Clustering and Principal Component Analyses of Constraints in Smallholding Pig Keeping Systems in Manokwari, Indonesia

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Abstract. The research was aimed at identifying clusters and constraints on small holding pig keeping systems in Manokwari, Papua. A total of 50 pig farmers were selected purposively from 15 villages in urban and rural areas of Manokwari. Questions were focused on the constraints of small holding pig keeping systems development in Manokwari. To classify constraints, a total of seven constraints have been noted. Agglomerative hierarchical clustering (AHC) and principle component analysis (PCA) were used for clustering analysis and grouping based on components of constrains. Feeding and breeding had Eigen values of 9487 and 2010, respectively. Furthermore, Feeding and breeding had higher variability compared with other components that were 63.250 and 13.397%, respectively (Cumulative axis 1 and 2 were 76.65%). Feeding and breeding had a positive coefficient correlation (Pearson n) rF1 that could be found in some farmers in urban and rural of Manokwari.

Key Words: pig, small holding systems, clustering, component analysis, development constraints, Papua

Introduction

Pigs indeed play vital roles in Papuan life, place high rank of agriculture animal and are kept for different functions such as local and regional meat demand, marriages, funerals, anniversaries, and other social-related activities. Although pigs are highly valued, this is not shown in the way pigs are kept. In the coming future pigs may not sufficiently support Papuan livelihoods due to many pressures.

Pig keeping systems in West Papua, particularly in Manokwari, are currently facing many pressures such as growing population and urbanization, and importations of other livestock products from outside West Papua, such as poultry and beef. Nowadays, urban consumers tend to alternate their consumption of pork with other livestock and fish products. Social acceptance towards presence of pigs is reduced due to the smell of pig units and religious reasons (Phung, 2006). Increasing numbers of non-pork consumers have resulted in decreasing numbers of pig farms (Ashari et al., 1995), reluctances in consuming pork, and decreasing land availability. Local government policies tend to neglect smallholding pig farmers in Manokwari. In developing animal production systems, particularly smallholding farming systems, the farming household is the center (Perkins, 2002). Thereby, innovation in terms of messages and technical issues has to be based on farmers' needs, experience, values and opinion (Boogard et al., 2006). These indicators would determine priority needs, main constraints and opportunities in pig keeping improvement. By knowing farmers' perceptions, it will enable other important stakeholders and policy makers to improve or alter their development and policy messages. This research was done to gain insights of pig farmers' constraints by clustering and analyzing its components.

Materials and Methods

Field studies were done on six districts of Manokwari regency, i.e. Nothern Manokwari

district, Eastern Manokari District, Western Manokwari district, Warmare district, Prafi district and Masni district. Respondents chosen were guided by local extensionists, originated from 15 villages. In urban areas selected farmers origin at Anggrem, Borobudur, Fanindi, Wosi, Amban and Susweni, while in rural areas selected farmers originated at Tanah Merah, Nimbai, Waseki, Aimasi, Mokwan, Mimbowi, SP-8 Masni, Bremi and Warbefor. Three urban villages, Anggrem, Fanindi and Wosi, are situated on coastal areas of Manokwari as well as the two rural villages, i.e. Bremi and Warbefor, which are located in the Northern coastal line of Manokwari. Anggrem, Fanindi and Wosi are located at less that 5 meter above sea level. Amban and Susweni are located at 110 m above sea level. The rural villages Bremi and Warbefor, are located less than 5 meter above sea level. While most villages in Prafi valley, such as Tanah Merah, Waseki, Nimbai, Aimasi, Mokwan, Mimbowi and SP-8, are located at about 20 to 25 meter above sea level.

Participatory situation analysis (PSA) was employed in approaching pig farmers (Conroy, 2005). Interviews using questionnaire were done to collect information concerning constraints from 50 pig farmers. Focused questionnaires were concerning constraint perfectives faced by farmers and how farmers dealt with constraints with its priority scales. Constraints faced by pig farmers during interviews were recorded and grouped based on fields of interests. In this analysis, values of constraints were graded from 1 to 3, i.e. based on importance for improvements. Due to this non-parametric, i.e. categorical data, data analysis using principal component analysis (PCA) was applied (Harris, 2001). PCA helps in depicting relational parameters, seeking un-correlating between parameters and graphing two and three dimensional graphics. Prior to PCA, clustering analysis using Agglomerative Hierarchical Clustering (AHC) was employed in classifying similarity and dissimilarity parameters into three diagrams based on unweighted pair-group average (UPGA). In Principal component analysis (PCA), we incorporated seven factors (Factor 1-7) consisted of feeding, breeding, housing, reproduction, disease, information and other, respectively. We purposively classified category of “other” (in factor 7) due to its less appearance while largely mentioned by pig farmers. The PCA was applied to find correlation of factors. In statistical analysis, qualitative and quantitative data were recorded and stored in Excel database (2003). Further, all data were analyzed using principal component analysis (XLSTAT, 2009) to understand correlation between factors. Agglomerative hierarchical clustering (AHC) was used in classifying constraints in similarity classes.

Results and Discussion

Correction of methods

Of the observation and interviews with pig farmers in Manokwari, 18 constraints identified. These constraints, with sets of priorities identified by Iyai (2008) were feeding, breeding, housing materials, reproduction healthy, diseases, marketing or agribusiness, insecurities, husbandry information, transporting taxation, bureaucracy, labor, fuel, shipping, pig farming location, drainage, un-housed livestock and predators. From 18 constraints then amount of seven most prominent traits were chosen, i.e. feeding, breeding, housing, reproduction, disease, information and other. We purposively classified a category of “other” due to its less present while mentioned by pig farmers. From this data, we then attempted to classify the similarity due to the fact that many categorical counts would lead to lack of concise analysis.

Classification of constraints based on AHC

Constraints in urban and rural pig farming systems could be classified into three classes. In AHG graph (Figure 1 a.b.), factors of 1 (feeding), 2 (breeding), and 7 (other) were classified into class 1. Factors of 3 (housing materials), 4 (reproduction) and 5 (diseases) were grouped into class 2, while, factor of 6 (information) was included into class 3. Classification proved that feeding, breeding and other were factors that would have severe correlation. Different and trend analyses therefore should be made. Improvement in terms of innovation can be made from the classes and subsequent effects such as in class 1 for breeding and reproduction, in class 2 for disease and in class 3 for information will be improved. Factor of "other" needs to be further explored. Housing materials and reproduction has similar weighing and diseases as well. These constraints had encountered and apparently faced by pig farmers. Information then further mentioned as a subsequent result of constraints that hampered pig farmers in Manokwari. Feeding and breeding were the two primary constraints revealed by pig farmers in Manokwari. Perkins (2002) and Chambers (1989) revealed that to promote innovation, farmers are the first.

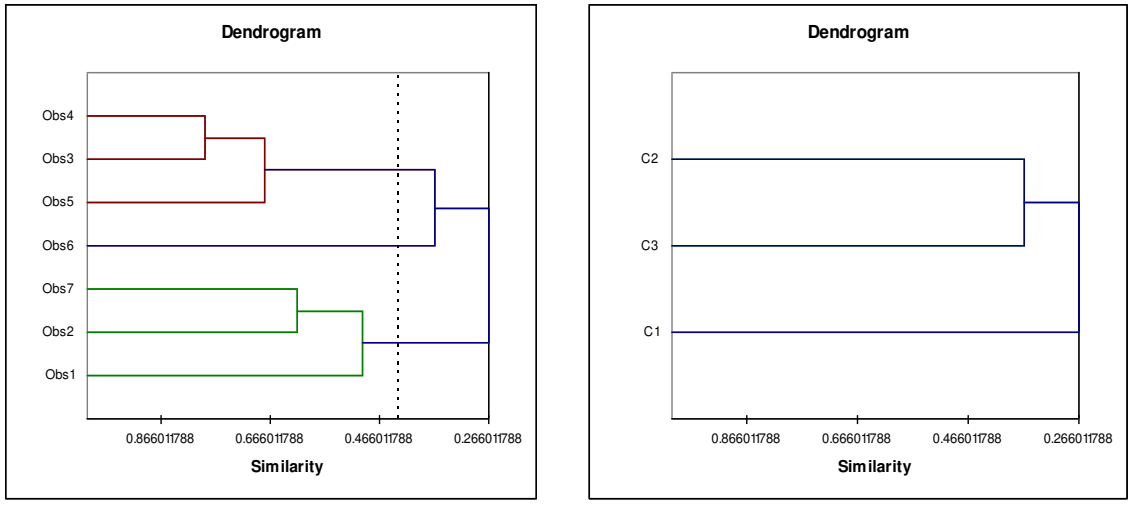
Developing animal production systems, with its complexity of constraints, need wise plans and action to be done. Constraints faced by pig farmers are varied in every individual farmer. As well as urban farmers, rural farmers have similar constraints that need certaint approach to deal with. Understanding constraint and its combinations is usefull for tackling priority constraints.

Distribution of constraints and variables (axes) on PCA

PC analysis is usefull data reduction techique which works by reducing interco-relationship amongst factors (components). Additional advantage is that not only number of comparisons between treament reduced, but the meaningfullness of these comparisons is also having clear meaning. Eigen value and percentage variance (variability) of the F1 axis was high (63.25%). The proportion of the variance is merely the Eigen value for that axis divided by the total variance, i.e. the sum of the diagonal of the cross-product matrix. Other Eigen values and variability combinations were under these two combinations.

Variables of pig farming locations both in urban and rural areas were prone to occupy quadrant IV of the first axis and the second axis of PCA. The first axis of PCA is the most important to explain variability across the variables (constraints factors). Feeding seemed to be he first axis of PCA that had high positive correlation with some villages. Although, "other" had occupied the similar axis of PCA, the relationship was quite low.

The percentage variability of Eigen value for the first axis and second axis of PCA were 63.25 and 13.397%, respectively. The location of constraints and villages based in the three regions of PCA axes is based on correlation coefficient between variables. Therefore the location of the variables in the diagram was significant and important. Example could be drawn on Figure 2. that villages occupied specific constraints region of the variables and are close to each other prone to have similar characteristics between each other and consequently the correlation coefficient between those characteristics should be high. However, the villages occupying opposite places in the diagram, for instances, opposite direction of an axis shown distinct variation, e.g. Bremi, an urban village. diagram, for instances, opposite direction of an axis shown distinct variation, e.g. Bremi, an urban village.



a. b.

Figure 1a.b. A binary clustering tree of classified constraints. Dotted-line shown truncation.

Table 1. Percentage of variability and eigen value of PCA axes (observation)

Axes	Eigen value	Variability (%)
F1	9.487	63.250
F2	2.010	13.397
F3	1.675	11.164
F4	1.079	7.190
F5	0.593	3.954
F6	0.157	1.045

F1: feeding; F2: breeding; F3: housing materials; F4: reproduction; F5: diseases; F6: information; F7: others

Efforts of urban and rural pig farmers

Findings of this study related to self efforts done by urban and rural pig farmers were on the basis of self attempts. Feeding was the first constraint, in which urban pig farmers mostly were done by making a group to purchase some crops at rural farmers. Some agricultural and crop residual were sometimes bought from local markets.

Most breeds in Manokwari were originated from large variety breed. VDL, China and are the domestic breed rose in Manokwari. No improvement has been made yet in Manokwari. Reproduction, particularly to improve sow productivity, was made by renting high fertile boars to be mated. During data collection, one farmer had contacted veterinarian to heal diseases using injection. Not many attempts made by pig farmers to overcome diseases. This is due to the fact that technical information should be obtained by pig farmers were lagging behind. Other was derived from insecurities, husbandry information, transporting taxation, bureaucracy, labor, fuel, pig farming location, drainage, free-range practice, and predator. One interested finding was transporting taxation that found in urban pig farmers, with whom taxation via harbor was quite expensive. Negotiation was being made with local officer finding similar agreement. In general, out of 50 pig farmers, 11 (22%) farmers had no attempts, 3 (6%) with personal efforts, and the rest with making proposal to local government. One farmers contacted veterinary for infectious diseases (Data is not shown). Last but not least was accessing pig farmers to cash from banks. Interviewing result reported that banks were

reluctant to provide cash due to underestimated banks. Pig farmer agribusiness in Manokwari still has no place and played no role in banks perception. This perception therefore needs action to be done. How to stimulate pig farmer access to banks become the further challenges of this field.

Eigen vectors and correlation coefficients between constraints and the PCA axes.

The values of Eigen vectors for constraint variables and the axes of PCA were shown in Table 2. Eigen vectors contain the set of scores that show the weight of each variable, i.e. villages on each axis of PCA. Eigen vectors vary between -1 to +1 and if the value of the Eigen vector for a specific variable is close to absolute of 1, it is more important to weight on the axes. As shown in Table 2, the Eigen vectors for variables of villages had higher compared to the Eigen vectors of other variables. Eigen vector of observation 7 was deduced from analysis by the reason of filtering factors. Filtering factor is used to reduce the number of factors for which results are displayed. The average majority of findings was feeding constraint. Both villages in urban and rural areas tell and share the similar evidance. This evidance is mostly posed by small-scale pig farmers in Asia such as in India (Deka et al., 2007), in Vietnam (Dai Peters et al., 2005) and Philiphina (Lanada et al., 2005), Africa such as Zimbabwe (Chiduwa et al., 2008) and Central Kenya (Wabacha et al., 2004), and Latin America such as in Mexico. Some village farmers confirm breeding as well being the major severe constraint. This situation occur as yet due to the fact that no breed improvement is made. One finding as a reason is that the infectious diseases is being the primary concern, in which disease is the fifth factor (F5). This was contrary with for instances, Bali cattle that become the national program for *swasembada daging* plans in 2014.

In line with driving factors of local government policy of housing animal in Manokwari, housing materials is encountered being the ongoing cases. Table 2 and 3. drawn the similar meaning. What implication of AHC (Figure 1.) that should be taken is that factors of breeding, housing and disease are having the similar groups and have corelation of showing high performances of animal agriculture, in particular, pigs. Feeding, breeding and other have proven affecting animal agricultural productivity. Information is a non-technical driving factor that encounters inducing management knowledge of pig farmers inmaintaining their sustainability.

Urban and Rural villages have encountered many constraints as societal concerns are gained toward animal products and animal farming systems. Obtaining healthy food from red and white meat. Smell of adour become the high concern of society. Urban pig farmers have less chances in obtaining feeding. Crops and offal are available in a range of shortages, as many expamples highlighted by Pattiselanno and Iyai (2005), Peters (2001) and in general in Indonesia by Liano and Siagian (2005). Low adequate nutrients gained and offered to pigs were the experiences practised by large number of pig farmers in the Tropical countries (Eusebio, 1980 and Udo, 1988).

Variables of villages' constraints that were drawn from urban and rural areas were shown in Table 2. Rural areas were Tanah Merah, Nimbai, Aimas, Waseki, Mokwan, Mimbowi, SP-8, Warbefor and Bremi. While,

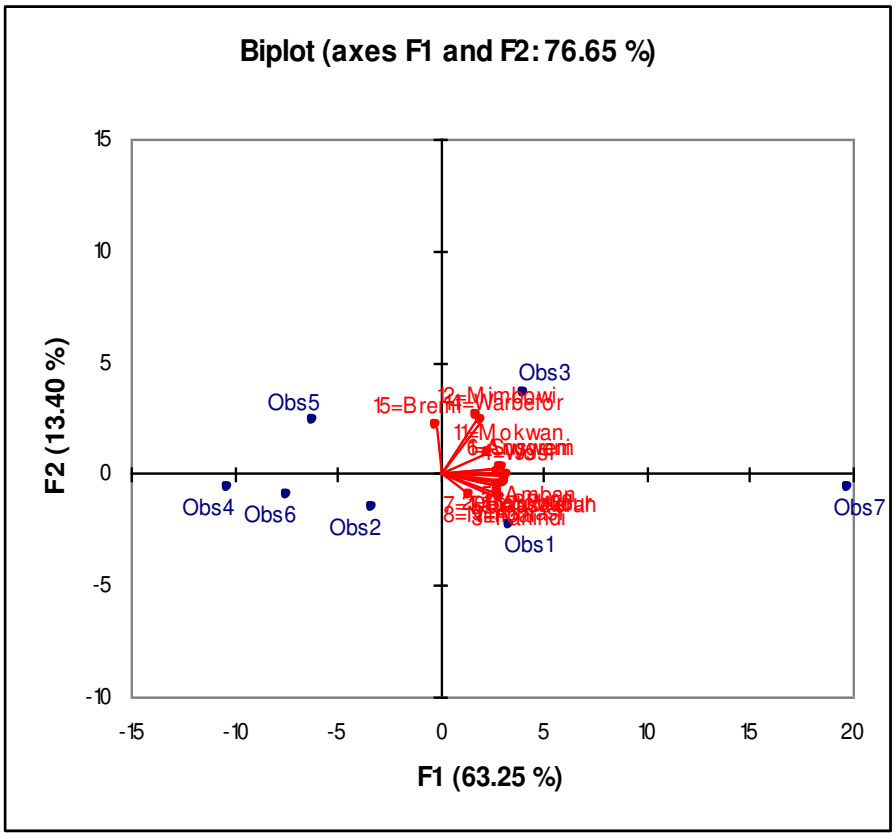


Figure 2. Distribution of villages and constraints in the two first PCA axes.

urban areas comprised of Anggrem, Borobudur, Fanindi, Wosi, Amban, Susweni.

Values of Eigen vectors in particular F1 had shown severe positive weighting. Out of 15 villages, only the last village had smaller number than others in the first axis. In the second axis, rural villages, such as Mimbowi, Warbefor, Bremi and Mokwan had higher weight of variables while the rest did not. The possibility of using other factors has to be considered to seek high number of correlation so that factors shown high correlation will be depicted and possibility in finding higher weight number of variables will be achieved.

Table 3 shown that the coefficient of correlation (Pearson's) reveals the relationship between the PCA scores and individual variable used to construct the axes. The table of correlation coefficient can be quite helpful in providing a quick interpretation of the ordination. F1 has higher correlation coefficient (Pearson (n)).

Pearson (n) correlation (Fig. 1) shown that several villages in urban areas such as Anggrem (r=0.927), Borobudur (r=0.958), Amban (r=0.976), and one village in rural area, i.e. SP-8 (r=0.967), had higher positive relationship with the first axis of PCA. Bremi, village of rural areas, had negative and low relationship with the first axis. In relation with the second axis of PCA, Mimbowi (r=0.783), Warbefor (r=0.723) and Bremi (r=0.664) had positive correlation. However, several villages in both urban and rural had low negative relationship, i.e. Borobudur (r=0.134), Fanindi (r=0.334), Tanah Merah (r=0.155), Nimbai (r=0.292) and Waseki (r=0.274) were rural villages had low negative relationship of the second axis of PCA. This

Table 2. Eigen vectors of constraints for the first six axes (Observation)

Variables	Axes (Observation)					
	F1	F2	F3	F4	F5	F6
1=Anggrem	0.301	0.048	0.163	-0.073	0.375	-0.115
2=Borobudur	0.311	-0.094	-0.136	0.124	0.050	-0.319
3=Fanindi	0.288	-0.236	-0.034	-0.030	-0.386	-0.220
4=Wosi	0.273	0.014	-0.411	-0.065	-0.083	0.007
5=Amban	0.317	-0.017	-0.083	-0.102	-0.139	-0.279
6=Susweni	0.282	0.057	-0.356	0.034	0.192	-0.061
7=Tanah Merah	0.284	-0.110	0.321	-0.158	0.119	0.013
8=Nimbai	0.135	-0.206	0.283	0.686	-0.387	0.253
9=Aimasi	0.280	-0.194	0.000	-0.295	0.054	0.741
10=Waseki	0.280	-0.117	0.272	-0.278	-0.192	-0.007
11=Mokwan	0.224	0.190	0.192	0.434	0.557	0.041
12=Mimbowi	0.174	0.552	-0.070	0.183	-0.304	-0.011
13=SP-08	0.314	-0.057	0.182	0.046	0.007	-0.064
14=Warbefor	0.198	0.510	-0.217	-0.019	-0.124	0.345
15=Bremi	-0.016	0.469	0.522	-0.280	-0.148	-0.134

F1: feeding; F2: breeding; F3: housing materials; F4: reproduction; F5: diseases; F6: information; F7: others.

Table 3. Pearson correlation of constraints

Variables	Pearson correlation coefficient (r) of axes					
	r_{F1}	r_{F2}	r_{F3}	r_{F4}	r_{F5}	r_{F6}
1=Anggrem	0.927	0.067	0.210	-0.075	0.289	-0.045
2=Borobudur	0.958	-0.134	-0.176	0.128	0.039	-0.126
3=Fanindi	0.888	-0.334	-0.044	-0.031	-0.297	-0.087
4=Wosi	0.842	0.020	-0.532	-0.067	-0.064	0.003
5=Amban	0.976	-0.024	-0.107	-0.106	-0.107	-0.110
6=Susweni	0.870	0.081	-0.461	0.035	0.148	-0.024
7=Tanah Merah	0.876	-0.155	0.416	-0.164	0.092	0.005
8=Nimbai	0.417	-0.292	0.366	0.712	-0.298	0.100
9=Aimasi	0.862	-0.274	-0.001	-0.306	0.042	0.293
10=Waseki	0.862	-0.165	0.352	-0.289	-0.148	-0.003
11=Mokwan	0.691	0.270	0.248	0.451	0.429	0.016
12=Mimbowi	0.537	0.783	-0.091	0.190	-0.234	-0.004
13=SP-08	0.967	-0.080	0.236	0.048	0.005	-0.025
14=Warbefor	0.609	0.723	-0.280	-0.020	-0.096	0.136
15=Bremi	-0.050	0.664	0.675	-0.291	-0.114	-0.053

F1: feeding; F2: breeding; F3: housing materials; F4: reproduction; F5: diseases; F6: information; F7: others. r: correlation

meant that several villages both in urban and rural facing similar constraints while in the second axis, breeding was not slightly existed as constraints. Availability of existing local and crossbreed pigs still satisfy urban and rural farmers.

Conclusions

Using principal component and clustering constraints faced and posed by smallholder pig farmers priority needs would be derived. Constraints could be grouped into three classes. Both combination of feeding and breeding has

strongest constraint correlation coefficient and drawn in Biplot of PCA. Several villages seemingly faced similar constraints that need further studies.

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References

Ashari, K Diwyanto, E Djuarini, S Brotowibowo, ND Purwantari, R Matondang and S Nastiti. 1995. Petunjuk Pelaksanaan Analisis Potensi Penyebaran dan Pengembangan Peternakan. Dirjen Bina Penyebaran dan Pengembangan Peternakan & Balai Penelitian Ternak. Jakarta.

Chambers R. 1989. Farmer Innovation and Agricultural Research. In Chambers, Robert, Arnold Pacey and Lori Ann Thrupp (Ed). Intermediate Technology Publications. 103-105. Southampton Row, London WC1B 4HH, UK.

Chiduwa G, M Chimonyo and TE Halimani. 2008. Herd dynamic and contribution of indigenous pigs to the livelihood of rural farmers in a semi arid area of Zimbabwe. Tropic. Anim. Health Prod. 40:125-136.

Conroy C. 2005. Participatory livestock research; a Guide. ITDG publishing. Warwickshire. UK.

Deka R, W Thorpe, ML Lapar and A Kumar. 2007. Assam's pig sub sector: current status, constraints and opportunities. ILRI. New Delhi. India.

Eusebio JA. 1980. Pig production in the Tropics. Intermediate tropical agriculture series. WJA Payne (Ed). Longman group Ltd. Essex. UK.

Harris RJ. 2001. A primer of multivariate statistic. Third Edition. Lawrence Erlbaum Associates, Mahwah Publisher. Mahwah New Jersey. London.

Iyai DA. 2008. Innovation possibilities in pig keeping systems in Manokwari, Papua Barat province-Indonesia. MSc. Thesis. Wageningen University.

Jones R. 2002. Priorities for pig research in Southeast Asia and the Pacific to 2010. ACIAR Working Paper No. 53. March 2002. Australian Center for International Agriculture Research. Canberra.

Lanada EB, JALM Lee, SJ Moore, S Basito, Chotiw-an and AA Taveros. 2005. A Longitudinal Study of Sows and Boars Raised by Smallholder Farmers in The Philippines. J. Preventive Vet. Med. 70: 95-113.

Liano D and P Siagian. 2002. Pig production in Indonesia. ACIAR Working Paper No. 53. March 2002. Australian Center for International Agriculture Research. Canberra.

Pattiselanno F and DA Iyai. 2005. Peternakan babi di Manokwari; mempertahankan tradisi dan meningkatkan taraf hidup. Salam. No.13. Desember 2005.

Perkins R. 2002. Priorities for pigs research in Southeast Asia and the Pacific to 2010. ACIAR Working Paper No. 53. March 2002. Australian Center for International Agriculture Research. Canberra. Australia.

Peters D, NT Tinh, MT Hoan and NT Yen. 2005. Rural income generation through improving crop-based pig production systems in Vietnam: diagnostics, interventions and dissemination. Agric. and Human Value 22:78-85.

Peters J. 2001. Local human-sweet potato-pig systems: characterization and research in Irian Jaya, Indonesia with limited reference to Papua New Guinea. A 2nd literature review. "Poverty Alleviation and Food Security through improving the Sweet potatoes-Pig Systems in Indonesia and Vietnam" International Potato Center (CIP).

Phookan Ai, S Laskar, A Aziz and RN Goswami. 2006. Reproductive performance of indigenous pigs of the Brahmaputra valley of Assam. Tamilnadu J. Vet. and Anim. Sci. 2 (4):21-125, July- August 2006.

Udo HMJ. 1988. Pig production in the Tropics. Lecture notes. Department of Tropical Animal production. Wageningen Agricultural University. The Netherlands.

Wabacha JK, JM Maribei, CM Mulei, MN Kyule, KH Zessin and WOluoch-Kusura. 2004. Characterisation of smallhoder pig production in Kikuyu Division, Central Kenya. J. Preventive Vet. Med. 63:183-195.

Walter, 2006. How to weigh a pig with a string. Sugar Mountain Farm. 31 July 2008. http:// sugarmountain.com/blog/2006/01/how-to-weigh-pig-with-string.html

XLSTAT. 2009. XLSTAT Version 2009.1.02. Microsoft Excel®. Copyright Addinsoft 1995-2009.