliages as sources of protein. *Livestock Research for Rural Development*, Volume 9, Number 2
- Đỗ Thanh Liêm. 2002. Feed and feeding. Agricultural publisher, Ho Chi Minh city. Pp. 71-72; 271-292.
- Hoàng Hương Giang, Trần Quốc Việt*, J E Lindberg** and B Ogle**2010. Effects of microbial enzymes and a complex of lactic acid bacteria and *Saccharomyces boulardii* on growth performance and total tract digestibility in weaned pigs. *Livestock Research for Rural Development* 22 (10)
- Hoàng Nghĩa Duyet 2010. Ensiled taro foliage (leaves + stems) as replacement for soybean meal in the diet of Mong Cai sows in Central Vietnam. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Hoàng Nghĩa Duyet 2010. Giant taro leaves (*Alocasia macrorrhiza*) for replacement of soybean meal in diets for Mong Cai sows in Central Vietnam. *Livestock Research for Rural Development* 22 (8)
- Hoàng Nghĩa Duyet and Nguyễn Thị Lộc 2000. The effect of dietary protein level on the reproductive performance of Mong Cai sows. Workshop-Seminar on Making Better Use of Local Feed Resources. SAREC-UAF, January 2000

- Hoang Nghia Duyet and T R Preston. 2003. Ensiled mixed foliage of taro leaves + petioles and banana pseudo-stems as replacement of rice bran for Mong Cai sows in small-holder farms in Vietnam. *Livestock Research for Rural Development* 25 (4) 2003
- Hoang Nghia Duyet and T R Preston. 2013. Ensiled mixed foliage of taro leaves + petioles and banana pseudo-stems as replacement of rice bran for Mong Cai sows in small-holder farms in Vietnam. *Livestock Research for Rural Development* 25 (4) 2013
- Hoang Nghia Duyet. 2003. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam.
- Hoang Toan Thang, Tran Van Phung. 2005. Effects of Lysine rates and metabolizable energy on growing piglets in stage of growth from 28 to 56 days old, *Journal of Animal Husbandry Sciences and Technics*. Vol 4, 2005
- Homewood, K., Kristjanson, P. and Chenevix Trench, P. 2009. Staying Maasai? Livelihoods, conservation and development in East African rangelands. New York: Springer.
- Githui, E.G., de Villiers, E.P. and McArthur, A.G. 2009. *Plasmodium* possesses dynein light chain classes that are unique and conserved across species. *Infection, Genetics and Evolution* 9(3):337-343.
- L. D. Ngoan, and J.E. Lindberg. 2001. Ileal and total tract digestibility in growing pigs fed cassava root meal rice bran diets with inclusion of fish meal and fresh or ensiled shrimp by products. *Asian-Aust. J. Anim. Sci.* 2001. Vol. 14, No. 2: 216-223.
- La Van Kinh 2002. Determination of protein and amino acid for pregnant sow and lactating sow. *Science and Technology Journal of Agricultural Rural Development*, Issue 10/2002. Pp 25-28
- La Van Kinh and Nguyen Van Phu. 2002. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam.
- La Van Kinh and Pham Tat Thang. 2003. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam.
- La Van Kinh và Vương Nam Trung. 2000; 2001. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam.
- La Van Kinh, Huynh Thanh Hoai, Vuong Nam Trung, Nguyen Thi Yen. 2003. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam
- La Van Kinh. 2003. Chemical composition and nutrient value of Vietnam feedstuffs. Agricultural Publisher, Ho Chi Minh city, 2003. Pp 71-75.
- Lam Quang Nga, Ulf Magnusson* and Brian Ogle* 2000. Evaluation of the reproductive performance of an indigenous pig breed in Vietnam (Mong Cai) and a cross-breed fed on local and conventional feeds. Workshop-Seminar on Making Better Use of Local Feed Resources. SAREC-UAF, January 2000
- Le Thi Men, Brian Ogle* and Vo Van Son 2000. Evaluation of water spinach as a protein source for BaXuyen and Large White sows. Workshop-Seminar on Making Better Use of Local Feed Resources. SAREC-UAF, January 2000
- Le thi Men, Bui Hong Van, Mai thi Chinh and T R Preston* 1997. Effect of dietary protein level and duckweed (*Lemna* spp) on reproductive performance of pigs fed a diet of ensiled cassava root or cassava root meal. *Livestock Research for Rural Development*, Volume 9, Number 1

- Le Thi Men, Do Vo Anh Khoa, Vo Minh Goi and Doan Thi Minh Nguyet. 2010. Coconut meal to replace part of the protein of catfish residue meal in the diets for fattening pigs in the Mekong delta of Vietnam. Proceeding of Livestock production, climate change and resource depletion. Pakse. Lao PDR
- Le Thi Men, S. Yamaski, T. S. Caldwell, R. Yamada, R. Takada and T. Taniguchi. 2006. Effect of farm household income levels and rice-based diet or water hyacinth (*Eichhornia crassipes*) supplementation on growth/cost performances and meat indexes of growing and finishing pigs in the Mekong Delta of Vietnam. *Animal Science Journal* 77: 320-329.
- Le Thi Men, Seishi Yamasaki and Ryoza Takada. 2005. The effect of supplement of Rau Dua (*Ludwigia adscendens*) and *Trichanthera* (*Trichanthera gigantea*) leaves in the diets for pig production in the Mekong delta of Vietnam. Proceedings of the Technology development for Livestock Production. Cantho University.
- Le Van Lien, Nguyen Thi Phung, and Le Viet Ly 2000. Ensiled fish by-products as a protein supplement for fattening pigs. Workshop-Seminar on Making Better Use of Local Feed Resources. SAREC-UAF, January 2000
- Le Van Tho. 2002. Determination of digestible ileal protein and amino acid of some soyabean meal for pig by ileocecal valve cannulation. Doctoral thesis. Library of Nong Lam University.
- Luu Huu Manh, Nguyen Nhut Xuan Dung and Erik Lindberg. 2003. Effects of replacements of fish meal with rice distiller's waste on performance and carcass quality of growing pigs. Workshop "make better use of local feed resource", Hue.
- Luu Huu Manh, Nguyen Nhut Xuan Dung, Seishi Yamasaki and Ryoza Takada. 2005. Effects of addition of sugar cane syrup to growing-finishing pigs diets on performance, digestibility, nitrogen retention and plasma nitrogen urea. Proceedings of the Technology development for Livestock Production. Cantho University.
- Luu Huu Manh, Tran Chi Binh, Nguyen Nhut Xuan Dung and Bui Phan Thu Hang 2000. Composition and nutritive value of rice distillers' by-product (hem) for small-holder pig production. Workshop-Seminar on Making Better Use of Local Feed Resources. SAREC-UAF, January 2000
- N T H Nhan, N V Hon and T R Preston 2011. Studies on ensiling of and Taro (*Colocasia esculenta*) and feeding the silage to fattening pigs as partial replacement of a basal diet of rice bran, broken rice, soybean meal and fish meal. *Livestock Research for Rural Development* 23 (5)
- N T Long, T T B Ngoc and L T H Thao (2010). Influence of phytase supplementation to rice bran - based diets on the digestibility and phosphorus excretion in growing pigs. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Ngo Huu Toan and T R Preston 2007. Taro as a local feed resource for pigs in small scale household condition. MEKARN Regional Conference 2007: Matching Livestock Systems with Available Resources. National Institute of Animal Husbandry, Hanoi, Vietnam
- Ngo Huu Toan and T R Preston*2007. Evaluation of uncultivated vegetables for pigs kept in upland households. *Livestock Research for Rural Development* 19 (10)
- Nguyen Ba Mui. 2004. The effect of partial replacement on energy in diets with silaging pineapple pulp to productivity of lactating sows and the influence of silage pineapple's pulp on rate of weaned pigs having diarrhea. *Journal of Agricultural Science and Technology*. Hanoi University of Agriculture. Episode 4. No. 6/2004. Page 51-55.
- Nguyen Ba Mui. 2007. The effect of pineapple pulp in the diet on composition of feces, urine and loss of nitrogen in waste during the pig reserve in contributing to reducing environmental pollution. *Journal of Animal Science and Technology* in 2007. No. 2, 2007. Page 9-13.
- Nguyen Cong Oanh, Tran Hiep, Ha Xuan Bo, J. Bindelle, A. Thewis and Vu Dinh Ton. 2013. Digestibility in vitro of the nutrients in Tieu banana and digestibility in vivo, efficiency uses nitrogen of diet has green and ripe banana in swine. *Journal of Animal Husbandry Sciences and Technics*. Vol 8, 2013, pages 9- 19.
- Nguyen Duy Tram Quynh and T R Preston* 2004. Effect of method of processing cassava leaves on intake, digestibility and N retention by Ba Xuyen piglets. *Livestock Research for Rural Development* 16 (10) 2004

- Nguyen Hoa Ly, Le Van An and Le Duc Ngoan 2000. Evaluation of ensiled shrimp by-products for fattening pigs. Workshop-Seminar on Making Better Use of Local Feed Resources. SAREC-UAF, January 2000
- Nguyen Hung Quang. 2010. Effect of supplementation Amoxy-comby and SELKO pH on the growth and prevention of diarrhea in 4-blood-crossbred pigs after weaning. Journal of Animal Science and Technology - Livestock Association, 2010. No. 10/2010. Page 1-7.
- Nguyen Nghi, Le Thanh Hai, Phan Bui Ngoc Thao, Ngo Minh Long, Nguyen Cong Phat.1994. Effect of energy and protein levels in diet on some technical parameters for sow. Scientific report in National conference of Animal husbandry and Health in Ha Noi, July, 1994.
- Nguyen Nghi, Tran Quoc Viet, Bui Thi Goi, Nguyen Thi Mai, Pham Van Loi.1995. Effect of energy and protein levels in diet on some technical parameters for different breed pig in Northern Vietnam. Selected studies on Animal husbandry by National Institute of Animal Science. Ha Noi Agricultural publisher, Pp 24-32.
- Nguyen Ngoc Phuc, Nguyen Que Coi, Pham Xuan Hao, Nguyen Huu Xa, Le Van Sang, Nguyen Thi Binh and Tran Thi Huyen. 2011. The effect of food form (liquid and dry) and the type of cage (closed and open) to the growth rate of meat pigs. Journal of animal science and technology in 2011. No. 33, 12/2011. Page 69 – 79.
- Nguyen Ngoc Phuc, Nguyen Que Coi, Pham Xuan Hao, Nguyen Huu Xa, Le Van Sang, Nguyen Thi Binh and Tran Thi Huyen. 2011. The effects of food form (liquid and dry) and the type of cage (closed and open) to the ability of meat creating and meat quality of commercial pigs. Journal of Animal Science and Technology in 2011. No. 31, 8/2011. Page 55 – 65.
- Nguyen Nhat Xuan Dung, Luu Huu Manh, Truong Van Phuoc, Peter Udén and Brian Ogle. 2005. The effect of substituting a basal diet for growing pigs with fresh forages on apparent digestibility and nitrogen retention. Workshop on Forages for Pigs and Rabbits, 21-24 August 2006, MEKARN-CelAgrid
- Nguyen Nhat Xuan Dung, Luu Huu Manh, Truong van Phuoc, Peter Udén and Brian Ogle. 2005. The effect of substituting a basal diet for growing pigs with fresh forages on apparent digestibility and nitrogen retention. Workshop on Forages for Pigs and Rabbits, 21-24 August 2006, MEKARN-CelAgrid
- Nguyen nhu Pho. 2001. Effect of energy levels in pregnant diet on sow productivities. Ariculture – Forestry Science and Technology Journal, issue 3/2001, Pp 90-94.
- Nguyen Nhut Xuan Dung, Dang Thi Ngoc Han, Do Vo Anh Khoa and Luu Huu Manh 2010. Effects of turmeric (*Curcuma longa*) and garlic on growth performance, feed conversion and blood fat components of growing–finishing pigs. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Nguyen Nhut Xuan Dung, Le Lan Anh, Luu Huu Manh and Brian Ogle 2007. Effects of fermented liquid feeds and *Lactobacillus subtilis* and phytase on pig performance and environmental impact. MEKARN Regional Conference 2007: Matching Livestock Systems with Available Resources. National Institute of Animal Husbandry, Hanoi, Vietnam
- Nguyen Nhut Xuan Dung, Luu Huu Manh and Brian Ogle. 2005. Effect of fermented liquid feeds on the performance, digestibility, nitrogen retention and plasma urea nitrogen (PUN) of growing-finishing pigs. Proceedings of the Technology development for Livestock Production. Cantho University.
- Nguyen Nhut Xuan Dung, Pham Quang Minh , Luu Huu Manh, Vo Minh Goi and Brian Ogle 2007. Effect of different techniques for fermenting liquid feed on performance and Enterobacteria counts of grower and finisher pigs. MEKARN Regional Conference 2007: Matching Livestock Systems with Available Resources. National Institute of Animal Husbandry, Hanoi, Vietnam
- Nguyen Thanh Thuy, J. E. Lindberg and B. Ogle. 2010. Digestibility and nitrogen Balance of diet that include marine fish meal, catfish (*pangasius hypophthalmus*) by-product meal and silage, and processing waste water in growing pig. Asian-Aust J. Anim. Sci. Vol 23, No 7: 924-930.
- Nguyen Thi Hoa Ly, Le Duc Ngoan and A C Beynen 2007. Ileal and total tract digestibility of aminoacids in pigs fed cassava leaves and sweet potato vines in their diets both in silage and in dry form. MEKARN Regional Conference

- 2007: Matching Livestock Systems with Available Resources. National Institute of Animal Husbandry, Hanoi, Vietnam
- Nguyen Thi Hoa Ly, Nguyen Thi Loc, Du Thanh Hang and Truong Thi Thuan 2003. Effect of dietary protein level on the performance of growing pigs under village conditions in Central Vietnam. Sida-SAREC 1988-2003, Hue University of Agriculture and Forestry
- Nguyen Thi Hoa Ly, Tran Thanh Hai and T R Preston 2010. Ensiled taro (*Colocasia esculenta*) and cassava (*Manihot esculenta* Crantz) leaves as protein sources in diets for pigs in the upland conditions in central Vietnam. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Nguyen Thi Kim Loan. 2004. The effects of weaning train for piglets early to growth-stage, and disease susceptibility training from newly born piglets to 60 days old. Journal of Animal Science and Technology, 2004 No1, 2004. Page 5-7.
- Nguyen Thi Kim Loan. 2007. Effect of feeding frequency and kind of feed on sow productivities. Agriculture – Forestry Science and Technology Journal, issue 3/2001 /2007, Pp 90-94.
- Nguyen Thi Kim Loan. 2007. The effect of using of garlic, ginger and turmeric in feedstuffs for weaned piglets. Journal of Animal Science and Technology - Livestock Association, 2007. No. 10/2007. Page 11-13.
- Nguyen Thi Kim Loan. 2008. Effect of crude fiber level in pregnant sow diet on sows performance. Journal of Animal Husbandry Sciences and Technics. Vol 3/2008, pp. 8-12
- Nguyen Thi Loc 2007. Using recommended protein feed resources and enhancing capacity for women in pig production in a mountainous ethnic minority community. MEKARN Regional Conference 2007: Matching Livestock Systems with Available Resources. National Institute of Animal Husbandry, Hanoi, Vietnam
- Nguyen Thi Loc and Le Khac Huy 2003. Effects of DL-methionine supplementation in ensiled cassava root-based diets on the performance and economic efficiency of F1 (Large White x Mong Cai) fattening pigs. Sida-SAREC 1988-2003, Hue University of Agriculture and Forestry
- Nguyen Thi Loc, Brian Ogle and Thomas R Preston 1997. Protein supplementation of traditional diets for crossbred pigs under village conditions in Central Vietnam. Livestock Research for Rural Development, Volume 9, Number 2
- Nguyen Thi Loc, Nguyen Thi Hoa Ly, Vo Thi Kim Thanh and Hoang Nghia Duyet 2000. Ensiling techniques and evaluation of cassava leaf silage for Mong Cai sows in Central Vietnam. Workshop-seminar "Making better use of local feed resources" SAREC-UAF, January , 2000.
- Nguyen Thi Luong Hong and Bui Quang Tuan. 2001. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam
- Nguyen Thi Thuy and J Ly 2002. A short-term study of growth and digestibility indices in Mong Cai pigs fed rubber seed meal. Livestock Research for Rural Development 14 (2)
- Nguyen Thi Tiet, Ngo Ke Suong. 2002. Comparison the digestive ability of enzyme Pancreatin (CPP) with enzyme DPS on meat pigs. Journal of Animal Science and Technology - Livestock Association. 202. No. 3/2002. Page 7-10.
- Nguyen Thi Tinh, Dai Peters, Pham Ngoc Thach Thanh Thuy Tran. 2002. Silaging yam for feeding meat pigs. Journal of Agriculture and Rural Development, 2002. No. 7/2002. Page 454-456.
- Nguyen Thi Tuyet Le, Le Viet Phuong and Bui Quang Tuan 2010. Evaluation of ensiling capacity of Gac shell (*Momordica cochinchinensis* Spreng) to be used in chicken and pig feeding. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Nguyen Thien, Phan Dich Lan, Vo Trong Hot, Hoang Van Tien and Pham Sy Lang. 1996. Pig husbandry in householder and farm scales. Ha Noi Agricultural publisher, Pp 35-45.
- Nguyen Tuyet Giang and T R Preston. 2011. Taro (*Colocasia esculenta*) silage and water spinach as supplements to rice bran for growing pigs. Livestock Research for Rural Development 23 (3)

- Nguyen Van Phong, Nguyen The Hoa Ly, Nguyen Van Nhap and Du Thanh Hang. 2013. Protein enrichment of cassava by-products using *Aspergillus niger* and feeding the product to pigs. *Livestock Research for Rural Development* 25 (7) 2013
- Nguyen Van Phong, Nguyen The Hoa Ly, Nguyen Van Nhap and Du Thanh Hang 2013. Protein enrichment of cassava by-products using *Aspergillus niger* and feeding the product to pigs. *Livestock Research for Rural Development* 25 (7)
- Nguyen Van Thuong, Sumilin.I.S., Nguyen Nghi, Bui Van Chinh. 1992. Handbook of Vietnam feedstuffs chemical composition and nutrient value. Ha Noi Agricultural publisher.
- Ninh Thi Len, Tran Quoc Viet, Le Van Huyen and Nguyen Thi Hong. 2010. Apparent and standardized ileal digestibility of amino acids in several feedstuffs commonly used for growing-fattening pigs in Vietnam. *Journal of Animal Husbandry Sciences and Technics*. Vol 26 November 2010.
- Ninh Thi Len, Tran quoc Viet, Le Van Huyen và Sam van Hai. 2011. Determination of energy, protein and acid amin (lyzin, methionin, threonin and tryptophan) requirement for 4 ways crossed growing-fattening pigs in Vietnam. *Journal of Agriculture and Rural Development*. Vol 5/2011, pp. 64-72.
- Ninh Thi Len, Tran quoc Viet, Le Van Huyen và Sam van Hai. 2011. Research on requirement of lyzin, methionin, threonin và tryptophan for 4 ways crossed growing-fattening pigs. *Journal of Agriculture and Rural Development*. Vol 5/2011.
- Ninh Thi Len, Tran Quoc Viet, Le Van Huyen, Lai Thi Nhai. 2010. Chemical composition, total tract digestibility and energy values of several feedstuffs used for growing-fattening pigs in Vietnam. *Journal of Animal Husbandry Sciences and Technics*. Vol 25 August 2010
- Pham Duy Pham, Nguyen Thi Huong, Nguyen Tien Thong. 2010. The effect of using Adimix butyrate and All-zym to alternate antibiotics added to pigs' feed. *Journal of Animal Science and Technology - Livestock Association*, 2010. No. 9/2010. Page 8-12.
- Pham Duy Pham. 2008. The effect of adding organic acids (ultracid lacydry and adimix butyrate) in feedstuffs for piglets after weaning to 60 days old. *Journal of animal science and technology in 2008*. No. 14, 10/2008. Page 39 – 46.
- Pham Hong Son, Pham Quang Trung, Tran Quang Vui and Dinh Thi Bich Lan (2003). Preliminary research results on application of a local medicinal herb (*Achyranthes aspera*) as dietary supplement to sows to prevent diarrhea in piglets. Sida-SAREC 1988-2003, Hue University of Agriculture and Forestry
- Pham Khanh Tu, Hoang Nghia Duet, Nguyen Thi Vinh, Brian Ogle and Antol Beynen 2003. Effect floor types on performance and health of F1 (Yorkshire x Mong cai) fattening pigs and of Mong cai gilts raised by smallholders. Sida-SAREC 1988-2003, Hue University of Agriculture and Forestry
- Pham Nhat Le. 1994. Raising Yorkshire and Landrace breeds in Vietnam Northern house holders. Scientific report in National conference of Animal husbandry and Health in Ha Noi, July, 1994.
- Pham Sy Tiep, Nguyen Van Binh. 2008. Research on processing and using herbal-based products to add on feedstuffs for pigs to improve the efficiency of livestock production. *Journal of Animal Science and Technology - Livestock Association*, 2008. No. 10/2008. Page 8-13.
- Pham Sy Tiep, Nguyen Van Luc and Dang Hoang Bien 2005. Processing *Alocasia macrorrhiza* (taro) roots for fattening pigs under mountainous village conditions. Workshop-seminar Making Better Use of Local Feed Resources, 23-25 May, 2005, MEKARN-CTU
- Pham Sy Tiep, Nguyen Van Luc, Nguyen Manh Hung, Tran Van Tu and Tran Van Phung 2007. Study on the processing and use of *Alocasia macrorrhiza* (Giant taro) leaves in diets for Mong Cai sows and crossbred F1 (Large White x Mong Cai) growing pigs under mountainous village conditions. MEKARN Regional Conference 2007: Matching Livestock Systems with Available Resources. National Institute of Animal Husbandry, Hanoi, Vietnam

- Pham Sy Tiep, Nguyen Van Luc, Nguyen Manh Hung, Tran Van Tu, Tran Van Phung 2010. Processing, using and developing the giant taro (*Alocasia macrorrhiza*) for raising pigs in northern mountainous households of Vietnam. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Pham Sy Tiep, Thi Phi Hoang Phuong, Nguyen Thi Huong, Do Thi Ha, Kieu Thi Hue. 2010. The effect of supplementation soybean oil to the diet on reproductive performance of lactating sows in summer. Journal of animal science and technology in 2010. Number 12, 2010. Page 10-16.
- Pham Sy Tiep, Tran Thanh Nho, Nguyen Van Thich, Nguyen Van Binh. 2011. The effect of glucose supplementation on performance of breastfeeding pigs and weaned pigs. Journal of Animal Science and Technology - Livestock Association, 2011. No. 11/2011. Page 2-7.
- Pham Thi Hien Luong, Phan Dinh Tham and Tu Quang Hien. 2006. Effects of Lysine rates and ME in diets on the growth and feed conversion ratio between pigs F1 (York x MC) and growing-fattening pigs F1 (York x Mong Cai) in Thai Nguyen province. Journal of Animal Husbandry Sciences and Technics. Vol 12, 2006
- Ta Van Dung, Nguyen Thi Lien and Tran van phung. 2008. Effects of protein /ME rates with supplementation essential amino acids on the growth of weaned piglet. Journal of Animal Husbandry Sciences and Technics. Vol 5, pp. 4-8.
- Thornton, P.K., van de Steeg, J., Notenbaert, A. and Herrero, M. 2008. The livestock-climate-poverty nexus: A discussion paper on ILRI research in relation to climate change. ILRI Discussion Paper 11. Nairobi: ILRI.
- Thuy, N.T., and J. Ly. 2002. A short-term study of growth and digestibility indices in Mong Cai pigs fed rubber seed meal. Livestock Research for Rural Development . 14 (2): 35-37.
- Tran Hue Vien, Tran van phung. 2004. Research on maintainable requirement of Histidine for growing pig. Journal of Animal Husbandry Sciences and Technics. Vol 2, 2004
- Tran Quoc Viet, Ninh Thi Len and Le Minh Lich. 2001; 2003. Report of National project "Research on Science and technology solution and feed ingredient using for high quality animal husbandry". Library of Institute of agricultural science for southern Vietnam
- Tran Quoc Viet, Ninh Thi Len, Le Van Huyen and Bach Manh Dieu. 2010. The effect of adding bentonite to feedstuffs on performance of both meat pigs and pregnant, lactating sows. Journal of Animal Science and Technology - Livestock Association, 2010. No. 5/2010. Page 13-18.
- Tran Quoc Viet, Ninh Thi Len, Le Van Huyen and Bach Manh Dieu. 2010. The effect of adding zeolit to feedstuffs on performance of both meat pigs and pregnant, lactating sows. Journal of Animal Science and Technology - Livestock Association, 2010. No. 6/2010. Page 2-6.
- Tran Quoc Viet, Trinh Vinh Hien, Ninh Thi Len, Hoang Huong Giang. 2006. Study the effect of zeolite in feedstuffs for meat pigs. Journal of Animal Science and Technology in 2006. Special Issue, 1/2006. Page 18 – 23.
- Tran Quoc Viet. 2003. Determination of energy and lysine requirement for crossed b F2 weanling piglet ($\frac{1}{4}$ exotic breed) of 7-18 kg. Journal of Agriculture and Rural Development. Vol 1, 2013, pages 46-48.
- Tran Thi Bich Ngoc, Le Dinh Phung, Tran Thi Thanh Thao, Pham Hung Cuong, Vu Chi Cuong, Nguyen Huu Minh, Vu Thi Khanh Van. 2013. The effect of enzyme, organic acids and bentonite supplements to the diet on emissions of nitrogen, phosphorus, hydrogen sulfide and ammonia from pigs' waste 20-50kg. Journal of Agriculture and Rural Development. In 2013. No. 9/2013. Page 77-85.
- Tran Thi Bich Ngoc, Ninh Thi Len and Lai Thi Nhai 2010. The effect of dietary fiber level on gut environment and bacteria development of Mong Cai and exotic (Landrace x Yorkshire) pigs of different ages. MEKARN Conference 2010, Live stock production, climate change and resource depletion
- Tran Thi Dan. 2002. Effect of supplementation fish fat or coconut oil on post pregnant sow diet and temperature maintenance at piglet birth place. Animal husbandry and Technology Journal Issue 4 /2002. Pp. 8-9
- Tran Thi Thu Hong and Le Thanh Ca 2013. The protein content of cassava residue, soybean waste and rice bran is increased through fermentation with *Aspergillus oryzae*. Livestock Research for Rural Development 25 (7)

- Tran Thi Thu Hong and Le Thanh Ca. 2013. The protein content of cassava residue, soybean waste and rice bran is increased through fermentation with *Aspergillus oryzae*. *Livestock Research for Rural Development* 25 (7) 2013
- Tran Van Phung, Bui Thi Thom and Phan Dinh Tham. 2008. Research on using low protein diet with amino acid balanced (lysine, methionine, tryptophan and threonine) for pig in stage of 18-50 kgs. *Journal of Animal Husbandry Sciences and Technics*. Vol 4, 2008, pages 4-9.
- Tran Van Phung, Bui Thi Thom, Ho Thi Bich Ngoc. 2008. Effects of protein /ME with different protein levels in diet on growth of pigs from 18 to 50 kilos. *Journal of Agriculture and Rural Development*. Vol 2/2008, pp. 41-45.
- Tran Van Phung, Dao Van Khanh, Ha Thi Hao. 2004. Effect of different protein on growth piglet in the stage of 28-56 days old. *Journal of Agriculture and Rural Development*. Vol 8, 2004, pages 1119 - 1120.
- Tran Van Phung, Le Thi Ha, Tran Hue Vien. 2007. Research on using low protein diet with amino acid balanced (lysine, methionine, tryptophan and threonine) for piglets in stage of 28- 56 days old. *Journal of Agriculture and Rural Development*. Vol 3, 2007, pages 38-45.
- Tran Van Phung, Tran hue Vien. 2004. Effects of different from essential amino acid profile on growth piglets in early stage of growth from 26 to 56 days old. *Journal of Agriculture and Rural Development*. Vol 10, 2004, pages 1370-1371.
- Tran Van Phung, Tran Hue Vien. 2004. Research on appropriate additional rate of some trace minerals for weaned piglets F2 (F1 Landrace x (Yorkshire x Mong Cai)). *Journal of Animal Science and Technology - Livestock Association*, 2004. No. 4/2004. Page 11-14.
- Tran Van Phung, Tu Quang Hien. 2004. Research on using EM products in pig raising farms in Thai Nguyen province. *Journal of Agriculture and Rural Development*, 2004. No. 7/2004. Page 997-998.
- Tran Van Phung. 2004. Research on maintainable requirement of methionine and cystine for growing piglet from 45 kg to 50 kg. *Journal of Agriculture and Rural Development*. Vol 3, 2004, pages 320-321.\
- Truong Huu Dung, and Phung Thi Van and Nguyen Khanh Quac. 2004. The growth and carcass composition of crossbred combinations D x (LR x Y), D x (Y x LR) with 2 raising models in household farms at Thai Nguyen province. *Journal of Livestock Science and Technology*, 2004. Number 4, 2004. Page 6 –
- Vo Thi Kim Thanh and Brian Ogle. 2003. Evaluation of ensiled groundnut leaves for growing pigs Sida-SAREC 1988-2003
- Vo Thi Kim Thanh, Nguyen Thi Loc, Dao Thi Phuong and Phung Thi Luu. 2000. Evaluation of ensiled groundnut leaves for fattening pigs. Workshop-seminar "Making better use of local feed resources" SAREC-UAF, January, 2000.
- Vu Duy Giang, Ton That Son and Nguyen Thi Luong Hong. 1997. *Nutrition and Feedstuffs*. Ha Noi Agricultural Publisher.
- Vu Thi Khanh Van, Tran Thi Bich Ngoc, Vu Duong Quynh, Pham Hung Cuong, Vu Chi Cuong and Le Dinh Phung. 2012. Excretion of nitrogen and phosphorus from pigs' waste 15-35 kg were fed with diets containing crude protein and crude fiber with different level. *Journal of Animal Science and Technology*, 2012 No. 10, 2012. Page 22-28.
- Vu Thi Khanh Van, Tran Thi Bich Ngoc, Vu Duong Quynh, Pham Hung Cuong, Vu Chi Cuong and Le Dinh Phung. 2012. Emissions of ammonia, hydrogen sulfide, and greenhouse gases from waste of growing pigs 15-35 kg were fed with diets containing crude protein and crude fiber with different level. *Journal of Animal Science and Technology*, 2012 No. 12, 2012. Page 45-51.
- Vuong Nam Trung and La Van Kinh. 2010. Determination of the apparent digestibility coefficient of protein, amino acids and energy of common feed ingredients for pig. *Science and Technology Journal of Agricultural Rural Development*, Issue 3/2010. Pp 78-83.
- Vương Nam Trung. 2009. Effect of nutrient density in diet on hormone level and semen quality of young pure boar. *Animal husbandry and Technology Journal* Issue 2 /2009. Pp. 2-8

Vương Nam Trung. 2010. Effect of nutrient density in diet on hormone level and productivity of pure Yorkshire gilt.
Animal husbandry and Technology Journal Issue 3 /2010. Pp. 12-17

Tables

Part 1. Chemical composition and energy

Table 1.1. The chemical composition (%) and energy values (kcal kg⁻¹) of the typical leaves, tubers and fruits for pigs (La Van Kinh et al., 2003)

Items	N	DM	CP	EE	CF	Ash	Ca	P	Total starch	GE	DE	ME
1	8	12.08	1.92	0.36	1.97	1.71	0.12	0.06	4.87	480	289	259
2	18	19.77	4.89	1.18	3.50	1.34	0.18	0.07	7.82	896	573	530
3	2	5.19	1.10	0.20	0.69	0.86	0.07	0.02	2.34	209	150	140
4	9	8.93	2.48	0.31	1.27	1.25	0.06	0.06	3.17	369	241	226
5	4	6.77	1.14	0.23	1.53	1.29	0.10	0.04	3.36	267	149	137
6	5	6.44	2.07	0.24	0.68	1.56	0.22	0.07	1.71	254	185	168
7	6	9.05	1.43	0.39	1.62	1.44	0.12	0.02	3.77	362	241	224
8	6	7.81	1.35	0.14	1.03	2.20	0.11	0.04	2.39	284	168	158
9	7	10.85	1.28	0.59	1.02	0.73	0.03	0.04	6.38	463	385	367
10	6	5.05	0.53	0.11	0.49	0.25	0.02	0.01	2.78	208	172	162
11	4	21.20	0.98	0.56	0.72	0.94	0.03	0.03	18.24	868	747	732
12	4	26.88	0.97	0.57	0.54	1.08	0.04	0.04	22.14	1110	952	937
13	5	7.64	0.76	0.23	0.74	0.50	0.53	0.52	5.62	3.17	259	248
14	4	35.05	1.34	0.36	1.11	1.09	0.05	0.04	28.33	1433	1230	1209
15	13	30.54	1.54	0.33	0.88	0.75	0.03	0.07	23.72	1366	1144	1123

1. Sweet potato leaves; 2: Cassava leaves; 3: Cabbage leaves; 4: water spinach; 5: water hyacinth; 6: Duckweed; 7: water-taro; 8: Pistia; 9: Pumpkin squash; 10: Calabash; 11: Banana stem; 12: Ripped banana; 13: Papaya; 14: Fresh bitter cassava; 15: Freshsweet potato vines.

Table 1.2. Chemical ingredients of uncultivated vegetables used in dry season

	DM %	As % of DM		CF	Ash
		CP	EE		
<i>Idigofera galegrides DC</i>	33.6	13.4	3.9	23.8	4.5
<i>Musa balbesiana Colla</i>	5.40	5.6	1.5	16.9	9.8
<i>Hibiscus rosa siencis</i>	18.2	16.5	1.5	10.6	10.3
<i>Boehmeria nivea (L) Gaud</i>	12.2	26.1	2.9	12.2	13.1
<i>Leucaena leucocephala</i>	25.0	24.6	3.2	10.2	4.8
<i>Ipomoea batatas (L) Lamk</i>	13.2	7.6	3.9	11.2	9.3
<i>Piper lolot DC</i>	13.1	31.1	0.9	25.4	9.2
<i>Abelmoschus mochatatus Med</i>	14.3	23.9	2.8	25.9	8.0
<i>Commelina communis L.</i>	10.0	13.9	1.4	14.5	13.9
<i>Amaranthus tricolor L.</i>	17.7	25.0	0.7	10.9	16.5
<i>Amaranthus spinosus L.</i>	15.4	24.8	3.9	9.2	17.8
<i>Colocasia esculenta L Schott</i>	13.9	14.1	3.8	8.3	11.9
<i>Portulaca oleracea L.</i>	13.9	14.7	4.4	8.6	13.0
<i>Gyrura crepidioides Benth</i>	9.12	27.5	2.7	14.0	10.3

Source: Ngo Huu Toan and Preston (2007)

Table1.3.Chemical composition (%) and oxalate content of processed taro leaves

Ingredients	DM	CP	CF	Ash	Oxalate, mg/100g
Fresh leaves	13.7	25.3	11.4	10.5	760 ^d
Drying by sunlight	88.4	25.6	11.3	13.3	600 ^c
Soaking	17.2	25.6	11.5	10.5	570 ^b
Cooked	9.6	25.6	11.3	10.4	360 ^a
Ensiling	17	25.3	11	10.5	350 ^a
SEM	0.13	0.1	0.14	0.091	0.006
P	0.001	0.12	0.3	0.43	0.001

Source: Du Thanh Hang and T R Preston, 2010

Table I.4. Chemical composition of leaves and petioles of different Taro varieties (%)

	Ao Trang	Chia Voi	Quang	Tim	SEM	P
<i>DM, %</i>						
Leaves	15.6 ^a	15.5 ^a	14.4 ^b	15.5 ^a	0.218	0.002
Petioles	6.8 ^a	6.8 ^a	5.9 ^b	6.9 ^a	0.104	<0.001
<i>Crude protein, % in DM</i>						
Leaves	26.0 ^a	20.8 ^b	24.7 ^a	15.9 ^b	0.201	<0.001
Petioles	8.7 ^a	7.3 ^b	10.7 ^a	6.2 ^b	0.074	<0.001
<i>Oxalate, % in DM</i>						
Leaves	2.0 ^a	1.8 ^a	2.3 ^b	1.8 ^a	0.002	<0.001
Petioles	2.9 ^a	3.1 ^a	3.5 ^b	4.4 ^c	0.103	<0.001

^{ab} Means without common letter differ at $P < 0.05$

Source: Du Thanh Hang and Nguyen Trung Kien (2012)

Table 1.5. The chemical composition (%) and energy values (kcal kg⁻¹) of rich energy feedstuff for pigs (La Van Kinh et al., 2003)

Items	N	DM	CP	EE	CF	Ash	Ca	P	Total starch	GE	DE	ME
1	23	88.18	3.00	0.63	2.25	1.81	0.15	0.12	81.25	3740	3198	3152
2	71	88.57	8.54	4.07	2.31	1.43	0.12	0.31	72.99	3967	3364	3298
3	67	87.64	8.80	1.70	0.93	1.02	0.18	0.21	75.44	3863	3417	3337
4	10	88.9	7.50	1.62	11.19	4.19	0.26	0.30	63.09	3767	2741	2655
5	44	89.11	12.52	13.79	7.14	7.89	0.32	1.15	47.47	4132	2799	2671
6	10	88.70	11.28	10.07	11.57	8.72	0.26	1.30	48.22	4224	2280	2233
7	8	89.09	7.87	5.66	20.76	9.70	0.36	0.59	-	3639	1524	1446
8	17	88.44	12.54	10.02	3.79	7.26	0.13	1.56	54.34	4159	2727	2621
9	30	88.17	14.16	3.79	7.02	3.73	0.16	0.75	59.52	3961	2713	2617

1. Cassava root meal; 2: Maize; 3: Broken rice; 4: Rice; 5: Rice bran 1; 6: Rice bran 2; 7: Rice bran 3; 8: Rice bran with husks; 9: Cassava byproducts

Table1.6. Chemical composition of common high energy feedstuffs in the North (Dao Thi Phuong et al., 2013)

	DM (g kg ⁻¹)	Chemical composition (g kg ⁻¹ DM)						
		CP	EE	CF	Ash	NFE	OM	NDF
Tay Bac maize ¹	877	97.3	48.1	32.0	13.2	686.4	863.8	238.3
Red River Delta maize ²	896	112	53.0	35.0	10.6	685.4	885.4	228.0
Thanh Hoa maize ³	844	86.9	59.5	31.9	30.3	635.4	813.7	230.5
Rice bran 8%CP	902	99.2	98.7	173.5	115.1	415.5	786.9	355.8
Rice bran 10%CP	875	141.2	141	157.3	72.1	363.4	802.9	254.0
Rice bran 13%CP	908	166.1	240.2	123.2	89.1	289.4	818.9	223.7
Molar paddy	885	77.1	2.4	126	61.0	618.5	824	246.8
Broken rice	877	80.6	9.9	6.6	4.6	775.3	872.4	75.0
Wheat bran	873	166.9	43.9	117.5	5.9	538.8	867.1	449.9
Cassava meal in factory	873	33.0	16.0	38.0	26.0	760	847	85.0
Handmade cassava meal	882	28.0	4.8	27.9	23.8	797.5	858.2	66.9
Cassava byproduct	857	15.0	28.2	64.6	29.3	719.9	827.7	392.2

Table 1.7. The chemical composition (%) and energy values (kcal kg⁻¹) of plant protein feedstuffs for pigs (La Van Kinh et al., 2003)

Items	n	DM	CP	EE	CF	Ash	Ca	P	Total starch	GE	DE	ME
1	41	90.11	36.32	17.40	7.52	5.29	0.43	0.52	24.46	5078	4196	3852
2	16	87.99	20.81	2.16	5.96	4.00	0.35	0.41	49.72	3987	3390	3219
3	5	89.14	22.12	2.23	4.66	3.64	0.18	0.46	50.31	3955	3480	3308
4	4	89.82	34.94	14.43	8.46	7.27	0.44	0.48	32.19	4984	4084	3756
5	4	95.46	29.44	43.42	2.83	2.75	0.17	0.31	14.45	6500	5542	5164
6	28	88.98	43.24	2.51	5.05	6.96	0.50	0.63	35.24	4256	3648	3362
7	20	89.52	39.74	7.96	10.10	5.70	0.52	0.56	29.49	4555	3428	3129
8	14	91.32	36.72	9.21	16.40	10.07	1.53	0.64	17.31	4222	3363	3103
9	3	92.75	13.99	6.14	39.52	2.91	0.12	0.19	31.99	4291	2276	2104
10	23	92.32	17.86	9.15	13.92	7.17	0.35	0.56	42.33	4334	2945	2758
11	3	92.80	24.65	9.08	28.31	4.88	0.20	0.93	25.09	46.76	2684	2536
12	3	90.45	60.49	1.08	1.15	2.73	0.29	0.52	25.51	4775	4197	3770

1. Soybean seed; 2: Green bean seed; 3: black bean seed; 4: winged bean seed; 5: peanut seed; 6: soybean cake; 7: Peanut cake; 8: Sesame cake; 9: Rubber cake; 10: Coconut cake; 11: Cotton cake; 12:Maize gluten.

Table 1.8. The chemical composition (%) and energy values (kcal kg⁻¹) of animal protein feedstuffs for pigs (*La Van Kinh et al., 2003*)

Items	N	DM	CP	EE	CF	Ash	Ca	P	NaCl	GE	DE	ME
1	18	90.76	56.58	5.67	1.49	23.25	5.15	2.84	1.95	3821	3468	3090
2	7	89.76	50.84	4.48	0.69	30.17	5.32	2.65	5.70	3478	3055	2752
3	6	90.16	55.45	2.92	0.49	26.26	3.71	2.32	3.05	3628	3189	2848
4	4	93.42	60.05	6.32	0.84	25.22	4.31	2.79	6.98	3922	3717	3306
5	19	90.89	49.09	4.34	1.21	31.45	5.72	2.43	7.77	3393	2916	2641
6	44	90.23	57.89	6.77	1.49	20.47	5.10	2.31	1.57	3996	3622	3219
7	6	91.23	48.95	6.51	2.17	28.47	4.93	2.87	4.64	3529	3057	2771
8	13	92.41	41.78	4.72	1.33	40.85	4.05	1.93	26.17	2893	2470	2254
9	3	88.28	38.54	3.23	0.80	42.43	4.91	3.16	3.92	3120	2202	1987
10	13	89.00	31.61	2.44	6.92	36.37	9.31	1.15	-	2659	1661	1476
11	7	89.13	47.92	2.23	2.49	33.53	2.96	1.16	4.38	3024	2610	2278
12	4	95.36	55.18	10.05	1.53	25.85	9.60	4.65	-	3967	3436	3040
13	2	92.34	58.82	12.90	3.70	3.53	0.24	0.64	-	5111	4008	3565
14	1	91.13	82.34	1.64	1.08	2.45	0.49	0.11	-	4783	-	-

1. Bo fish, 2 Bo lo fish, 3 Com fish, 4 Liet fish, 5 mixed fish, 6 fish meal, 7 fish meal, 8 salty fish meal, 9 fish head meal, 10 shrimp head meal, 11, 12 meat and bone meal, 13, silkworm chrysalis, 14, feather meal

Table1.9. Chemical composition of common high protein feedstuffs in the North (Dao Thi Phuong et al., 2013)

	DM (g kg ⁻¹)	Chemical composition (g kg ⁻¹ DM)						
		CP	EE	CF	Ash	NFE	OM	NDF
Roasted soybean	937	421	202.2	58.2	60.4	195.2	876.6	121.0
Whole hulled soybean cake	899	490.2	15.2	88.9	82	222.7	817.0	247.3
De-hulled soybean cake	895	531.4	11.2	45.8	65.8	240.8	829.2	236.9
Coconut cake	904	189	32	144	62	477	842.0	321
Palm oil cake	908	160.9	91.7	197.5	51	406.9	857.0	708.3
Fish meal 55% CP	883	626	133	*	177	*	706.0	*
Fish meal 60% CP	928	659.2	58.8	*	263.1	*	664.9	182.2
Fish meal 65% CP	883	693.5	74	*	241.8	*	641.2	64
Meat & bone meal 45% CP	923	491	37	*	356	*	567.0	*
Meat & bone meal 50% CP	913	600	103	*	384	*	529.0	*

Table 1.10. Chemical composition and energy value of feedstuffs for pigs in the North (Ninh Thi Len et al., 2010)

Feedstuffs								
	Thanh Hoa maize	Son maize	La Cass. root meal	Brocken rice	Rice bran, type 1	Rice bran, type 2	Indian soya meal	Fish meal
Chemical composition (g kg ⁻¹ DM)								
DM	877	884	887	877	902	901	899	905
CP	97.3	86.9	18.7	80.6	99.2	74.9	490.2	664.0
EE	48.1	59.5	9.1	9.9	98.7	66.4	15.2	72.0
CF	32.0	31.9	43.2	6.6	173.5	241.8	88.9	*
NDF	238.3	230.5	69.0	75.0	355.8	422.9	247.3	*
Ash	13.2	30.3	21.3	4.6	115.1	124.9	82.0	268.6
OM	987	967	979	995	885	875	918	731
NFE	809	791	908	898	514	492	324	*
Energy value (kcal kg ⁻¹ DM)								
GE	4366	4376	4076	4092	4415	4296	4482	4438
DE	3882	-	3630	3965	2383	1811	3887	3694
ME	3779	-	3561	3870	2294	1733	3681	3483

Table1.11. Energy values of common feedstuffs for pigs in the North

	Values (kcal kg ⁻¹)					
	Gross energy (GE)		Digestible energy (DE)		Metabolizable energy (ME)	
	Mean	± SEM	Mean	± SEM	Mean	± SEM
Rich energy feeds						
Tay Bac maize	4366	69.8	3887	52.1	3827	22.5
Red River Delta maize	4450	56.5	4027	80.2	3939	36.4
TB Bac maize	4376	43.2	3882	20.3	3779	43.1
<i>Maize (Average)</i>	<i>4397</i>	<i>29.7</i>	<i>3932</i>	<i>33.5</i>	<i>3848</i>	<i>20.8</i>
Rice bran 8% CP	4296	22.4	1811	47.4	1733	33.7
Rice bran 10% CP	4415	33.8	2383	26.6	2294	27.9
Rice bran 13% CP	3926	26.5	2980	63.2	2890	41.6
<i>Rice bran (Average)</i>	<i>4212</i>	<i>31.5</i>	<i>2391</i>	<i>22.4</i>	<i>2306</i>	<i>55.2</i>
Broken rice 8%CP	4092	37.8	3965	18.8	3870	60.7
Wheat bran	3887	47.7	2345	51.3	2221	32.9
Whole cassava root	4076	66.2	3630	65.1	3561	40.3
Cassava root	3944	69.4	3688	77.3	3620	72.5
Cassava byproducts	4918	70.4	2285	35.7	2277	51.3
Rich protein feeds						
Roasted soybean	5032	44.2	4217	43.2	4164	32.8
India soyabean with hull	4482	35.7	3887	34.9	3681	46.5
De-hulled soybean cake	4526	68.4	4046	48.3	3840	57.4
Coconut cake	3913	71.3	3905	29.2	3005	66.1
Palm kernel cake	4295	55.4	2350	35.1	2185	70.8
Fish meal 55%CP	4531	72.6	3195	123.0	2961	36.3
Slight fish meal 60%CP	3982	66.9	3674	120.1	3463	42.6
Peru fish meal 65%CP	4442	48.3	3738	112.2	3540	53.7
Meat and bone meal 45%CP	4322	39.5	2781	70.4	2555	36.9
Meat and bone meal 50%CP	3954	56.7	2520	80.2	2604	42.3
Blood meal	4955	62.3	2912	63.4	2591	44.8

Table 1.12. Correction factor K for estimate the energy values (La Van Kinh et al., 2003)

Feedstuffs	DE (pig)	ME (pig)	ME (poultry)
Sweet potato, cassava	-30	-37	-61
Vegetable on land	+6	+6	-20
Water spinach	-23	-20	-38
Water ferns	+37	+35	-21
Fresh roots	+30	+25	+16
Roots feed: sweet potato, fresh cassava	+101	+94	-13
Carrot	+44	+42	+19
Potato	+44	+42	-12
Cassava meal	+228	+213	+181
Ngang powder	-229	-305	-304
Fresh cassava byproduct	-182	-186	-41
Dry cassava byproduct	-583	-592	-150
Beer, alcohol brewers	-108	-104	-53
Cotton seed	-350	-269	-687
Sesame seed	750	748	728
Dry shelled rubber cake	-378	-347	-530
Dry cotton cake	+177	+244	+54
Dry sesame cake	+366	+380	+326
Dry shelled rubber cake	+409	+385	+511
Dry coconut cake	-81	-98	-77
Maize meal	+150	+161	+212
Rice broken	+221	+210	+162
Rice bran	-456	-433	-395
Cassava root meal	-282	-263	-197
Maize gluten	+73	+29	+416
Soybean seed	+349	+305	+225
Green bean	+257	+241	+10
Black bean	+250	+234	+163
Winged bean	+370	+323	-106
Peanut	+403	+377	416
Red bean	+269	+250	176

White bean	+223	+212	-278
DDGS	+164	+169	-355
Dry peanut cake	-44	-52	+91
Fresh soybean residue	-50	-52	+28
Unsalted cattle fish	-47	-42	+47
Com fish	-74	-54	+9
Illness fish	+71	+57	+43
Mix fish	-109	-63	-58
Unsalted fish meal	-25	-33	+54
Salty fish meal, fish head	-243	-208	-124
Shrimp head meal, finger-crab	-373	-359	-93
Meat and bone meal	-256	-270	-123



Part 2. Amino acid composition

Table 2.1. The content of crude protein and amino acids composition of main feedstuffs in Vietnam (% as DM) (La Van Kinh et al., 2003)

Feedstuffs	CP	Lys	Met	Cys	Thr	Trp	Leu	Iso	Val	Arg
Sweet potato leaves	23.73	0.725	0.483	0.204	0.654	0.274	1.166	0.608	0.782	0.950
Cassava leaves	27.26	1.179	0.450	0.324	1.028	0.466	1.936	1.020	1.276	1.490
Water spinach	25.68	0.913	0.357	0.193	0.902	0.302	1.503	0.840	1.016	1.232
Algae meal	64.19	2.760	1.273	0.578	2.960	-	5.305	3.130	4.213	4.185
Cassava root meal	2.71	0.09	0.031	0.035	0.079	0.022	0.118	0.073	0.096	0.280
Yellow maize	9.68	0.270	0.200	0.212	0.323	0.074	1.097	0.317	0.432	0.478
Glutinous maize	11.18	0.270	0.206	0.184	0.344	0.06	1.236	0.330	0.452	0.524
Rice broken	10.22	0.342	0.275	0.244	0.341	0.111	0.779	0.373	0.530	0.787
Pure rice bran	15.13	0.618	0.300	0.330	0.511	0.156	0.982	0.491	0.729	1.047
Polished rice bran	13.81	0.471	0.348	0.384	0.440	0.169	0.902	0.483	0.659	0.952
Cassava byproducts	15.18	0.603	0.239	0.330	0.479	0.203	0.932	0.473	0.687	0.977
Maize gluten	67.78	1.173	1.650	1.173	2.328	0.339	11.35	2.972	3.266	2.190
Soybean seed	41.89	2.405	0.596	0.657	1.501	0.553	2.956	1.606	1.648	2.684
Soybean cake	50.67	2.897	0.701	0.779	1.897	0.745	3.786	2.077	2.189	3.374
Peanut cake	48.53	1.502	0.538	0.670	1.225	0.429	2.811	1.386	1.813	4.538
Bo fish	57.62	3.391	1.143	0.449	2.110	0.521	3.339	1.997	2.407	2.708
Unsalted fish meal	61.79	4.147	1.529	0.622	2.278	0.632	4.136	2.155	2.605	3.231
Salted fish meal	44.03	2.706	0.816	0.378	1.690	0.394	2.877	1.642	1.930	2.358
Shrimp head meal	36.38	1.537	0.476	0.269	1.136	0.295	1.991	1.641	1.351	2.271
Meat & bone meal	53.76	2.628	0.630	0.630	1.748	0.217	3.194	1.542	2.454	3.725

Table 2.2. Contents of dry matter, crude protein and amino acid composition (g kg⁻¹) (Ninh Thi Len et al., 2010)

	Maize	Broken rice	CR meal	Rice bran	Fish meal	Soy meal
Dry matter	874.0	872.0	893.0	905.0	872.0	895.0
Crude protein	117.0	74.0	33.0	102.0	666.0	511.0
Arginine	5.1	5.6	1.3	9.9	43.2	35.7
Cysteine	2.5	2.1	0.7	1.8	7.9	9.2
Histidine	3.1	1.7	1.1	2.9	14.2	12.3
Isoleucine	4.0	2.5	2.0	3.0	29.5	19.9
Leucine	16.7	5.6	2.4	8.1	53.4	34.8
Lysine	2.5	3.3	1.5	6.3	54.7	29.5
Methionine	2.1	1.9	0.7	2.8	21.8	6.8
Phenylalanine	6.2	3.5	2.2	6.4	28.6	24.8
Threonine	3.2	3.0	1.1	3.4	29.6	19.5
Tryptophan	0.9	1.2	0.5	1.7	7.3	6.8
Tyrosine	4.3	3.6	0.7	6.5	27.7	17.5
Valine	6.3	4.2	2.1	5.9	29.5	21.9

Table2.3. Crude protein content and amino acid compositions of rich energy feedstuffs in the North (g kg⁻¹)

	Tay Bac maize	Red RD maize	Rice bran 8% CP	Rice bran 10%CP	Rice bran 13%CP	Broken rice	Wheat bran	Whole cassava root
DM	877	896	902	875	908	877	873	887
CP	97.3	112	99.2	142.0	166	80.6	166.9	18.7
Arg	4.66	5.1	6.9	9.4	11.6	5.6	12.3	1.3
Cys	2.05	2.5	1.08	1.7	4.7	2.1	3.46	0.7
His	1.77	3.1	2.9	3.7	3.3	1.7	3.36	1.1
Iso	1.93	4.0	3.0	4.4	4.16	2.5	3.41	2.0
Leu	6.15	16.7	8.1	9.5	8.9	5.6	7.32	2.4
Lys	2.39	2.5	3.3	4.7	6.7	3.3	5.32	1.5
Met	2.05	2.1	1.8	3.1	3.1	1.9	2.38	0.3
Phe	2.63	6.2	3.4	6.2	6.6	3.5	5.06	2.2
Thr	1.88	3.2	3.4	5.4	3.4	3.0	3.99	1.1
Try	0.67	0.9	1.07	1.16	2.04	1.2	2.06	0.04
Tyr	2.24	4.3	6.5	7.3	7.3	3.6	4.19	0.7
Val	3.22	6.3	5.9	7.8	7.4	4.2	6.94	2.1

Table 2.4. Crude protein content and amino acid compositions of high protein feedstuffs (g kg⁻¹)

	Roasted soybean meal	Whole soybean cake	De-hulled soybean cake	Coconut byproduct	FM 55%CP	FM 60%CP	FM 65%CP	Meat & bone meal 45%CP	Meat & bone meal 50%CP
DM	878	899	895	904	893	923	883	926	952
CP	417	490.2	531.4	189	626	659	693.5	492	554
Arg	30.3	35.7	37.2	12.6	29.0	39.4	43.2	34.4	37.7
Cys	6.49	7.2	8.18	3.85	6.7	8.52	8.78	5.4	6.6
His	6.81	12.3	14.15	4.22	13.4	16.14	19.5	9.8	11.1
Iso	19.24	18.9	23.28	6.39	22.9	23.33	27.7	14.3	16.6
Leu	30.57	30.8	34.63	11.08	41.9	45.99	55.9	29.5	34.3
Lys	23.98	29.5	32.57	7.25	39.1	48.43	56.40	24.6	28.3
Met	7.96	6.8	8.20	4.89	14.5	19.03	24.4	6.4	7.2
Phe	20.11	22.11	24.8	8.97	22.3	24.48	25.7	16.7	19.4
Thr	16.19	19.5	20.13	7.67	24.3	25.17	27.5	16.2	18.8
Try	7.13	6.8	7.45	1.36	6.31	7.21	8.9	3.0	3.9
Tyr	15.10	14.5	16.33	6.08	17.3	21.31	23.08	10.4	12.6
Val	23.17	21.9	23.23	11.08	29.0	34.35	36.32	21.6	24.9

Table 2.5. Correlation equations for essential amino acid estimation in common feeds (La Van Kinh et al., 2003)

Feedstuffs	CP(%)	Lys*	Met	Cys	Thr	Try	Leu	Iso	Val	Arg
Maize	8.85	1.02	0.119	0.731	0.472	0.433	-1.56	0.452	0.58	0.29
		0.159	0.182	0.127	0.277	0.018	1.44	0.266	0.373	0.444
		0.696	0.704	0.268	0.697	0.059	0.891	0.666	0.765	0.323
Rice broken	8.96	-0.489	-0.534	-0.733	-0.318	0.404	-0.489	-0.902	-0.880	0.52
		0.386	0.334	0.322	0.368	0.068	0.807	0.463	0.612	0.714
		0.701	0.606	0.79	0.86	0.347	0.766	0.734	0.738	0.461
Rice bran	12.68	-0.340	0.066	-0.215	0.220	0.671	0.448	0.342	0.323	-0.389
		0.424	0.198	0.239	0.318	0.054	0.615	0.301	0.456	0.719
		0.741	0.622	0.672	0.882	0.192	0.823	0.671	0.789	0.840
Cass. bran	13.58	0.44	1.40	1.41	0.479	-1.32	3.04	1.32	3.34	-0.60
		0.359	0.055	0.114	0.280	0.238	0.378	0.210	0.198	0.687
		0.645	0.127	0.293	0.772	0.926	0.621	0.678	0.585	0.70
Soybean	37.73	0.22	-6.55	3.50	-0.20	-0.24	-6.61	-1.13	-7.04	-15.3
		0.574	0.314	0.07	0.363	0.139	0.88	0.410	0.581	1.05
		0.363	0.705	0.112	0.27	0.492	0.378	0.462	0.662	0.511
Dry soya cake	45.58	-14.2	1.19	-0.146	-6.73	-1.39	-7.76	-3.12	-5.39	-15.4
		0.89	0.111	0.158	0.523	0.182	0.913	0.476	0.548	1.00
		0.887	0.632	0.609	0.827	0.415	0.80	0.572	0.64	0.606
Dry peanut cake	43.70	-3.03	0.524	-1.45	0.604	0.450	-2.58	1.44	0.60	-6.50
		0.382	0.096	0.163	0.235	0.0795	0.657	0.255	0.358	1.10
		0.943	0.78	0.704	0.854	0.835	0.915	0.737	0.86	0.732
Dry sesame cake	39.25	-16.2	0.20	1.72	0.38	-9.78	4.94	-0.63	2.43	8.26
		0.646	0.251	0.134	0.314	0.326	0.464	0.305	0.317	0.788
		0.736	0.642	0.447	0.904	0.235	0.799	0.819	0.765	0.644
Dry Coconut cake	18.12	-2.21	0.245	0.261	-1.48	-0.563	-1.34	-1.45	-1.98	-8.93
		0.399	0.124	0.126	0.381	0.112	0.667	0.402	0.570	1.50
		0.931	0.883	0.589	0.923	0.880	0.877	0.823	0.848	0.964

Equation $Y = ax + b$; In table, row 1 is a; row 2 is b; and row 3 is R^2 .

Part 3. Total tract and ileal digestibility

Table 3.1. Effects of breeds on digestibility of nutrients of whole rubber seed contained-diet (Thuy and Ly, 2002)

	pHfeces	Digestibility, %			
		DM	OM	NDF	CP
Breed					
Mong Cai	6.09	71.7	72.8	77.6	82.9
Yorkshire	6.15	72.3	72.1	75.1	86.2
SE	0.41	3.5	3.8	3.5	2.4
Diets					
Control	6.09	70.7	70.6	79.1	84.8
27% rubber seed	6.14	73.2	73.3	73.6	84.3
SE	0.40	3.3	3.3	3.4	2.7

Table 3.2.Total tract apparent digestibilities (%) of crude protein and some essential amino acids in pigs (Vuong Nam Trung and La Van Kinh, 2010)

Feedstuff	Protein	Lys	Met+Cys	Thr	Try	Met
Rice bran	69.31 ^b	71.17 ^{ab}	72.52 ^{ab}	63.29 ^a	62.98 ^a	77.24
Broken rice	69.03 ^b	73.42 ^{ab}	70.73 ^{ab}	67.75 ^a	62.30 ^a	71.34
Maize	75.85 ^{ab}	68.26 ^a	67.77 ^a	76.83 ^{ab}	64.33 ^a	76.77
Cassava byproducts	68.56 ^b	68.72 ^a	68.23 ^a	69.25 ^{ab}	66.55 ^a	72.66
Soybean meal	80.30 ^{ab}	83.57 ^c	80.77 ^{ab}	86.21 ^b	81.14 ^b	79.29
Soybean cake	81.29 ^a	82.91 ^{bc}	83.95 ^b	84.66 ^b	82.21 ^b	78.67
Fish meal	85.03 ^a	85.41 ^c	81.16 ^{ab}	81.03 ^{ab}	84.79 ^b	80.22

Table 3.3.Total tract apparent digestibility of energy and proximate composition of common feeds in growing pigs (Ninh Thi Len et al., 2010)

	Feedstuffs								
	Thanh maize	Hoa	Son maize	La Cassava root meal	Brocken rice	Rice bran, type 1	Rice bran, type 2	Indian soyame al	Fish meal
GE	88.7	-	-	89.1	96.9	54.0	42.2	86.7	83.2
DM	87.2	-	-	88.9	97.2	56.0	40.4	87.6	89.1
CP	81.5	-	-	83.2	88.6	69.5	39.1	88.3	94.8
EE	85.3	-	-	57.2	81.4	64.0	40.6	72.9	83.6
CF	44.2	-	-	63.9	63.2	14.5	10.2	62.7	*
NDF	77.3	-	-	68.2	75.4	22.1	11.3	75.0	*
Ash	36.2	-	-	53.8	56.3	23.7	20.7	79.5	89.9
OM	88.8	-	-	89.7	97.3	60.2	43.2	88.3	88.7
NFE	91.7	-	-	91.4	98.6	73.1	60.3	96.0	*

Table 3.4. Total tract apparent digestibility of major nutrients in growing pigs

	Apparent digestibility (%)						
	DM	OM	CP	CF	EE	Ash	NFE
Tay Bac maize	89.0	89.6	82.7	46.2	83.9	42.8	92.5
Red River Delta maize	90.4	90.9	84.4	46.7	83.7	41.1	94.3
Thanh Hoa maize	87.2	88.8	81.5	44.2	85.3	36.2	91.7
<i>Maize (Average)</i>	<i>88.9</i>	<i>89.8</i>	<i>82.9</i>	<i>45.7</i>	<i>84.3</i>	<i>40.0</i>	<i>92.8</i>
Rice bran 8% CP	40.4	43.2	39.1	10.2	40.6	20.7	60.3
Rice bran 10% CP	56.0	60.2	69.5	14.5	64.0	23.7	73.1
Rice bran 13% CP	68.3	72.7	74.7	32.5	84.2	24.3	77.6
<i>Rice bran (Average)</i>	<i>54.9</i>	<i>58.7</i>	<i>61.1</i>	<i>19.1</i>	<i>62.9</i>	<i>22.9</i>	<i>70.3</i>
Molar paddy	68.4	66.0	69.5	15.3	63.0	22.7	74.3
Broken rice	90.4	89.8	88.2	69.0	63.8	93.8	93.2
Wheat bran	70.4	62.8	76.3	28.5	76.2	63.8	64.2
Whole cassava root	84.5	83.2	60.6	49.1	70.3	78.4	85.8
De-shelled cassava root	90.3	91.3	87.4	61.3	62.2	50.7	92.5
Cassava byproduct	62.5	60.7	62.0	36.2	74.9	35.0	64.3

Table 3.5. Total tract apparent digestibility of proximate composition of some rich protein feeds in growing pigs

	Apparent digestibility (%)						
	DM	OM	CP	CF	EE	Ash	NFE
Roasted soybean	85.3	83.9	86.3	58.6	82.1	84.7	90.3
Whole soybean cake	87.6	88.3	88.3	62.7	72.9	79.5	96.0
De-shelled soybean cake	89.9	90.1	89.8	72.2	77.1	85.4	97.0
Coconut cake	78.2	78.4	73.3	67.9	64.7	62.5	84.9
Palm kernel cake	77.8	76.42	70.6	66.2	60.4	52.9	80.3
Fish meal 55% CP	80.2	78.1	79.8	*	78.4	72.1	*
Fish meal 60% CP	74.1	87.4	83.7	*	79.1	37.1	
Fish meal 65% CP	89.4	87.5	92.8	*	86.4	91.7	*
Meat & bone meal 45% CP	73.2	71.1	72.1	*	77.8	68.9	*
Meat and bone meal 50% CP	73.4	73.2	73.8	*	79.8	67.2	*
Blood meal	84.3	81.1	78.5	*	*	62.4	*

Table 3.6. Effect of processing methods of taro leaves on digestibility and nitrogen retention (% in DM)

	CTL	FTL	ETL	SEM	P
DM Intake, g/d	1108	1120	1067	33.2	0.5
DM taroleaf intake, g/d	187	184	183	9.07	0.94
Digestibility, %					
DM	81.2	84.3	85.0	0.85	0.3
OM	85.6	86.7	87.2	0.69	0.3
CF	55.5 ^a	48.2 ^b	57.9 ^a	2.69	0.03
CP	72.1 ^a	69.7 ^a	76.2 ^b	1.66	0.02
N retention (g)	10.8 ^a	8.4 ^b	10.2 ^a	0.55	0.004
N retention/ digested N, %	76.6 ^a	63.2 ^b	72.8 ^a	2.63	0.004

Source: Du Thanh Hang and Preston (2007)

Table 3.7. Mean values of feed intake, apparent digestibility and N balance in growing Van Pa pigs fed cassava root meal and rice bran and increasing proportions (0 to 100%) of dietary protein from a mixture of ensiled taro leaves and cassava leaves (MTC) replacing protein from fish meal (FM)

	FM	MTC50	MTC100	SEM	P
DM intake, g/d	920 ^a	860 ^b	703 ^c	12.6	0.001
Apparent digestibility, %					
DM	88	84	84	1.75	0.406
OM	89	87	87	1.32	0.483
CP	76	68	69	3.45	0.266
N retention, g/d	7.6 ^a	5.8 ^{ab}	4.8 ^b	0.47	0.015

abc mean values within rows without common letter are different at P < 0.05
SEM: Standard error of mean; P: probability

Source: Nguyen Thi Hoa Ly et al. (2010)

Table 3.8. Ileal apparent digestibility (%) of amino acids of soybean and soybean meals in growing pigs (Le Van Tho, 2000)

Amino acids	Roasted soybean	Extruded soybean	Indian soybean cake	Argentin soyabean cake
Arginine	79.34±3.76	85.35±1.56	87.18±2.38	90.47±2.26
Histidine	77.54±3.20	81.00±1.34	74.27±4.89	81.88±6.13
Isoleucine	66.70±3.99	70.29±3.32	71.27±5.77	74.05±6.24
Leucine	75.41±0.98	74.06±1.45	73.36±5.70	76.08±3.87
Lysine	70.37±1.39	79.89±2.10	77.95±5.80	74.84±11.07
Methionine	64.29±2.93	66.44±1.99	63.68±10.51	64.45±7.42
Phenylalanine	72.20±2.04	75.03±3.48	75.74±4.02	79.42±2.67
Threonine	63.55±2.13	70.70±3.15	70.35±4.70	72.43±10.14
Valine	69.77±1.01	71.55±2.05	67.88±6.17	73.77±6.22

Table 3.9.Ileal true digestibility (%) of crude protein and amino acids of soybeans and its byproducts in growing pigs (Le Van Tho, 2000)

Amino acid	Roasted soybean	Extruded soybean	Indian soybean cake	Argentin cake	soybean
Crude protein	64.25	64.00	70.84	73.22	
Arginine	76.70	83.84	85.57	90.00	
Isoleucine	65.17	66.89	67.92	72.25	
Leucine	72.49	71.14	71.20	73.43	
Lysine	70.14	79.69	72.41	79.66	
Methionine	69.98	71.35	67.33	74.95	
Threonine	59.97	64.10	64.23	66.60	
Valine	67.71	67.86	64.75	69.89	
Cysteine	56.56	61.32	67.20	58.08	

Table 3.10. Apparent ileal digestibility (%) of amino acid of leaves and foliage in crossbred growing pigs (LD x LW)(Bui Huy Nhu Phuc and J E Lindberg, 2001)

Amino acid	Sun-dried cassava leaves	Ensiled cassava leaves	Groundnut vines	Leucaena leaves
Arginine	50 ^a	56 ^b	77 ^c	48 ^a
Histidine	61 ^a	68 ^b	73 ^c	67 ^b
Isoleucine	48 ^a	68 ^b	73 ^c	67 ^b
Leucine	50 ^a	57 ^b	72 ^c	52 ^a
Lysine	64 ^a	64 ^a	73 ^c	61 ^a
Methionine	56 ^a	55 ^a	73 ^b	57 ^a
Phenylalanine	55 ^a	52 ^a	68 ^b	55 ^a
Threonine	52 ^a	54 ^a	69 ^b	52 ^a
Tyrosine	64	61	65	60
Valine	60 ^a	62 ^a	72 ^b	61 ^a

Table 3.11. Ileal apparent digestibility (%) of amino acids of fishmeal (FM), fresh shrimp byproducts (FSB) and ensiled shrimp byproducts (ESB) in growing pigs (MC x LW) (Ngoan and Lindberg, 2001)

Amino acid	Diets			
	Basal	FM	FSB	ESB
Arginine	75.7 ^a	48.6 ^b	78.2 ^b	77.1 ^b
Histidine	72.9 ^a	75.6 ^b	74.6 ^b	74.4 ^b
Isoleucine	72.7 ^a	74.4 ^b	73.7 ^{ab}	73.3 ^{ab}
Leucine	73.2 ^a	75.9 ^b	75.3 ^b	74.8 ^b
Lysine	73.6 ^a	76.7 ^b	75.8 ^b	75.8 ^b
Methionine	69.2 ^a	74.9 ^b	72.5 ^b	73.3 ^b
Phenylalanine	69.9 ^a	72.5 ^b	72.8 ^b	69.8 ^b
Threonine	68.8 ^a	71.2 ^b	72.4 ^b	66.6 ^{ab}
Tyrosine	70.8 ^a	75.8 ^a	75.3 ^b	74.4 ^b
Valine	72.2 ^a	75.5 ^b	74.5 ^b	74.2 ^b

Table3.12. Ileal apparent digestibility (%) of amino acids in groundnut cake (GNC), soyabean cake (SB), soyabean meal (SM), fishmeal (FM) and shrimp byproducts (SBP) in growing Mong Cai pigs (Ngoan et al., 2001)

Amino acid	Basic diet	GNC	SM	SB	FM	SBP	SEM	P
Arginine	74.35 ^{ab}	71.60 ^b	72.30 ^b	77.16 ^a	76.75 ^a	75.54 ^{ab}	0.45	0.01
Histidine	87.63 ^a	82.01 ^b	78.76 ^{bc}	81.41 ^b	75.13 ^c	81.41 ^b	0.39	0.01
Isoleucine	77.39 ^c	79.63 ^c	85.57 ^{ab}	88.07 ^a	85.69 ^{ab}	84.02 ^{ab}	0.32	0.01
Leucine	73.53 ^b	81.45 ^a	72.54 ^b	74.45 ^b	79.67 ^a	78.72 ^{ab}	0.45	0.01
Lysine	88.44 ^a	82.13 ^{ab}	72.95 ^c	80.58 ^b	74.66 ^c	80.37 ^b	0.63	0.01
Methionine	91.29 ^a	89.30 ^{ab}	87.94 ^{bc}	89.94 ^{ab}	86.73 ^c	87.27 ^{bc}	0.24	0.01
Phenylalanine	78.38 ^a	78.22 ^a	81.20 ^b	82.02 ^b	83.29 ^b	79.32 ^a	0.46	0.01
Threonine	81.96 ^a	74.48 ^{ab}	72.64 ^b	73.10 ^b	70.97 ^c	70.80 ^c	0.46	0.01
Valine	79.78 ^a	74.84 ^b	79.41	79.22 ^a	78.93 ^a	76.72 ^{ab}	0.64	0.01

Table3.13. Ileal apparent digestibilities (%) of nutrients and amino acids of coconut, rubber, peanut and sesame cakes in growing pigs (LD x LW) (Bui Huy Nhu Phuc, 2003)

Parameters	Treatment				SE	P
	Coconut cake	Rubber seed meal	Peanut cake	Sesame cake		
OM	64.1 ^a	52.7 ^b	84.05 ^b	46.34 ^d	3.6	0.01
CP	65.7 ^a	66.4 ^a	77.11 ^b	68.01 ^a	1.47	0.01
EE	75.4	78.2	83.7	75.8	2.82	0.78
CF	25.1 ^a	9.38 ^b	29.85 ^b	13.58 ^b	2.89	0.01
NDF	45.5 ^a	30.1 ^b	47.0 ^a	15.9 ^b	3.63	0.01
NFE	75.9 ^a	63.1 ^b	82.5 ^a	43.0 ^c	3.92	0.01
Essential amino acid						
Arginine	68.1 ^b	77.1 ^a	93.8 ^c	93.2 ^c	2.68	0.01
Histidine	55.2 ^a	67.4 ^a	86.5 ^b	71.6 ^a	3.96	0.02
Isoleucine	67.5	73.0	69.0	68.5	3.3	0.01
Leucine	68.6 ^a	74.1 ^a	90.2 ^b	75.1 ^a	2.97	0.01
Lysine	69.3 ^a	64.7 ^a	87.1 ^b	85.9 ^b	1.85	0.01
Methionine	79.4 ^a	82.6 ^a	90.1 ^b	84.2 ^{ab}	2.24	0.04
Cystine	59.0 ^a	71.2 ^a	88.2 ^b	74.6 ^a	4.36	0.01
Phenylalanine	67.3 ^a	71.76 ^{ab}	90.2 ^c	83.0 ^{bc}	3.21	0.01
Threonine	59.6 ^a	68.7 ^a	88.9 ^b	85.8 ^b	2.81	0.01
Tyrosine	71.9 ^a	81.8 ^{ab}	84.3 ^b	59.1 ^b	2.54	0.01
Valine	77.1 ^a	84.1 ^a	89.9 ^b	87.59 ^b	2.15	0.02

Table 3.14. Ileal apparent and true digestibility coefficients of crude protein and amino acids in growing pigs(Ninh Thi Len et al., 2010)

	Maize		Broken rice		CR meal		Rice bran		Fish meal		Soybean meal	
	AD	TD	AD	TD	AD	TD	AD	TD	AD	TD	AD	TD
CP	0.77	0.83	0.82	0.91	0.69	0.90	0.66	0.73	0.89	0.94	0.83	0.88
Arg	0.86	0.90	0.87	0.91	0.77	0.94	0.74	0.77	0.94	0.96	0.92	0.95
Cys	0.82	0.87	0.82	0.88	0.73	0.90	0.67	0.74	0.84	0.92	0.83	0.91
His	0.83	0.85	0.90	0.95	0.74	0.81	0.70	0.73	0.92	0.94	0.91	0.94
Iso	0.80	0.85	0.85	0.93	0.70	0.80	0.57	0.64	0.92	0.95	0.90	0.93
Leu	0.87	0.89	0.89	0.95	0.81	0.94	0.70	0.74	0.92	0.95	0.88	0.91
Lys	0.73	0.86	0.82	0.92	0.76	0.97	0.66	0.72	0.93	0.96	0.90	0.93
Met	0.85	0.92	0.85	0.93	0.67	0.88	0.70	0.76	0.91	0.94	0.87	0.90
Phe	0.85	0.90	0.84	0.92	0.75	0.87	0.67	0.72	0.91	0.96	0.91	0.96
Thre	0.71	0.80	0.83	0.93	0.64	0.89	0.53	0.62	0.91	0.96	0.85	0.90
Try	0.66	0.79	0.74	0.84	0.60	0.82	0.60	0.68	0.85	0.93	0.83	0.91
Tyr	0.83	0.86	0.91	0.94	0.74	0.91	0.71	0.73	0.92	0.94	0.92	0.94
Val	0.80	0.84	0.86	0.92	0.73	0.83	0.66	0.70	0.87	0.90	0.87	0.90

AD: Ileal apparent digestibility; TD: Ileal true digestibility

Table 3.15. Ileal apparent digestibility coefficient of amino acid of common energy feedstuffs in growing pigs

	Tay Bac maize	Red maize	RD	Rice bran 8% CP	Rice bran 10%CP	Rice bran 13%CP	Broken rice	Wheat bran	Whole cassava root
Protein	0.75	0.77		0.66	0.69	0.77	0.82	0.76	0.69
Arg	0.85	0.86		0.64	0.72	0.76	0.87	0.77	0.77
Cys	0.82	0.82		0.67	0.69	0.74	0.82	0.77	0.73
His	0.81	0.83		0.70	0.81	0.86	0.90	0.82	0.74
Iso	0.73	0.80		0.57	0.74	0.72	0.85	0.75	0.70
Leu	0.84	0.87		0.70	0.74	0.74	0.89	0.81	0.81
Lys	0.76	0.73		0.66	0.68	0.76	0.82	0.72	0.76
Met	0.85	0.85		0.70	0.74	0.71	0.85	0.68	0.67

Table. 3.16. Ileal true digestibility coefficient of amino acid of rich energy feedstuffs in growing pigs

	Tay maize	Bac Red maize	RD	Rice 8% CP	bran	Rice 10%CP	bran	Rice 13%CP	bran	Broken rice	Wheat bran	Whole cassavaroot
Protein	0.88	0.83	0.73	0.72	0.90	0.91	0.83	0.80				
Arg	0.91	0.90	0.77	0.78	0.83	0.91	0.79	0.94				
Cyst	0.88	0.87	0.74	0.73	0.84	0.88	0.80	0.90				
His	0.87	0.85	0.73	0.83	0.87	0.95	0.83	0.81				
Iso	0.86	0.85	0.64	0.77	0.75	0.93	0.79	0.80				
Leu	0.91	0.89	0.74	0.77	0.87	0.95	0.84	0.94				
Lys	0.92	0.86	0.72	0.74	0.90	0.92	0.80	0.97				
Met	0.93	0.92	0.76	0.82	0.75	0.93	0.74	0.88				
Phe	0.91	0.90	0.72	0.80	0.92	0.92	0.84	0.87				
Thr	0.83	0.80	0.62	0.68	0.82	0.93	0.76	0.89				
Try	0.76	0.79	0.68	0.74	0.83	0.84	0.78	0.82				
Tyr	0.88	0.86	0.73	0.82	0.86	0.94	0.88	0.91				
Val	0.84	0.84	0.70	0.78	0.83	0.92	0.78	0.83				

Table 3.17. Ileal apparent ileal digestibility coefficient of amino acids of rich protein feedstuffs in growing pigs

	Roasted soybean	Whole soybean cake	De-shelled soybean cake	Coconut kernel cake	FM 55% CP	FM 60% CP	FM 65% CP	M& B meal 45% CP	M& B meal 50% CP
CP	0.80	0.83	0.86	0.70	0.80	0.87	0.89	0.75	0.79
Arg	0.85	0.85	0.86	0.73	0.82	0.88	0.87	0.84	0.86
Cys	0.81	0.83	0.85	0.71	0.81	0.83	0.89	0.61	0.64
His	0.88	0.91	0.91	0.71	0.80	0.85	0.88	0.76	0.78
Iso	0.88	0.90	0.91	0.72	0.78	0.91	0.90	0.80	0.83
Leu	0.87	0.88	0.92	0.61	0.81	0.91	0.89	0.81	0.79
Lys	0.85	0.90	0.91	0.64	0.85	0.87	0.89	0.79	0.83
Met	0.87	0.87	0.81	0.79	0.86	0.87	0.88	0.66	0.75
Phe	0.90	0.91	0.91	0.64	0.79	0.91	0.90	0.81	0.81
Thr	0.89	0.85	0.91	0.72	0.80	0.90	0.91	0.77	0.79
Try	0.80	0.83	0.87	0.78	0.83	0.79	0.83	0.67	0.76
Tyr	0.94	0.92	0.91	0.67	0.82	0.90	0.89	0.82	0.84
Val	0.90	0.87	0.93	0.79	0.86	0.90	0.92	0.78	0.81

Table 3.18. Ileal true digestibility coefficient of amino acids of rich protein feedstuffs in growing pigs

	Roasted soybean	Whole soybean cake	De-shelled soybean cake	Coconut kernel cake	FM 55% CP	FM 60% CP	FM 65% CP	M&B meal 45% CP	M&B meal 50% CP
CP	0.87	0.88	0.89	0.77	0.84	0.93	0.90	0.86	0.86
Arg	0.89	0.95	0.90	0.78	0,88	0.90	0.91	0.88	0.90
Cys	0.88	0.91	0.92	0.75	0,85	0.89	0.93	0.72	0.73
His	0.90	0.94	0.93	0.73	0,84	0.94	0.90	0.88	0.89
Iso	0.90	0.93	0.93	0.76	0,87	0.94	0.92	0.95	0.96
Leu	0.89	0.91	0.93	0.64	0,89	0.91	0.91	0.89	0.86
Lys	0.89	0.93	0.94	0.70	0,92	0.91	0.93	0.87	0.90
Met	0.95	0.90	0.93	0.83	0,94	0.94	0.90	0.74	0.87
Phe	0.92	0.96	0.94	0.75	0,90	0.94	0.95	0.92	0.90
Thr	0.92	0.90	0.93	0.82	0,91	0.87	0.88	0.83	0.84
Try	0.85	0.91	0.92	0.81	0,87	0.93	0.92	0.94	0.87
Tyr	0.96	0.94	0.94	0.69	0.88	0.92	0.91	0.83	0.86
Val	0.92	0.90	0.89	0.81	0,94	0.93	0.95	0.84	0.88

Source: Dao Thi Phuong and et al. (2013)

Table 3.19. Ileal apparent digestibility coefficients of amino acids in LW x MC growing pigs (Nguyen Thi Hoa Ly et al. 2007)

	ECL	DCL	ESPV	DSPV	Mix-D	Mix-E	SEM	P
<i>Ileal</i>								
DM	0.70 ^{ab}	0.69 ^b	0.73 ^{ac}	0.70 ^{ab}	0.69 ^b	0.72 ^{ab}	0.01	0.026
OM	0.74	0.73	0.75	0.74	0.74	0.76	0.009	0.304
CP	0.47 ^{ab}	0.44 ^a	0.49 ^b	0.45 ^{ab}	0.46 ^{ab}	0.49 ^b	0.012	0.025
NDF	0.26 ^{ab}	0.22 ^a	0.28 ^b	0.22 ^a	0.28 ^b	0.31 ^b	0.014	0.001
<i>EAA</i>								
Arginine	0.53 ^{ab}	0.52 ^a	0.63 ^b	0.57 ^{ab}	0.57 ^{ab}	0.57 ^{ab}	0.022	0.033
Histidine	0.69 ^{ab}	0.69 ^a	0.70 ^{ab}	0.68 ^a	0.73 ^{ab}	0.75 ^b	0.013	0.008
Isoleucine	0.65 ^a	0.65 ^a	0.76 ^b	0.76 ^b	0.75 ^{ab}	0.76 ^b	0.024	0.004
Leucine	0.68 ^a	0.65 ^a	0.79 ^b	0.76 ^b	0.76 ^b	0.76 ^b	0.014	0.001
Lysine	0.70 ^a	0.68 ^a	0.72 ^{ab}	0.67 ^a	0.69 ^a	0.79 ^b	0.022	0.010
Methionine	0.71	0.72	0.74	0.70	0.72	0.72	0.010	0.171
Phenylalanine	0.58 ^{ac}	0.61 ^a	0.74 ^b	0.65 ^{ab}	0.67 ^a	0.69 ^{ab}	0.022	0.001
Threonine	0.66 ^a	0.63 ^a	0.75 ^b	0.71 ^b	0.72 ^b	0.75 ^b	0.017	0.001
Tyrosine	0.74 ^a	0.76 ^a	0.88 ^b	0.65 ^c	0.83 ^b	0.84 ^b	0.018	0.001
Valine	0.59 ^a	0.59 ^a	0.67 ^{ab}	0.68 ^b	0.64 ^a	0.68 ^b	0.022	0.022
<i>Non-EAA</i>								
Alanine	0.72 ^{ab}	0.68 ^a	0.81 ^{bc}	0.76 ^b	0.76 ^b	0.78 ^b	0.014	0.001
Aspartic acid	0.67 ^a	0.7 ^a	0.68 ^a	0.79 ^b	0.79 ^b	0.77 ^b	0.014	0.001
Glutamic acid	0.63	0.66	0.66	0.57	0.60	0.67	0.029	0.111
Glycine	0.55	0.51	0.63	0.57	0.53	0.61	0.030	0.062
Proline	0.54	0.53	0.60	0.54	0.54	0.63	0.022	0.031
Serine	0.64	0.63	0.68	0.69	0.74	0.67	0.028	0.119

^{abc} Mean values within rows without a common letter are different at $P < 0.05$

DCL: dried cassava leaves, ECL: ensiled cassava leaves, DSPV: dried sweet potato vines and ESPV: ensiled sweet potato vines; 50: 50 (on DM basis) mixture of cassava leaves and sweet potato vines in dried (Mix – D) or ensiled form (Mix –E)

Table 3.20. Mean values for feed intake and ileal apparent and total tract digestibility of duck weed (DW), cassava leaves (CL), sweet potato vines (SPV) and stylo

	DW	CL	SPV	Stylo	SEM	Prob.
<i>Mean daily intake, g/d</i>						
Dry matter	1373	1177	1583	1422	124	0.24
Crude protein	189	157	129	120	15.4	0.068
Crude fibre	87.3	85.2	103	132	10.3	0.057
Crude protein, g/kg DM	140 ^a	133 ^a	81.8 ^b	84.2 ^b	7.9	0.003
<i>Ileal apparent digestibility, %</i>						
Organic matter	81.7	80.9	81.2	79.6	0.52	0.08
Crude protein	73.2 ^d	69 ^c	65.7 ^b	60.7 ^a	1.13	0.004
Crude protein#	70.4	66.9	68.3	63	2.3	0.08
Crude fat	59.8 ^c	55.9 ^{bc}	52.5 ^{ab}	49.5 ^a	1.73	0.01
Crude fiber	21.1	18.3	18.1	17.1	1.2	0.16
<i>Total tract apparent digestibility, %</i>						
Organic matter	87.9 ^b	88.4 ^b	84.8 ^a	83.8 ^a	0.63	0.001
Crude protein	75.7 ^c	72.8 ^c	68.7 ^b	63.6 ^a	1.1	0.004
Crude protein#	73	70.8	71.1	65.8	2.4	0.12
Crude fat	65.1 ^a	62.2 ^a	58.7 ^b	54.3 ^b	1.78	0.01
Crude fiber	49.2 ^a	50.76 ^a	46.4 ^b	43.9 ^b	1.47	0.03
<i>Proportion of total tract apparent digestibility that occurred post-ileum, %</i>						
Organic matter	7.05	8.54	4.25	5.01		
Crude protein	3.30	5.22	4.37	4.56		
Crude fat	8.14	8.54	4.25	5.01		
Crude fiber	57.1	63.9	61.0	61.0		

Corrected by covariance for differences in the crude protein content of the diets

^{a bc} Means with different superscripts within rows are different at $P < 0.05$

Source:

Part 4. Nutrient requirements

Table 4.1. Effects of energy and lysine concentration on growth performance in suckling pigs

Energy (kcal kg ⁻¹)	3200			3300			3400		
Lysine (mg kcal ⁻¹)	4.5	5.0	5.5	4.5	5.0	5.5	4.5	5.0	5.5
Daily gain (g/day)	220 ^c	243 ^a	226 ^{bc}	229 ^{bc}	249 ^a	235 ^{ab}	213 ^c	247 ^a	233 ^b
Feed intake (g/day)	248	250	231	252	278	256	259	260	285
Feed expense (VND /kg WW)	4784	4489	4779	4928	4872	4863	5363	5032	5557

Source: La Van Kinh and Vương Nam Trung (2000)

Table 4.2.Effect of replacing whey powder by lactose on growth performance of suckling pigs

Whey replacement (%)	Control	20	40	60	80	100
Daily gain (g/head/day)	215 ^a	207 ^{ab}	205 ^{ab}	200 ^{ab}	197 ^b	193 ^b
Feed intake (g/head)	285	278	280	276	292	307
Feed expense (/VND/kg WW)	6255	6236	6090	6246	6846	6613

Source: La Van Kinh and Vương Nam Trung (2000)

Table 4.3. Effects of lysine and crude protein levels on growth performance of pigs from day 1 to 28 of age

<i>Crude Protein (%)</i>	21		23	
<i>Lysine (%)</i>	1.6	1.5	1.6	1.5
Weight at 28 days (kg)	7.23	7.52	7.61	7.97
ADG (g/d)	205	215.36	218.93	231.07
FCR 0-21 days	3.18	2.53	2.63	2.52
FCR 21-28 days	0.85	0.90	0.93	0.76

Source: Ton That Sơn et al. (2010)

Table 4.4.Effect of protein and lysine ratios on performance of weaned piglets

Stage 1 (CP% - lysine%)	22-1.5	24-1.5	22-1.65	24-1.65
Stage 2 (CP% - lysine%)	20-1.35	20-1.5	22-1.35	22-1.35
Daily gain 28-56 days (g/d)	472	467	426	433
FCR 28-56 days	1.44	1.50	1.55	1.53
Feed costed (VND kg ⁻¹ LW)	7.512	7.947	8.111	8.100

Source: La Van Kinh and Vương Nam Trung (2001)

Table 4.5. Effects of DE density and lysine concentration in diets on growth performance of weaned pigs

MJ DE kg ⁻¹	15			14			13		
Lysine (% as DM)	1.0	0.9	0.8	1.0	0.9	0.8	1.0	0.9	0.8
Daily gain (g/d)	539 ^b	546 ^b	503 ^a	480 ^a	522 ^b	470 ^a	481 ^a	438 ^a	440 ^a
Feed intake (g/d)	835	826	830	813	821	839	821	823	826
FCR	1.55	1.51	1.65	1.69	1.58	1.79	1.71	1.88	1.90
Feed expenditure (VND kg ⁻¹ LW)	5673	5370	5631	5732	5193	3631	5766	6095	5898

Source: Tran Quoc Viet and Le Minh Lich (2001)

Table 4.6. Effects of ME density and lysine concentration on growth performance of weaned pigs

kcal ME kg ⁻¹	3100			3200		
Lysine (% as DM)	1.1	1.3	1.5	1.1	1.3	1.5
7-14 kg LW						
Feed intake (g/d)	619	649	639	618	668	681
Daily gain (g/d)	260 ^a	276 ^a	272 ^a	270 ^a	321 ^b	325 ^b
FCR	2.38	2.35	2.35	2.29	2.08	2.05
Feed expenditure (VND)	9,020	9,089	9,470	9,000	8,424	8,549
14-22 kg LW						
Feed intake (g/d)	778	791	789	778	790	797
Daily gain (g/d)	310 ^a	327 ^{ab}	323 ^a	315 ^a	363 ^c	359 ^{bc}
FCR	2.51	2.42	2.44	2.47	2.18	2.22
Feed cost (VND)	9,513	9,462	9,833	9,707	8,829	9,257

Source: Nguyen Thi Luong Hong and Bui Quang Tuan (2001)

Table 4.7. Effects of ME density and lysine concentration on growth performance of weaned pigs

kcal ME kg ⁻¹	3000			3100		
Lysine (% as DM)	0.9	1.1	1.3	0.9	1.1	1.3
5-10 kg LW						
Feed intake (g/d)	500	510	500	500	530	521
Daily gain (g/d)	152	159	154	153	191	183
FCR	3.29	3.20	3.28	3.27	2.77	2.85
Feed costed (VND)	10,561	10,656	11,316	10,726	9,418	10,032
14-22 kg LW						
Feed intake (g/d)	773	783	777	767	780	777
Daily gain (g/d)	210	222	218	212	248	242
FCR	3.67	3.53	3.56	3.61	3.15	3.20
Feed costed (VND)	11,781	11,755	12,282	11,841	10,710	11,264

Source: Nguyen Thi Luong Hong and Bui Quang Tuan (2001)

Table 4.8. Effects of ME density, and lysine and ME ratio on weaned pigs performance

	ME (MJ/kg)			Lysine :ME (g/MJME)		
	13	14	15	8	9	10
ADG	453.0	490.2	529.0	470.8	501.5	499.8
FCR	1.81	1.68	1.57	1.76	1.64	1.65

Source: Tran Quoc Viet et al. (2003)

Table 4.9. Effects of protein levels on LW and FCR of weaned piglets

	Crude Protein level (%)		
	18	19	20
LW at 56 dayold (kg)	15.33	15.39	15.78
FCR	1.49	1.48	1.47

Source: Tran Dinh Phung et al. (2004)

Table 4.10. Effects of DE density and lysine concentration on growth performance of piglets of 5-17 kg

<i>MJ DE kg⁻¹</i>	13			13.5		
<i>Lysine (% as DM)</i>	0.90	1.10	1.30	0.90	1.10	1.30
ADG (5-10 kg)	152	159	154	153	191	183
ADG (10-17 kg)	210	222	218	212	248	242
FCR (5-10 kg)	3.29	3.20	3.28	3.27	2.77	2.85
FCR (5-17 kg)	3.67	3.53	3.56	3.61	3.15	3.20

Source: Dang The Nhung et al. (2006)

Table 4.11. Effects of ME density and lysine concentration on growth performance of growing pigs

Energy (MJME)	12.5			13.5			14.5		
Lysine (%DM)	0.55	0.65	0.75	0.55	0.65	0.75	0.55	0.65	0.75
Feed intake (kg/d)	1.75 ^b	1.78 ^b	1.79 ^b	1.86 ^b	2.26 ^a	1.76 ^b	1.81 ^b	2.12 ^a	2.11 ^a
ADG (g/d)	524 ^a	524 ^a	569 ^b	568 ^{ab}	645 ^c	635 ^c	575 ^{ab}	639 ^c	684 ^d
FCR	3.35 ^b	3.21 ^b	3.18 ^{ab}	3.28 ^a	2.78 ^a	2.77 ^a	3.18 ^{ab}	2.90 ^a	2.75 ^a
Backfat thickness (mm)	13.41 ^{ab}	12.56 ^{ab}	12.09 ^a	12.68 ^{ab}	11.79 ^b	12.87 ^{ab}	15.23 ^c	14.56 ^{bc}	13.79 ^{bc}

Source: Do Van Quang (2001)

Table 4.12. Effects of ME density and lysine concentration on growth performance of growing pigs

kcal ME kg ⁻¹	3250			3100		
Lysine (% as DM)	1.15	1.05	0.95	1.15	1.05	0.95
Daily gain (g/d)	582.6 ^a	625.6 ^a	614.9 ^a	603.3 ^a	624.8 ^a	617.4 ^a
Feed intake (kg/d)	1.86	1.94	1.93	1.94	2.01	2.00
FCR	3.19	3.10	3.14	3.22	3.22	3.24
Feed expense (1,000VND)	8.62	7.92	7.77	8.75	7.91	7.63

Source: Tran Quoc Viet (2003)

Table 4.13. Effects of ME density and lysine concentration on growth performance of growing pigs

kcal ME kg ⁻¹	3250			3000		
Lysine (% as DM)	1.1	0.95	0.75	1.1	0.95	0.75
ADG (g/d)	615.8	581.5	532.3	572.1	541.8	527.1
FCR	3.26	3.25	3.66	3.50	3.71	3.80
Profit (1,000 VND/head)	258	225	130	233	196	174

Source: Hoang Nghia Duyet (2003)

Table 4.14. Effects of protein levels and lysine levels in diets on FCR of growing pigs

	High protein		Medium protein		Low protein	
	LC	LT	LC	LT	LC	LT
LW at 90 exp. days (kg)	90.3	88.8	85.1	88.1	86.5	81.9
FCR	2.35	2.40	2.51	2.40	2.45	2.60

LC: high lysine; LT = low lysine; Source: Bui Thi Thom et al. (2010)

Table 4.15. Effect of energy levels and seasons on growth performances of two crossbreds of growing pigs

	4 bloody crossed		2 bloody crossed	
	High ME	Low ME	High ME	Low ME
	Summer			
ADG (g/d)	820	832	767	769
Backfat thickness (cm)	0.91	0.93	1.08	0.97
FCR	2.17	2.04	2.34	2.19
	Winter			
ADG (g/d)	913	906	830	826
Backfat thickness (cm)	1.01 ^b	0.97 ^a	1.14	1.11
FCR	2.57	2.48	2.96	2.77

Source:

Table 4.16. Effect of digestible lysine levels on growth performance and backfat thickness of 4-blooded crossbred pigs in summer and winter

	Digestible lysine and ME ratio (gMcal ⁻¹)					
	2.35	2.65	2.95	3.25	3.55	3.85
Summer						
ADG (g/d)	756 ^a	799 ^b	824 ^{bc}	843 ^{cd}	874 ^e	860 ^{de}
Backfat thickness (cm)	1.01	0.98	0.93	0.89	0.86	0.86
FCR	2.75 ^a	2.65 ^{ab}	2.55 ^{bc}	2.49 ^c	2.42 ^c	2.44 ^c
Winter						
ADG (g/d)	852 ^a	870 ^{ab}	915 ^{bc}	942 ^d	941 ^d	938 ^d
Backfat thickness (cm)	1.11 ^a	1.12 ^a	0.98 ^b	0.94 ^b	0.90 ^b	0.90 ^b
FCR	2.69 ^a	2.65 ^a	2.50 ^b	2.43 ^b	2.43 ^b	2.42 ^b

Source: Ninh Thi Len et al. (2011)

Table 4.17.Effect of digestible lysine level on growth performance and backfat thickness of 2- blood crossbred pigs in summer and winter seasons

	Digestible lysine and ME ratio (gMcal ⁻¹)					
	2.35	2.65	2.95	3.25	3.55	3.85
Summer						
ADG (g/d)	709 ^a	728 ^a	773 ^c	809 ^b	790 ^b	799 ^{bc}
Backfat thickness (cm)	1.12	1.08	1.00	1.06	0.99	0.90
FCR	3.17 ^a	3.10 ^a	2.97 ^b	2.81 ^c	2.82 ^c	2.86 ^c
Winter						
ADG (g/d)	792 ^a	802 ^a	821 ^{ab}	855 ^b	852 ^b	848 ^b
Backfat thickness (cm)	1.22 ^a	1.21 ^a	1.10 ^b	1.12 ^b	1.06 ^c	1.04 ^c
FCR	2.98 ^a	2.92 ^a	2.84 ^b	2.80 ^b	2.82 ^b	2.82 ^b

Source: Ninh Thi Len et al. (2011)

Table 4.18. Effects of ME density and CP level on reproductive performance of pregnant sows

ME density (kcal kg)	3000			3100			3200		
CP (%)	11	12	13	11	12	13	11	12	13
BW gain (kg)	24.1 ^c	25.6 ^b	26.4 ^b	28.6 ^{ab}	28.7 ^a	28.6 ^a	30.2 ^a	30.5 ^a	30.4 ^a
Fetal W gain (kg)	24.4 ^c	25.2 ^{bc}	26.2 ^{bc}	26.3 ^{bc}	27.2 ^b	28.9 ^a	26.5 ^{bc}	29.0 ^{ab}	27.8 ^{ab}
N ⁰ piglet /litter	10.0	10.2	10.2	10.0	10.4	11.2	10.2	11.0	10.4
LW of weaned piglet (kg)	1.38 ^c	1.46 ^{bc}	1.54 ^{ab}	1.55 ^{ab}	1.57 ^{ab}	1.61 ^{ab}	1.53 ^{ab}	1.65 ^a	1.63 ^a
Feed cost(VND/piglet)	51399	53981	53099	53936	51654	48466	55329	52662	56489
LW lost of sow(%)	9.91	9.43	10.27	10.48	10.76	10.81	11.36	11.73	11.53

Source: La Van Kinh and Nguyen Van Phu (2002)

Table 4.19. Effects of daily feed intake (kg/d; DFI) and body score of pregnant sows on reproductive performance

<i>Body score</i>	<i>Fat</i>				<i>Thin</i>			
	<i>DFI</i>	<i>DFI</i>	<i>DFI</i>	<i>DFI</i>	<i>DFI</i>	<i>DFI</i>	<i>DFI</i>	<i>DFI</i>
<i>DFI period 1</i>	1.6	1.8	2.0	2.2	1.8	2.0	2.2	2.4
<i>DFI period 2</i>	2.4	2.7	3.0	3.3	2.7	3.0	3.3	3.6
BW gain of sow (kg)	23.5	24.4	25.6	26.1	26.1	26.8	28.4	29.7
Fetal W gain (kg)	24.6	24.8	25.4	25.7	25.9	27.1	27.2	27.4
N ⁰ piglet /litter	10.2	10.6	10.0	10.0	10.2	10.0	10.4	10.0
LW at born (kg/head)	1.56 ^b	1.67 ^a	1.58 ^b	1.56 ^b	1.55	1.58	1.66	1.58
Mortality (24h at birth)	0.8	-	0.4	0.4	0.2	0.2	-	-

Source: La Van Kinh and Nguyen Van Phu (2002)

Table 4.20. Effects of daily ME (kcal) and CP (g) intake on reproductive performance of pregnant sows at different parities

Sows at the 1st- 2nd litters						
<i>ME intake at period 1</i>	3540	4130	4720	3540	4130	4720
<i>Protein intake at period 1</i>	144	168	192	168	196	224
N ⁰ piglet /litter	12.7	12.3	12.3	12.0	11.3	12.0
LW at born (kg/head)	0.60	0.63	0.71	0.68	0.67	0.73
FCR born to weaned	3.41 ^a	3.82 ^a	4.51 ^b	3.74 ^a	3.95 ^a	4.43 ^b
Feed costs (VND /weaned piglet)	8.753	9.806	11.577	9.806	10.357	11.615
Sows at the 3rd to 6th litters						
<i>ME intake at period 1</i>	3245	3835	4425	3245	3835	4425
<i>Protein intake at period 1</i>	132	156	180	154	182	210
N ⁰ piglet /litter	11.3	11.8	11.8	12.5	11.5	13.0
LW at born (kg/head)	0.70	0.68	0.65	0.70	0.68	0.70
FCR born to wean (kg)	3.46	3.81	4.35	3.29	3.77	3.96
Feed costs (VND /weaned piglet)	8.882	9.780	11.166	8.626	9.885	10.383

Source: Tran Quoc Viet and Ninh Thi Len (2003)

Table 4.21. Effect of crude protein and crude fibre levels on performance of weaned piglets

	Level of CP			Level of CF		P value		
	18%	16%	14%	8%	6%	CP	CF	CPx CF
Daily gain (g)	490	474	438	468	467	0,17	0,96	0,94
Daily feed intake (kg)	1.04	1.03	1.08	1.04	1.07	0.52	0.44	0.56
FCR	2.15	2.21	2.52	2.27	2.31	0.17	0.81	0.72

Source: Vu Thi Khanh Nguyen et al.(2012)

Table 4.22. Effects of CP and lysine levels in pregnant sow's diets on reproductive performance

<i>CP (%)</i>	<i>15</i>	<i>16</i>	<i>17</i>	<i>18</i>	<i>19</i>
<i>Lysine (%)</i>	<i>0.80</i>	<i>0.85</i>	<i>0.90</i>	<i>0.95</i>	<i>1.0</i>
N of piglet at born alive (head)	10.10	10.15	10.15	10.10	10.20
LW at born(kg/head)	1.47	1.48	1.46	1.46	1.46
No of weaned piglet	9.20	9.30	9.40	9.35	9.15
LW at weaning (kg)	6.60 ^b	6.68 ^b	6.83 ^b	7.23 ^a	7.24 ^a
Mortality (%)	8.33	7.59	6.69	6.84	9.21
BW lost of sow (%)	8.05	7.41	6.69	6.53	6.17
Feed costs (VND/kg LW piglet)	6.545 ^a	6.402 ^a	6.160 ^{ab}	5.811 ^c	6.018 ^{bc}

Source: La Van Kinh and Pham Tat Thang (2003)

Table 4.23. Effects of CP level and daily feed intake of pregnant sows on reproductive performance

<i>ME (kcalkg⁻¹)</i>	3000	3000	3000	3000	3000	3000	3000	3000
<i>Protein (%)</i>	14	14	14	14	16	16	16	16
<i>Daily feed intake (kg)</i>	2.0	2.5	3.0	<i>Ad-lib</i>	2.0	2.5	3.0	<i>Ad-lib</i>
N of piglet at born alive (head)	11.3	11.7	11.8	11.0	11.4	11.4	11.5	11.8
LW at born(kg/head)	0.56	0.61	0.65	0.58	0.63	0.59	0.59	0.55
No of weaned piglet	10.5	11.2	10.9	11.3	11.4	11.1	11.5	11.2
LW at weaning (kg)	5.8	6.1	6.2	6.3	6.3	5.9	5.9	5.8
Feed costs (VND/ weaned piglet)	11009	10793	11632	12470	9953	11540	12694	14454

Source: Tran Quoc Viet and Ninh Thi Len (2003)

Table 4.24.Effect of DE and digestible lysine on growth performance of growing pigs (90 – 180 days old)

Parameters	T1 ^(*) (3400-0.75)	T 2 (3060-0.68)	T 3 (2720-0.60)	SEM	P
Initial LW(kg)	37.7	36.6	37.2	1.2	0.83
Final LW (kg)	103.5 ^a	97.1 ^b	94.6 ^b	1.4	0.01
Daily gain (g)	731 ^a	672 ^b	637 ^b	16	0.01
Total feed consumed (kg/pig)	184	179	174	5	0.34
FCR	2.81	2.97	3.05	0.09	0.16
Backfat thickness at beginning (mm)	6.45	6.55	6.58	0.25	0.96
Backfat thickness at finishing (mm)	12.58 ^a	11.54 ^{ab}	11.00 ^b	0.31	0.01

^(*)3400-0,75: 3400 kcal DE /kg; 0,75 % digestible lysine

Source: Vuong Nam Trung, 2011

Table 4.25.Effect of DE and digestible lysine ratio on sperm quality of boars

Parameters	T1(*) (3400-0.75)	T2 (3060-0.68)	T3 (2720-0.60)	SEM	P
Volume V (ml)	142.76	139.78	136.65	7.16	0.83
Activity A (%)	0.75	0.76	0.74	0.01	0.58
Concentration C (million /ml)	267.42	259.54	242.69	7.38	0.07
VAC (billion)	30.57	29.02	26.72	1.59	0.24
K (%)	13.25 ^b	14.08 ^{ab}	15.70 ^a	0.37	0.01

Source: Vuong Nam Trung, 2011

Part 5. Local and available feed resources for pigs

Table 5.1. Mean values for weight gain, feed intake and conversion, for pigs fed a diet of rice by-products as compared with ensiled cassava root and protein supplement plus fresh duckweed (12 pigs per treatment)

	Control	ECR	SE/Probability
Live weight (kg)			
Initial	26.3	25.3	
Final	92.3	86.6	
Daily gain	0.594	0.562	±0.012/0.08
Feed intake (kg/d)			
ECR	0	2.65	
Duckweed	0	1.77	
Supplement	0	0.385	
Concentrate	1.92	0	
Total DM	1.67	1.54	
Feed DM/ADG	2.78	2.76	±0.05/0.83
Back fat depth (cm)	2.95	2.09	±0.17/0.002

Source: Bui Hong Van et al. (1997)

Table 5.2.Effect of water spinach levels in diets for Ba Xuyen x LW sows on reproductive performance

<i>Litter weight (kg)</i>						
At birth	8.23	6.76	±0.28/0.004	7.47	7.53	±0.28/0.89
21 days	26	20.9	±1.52/0.04	24.5	22.43	±1.53/0.38
42 days	56.8	43.9	±3.07/0.01	52.1	48.7	±3.08/0.47
<i>Mean per piglet (kg)</i>						
At birth	0.936	0.938	±0.02/0.96	0.942	0.932	±0.02/0.73
21 days	3.46	3.54	±0.17/0.76	3.54	3.46	±0.17/0.53
42 days	7.55	7.58	±0.29/0.94	7.66	7.48	±0.29/0.68
<i>Daily gain in weight (kg)</i>						
0-21 days	0.112	0.114	±0.007/0.80	0.116	0.109	±0.007/0.53
0-42 days	0.153	0.153	±0.006/0.98	0.156	0.151	±0.006/0.60
<i>Total feed DM/kg piglet #</i>						
At birth	17.1	20.2	±0.72/0.01	18.5	18.7	±0.72/0.80
21days	6.28	7.42	±0.37/0.048	6.55	7.12	±0.27/0.36
42 days	4.49	5.1	±0.17/0.028	4.72	4.87	±0.17/0.56

#Dry matter intake (and litter) up to birth, 21 or 42 days (weaning) of age of litter

Source: Le Thi Men et al. (1997)

Table 5.3. Effect of protein (groundnut cake and fish meal) supplements in traditional diet and locations on growth of pigs

Item	Protein supplement		P	Village		P	SE
	No	Yes		XL	BH		
Final LW, kg	45.9	68.2	0.001	57.9	56.2	0.49	1.75
ADG, g	204	375	0.001	292	290	0.84	9.5

Source: Nguyen Thi Loc et al. (1997)

Table 5.4. Effect of including chopped water spinach (CWS) in the diet on the reproductive performance of BaXuyen and Large White sows

	Control	30% CWS	SE	P
Litter size				
Total at birth	9.2	10.2	0.408	0.122
At 35 days	8.5	9.5	0.312	0.053
Live weight per piglet (kg)				
At birth	1.2	1.3	0.059	0.199
At 35 days	7.5	7.5	0.278	0.935
Litter weight (kg)				
At birth	10.6	12.9	0.674	0.037
At 35 days	68.4	76.1	1.873	0.020
Piglet mortality (%)	6.85	6.15	3.240	0.881
Sow weight changes				
Pregnancy gross gain (%)	19.3	21.9	0.672	0.025
Pregnancy net gain (%)	11.9	11.6	1.466	0.760
Weight loss in lactation (%)	10.3	12.0	0.536	0.056

Source: Le Thi Men et al. (2000)

Table 5.5. Effect of replacing fermented fish with ensiled groundnut vines (EGV) on the growth performance of fattening pigs

	Traditional diet	EGV50	SE
No of pigs	20	20	
Days in experiment	150	150	
Initial LW (kg)	15.8	16.1	0.17
Final LW (kg)	77.0	79.1	0.78
Daily gain (g/day)	408	421	5.00
FCR, DM kg/kg LW	3.98	3.90	0.04
Feed cost/ kg gain (VND)	10138	7950	

Source: Vo Thi Kim Thanh et al. (2000)

Table 5.6. The effects of duck weed, *Para* grass and water spinach supplementation on nutrient digestibility and nitrogen retention in growing pigs

Item	Treatment				P	SE
	Control	Duck weed	Para grass	Water spinach		
Digestibility,%						
DM	697	726	711	738	0,29	14,3
CP	766	768	774	780	0,96	23,3
EE	702	722	674	723	0,48	23,9
NDF	475	502	550	528	0,18	35,4
ADF	385	335	353	329	0,44	16,7
N balance, g /day						
N intake	53,3 ^c	56,7 ^b	54,3 ^c	60,0 ^a	0,01	0,46
N retention	32,8 ^{bc}	37,5 ^b	31,6 ^c	43,3 ^a	0,01	1,09

Source: Nguyen Nhut Xuan Dung (2005)

Table 5.7. Effect of treatment on final live weight (LW), weight gain (WG) and daily gain (ADG) of the pigs

Treatment	WG, kg/pig	ADG, g	FCR, kg/kg	Back-fat thickness, mm
Concentrate	37.0	755	3.50	10.1
Conc. + WH cooked stems	40.5	826	3.64	10.6
Conc. + WH fresh stem	42.0	857	2.99	10.1
Conc. + WH cooked leaves	35.3	719	3.37	11.4
Conc. + WH fresh leaves	39.5	806	3.04	11.0
<i>P-value</i>	<i>>0.05</i>	<i>>0.05</i>	<i>>0.05</i>	<i>>0.05</i>

WH: water hyacinth; Source: Nguyen Ba Trung (2006)

Table 5.8. Nutrient digestibility (%) of the diets with whole water hyacinth stem and chopped water hyacinth

<i>Item</i>	<i>Treatment</i>		water ^{SE}	<i>P</i>
	Whole water hyacinth	Chopped hyacinth		
DM	60.6	68.4	0.170	<0.01
OM	71.5	76.0	0.296	<0.01
CP	69.9	70.7	0.338	0.25
NFE	85.6	91.3	0.338	<0.01
CF	70.8	71.6	0.178	<0.01

Source: Le Thi Men (2006)

Table 5.9. Effect of low (LSP) or high (HSP) dietary content of sweet potato leaves on intake of leaves, live weight change (means \pm SE) and feed conversion of Mong Cai gilts

	LSP	HSP	P
Weight gain in pregnancy, %	23.8 \pm 8.3	16.6 \pm 5.4	0.03
Litter size at birth	13.9 \pm 2.2	13.1 \pm 1.50	0.35
Time for farrowing, minutes	74.6 \pm 21.1	80.2 \pm 25.7	0.60
Piglet birth weight, kg	0.67 \pm 0.09	0.63 \pm 0.06	0.32
Litter size at weaning	8.7 \pm .95	8.7 \pm 1.57	1.0
Piglet weight at weaning, kg	6.9 \pm 0.83	6.5 \pm 0.54	0.17
Weight loss in lactation, %	14.1 \pm 3.0	17.6 \pm 2.02	0.007
Back fat at farrowing, mm	26.0 \pm 2.5	21.2 \pm 0.92	0.001
Return to oestrus, days	7.9 \pm 1.5	10.5 \pm 2.12	0.005

Source: Hoang Nghia Duyet (2003)

Table 5.10. Effect of *Alocasia macrorrhiza* root meal processed by different methods on feed intake and growth performance of growing pigs (20 - 50 kg LW)

	DR	RW	NH	AA	CTRL
Live weight (kg)					
Initial	20.7	20.1	20.2	20.5	20.3
Final	49.6	50.7	52.2	51.6	52.3
Feed DM intake (kg)					
Daily feed intake (g)	1053 ^a	1114 ^{ab}	1253 ^b	1191 ^b	1264 ^b
ADG (g)	413 ^a	437 ^{ab}	457 ^b	441 ^b	458 ^b
FCR (kg feed / kg gain)	4.2 ^a	3.6 ^{ab}	3.4 ^b	3.5 ^b	3.4 ^b

*abc*Mean values within rows without common superscript are different at $p < 0.05$. DR dried roots (not soaked); RW dried roots, after soaking in rice washing water; NH dried roots after soaking in sodium hydroxide; AA dried roots, after soaking in acetic acid.

Source: Pham Sy Tiep et al. (2005)

Table 5.11. Mean values for feed intake, live weight at slaughter, feed conversion rate and carcass lean percentage in pigs fed Taro leaves and stems in fresh form (FL), cooked (CL) or ensiled (SL)

	Treatments			Probability
	FL	CL	SL	
Slaughter live weight, kg	65.3 ^c	72.2 ^b	77.4 ^a	0.01
Live weight gain, g/day	443 ^c	498 ^b	541 ^a	0.01
DM intake, kg/day	1.52 ^c	1.58 ^b	1.66 ^a	0.04
DM feed conversion	3.43 ^a	3.18 ^b	3.07 ^c	0.03
Lean meat percentage (%)	46.5 ^b	48.5 ^a	46.1 ^b	0.005

a,b,c. Means with different superscripts within rows are different at $P < 0.05$

Source: Ngo Huu Toan and Preston (2007)

Table 5.12. Mean values for content of crude protein (CP) and calcium oxalate in leaves of 3 varieties of *Alocasia macrorrhiza* ensiled with molasses or rice bran (samples taken at days 0 and 21)

	4% rice bran				4% molasses			
	CP (% in DM)		Calcium oxalate (mg/kg)		CP (% in DM)		Calcium oxalate (mg/kg)	
	day0	day21	day0	day21	day0	day21	day0	day21
WiL	29.5	28.3	69.8	21.6 ^a	29.3	26.8	69.5	21.8 ^a
WaL	27.8	27.2	67.1	15.4 ^b	27.7	26.7	67.3	15.2 ^b
WhL	26.3	25.8	65.7	14.6 ^b	26.5	25.4	66.1	14.3 ^b

^{ab} Values within columns with differing superscript letters are different at $P < 0.05$

Source: Pham Sy Tiep et al. (2007)

Table 5.13. Effect of *Alocasia macrorrhiza* leaves (WaL) on the reproductive performance of Mong Cai sows

	Control	WaL
Daily feed intake (kg DM)	2.15	2.23
Piglets born alive/litter	10.3	10.3
Piglets at weaning at 35 days/litter	9.61	9.53
Weight of piglets born alive/litter (kg)	8.37	8.31
Weight of piglets at 35 days weaning /litter (kg)	40.4	40.1
Loss in weight of sows (kg)	16.5	16.7
Feed costs for production of 1 kg piglets at 60 days (VND)	23276 ^a	21143 ^b

^{ab} Values within rows with different superscript letters are different at $P < 0.0$

Source: Pham Sy Tiep et al. (2007)

Table 5.14. Effect of ensiled *Alocasia macrorrhiza* leaves on the performance of growing pigs (trial lasted 65 days)

	EAL0	EAL10	EAL20	EAL30
Final weight, kg	47.8 ^a	46.1 ^{ab}	45.7 ^{ab}	43.3 ^b
Daily live weight gain, g	500 ^a	472 ^{ab}	468 ^b	429 ^c
Feed intake, kg/day	1.46 ^a	1.48 ^a	1.45 ^a	1.38 ^b
FCR, kg/kg gain	2.6	2.7	2.8	2.9
Feed cost/kg gain, VND	6138 ^a	5786 ^{ab}	5188 ^b	5011 ^b

^{abc} Values within rows with different superscript letters differ at $P < 0.05$

Source: Pham Sy Tiep et al. (2007)

Table 5.15. Effect of molasses (M) and Hammer-milling (H), and ensiling time, on the crude protein (% in DM) of taro leaves (T) and taro leaves plus stems (TS)

	Ensiling time, days					SEM	P
	0	7	14	30	60		
T	27.84 ^a	27.87 ^a	26.96 ^b	26.43 ^{bc}	26.01 ^c	0.170	0.001
HT	27.84 ^a	27.66 ^a	26.10 ^b	26.39 ^b	25.50 ^b	0.189	0.001
TM	26.86 ^a	26.86 ^a	25.63 ^b	25.12 ^c	24.87 ^d	0.035	0.001
TS	17.22 ^a	17.18 ^a	16.97 ^a	16.54 ^b	15.98 ^c	0.106	0.001
HTS	17.07 ^a	17.07 ^a	16.65 ^{ab}	16.27 ^b	15.41 ^c	0.112	0.001
TSM	16.48 ^a	16.42 ^{ab}	16.05 ^b	15.74 ^c	14.98 ^d	0.084	0.001

SEM: standard error of mean; P: probability
^{abcde}: Mean values within rows without common letter are different at $p < 0.05$

T: Taro leaves + 0.5 % NaCl, HT: Same as T but processed by hammer mill after chopping + 0.5 % NaCl, TM: Taro leaves + 4 % molasses + 0.5 % NaCl, TLS: Taro leaves + stem + 0.5 % NaCl, HTS: Same as TLS but processed by hammer mill after chopping + 0.5 % NaCl, TSM: Taro leaves + stem + 4 % molasses + 0.5 % NaCl

Source: Nguyen Thi Hoa Ly et al. (2010)

Table 5.16. Mean values (\pm SE) for reproductive performance of MC sows fed diets with 50 or 100% of soybean meal replaced by Taro leaf and stem silage

Item	ELS 50	ELS 100	P
At birth			
Litter size	12.60 \pm 0.25	11.80 \pm 0.58	0.24
Litter weight, kg	8.82 \pm 0.14	8.53 \pm 0.43	0.49
Average weight, kg	0.70 \pm 0.006	0.72 \pm 0.009	0.018
At 21 days			
Litter weight, kg	31.00 \pm 1.27	36.76 \pm 1.88	0.035
at weaning			
Litter size	11.00 \pm 0.63	11.00 \pm 0.45	1.0
Litter weight	79.44 \pm 2.24	89.50 \pm 2.92	0.026
Average weight	7.27 \pm 0.17	8.15 \pm 0.07	0.007
Percentage loss in lactation	18.7 \pm 1.24	15.5 \pm 0.42	0.036

Source:

Table 5.17. Mean values for growing and harvesting three species of Giant Taro at household level

Items	Unit	Bac Ha(<i>Alocasia odora</i>)	Cham(<i>Alocasia esculenta</i>)	Quang(<i>Xanthosoma violaceum</i>)	Prob.
Households	N	48	37	19	
Area planted	m ²	88.3	63.1	81.9	0.05
First harvest after planting	days	51.8 ^a	48.2 ^b	55.9 ^c	0.01
Time for re-harvesting	days	5.9	5.8	5.9	0.77
Harvest duration	days	141	143	145	0.11
Leaves+stems cut per harvest	number	1.58	1.78	1.63	0.15
Leaves+stems in 1 kg	number	13	15	15	
Stems+leaves harvested	kg/plant	0.34	0.32	0.33	0.27
Root yield/ m ²	kg	0.35 ^a	0.28 ^b	0.37 ^a	0.01
Stem+leave yield / household	kg	1577 ^a	1434 ^b	1292 ^c	0.01
Root yield/ household	kg	178 ^a	103 ^b	172 ^a	0.01

a,b,c difference between treatments at P <0.05

Source: Hoang Nghia Duyet (2010)

Table 5.18. Mean values of lactation traits of Mong Cai sows fed protein supplements of soybean meal (SBM), boiled Giant taro leaves and stems (GT) or a mixture of both (SBM-GT)

	SBM	SBM-GT	GT	P
Litter weight at 21 days, kg	28.3 ^a	29.8 ^a	27.0 ^b	0.02
Sow LW after farrowing, kg	98.2 ^a	89.4 ^b	89.4 ^b	0.01
Sow weight after weaning, kg	91.0 ^a	81.8 ^b	75.0 ^c	0.01
Weight lose in lactation, %	7.31 ^a	10.9 ^b	16.0 ^c	0.01
Time to re-mating, days	7.2 ^a	8.5 ^a	12.7 ^b	0.01
Cycle of reproduction, days	166 ^a	168 ^a	172 ^b	0.01
No of litters/year	2.20 ^a	2.18 ^a	2.12 ^b	0.01

^{abc} Means without common superscript are different at $P < 0.05$

Source: Hoang Nghia Duyet (2010)

Table 5.19.Effect of replacing fishmeal by a mixture of ensiled taro leaves and sweet potato vines in the gestation and lactation diets on piglet performance of Van Pa sows

	FM	T50	T100	SEM	P-value
<i>At birth</i>					
Litter size	6.33	7.33	6.50	0.674	0.505
% Mortality	5.17	9.63	5.72	4.050	0.703
Total litter weight, kg	2.59	3.05	2.98	0.263	0.430
Mean live weight, kg	0.46	0.44	0.44	0.007	0.155
<i>At 21 days</i>					
Litter size	5.50	6.00	6.17	0.399	0.487
Litter weight, kg	12.74	13.09	12.26	0.706	0.708
% Mortality	2.08	6.25	6.25	3.688	0.661
Piglet live weight, kg	2.32 ^a	2.18 ^{ab}	2.06 ^b	0.044	0.001
<i>At weaning (45 days)</i>					
Litter size at weaning	5.50	5.83	5.83	0.319	0.710
Litter weight at weaning, kg	25.33	24.51	23.28	1.400	0.590
Piglet live weight, kg	4.61 ^a	4.20 ^b	3.98 ^b	0.077	0.001
% mortality, birth to weaning	0.00	2.38	7.25	2.344	0.117

Source: Tran Thanh Hai et al. (2012)

Table 5.20. Mean values for reproductive performance of Momg Cai sows fed ensiled mixed banana pseudo-stems and taro foliage replacing rice bran

Item	<i>Ensiled banana stems/taro, % as DM replacing rice bran</i>					SEM	P
	100	75	50	25	0		
LW gain in pregnancy, kg	10.3	15.0	17.0	18.3	18.5	0.38	<0.001
LW at farrowing, kg	60.0	67.3	66.8	70.5	71.8	1.41	<0.001
LW loss during lactation, kg	23.1	19.9	17.3	15.6	15.3	0.46	<0.001
Litter size at birth	11.3	10.5	11.0	11.0	11.8	0.42	0.36
Birth weight, kg	0.545	0.608	0.648	0.660	0.667	0.0074	<0.001
LW at weaning, kg	9.50	9.75	10.0	10.5	9.75	0.24	0.09
Litter size, weaning	6.50	7.45	8.38	8.80	8.98	0.15	<0.001
Days to re-mating	12.0	10.8	7.50	7.00	6.75	0.46	<0.001
Litters/year	2.12	2.15	2.18	2.18	2.18	0.0077	<0.001
Feed DM in lactation, kg/day	2.13	2.85	3.10	3.55	3.73	0.054	<0.001

Source: Hoang Nghia Duyet (2013)

Table 5.21. Apparent digestibility of organic matter, crude protein and crude fiber, and N retention, in growing pigs fed a combination of maize and rice bran alone (RM) or supplemented with ensiled Taro foliage (leaves + stems) (TS50) with addition of rice wine by-product (TS50WB) or synthetic methionine (TS50M)

	RM	TS50	TS50WB	TS50M	SEM	P
<i>Apparent digestibility, %</i>						
OM	95.3 ^a	88.6 ^b	88.6 ^b	88.6 ^b	0.048	<0.001
CP	73.8 ^a	71.3 ^a	77.0 ^a	67.5 ^b	1.90	0.014
CF	48.1 ^a	58.3 ^{ab}	65.5 ^b	53.4 ^a	3.23	<0.001
<i>Daily N Intake, g</i>	24.0	24.7	24.8	24.6	0.407	0.53
<i>N retention</i>						
<i>g/day</i>	9.36 ^a	12.8 ^{bc}	15.4 ^c	11.7 ^{ab}	0.897	<0.001
% N intake	40.7 ^a	51.9 ^b	61.9 ^c	48.5 ^b	4.02	0.006
% N digested	53.4 ^a	72.4 ^b	80.6 ^c	68.3 ^b	4.62	0.017

^{ab} Means without common letter differ at $P < 0.05$

Source: Du Thanh Hang and Nguyen Trung Kien (2012)

Table 5.22. Mean values for daily feed intake and protein, total tract apparent digestibility and N retention for different levels of substitution of fish meal by cassava leaf silage

Treatment	ECL0	ECL50	ECL75	ECL100	SE/Prob.
Dry matter intake, g/day	1,264	1,226	1,251	1,191	42.0/0.62
Protein intake, g/day	156	148	151	127	
Protein in DM, %	12.3	12.1	12.1	10.7	
Digestibility, %					
Dry matter	90.1	89.5	87.4	89.6	0.73/0.08
Crude protein	86.6	84.9	80.1	79.6	1.30/0.001
N retention, g/day	14.2	13.8	12.0	9.91	0.74/0.001

Source: Du Thanh Hang (1998)

Table 5.23. Effect of including cassava leaf meal and water spinach in the diet on the reproductive performance of sows

	Control	CLM/ WS	SE	P
Litter size				
At birth	8.9	9.8	0.79	0.43
At weaning (49 days)	7.9	8.2	0.83	0.80
Litter weight (kg)				
At Birth	6.0	5.8	0.53	0.76
21 days	26.5	27.3	2.49	0.82
Weaning (49 days)	67.6	65.2	5.86	0.77
Weight loss lactation (kg)	11.7	13.7	0.57	0.02

Source: Lam Quang Nga et al. (2000)

Table 5.24. Effect of additives and ensiling time on crude protein (% in DM) of cassava leaf silages

	Time of ensiling, days					
	0	7	14	21	28	56
Control	29.7	29.5	29.2	29.5	27.4	23.3
M5	28.8	28.7	26.8	26.1	26.3	25.8
M10	25.9	23.9	23.5	23.9	23.3	24.1
CRM5	29.2	29.9	29.5	27.6	28.3	26.5
CRM10	26.8	24.9	24.9	24.5	24.9	24.2
RB5	29.8	29.4	28.2	27.9	27.2	27.2
RB10	27.9	26.7	26.0	25.5	25.8	25.1

Source: Nguyen Thi Loc et al. (2000)

Table 5.25. Effects of including ensiled cassava leaves in the diets of growing Mong Cai gilts on reproductive performance

Parameter	Control	ECL10*	ECL20*	SE/P
Live weight, kg				
Initial	14.2	14.1	14.9	0.39/0.32
At insemination	39.9	40.2	43.8	0.65/0.01
Live weight gain, g/day	284	293	268	7.88/0.12
Litter size				
At birth	7.00	7.75	6.67	0.74/0.54
At weaning	6.67	7.50	6.67	0.63/0.53
Piglet live weight, kg				
At birth	0.72	0.72	0.67	0.16/0.04
At weaning	7.25	7.07	6.67	0.20/0.79

* 10 and 20% of ensiled cassava leaves, respectively (DM basis)

Source: Nguyen Thi Loc et al. (2000)

Table 5.26. Mean value for feed intake, digestibility and N retention of pigs fed cassava leaves and broken rice

	Fresh cassava	Wilted cassava	SEM	Prob.
Intake, g DM/day				
Cassava leaves	58.5	75.8	5.80	0.080
Total DM	240	259	9.57	0.229
Cassava as % of total DM	23.8	28	2.01	0.198
Digestibility, %				
DM	89.1	90.9	1.75	0.50
OM	89.7	91.7	1.52	0.40
N	73.9	76.6	5.00	0.72
N Intake, g/day	4.80	5.43	0.25	0.122
N Retention, g/d	1.93	2.16	0.59	0.789

Source: Nguyen Duy Quynh Tram and Preston (2004)

Table 5.27. The chemical composition of cassava leaves analysed immediately after collection (fresh), or after washing (W), chopping and washing (CW) or chopping, washing and wilting 24 hours (CWW)

	Fresh	W	CW	CWW	SEM/P
Dry matter (%)	26.3	19.4	20.1	40.2	0.20/0.001
HCN (mg/kg DM)	1427	1202	1124	252	110/0.001
% reduction	100	16	21	82	

Source: Du Thanh Hang and Preston (2005)

Table 5.28. Mean values for intake of fresh cassava leaves in growing pigs according to the processing of the leaves (Chopped washed, Washed and Chopped washed wilted)

	CW	W	CWW	SEM/P
Intake of cassava leaves, g/day				
Fresh	1277	1228	687	
DM	248	247	277	13.6/0.22
Contribution of cassava leaves in the diet, %				
Of total DM	38.6	38.27	37.3	2.21/0.909
Of total protein	73.6	71.1	71.2	1.93/0.594
CP in diet DM, %	14.8	14.7	14.5	0.493/0.909

Source: Du Thanh Hang and Preston (2005)

Table 5.29. pH, dry matter and HCN concentration in ensiled cassava roots

Days ensiled	DM (%)	pH	HCN (mg/kg fresh silage)	HCN (% of initial HCN content)
0	37.5	5.6	112	100
30	37.8	4.1	77	69
60	37.4	3.8	59	53
90	37.7	3.8	51	46
120	37.3	3.8	44	41
150	37.4	3.8	39	35

Source: Nguyen Thi Loc and Le Khac Huy (2003)

Table 5.30. Effect of DL-methionine (M) supplementation levels on live weight gain and feed conversion ratio

	Control	0.1%M	0.2%M	0.3%M	SEM/Prob.
Initial live weight, kg	20.0	19.9	19.6	20.0	0.153/0.15
Final live weight, kg	88.2	93.3	97.5	95.4	0.371/0.001
Daily gain, g/day	568 ^d	611 ^c	649 ^a	628 ^b	2.89/0.001
Feed intake (kg/day)	2.09	2.12	2.09	2.10	0.015/0.42
Feed /kg LWG (kg)	3.67 ^d	3.47 ^c	3.21 ^a	3.34 ^b	0.030/0.001
Feed /kg LWG (VND)	8,367	7,937	7,651	8,086	61.5/0.001

abcd Means without letter in common are different at P<0.05

Source: Nguyen Thi Loc and Le Khac Huy (2003)

Table5.31. Effect of washing, wilting and ensiling on DM and HCN concentration

	Fresh leaves	Washing	Wilting	Ensiling	SEM	P
DM (%)	24.1	18.8	51.6	32.8	1.58	0.001
CP (% in DM)	27.8	27.7	27.5	25.7	0.56	0.033
HCN (mg/kg DM)	1491	1183	373	356	120	0.001
Reduction in HCN (%)	0	19	74	76		

Source: Du Thanh Hang and Preston (2006)

Table5.32. Effect of supplementary DL-methionine on live weight gain (LWG) and feed conversion ratio (FCR)

<i>Item</i>	Control	FCL	FCL+0.1	FCL+0.2	SEM	P
Dry matter intake (kg/day)	1.62	1.62	1.6	1.49	0.033	0.012
Crude protein intake (g/day)	26.9	27.3	28.3	27.3	1.13	0.8
Initial weight (kg)	85.1	71.3	77.4	86.7	1.495	0.001
Final weight (kg)	0.73	0.55	0.61	0.74	0.014	0.001
LWG (kg/day)						
FCR (kg)	2.81	3.83	3.38	2.66	0.138	0.001
Back fat (cm)	3.63 ^b	2.80 ^a	2.90 ^a	2.93 ^a	0.007	0.131
Loin eye area (cm ²)	28.5 ^b	27.0 ^{ab}	28.5 ^b	28.5 ^b	0.014	0.288
Thyroid gland (g)	33.9	32.8	34.1	36.9	0.253	0.253

FCL: fresh cassava leaves

Source Du Thanh Hang and Preston (2006).

Table 5.33. Effects of inclusion level of CLM on feed intake of sows and weight changes during the experiment

Item	CLM0	CLM10	CLM20	CLM30	SEM
No of piglets born/litter	9.9	12.7	11.2	11.7	0.92
No of weaned pigs/litter	8.5 ^a	10.1 ^b	9.2 ^a	9.4 ^a	0.35
Birth weight (kg/litter)	15.5	17.6	16.9	16.6	1.34
Birth weight (kg/piglet)	1.6	1.4	1.7	1.4	0.07
Weaning weight/litter (kg)	54.0	61.6	56.8	61.4	3.1
Weaning weight (kg/piglet)	6.2	6.1	6.2	6.6	0.22
Weight loss, kg	20.0	19.9	18.1	17.3	3.4

Source: Bui Huy Nhu Phuc và Brian Ogle (2005)

Table 5.34. Mean values for main effects of ensiled versus fresh cassava leaves and levels of supplementary methionine (M)

Item	Cassava		SEM	P	DL-methionine supplementation (%)			SEM	P
	Silage	Fresh			0	0.1	0.2		
<i>Daily gain</i>	0.578	0.657	0.010	0.001	0.540	0.599	0.712	0.012	0.001
<i>DM intake, g/day</i>	1.97	2.05	0.057	0.36	2.04	2.01	1.97	0.070	0.79
<i>FCR</i>	3.45	3.19	0.11	0.10	3.79	3.37	2.79	0.13	0.001
Liver, kg	1.39	1.61	0.025	0.006	1.59	1.46	1.46	0.035	0.060
Loin area, cm ²	27.1	28.0	0.221	0.012	27.8	27.2	27.6	0.300	0.350
Back fat, cm	2.99	2.88	0.057	0.196	3.24	2.90	2.66	0.080	0.007
Thyroid, g	32.2	34.6	0.688	0.031	35.6	31.5	33.2	0.900	0.030

Source: Du Thanh Hang (2009)

Table 5.35. Effects of inclusion of cassava leaf meal (CLM) on feed intake of sows and weight changes during the experiment

Item	CLM0	CLM10	CLM20	CLM30	SEM
<i>Feed intakes, kg/day</i>					
Pregnancy	2.3	2.3	2.3	2.3	0.01
Lactation	4.9	4.9	5.0	5.1	0.04
<i>Live weight, kg</i>					
<i>Gestation</i>					
At 21-day gestation	194	193	191	200	7.7
At 107-day gestation	235	233	230	238	6.9
Daily gain	40.6	40.0	39.5	38.3	3.2
<i>Lactation</i>					
At farrowing	221	217	216	219	7.2
At weaning	201	197	198	201	6.3
Weight loss for lactation	20.0	19.9	18.1	17.3	3.4
% Weight loss	9.05	9.17	8.38	7.25	

Source: Bui Huy Nhu Phuc (2005)

Table5.36. Effect of L-lysine and DL - methionine supplementation level in the diet on the growth and economic performance of crossbred growing pigs

Item	LowAA	MediumAA	HighAA	Very highAA	SEM	P-value
Live weight, kg						
Initial	20.1	20.0	20.8	19.6	0.426	0.247
Final	68.8 ^a	72.6 ^a	80.3 ^b	74.2 ^a	1.522	0.000
Daily gain	0.537 ^a	0.584 ^a	0.660 ^b	0.604 ^b	0.017	0.001
DM intake (kg/day)	1.60 ^a	1.59 ^a	1.71 ^b	1.64 ^{ab}	0.018	0.001
FCR (kg DM/kg LWG)	2.99 ^a	2.73 ^b	2.59 ^b	2.72 ^b	0.058	0.001
Feed cost (VND/kg LWG)	6 482	6 269	6 193	6 692	145.4	0.099

Source: Nguyen Thi Hoa Ly và Le Duc Ngoan (2005)

Table5.37. Effect of including ensiled cassava leaves in diet on the performance of growing pigs

	Control	ECL10	ECL15	ECL20	SEM	P
Live weight, kg						
Initial	23.2	23.3	23.9	23.7	0.52	0.688
Final	75.1	73.5	72.0	71.1	2.37	0.655
Daily gain, g/day	577	557	534	517	22.7	0.287
Feed						
DM intake (kg/day)	1.57	1.57	1.56	1.57	0.04	1.000
FCR (kg DM/kg LWG)	2.73	2.86	2.99	3.06	0.189	0.632
Feed cost (VND*/kg LWG)	7852	7225	7121	6767	483.7	0.472

Source: Nguyen Thi Hoa Ly (2006)

Table5.38. Effects of inclusion of CLM in the diets on the performance of growing pigs

	CLM0	CLM5	CLM10	CLM15	SEM
DWG, g/day	846	804	801	770	20.5
FCR	2.58	2.72	2.73	2.95	0.09
Feed intake, kg/day	2.18	2.18	2.18	2.27	0.07
Carcass dressing %	76.0	76.4	75.4	76.0	2.39
Loin eye area (cm ²)	31.9	32.9	38.3	40.6	3.7
Back fat thickness (mm)	15.3	13.0	12.3	11.6	1.65

Source: Bui Huy Nhu Phuc và Brian Ogle (2005)

Table5.39.Effect of CLM in the diets on the performance of growing pigs

	CLM0	CLM4	CLM8	CLM12	SEM
Carcass dressing, %	77.6	79.1	78.6	79.4	2.7
Loin eye area (cm ²)	17.0	15.5	13.7	12.2	1.4
Backfat thickness (mm)	55.3	57.0	57.5	58.5	4.5
Weight gain, g/day	545	572	548	570	15.6
FCR	3.24	3.24	3.27	3.33	0.09
Feed intake, kg/day	1.76	1.85	1.80	1.90	0.09

Source: Bui Huy Nhu Phuc and Brian Ogle (2005)

Table 5.40. Effect of using ensiled cassava leaves (ECL) on growth performance of pigs

	SP	ECL	SE	P
Days in experiment	90	90		
Initial live weight, kg	18.2	20.2	0.744	0.086
Final live weight, kg	53.6	55.3	0.833	0.187
Daily gain, g	394	390	8.075	0.755
FCR, DM kg/kg gain	3.57	3.61	0.075	0.669
Feed costs/kg gain (VND)	8951	7550		
% as control diet	100	84		

(Sweet potatoes vines: 500 VND/kg; Fish meal: 7.500 VND/kg; Rice bran: 2000 VND/kg; Fresh cassava roots: 300 VND/kg, Ensiled cassava leaves: 200 VND/kg)

Source: Nguyen Thi Loc (2007)

Table 5.41. Effect of using *Trichantera gigantea* on growth performance of pigs

	SP	TG	SE	P
No. of pigs	9	9		
Days in experiment	120	120		
Initial live weight, kg	9.3	9.1	0.482	0.810
Final live weight, kg	56.2	57.5	0.832	0.293
Daily gain, g	391	403	5.577	0.141
FCR, DM kg/kg gain	3.39	3.38	0.047	0,934
Feed costs/kg gain (VND)	9854	8786		
% of control diet	100	89		

(Rice bran: 2000 VND/kg; Sweet potato vices: 1000 VND/kg; *Trichantera gigantea*: 500 VND/kg; Ensiled cassava roots: 500 VND/kg; Fish meal: 9000 VND/kg).

Source: Nguyen Thi Loc (2007)

Table 5.42. Effect of ensiling process and addition of microorganism on nutritive value of cassava byproduct and rice bran

	Micro-organisms			<i>P</i>	Fermentation days				<i>p</i>	SEM
	AS	AS+SC	AS+SC +LB		0	7	14	21		
Cassava byproduct										
CP	8.81	9.39	9.68	0.001	3.52	7.21 ^b	8.45 ^c	12.2 ^d	<0.001	0.106
NDF	45.5	44.7	43.5	0.058	61.0	50.0 ^b	43.5 ^c	40.2 ^d	<0.001	0.515
ADF	19.3	19.3	19.6	0.21	23.7	22.6	13.5	22.1	0.39	0.3
CF	14.1	14.0	14.3	0.2	17.3	15.2 ^b	10.2 ^c	17.0 ^d	<0.001	0.4
Rice bran										
CP	17.7	17.5	17.9	0.33	13.9	17.6	17.7	17.9	0.54	0.18
NDF	35.1	35.2	33.8	<0.001	39.3	37.1 ^b	33.7 ^c	33.3 ^c	<0.001	0.17
ADF	13.6	13.5	13.4	0.72	14.6	13.8	13.2	13.5	0.081	0.163
CF	9.89	10.1	10.6	0.078	10.9	9.57 ^b	10.8 ^c	10.2 ^c	0.004	0.18
Cassava pulp??										
CP	31.8	30.4	32.1	0.25	11.3	28.9 ^b	31.5 ^c	33.8 ^c	0.003	0.72
NDF	29.3	30.7	29.3	0.045	24.9	32.5 ^b	28.8 ^c	28.0	<0.001	0.37
ADF	21.9	22.7	23.3	0.58	24.6	22.0	22.9	23.0	0.14	0.51
CF	15.4	14.8	15.4	0.91	21.2	16.7 ^b	14.8 ^c	14.0 ^c	<0.001	0.28

Source: Trần Thị Thu Hồng et al. (2013)

Table 5.43. Effect of ensiled cassava byproduct and cassava byproduct on growth performance of growing pigs

Index	Control	ECB	CB	SEM	<i>p</i>
Initial LW, kg	27.5	26.5	26.8	0.34	0.64
Final LW, kg	57.8 ^a	55.3 ^a	50.8 ^b	0.27	0.041
Daily gain, g/day	423 ^a	410 ^a	343 ^b	11	<0.001
Daily feed intake, kg DM	1.78 ^a	1.73 ^a	1.51 ^b	0.021	<0.01
FCR	4.12 ^a	4.20 ^a	4.35 ^b	0.027	<0.001

Source: Nguyen Van Phong (2013)

Table 5.44. Effect of replacing fish meal by fish silage (EFB) on the daily feed intake, growth rates and feed conversion ratio of growing-fattening pigs

	Ctrl	EFB50	EFB100
Number of pigs	8	8	8
Dry matter intake (kg/pig/day)	1.8	1.6	1.5
Daily weight gain (g/pig/day)	602 ^a	509 ^b	446 ^c
FCR	3.0	3.2	3.4

abc Means within rows with different superscripts differ (P<0.05)

Source: Le Van Lien et al. (2000)

Table 5.45. Effect of cassava meal (CM) on performance and carcass characteristics

	Diets			SE	P
	CM0	CM25	CM50		
Weight gain, g/day	575 ^a	637 ^b	587 ^{ab}	13.203	0.034
DM intake, kg/day	1.74	1.83	1.76	0.025	0.083
Crude protein, g/day	311	315	293	4.583	0.094
FCR	3.17 ^a	3.01 ^b	3.15 ^{ab}	0.040	0.036
Feed cost/kg LW gain, VND	18,000	15,500	15,000		
Backfat thickness (mm):	15.7	16.8	16.2	0.866	0.693
Iod index in back fat	53.7 ^a	51.5 ^b	48.9 ^c	0.494	0.001
C12:0 fat (%)	0.16 ^a	0.50 ^b	0.78 ^b	0.052	0.027
C14:0 fat (%)	1.38 ^a	2.09 ^b	2.62 ^b	0.080	0.016

Source: LeThi Men (2010)

Table5.46. Effect of cassava byproduct on milk quality of sows

Index	CBO	CBO3	CBO6	CBO9	SEM	P
Average milk yield (kg/day)	6.38	7.24	7.18	7.25	0.32	0.20
Milkcomposition (%)						
- DM	17.3	17.3	17.4	17.5	0.06	0.10
- CP	5.13	5.10	5.20	5.16	0.03	0.18
- EE	6.11 ^a	6.35 ^b	6.42 ^b	6.73 ^c	0.05	<0.001
- Lactose	5.25	5.32	5.38	5.33	0.03	0.06
- Milk engergy (MJ/kg)	5.04	5.05	5.12	5.09	0.02	0.05
Fatty acid composition (mg/g milk)						
C12:0	0.37	0.38	0.39	0.39	0.015	0.68
C14:0	4.10	4.20	4.30	4.28	0.06	0.15
C16:0	15.9	16.1	16.2	16.6	0.19	0.17
C16:1	8.91	8.48	8.73	7.60	0.45	0.20
C18:0	3.13 ^a	3.20 ^a	3.33 ^b	3.39 ^b	0.03	<0.001
C18:1	16.0 ^a	15.5 ^b	15.5 ^b	15.3 ^b	0.10	<0.001
C18:2	5.93 ^a	6.40 ^b	6.67 ^c	6.89 ^d	0.04	<0.001
C18:3	0.89 ^a	1.07 ^b	1.24 ^c	1.40 ^d	0.017	<0.001
C20:5, n-3 EPA	0.15 ^a	1.18 ^b	1.34 ^c	1.68 ^d	0.019	<0.001
C22:5, n-3 DPA	0.23 ^a	0.32 ^b	0.36 ^c	0.39 ^c	0.009	<0.001
C22:6, n-3 DHA	0.24 ^a	1.70 ^b	1.92 ^c	2.09 ^d	0.02	<0.001

Source: Nguyen Thi Thuy and Preston (2012)

Table5.47. Effect of cassava root meal (CRM) on performance and backfat thickness of finishing pigs

Monitoring Index	0CRM	33CRM	66CRM	100CRM	SEM	P
Daily weight gain, g	681	691	730	736	31.1	0.518
Daily feed intake, kg	2.24	2.29	2.27	2.23	0.04	0.687
FCR	3.31	3.34	3.14	3.04	0.12	0.235
Backfat thickness, mm	15.2	16.0	15.6	16.2	0.472	0.553

Source: Le Thi Men (2005)

Table 5.48. Effect of replacing FM by tofu residues

	Percentage of soybean residues replacing FM (%)					
	0	33	66	99	SEM	P
N balance, g/day						
Intake	15.4	15.5	15.7	15.9		
In faeces	1.7 ^a	2.6 ^b	3.2 ^b	4.5 ^c	0.3	0.001
In urine	7.7 ^b	6.4 ^b	4.5 ^a	4.5 ^a	0.5	0.002
Retention	6.0	6.6	8.0	6.9	0.6	0.120
Digestibility of N	43.7 ^a	50.8 ^a	64.3 ^b	60.2 ^b	3.9	0.013
N retent and N digested, %	39.0	42.5	51.1	43.2	3.6	0.160

Source: Tran Thi Thu Hong, 2003

Table 5.49. Effect of cassava meal (CM) and cassava byproduct (CB) proportions on DG, carcass characteristics and fatty acid compositions in fat of growing pigs

	Diets					SEM	P
	CRTL	25(CM+CB)	50(CM+CB)	75(CM+CB)	100(CM+CB)		
Daily gain, g/d	768	785	835	794	781	21.12	0.219
Slaughtered LW, kg	92.8	93.5	94.7	93.8	93.3	1.10	0.769
Carcass dressing, %	72.9	73.1	73.5	72.9	72.5	0.39	0.560
Backfat thickness (mm)	15.1 ^a	14.2 ^{abc}	13.6 ^b	14.3 ^{abc}	14.8 ^{ac}	0.26	0.016
Loin area, cm ²	53.0 ^a	54.2 ^{ab}	55.5 ^b	53.8 ^{ab}	53.1 ^{ab}	0.54	0.045
Iodine in blood index	58.5 ^a	57.6 ^{ab}	56.6 ^{bc}	55.8 ^c	54.68 ^d	0.26	0.047
C12:0 (%)	0.07 ^a	0.16 ^{ab}	0.23 ^b	0.25 ^b	0.33 ^c	0.01	0.011
C14:0 (%)	1.32 ^a	1.37 ^a	1.68 ^b	1.70 ^b	1.89 ^c	0.01	0.016
C16:0 (%)	21.45 ^a	21.53 ^a	21.70 ^b	21.74 ^b	22.06 ^c	0.01	0.027

Source: Le Thi Men, 2012

Table 5.50. The effect of replacement of protein from fishmeal by catfish's by-products meal or/and ensiled catfish by-products in diets for growing pigs

Parameters	Diets		
	Fishmeal	Catfish's by-products	Ensiled catfish by-products
Ileal digestibility			
OM	78,4	77,0	78,4
CP	73,2	73,1	74,9
EE	64,0	67,0	67,8
Daily feed intake, g	1.278	1.272	1.267
N retention, g/d	12,3	12,4	13,7

Source: Nguyen Thi Thuy (2010)

Table 5.51. Effect of genotypes and diets on performance and digestibility of Mong Cai and Large White pigs

	Intake, kg DM/day	LW gain, g/day	FCR	Digestibility, %			
				DM	OM	NDF	N
Genotype							
Mong Cai	1.36	273	4.78	71.7	72.8	77.6	82.9
Large White	2.09	533	3.97	72.3	72.1	75.1	86.2
SE	0.28**	32**	0.23*	3.5	3.8	3.5	2.4
Diet							
Control	1.45	377	4.15	70.7	70.6	79.1	84.8
Rubber seed	2.01	429	4.60	73.2	73.3	73.6	84.3
SE	0.37 ⁺	132	0.41	3.3	3.3	3.4	2.7

⁺ $P < 0.10$; * $P < 0.05$; ** $P < 0.01$

Source: Nguyen Thi Thuy and Ly (2002)

Table 5.52. Effect of shrimp by-products to cassava root meal ratio on pH, dry matter (DM), crude protein (N*6.25) and ammonia N (NH₃-N) in ensiled shrimp by-products

Parameter	Treatment	Days						SE	P
		0	7	14	21	28	56		
pH	SBSCA 3:1	8.4	7.6	8.2	-	-	-	0.07	0.001
	SBSCA 2:1	8.4	7.5	8.1	-	-	-	0.12	0.004
	SBSCA 1:1	8.2 ^a	4.2 ^b	4.1 ^b	4.1 ^b	4.2 ^b	4.3 ^b	0.08	0.001
DM,%	SBSCA 3:1	29.6	26.3	25.3	-	-	-	0.14	0.001
	SBSCA 2:1	31.5	27.0	25.6	-	-	-	0.26	0.001
	SBSCA 1:1	36.6 ^a	35.0 ^b	33.9 ^c	34.2 ^c	37.9 ^d	36.2 ^d	0.54	0.001
N*6.25,%	SBSCA 3:1	29.9	30.9	28.7	-	-	-	0.56	0.109
	SBSCA 2:1	19.1	21.2	19.5	-	-	-	0.56	0.072
	SBSCA 1:1	12.4 ^a	12.0 ^a	13.1 ^b	14.0 ^c	13.4 ^b	12.1 ^a	0.10	0.001
NH ₃ -N,	SBSCA 3:1	1.3	31.4	39.1	-	-	-	0.76	0.001
% of total N	SBSCA 2:1	1.8	29.3	35.1	-	-	-	0.33	0.001
	SBSCA 1:1	2.1 ^a	10.9 ^b	12.5 ^c	11.9 ^{bc}	11.0 ^b	13.2 ^c	0.25	.0001

SBSCA 3:1, etc.: Ratios of shrimp by-product to cassava root meal on a fresh weight and air-dry weight basis, respectively.

a-d: Means without common superscript are different ($P < 0.05$)

Source: Le Duc Ngoan et al (2000)

Table 5.53. Mean values for weigh gain, feed intake and feed conversion ratio for growing and finishing pigs fed increasing levels of Rice distillers' waste as replacement for fish meal (% as CP)

Item	Treatment (% rice distillers as CP)					
	Control	R25	R50	R75	R100	Prob.
Growing phase						
Daily gain, kg	0.536	0.542	0.558	0.569	0.558	0.58
Total DM, kg/day	1.57	1.59	1.64	1.59	1.65	
FCR	2.93	2.94	2.95	2.80	2.97	0.83
Finishing phase						
Daily gain, kg	0.580	0.571	0.560	0.550	0.570	0.55
Total DM, kg/day	2.13	2.10	2.20	2.04	2.25	0.64
FCR	3.67	3.67	3.92	3.73	3.69	0.84
Carcass weight, kg	73.85	69.75	72.4	62.2	77.05	0.12
Loin eye area, cm ²	42.3	40.6	40.3	42.6	47.5	0.21
Backfat thickness, cm	2.02	2.7	2.02	2.28	2.58	0.36

Source: Luu Huu Manh (2003)

Table5.54. Effect of replacing FM by brewers (B30, B60 and B100) as a protein content on performance and

	Control	B30	B60	B100	P
Growing phase					
Initial LW, kg	20.3	20.0	20.3	20.3	
Final LW, kg	52.3	52.5	49.7	48.1	
Weight gain, g/d	0.533 ^a	0.541 ^{ab}	0.490 ^{bc}	0.463 ^{bc}	0.01
Daily intake, kg DM	1.67 ^c	1.55 ^b	1.46 ^{ab}	1.33 ^a	0.01
FCR (in DM)	3.13 ^a	2.86 ^b	2.98 ^b	2.87 ^b	0.01
Fattening phase					
Initial LW, kg	45.3	46.7	44.3	44.33	
Final LW, kg	88.7	89.6	81.0	74.3	
Weight gain, g/d	0.722 ^a	0.716 ^a	0.611 ^b	0.500 ^c	0.01
Daily intake, kg DM	2.26 ^a	2.26 ^a	2.13 ^{ab}	1.93 ^b	0.01
FCR	3.14 ^a	3.18 ^a	3.49 ^{ab}	3.87 ^b	0.01

Source: Luu Huu Manh (2003)

Table5.55. Effect of brewers on growth performance and *villi* height and width of weaned piglets

	Treatments			SEM	P value
	Control	15% wort	30% wort		
LW, kg	7.13	7.25	7.16	0.11	0.739
Weight gain, g/d	527	546	519	8.43	0.141
FCR	2.61a	2.23b	2.33b	0.03	0.001
<i>Villus height (mm)</i>					
Duodenal	237 ^a	423 ^b	334 ^c	9.86	0.000
Jejunal	294 ^a	381b	241 ^c	10.93	0.000
Ileum	263 ^a	276 ^a	224 ^b	7.17	0.000
<i>Villus width (mm)</i>					
Duodenal	121 ^a	151 ^b	145 ^b	5.26	0.000
Jejunal	156 ^a	142 ^b	125 ^c	4.17	0.000
Ileum	92 ^a	138 ^b	134 ^b	4.28	0.000

Source: Dao Thi Phuong (2010).

Table 5.56. Effect of "A" molasses on the performance of growing pigs

	Control	Molasses	SEmean (Prob)
Daily gain, kg	0.551	0.538	0.031 (0.79)
Feed intake, kg/day			
Molasses	-	1.18	
Supplement	0.99		
Total DM	2.06	1.84	
Feed conversion,			
kg DM/kg gain	3.74	3.42	0.20 (0.36)
Cost of feed, Dong/kg #	415	488	
Cost of feed/kg gain	1651	1992	

Source: Bui Hong Van and Le Thi Men (1990)

Table 5.57. Mean values of growth and carcass parameters (3 replicates of 2 pigs/treatment; 126 day trial)

Item	Treatment			SE/Prob
	Control	Dehydrated cane juice	"A" molasses	
Daily gain, kg	0.497	0.527	0.484	0.01/0.920
Intake (kg DM/d)	1.86	1.93	2.35	0.03/0.001
FCR	3.75	3.68	4.97	0.17/0.005
Carcass dressing (%)	72.4	74.0	72.2	1.30/0.59
Back fat (mm)	27.1	28.7	28.7	1.73/0.75
Iodine index	87.1	61.6	62.4	1.27/0.001

Source: Bui Huy Nhu Phuc (1993)

Table 5.58. Effect of dietary protein levels(L, M and H) in gestation and lactation on reproductive performance of Mong Cai sows

	LP	MP	HP	P MP)	(LP- P (LP-HP)	P (MP-HP)
Piglets born	9.0 ±1.87	11.2± 2.17	10.6 ± 1.82	NS	NS	NS
Piglet born alive	9.0 ± 1.87	10.0± 1.22	10.4 ± 1.52	NS	NS	NS
Birth weight (g)	617± 30.0	695 ± 38.0	728±54.0	*	*	NS
Litter size at weaning	7.8 ± 1.1	9.0 ± 1.0	9.2± 0.4	NS	NS	NS
Piglet weaning weight, kg	6.4 ± 0.4	8.5± 0.9	8.2± 0.7	**	**	NS
LW lost in lactation, %	31	18	16	*	*	NS
Mortality, birth to weaning, %	13.3	10.0	11.5			

Source: Hoang Nghia Duyet and Nguyen Thi Loc (2000)

Table 5.59. Effect of protein level in the diet on the growth performance and economic return of crossbred growing pigs

	Low Protein	Medium Protein	High Protein	Very high Protein	SEM	Prob.
Final LW, kg	67.8	69.6	74.2	70.9	2.32	0.293
Daily gain, kg	0.535	0.560	0.608	0.576	0.024	0.217
Daily intake, kg DM	1.50	1.57	1.59	1.57	0.038	0.951
FCR	2.91	2.80	2.63	2.73	0.093	0.213
Feed cost *	6693 ^a	6278 ^b	6887 ^a	7397 ^a	243	0.030

*VND/ kg live weight gain;

^{ab} Means with different superscripts within rows are different at $P < 0.05$

Source: Nguyen Thi Hoa Ly et al. (2003)

Table 5.60. Effect of breed and foliage(L) on reproductive performance in MC and LW sows

	MC			Y		
	0L	50L	100L	0L	50L	100L
Size at birth	10.7 \pm 0.3	11.0 \pm 0.6	10.3 \pm 0.3	10.3 \pm 0.3	10.7 \pm 0.3	10.3 \pm 0.3
Weight at birth	6.8 \pm 0.15	6.7 \pm 0.29	6.1 \pm 0.22	13.2 \pm 0.3 ^a	13.2 \pm 0.43 ^a	11.4 \pm 0.7 ^b
Weight 21 days, kg	28.3 \pm 0.8 ^a	27.5 \pm 0.8 ^a	23.7 \pm 0.9 ^b	46.7 \pm 1.1 ^a	43.0 \pm 1.15 ^a	36.3 \pm 0.88 ^b
No. Piglets weaned	10.0 \pm 0.57	10.0 \pm 0.27	9.0 \pm 0.00	9.3 \pm 0.33	9.0 \pm 0.58	9.0 \pm 0.0
LW at weaning, kg	80.0 \pm 3.5 ^a	77.9 \pm 3.4 ^a	63.0 \pm 1.1 ^b	92.6 \pm 1.4 ^a	88.1 \pm 4.9 ^a	78.9 \pm 0.08 ^b
Total feedconsumed, kg	344 \pm 11.4	338 \pm 5.6	320 \pm 4.0	428 \pm 1.0	427 \pm 4.7	409 \pm 1.9
FCR	4.3 \pm 0.07 ^a	4.4 \pm 0.08 ^a	5.1 \pm 0.11 ^b	4.6 \pm 0.06 ^a	4.8 \pm 0.15 ^a	5.5 \pm 0.12 ^b
Feeds costed, VND kg ⁻¹	13 628 ^a	11 723 ^b	10 804 ^b	14 787 ^a	12 908 ^b	11 787 ^b
LW loss in lactation, %	13.5 \pm 0.6 ^a	16.5 \pm 0.7 ^a	17.6 \pm 0.3 ^b	16.4 \pm 0.6 ^a	16.9 \pm 0.6 ^a	21.3 \pm 0.5 ^b

^{a,b} Means within row and breed with different superscripts are different at P<0.05

Source:

Table 5.61. Effect of oil supplementation on diets contained cassava root meal (CRM) and byproducts (CB) on performance of growing pigs

Item	CRM- OILO	CB- OILO	CRM- OIL5	CB- OIL10	Prob.	SEM
Initial LW, kg	57.8	57.3	57.6	57.3	0.986	1.102
Final LW, kg	92.4	85.5	94	89.3	0.128	2.672
Daily gain, g	685 ^{ab}	598 ^a	715 ^b	634 ^{ab}	0.032	29.448
FCR	2.9	3.1	2.85	3.04	0.24	0.087
Carcass dressing, %	77.7	77.7	77.3	77.4	0.98	0.88
Loin eye area, cm ²	46.7	45.2	47.5	45.6	0.99	4.88
Backfat thickness, cm	2.2	2.17	1.93	2.37	0.09	0.18

ab Means in the same row without letter in common differ at P<0.05

Source: Le Thi Men (2003)

Table 5.62. Effects of microbial enzymes, lactic acid bacteria and *Saccharomyces* complexes on average daily feed intake (ADFI, g/pig/day), average daily weight gain (ADG, g/pig/day), feed conversion ratio (FCR, kg feed/kg gain) total tract digestibility (%) of weaned pigs

Item	Treatment				SEM	P value
	C	E	LY	LYE		
ADFI	620	626	621	624	4.62	0.79
ADG	380 ^a	401 ^{ab}	420 ^b	422 ^b	8.09	0.001
FCR	1.63 ^a	1.56 ^{ab}	1.48 ^b	1.48 ^b	0.02	0.002
Total tract digestibility (%)						
<i>Period 1²</i>						
Crude protein	80.6 ^a	84.8 ^b	85.7 ^b	85.9 ^b	0.37	<0.001
Crude fibre	58.0 ^a	61.8 ^b	61.5 ^b	62.0 ^b	0.44	0.001
Organic matter	80.0 ^a	83.0 ^b	84.0 ^b	84.2 ^b	0.31	<0.001
<i>Period 2³</i>						
Crude protein	83.6 ^a	85.0 ^b	86.4 ^c	86.6 ^c	0.24	<0.001
Crude fibre	62.7	63.0	63.3	63.3	0.66	0.90
Organic matter	82.1 ^a	83.7 ^a	85.9 ^b	85.8 ^b	0.35	<0.001

* Piglets were weaned at 21-24 days of age.

^{a, b} Means within a row with different superscripts are significantly different ($P < 0.05$).

Control: Basal diet without antibiotics or probiotics.

E: Basal diet + microbial enzymes (amylase, protease, cellulase, β -glucanase and xylanase).

LY: Basal diet + mixture of lactic acid bacteria (LAB) complex and yeast (*Enterococcus faecium* 6H2, *Lactobacillus acidophilus* C3, *Pediococcus pentosaceus* D7, and *Saccharomyces boulardii* Sb).

LYE: Basal diet + LAB-yeast complex + enzyme mixture.

Source: Hoang Huong Giang et al. (2010)

Table 5.63. Mean numbers (with SD) of aerobic microbes, *Escherichia coli*, and *Salmonella*+*Shigella* (as 10^6 /g) in faeces of piglets from the different experimental groups

Trials	Microbes	Age days of piglets				
		5	15	25	35	45
0g	Total aerobes	4059	431	483	826	371
		±1167	±124	±154	±201	±61
	<i>E. coli</i>	175.98	59.92	121.53	335.34	96.59
		±58.21	±19.46	±43.36	±130.46	±24.35
	<i>Sal.+ Shi</i>	357.41	20.27	51.44	57.32	19.12
		±133.29	±12.65	±27.96	±20.33	±7.30
20g	Total Aerobes	463.06	3368.02	865.95	588.94	485.22
		±121.16	±408.95	±127.28	±88.44	±148.5
	<i>E. coli</i>	111.68	276.14	272.43	247.15	170.13
		±45.53	±72.83	±79.89	±58.15	±56.43
	<i>Sal.+ Shi</i>	112.04	196.32	49.23	92.93	14.5
		±42.21	±45.86	±11.65	±30.43	±5.56
40g	Total Aerobes	184.51	360.14	375.28	114.77	389.76
		±33.82	±100.62	±41.78	±41.27	±69.13
	<i>E. coli</i>	22.37	139.92	90.82	52.99	203.42
		±4.88	±65.26	±18.09	±28.94	±50.28
	<i>Sal.+ Shi.</i>	5.2	13.27	15.40	14.65	28.21
		±1.05	±4.06	±3.67	±9.00	±6.76

Source: Pham Hong Son et al. (2003)

Table 5.64. Effect of fresh (FG) and dried garlic (DG) on performance of pigs

	Control	DG	FG	SEM	P
Daily feed intake, kg	1.82	2.15	1.79	0.10	0.05
FCR	3.01	2.93	2.86	0.13	0.70
Average daily gain	0.60	0.74	0.63	0.05	0.17
Backfat thickness, mm	13.75	13.5	14.75	0.89	0.59

Source: Nguyen Nhut Xuan Dung et al. (2010)

Table 5.65. Effect of turmeric (T), and turmeric and garlic (TG) on performance of pigs

	Control	T _{0.5}	TG _{0.05}	T _{0.1}	TG _{0.1}	SEM	P
Daily feed intake	1.92	2.18	2.11	1.89	1.94	0.08	0.11
FCR	3.06	3.10	2.76	3.13	3.01	0.44	0.97
ADG	0.63	0.73	0.76	0.64	0.72	0.07	0.53
Backfat thickness, mm	13.90	13.95	12.35	16.3	12.68	1.15	0.18

Source: Nguyen Nhut Xuan Dung et al. (2010)

Table 5.66. Effect of enzyme phytase supplementation on nutrient digestibility and N and P retention

Items	CTL	PHY	CAR	PHY-CAR	SEM
Digestibility, %					
DM	73.5 ^a	74.5 ^a	76.3 ^b	76.7 ^b	0.31
CP	79.0	79.6	79.6	79.5	0.19
NDF	42.1 ^a	43.8 ^a	46.3 ^b	46.7 ^b	0.49
P	46.5 ^a	61.6 ^b	47.4 ^a	64.1 ^b	1.58
Retention (%)					
P	46.4 ^a	61.6 ^b	47.4 ^a	64.1 ^b	1.58
N	69.8 ^a	70.7 ^{ab}	71.7 ^{bc}	72.1 ^c	0.37

a, b, c Values within the row without common superscript are different at P<0.05

Source: N T Long et al. (2010)

Table 5.67. Mean values for weight gain, backfat thickness and Iodine value for growing and finishing pigs fed increasing levels of coconut cakemeal as replacement of fish meal (as protein basic)

<i>Item</i>	Treatment			P
	CM0	CM25	CM50	
Daily gain, g	575 ^a	637 ^b	587 ^{ab}	0.034
Backfat thickness, mm	15.7	16.8	16.2	0.693
Iodine value	53.7 ^a	51.5 ^b	48.9 ^c	0.001
C12:0 of fat (%)	0.16 ^a	0.5 ^b	0.78 ^b	0.027
C14:0 of fat (%)	1.38 ^a	2.09 ^b	2.62 ^b	0.016

Source: Le Thi Men (2006)

Table 5.68. Chemical composition of *Tithonia diversifolia* and Taro (TD) with or without molasses

	No additive			Molasses			P- value		
	25TD	50TD	75TD	25TD	50TD	75TD	TD	Additive	TD*Additive
DM, %									
0 day	18.25	19.04	18.50	18.27	19.65	19.58	0.06	0.12	0.46
7 day	14.95	16.61	17.88	18.17	18.72	18.40	0.01	0.001	0.04
21 day	11.02	13.66	17.31	15.29	17.88	18.15	0.001	0.001	0.001
CP, % DM									
0 day	19.87	19.84	19.93	19.58	19.87	19.87	0.90	0.740	0.90
7 day	19.48	20.21	19.96	20.64	21.00	20.80	0.39	0.001	0.58
21 day	18.92	19.34	19.80	20.51	21.13	21.26	0.03	0.001	0.82
Lactic acid, % in DM									
0 day	0.76	0.45	0.27	2.86	2.55	2.37	0.001	0.001	1.00
7 day	1.80	1.27	0.94	3.62	3.30	2.81	0.001	0.001	0.60
21 day	4.31	1.43	0.75	6.41	3.68	3.16	0.001	0.001	0.34
Oxalate#, g/100g DM									
0 day	2.50	1.87	1.50	2.40	1.87	1.56	0.001	0.71	0.19
7 day	1.63	1.59	1.32	1.25	1.46	1.40	0.001	0.001	0.001
21 day	1.43	1.23	0.96	1.14	1.12	1.00	0.001	0.001	0.001

#As (COO)₂

Source: Nguyen Thi Hong Nhan et al. (2011)

Table 5.69. Mean values for feed intake, apparent coefficients of digestibility and changes in live weight for pigs fed a conventional diet with substitution of up to 20% by silage of mixed Tithonia; Taro (TTS)

	0TTS	10TTS	15TTS	20TTS	SEM	P
<i>Feed intake, kg/day</i>						
DMI, kg/day	2.18 ^a	2.16 ^a	2.07 ^{ab}	1.99 ^b	0.03	0.013
CPI, kg/day	0.346 ^a	0.343 ^a	0.328 ^{ab}	0.314 ^b	0.004	0.01
<i>Apparent digestibility, %</i>						
DM	78.0 ^a	77.6 ^a	76.9 ^a	75.1 ^b	0.29	0.001
OM	79.0 ^a	78.2 ^{ab}	77.7 ^b	76.4 ^c	0.18	0.001
CP	70.0 ^a	68.4 ^{ab}	68.2 ^{ab}	66.2 ^b	0.52	0.013
NDF	57.4	56.9	54.3	55.1	0.7	0.061
<i>Live weight, kg</i>						
Initial	64.2	64.5	64.6	64.8	0.25	0.09
Final	74.6	74.5	74.2	73.9	0.18	0.86
Daily gain	0.697 ^a	0.668 ^{ab}	0.640 ^{ab}	0.608 ^b	0.01	0.02

abc Mean values within rows without common superscript are different at $P < 0.05$

Source: Nguyen Thi Hong Nhan et al. (2011)

Table 5.70. Effect of ensiled sweet potato in diets on performance of growing pigs

	Ensiled sweet potato level (%)		
	26	22	19
Initial weight (kg)	17.86	17.47	16.97
Final weight (kg)	67.50	63.46	58.75
Weight gain (kg)	49.64	45.99	41.78
FCR	2.88	2.97	3.13
Feeds cost (đ/kg)	8182	8335	8693

Source: Nguyen Thi Tinh et al (2002)

Table 5.71. Effect of ensiled pineapple pulp (EPP) in sow's diet on piglet performance

	Control	10EPP	15EPP	20EPP
LW after 60 days (whole litter)	151.7	156.2	148.6	147.5
FCR	5.91	5.58	5.45	5.31
Food cost (VND/kg piglet)	17730	17280	17030	17120

Source: Nguyen Ba Mui et al. (2007a)

Table 5.72. Effect of oil supplementation in sow's diets on piglet performance

	Control	3% oil	5% oil	7% oil
ADG	196.43a	206.79ab	207.86ab	208.57b
Daily feed intake (kg/sow)	4.17a	4.33a	4.72b	4.73b
Diarrhea rate (%)	100	76.5	61.54	58.2

Source: Pham Sy Tiep et al (2010)

Part 6. Feeding methods

Table 6.1. Effect of fermented liquid feeds (FLF) on performance of grower-finisher pigs

	CRTL	NFLF	FLFBR _{12h}	FLFBR _{24h}	FLFBS _{12h}	FLFBS _{24h}	P	SE
Daily gain, kg	0.589 ^b	0.702 ^{ab}	0.598 ^{ab}	0.715 ^a	0.628 ^{ab}	0.643 ^{ab}	0.04	0.03
FCR, kg/kg	3.17	2.66	3.02	2.65	2.93	2.89	0.22	0.16
Back fat, mm	18.3	17.8	18.4	18.4	16.9	15.9	0.79	1.48
Bacteria, Log cfu/g faeces								
<i>Enterobacteriacounts</i>	4.03 ^a	3.54 ^{ab}	3.36 ^{ab}	2.35 ^b	3.10 ^{ab}	3.21 ^{ab}	0.004	0.25
<i>E.coli</i>	3.69 ^a	3.44 ^a	2.86 ^{ab}	2.01 ^b	2.83 ^{ab}	2.97 ^{ab}	0.001	0.23
Bacteria, Lg cfu/g Feeds								
<i>Enterobacteriacounts</i>	1.58 ^a	2.07 ^a	0.88 ^b	0.89 ^b	1.67 ^a	1.54 ^a	0.001	
<i>E.coli</i>	1.6	1.5	0.00	0.00	0.00	0.00		

^{a,b,c} Mean in the same row without common superscripts are different at ($P < 0.05$)

Source: Nguyen Nhut Xuan Dung et al. (2007)

Table 6.2. Effect of fermented liquid feeds (FLF), phytase (BS_{phy}) and *L. subtilis* (BS_{lac}) supplementation treated feeds on pig performance and P excretion

Growing phase	BS	FLF	FLF _{2%Mo}	BS _{PHY}	BS _{LAC}	P/SE
Total P excretion/P intake, %	79.1 ^a	60.5 ^b	83.9 ^a	58.1 ^b	59.8 ^b	<0.01/4.72
Organic P excretion/P intake, %	53.3 ^a	34.9 ^b	55.3 ^a	41.4 ^b	44.2 ^b	0.05/6.92
DMI, kg/day	152	158	157	151	136	0.21/6.98
Daily gain	0.749	0.805	0.765	0.752	0.749	0.73/0.03
Feed conversion ratio	2.70	2.61	2.66	2.69	2.42	0.21/0.16
Back fat thickness, mm	14.37	15.96	14.53	14.41	15.93	0.77/1.16

^{a,b} Data in a row with a different letters differ significantly ($P < 0.05$).

Source: Nguyen Nhut Xuan Dung et al. (2007b)

Table 6.3. Effect of feeding regime (Ad lib – A and restricted - R) in different growth stage on growth performance of growing pigs

Parameters	T1	T2	T3	T4	SEM	P
	A – A	A - R	R - A	R – R		
Initial LW (kg)	26.54	26.56	26.64	26.77	0.57	0.79
Final LW (kg)	101.5 ^a	95.1 ^b	96.0 ^{ab}	91.3 ^b	1.92	0.02
Daily gain (g)	581 ^a	531 ^b	537 ^{ab}	501 ^b	14	0.01
Backfat thickness (mm)	12.00 ^a	11.53 ^{ab}	11.72 ^{ab}	11.09 ^b	0.14	0.03
Daily feed intake (kg)	234 ^a	209 ^b	216 ^c	202 ^d	1.25	0.04
FCR	3.12	3.05	3.11	3.13	0.27	0.51

Source: Vuong Nam Trung (2010)

Table 6.4. Effect of feeding regime (Ad lib – A and restricted - R) in different stage on reproductive performance of sows

Parameters	A - A	A - R	R - A	R - R	SEM	P
N ⁰ of sows	15	14	14	12	-	-
Gestative 1 st breeding rate (%)	86.66	85.71	84.71	83.83	-	0.32
Pregnant duration (day)	113.8	116.0	115.0	114.6	1.12	0.28
Sow's LW increase (kg)	22.5	21.0	21.8	20.5	0.75	0.18
No. of piglet at born (piglet/litter)	10.54	10.41	10.30	9.81	0.36	0.45
No of piglets at weaning (piglet/litter)	10.00	10.00	9.84	9.36	0.44	0.28
Prenatal death fetus (fetus/litter)	0.26	0.14	0.14	0.17	0.06	0.77
Dry death fetus (fetus/litter)	0.33	0.36	0.86	0.25	0.35	0.35
LW at born (kg/piglet)	1.30	1.28	1.30	1.26	0.14	0.34

Source: Vuong Nam Trung (2010)

Table 6.5.Effect of fermented liquid feeds and liquid feeds on digestibility and performance and backfat thickness of growing pigs

	CRTL	NFLF	FLF	LAF	P/SEM
<i>Digestibility, %</i>					
DM	77.8	80.7	82.6	81.2	0.18/1.49
OM	81.7 ^b	84.4 ^{ab}	86.6 ^a	84.3 ^{ab}	0.05/1.09
CP	79.6 ^b	82.2 ^{ab}	85.9 ^a	83.2 ^{ab}	0.02/1.23
EE	81.4	83.1	86.7	80.8	0.78/2.45
PUN, mg/100ml	19.3 ^{ab}	22.9 ^b	15.1 ^a	21.8 ^{ab}	0.03/1.16
<i>Overall</i>					
Daily gain	0.552 ^b	0.541 ^b	0.598 ^a	0.601 ^a	0.01/0.01
FCR, kg/kg	3.79 ^b	3.76 ^b	3.09 ^a	3.41 ^{ab}	0.01/0.14
Backfat thickness, mm	13.9	13.8	14.7	14.7	0.62/0.69

Source: Nguyen Nhut Xuan Dung (2005)

Table 6.7. Effect of housing type (closed and open) on growth performance of piglets and growing pigs

	Closed pen	Open pen	SEM
ADG – After weaning	386.22a	364.17b	3.44
ADG – Fattening	837.25a	787.69b	3.59
FCR – After weaning	1.50	1.51	0.04
FCR – Fattening	2.58a	2.73b	0.04

Source: Nguyen Ngoc Phuc et al, 2011.

Table 6.8. Effect of dry and liquid feeds on performance of pigs

	Dry feed	Liquid feed	SEM
ADG – After weaning	364.51a	385.87b	3.40
ADG – Fattening	804.76a	820.17b	3.56
FCR – After weaning	1.53	1.48	0.04
FCR – Fattening	2.72a	2.59b	0.04

Source: Nguyen Ngoc Phuc et al.(2011)

Table 6.9. Effect of Ad libitum and restricted feeding

	Ad lib	Restricted
ADG	664.5	641.8
FCR	3.27	3.08

Source: Truong Huu Dung et al.(2004)

Table 6.10. Effect of substituting enzymes, organic acids, Bentonite and their mixture on H₂S and NH₃ emission in pigs

	Treatment				
	Control	Enzymes	Organic acids	Bentonite	Mixture
ADG	539.8	592.6	588.0	575.0	559.3
FCR	2.33	2.12	2.13	2.19	2.25
H ₂ S from pigs' waste	0.13	0.04	0.07	0.06	0.10
NH ₃ from pigs' waste	0.39	0.12	0.22	0.20	0.33

Note: Unit H₂S and NH₃ from waste: mg/hour/m²

Source: Tran Thi Bich Ngoc et al.(2013)