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Valuing and Defining Socio-Economical Factors of Pig Farming Systems at Manokwari, West Papua

(Penilaian dan Pendefinisian Faktor-Faktor Sosial-Ekonomi Sistem Peternakan Babi di Manokwari, Papua Barat)

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ABSTRAK

Penelitian bertujuan untuk menilai dan mendefinisikan komponen sosial dan ekonomi peternak babi telah dilakukan di Manokwari, Papua Barat. Studi partisipasi menggunakan partisipasi situasi analisis dilakukan untuk mendapatkan base line informasi. Data kualitatif dan kuantitatif kemudian dientri dalam Excel 2003 dan dianalisis menggunakan multivariate analisis yaitu analisis komponen utama (PCA). Juga dipakai analisis gerombol (CA) untuk *agglomerative hierrarchical analysis* untuk melihat kecenderungan pengelompokan base line data. Hasil penelitian diperoleh tiga kelas. Varians pada aksis pertama dan kedua adalah 41,832% dan 25,297%. Pada analisis PCA diperoleh beberapa komponen yang menunjukkan nilai positif misalnya *zones, breed raised, distance to market, distance to town* dan *land size.* Sedangkan, *wealth status* dan *litter size* bernilai negatif. Pada aksis kedua korelasi yang kuat ditunjukkan pada *litter size*, yaitu 0.945, komponen yang lain dengan nilai rata-rata dan negative dimiliki oleh *distance to market*. Dinilai bahwa *zone, wealth status, distances to market, distance to town* adalah komponen yang memiliki asosiasi dengan pengambilan keputusan peternak dalam produktifitasnnya. Namun secara ekonomi diperlukan pembuktian selanjutnya dalam hal pendapatan bersih dari produktifitas peternak.

Kata kunci : analisis komponen utama, analisis gerombol, sosial-ekonomi, peternak babi urban dan rural, manokwari

INTRODUCTION

There are various ways applied by farmers on raising pigs in troipical circumtances (Lemke *et al*., 2006). The farmers usually relied on resources and social aspects. Including farming components were household information, i.e. experiences, labor, work hours, and capital. These components can be compiled with social determinant factorssuch as household members, education and policy. These factors can also be combined based on farmers' choices and logical considerations.

Grouping farmers profile and social aspects aiming at evaluation, profile of social aspects were needed in order to help farmers in increasing their pig farming systems. Combination of farming components can also enhance the pig farming systems. By knowing this, farmers will have several ideas in improving their pig productivity. However, many data will be needed to be collected and collaborated (Jolliffe, 2002).

Due to many data base, incorporating pigs and social aspects by multivariate analysis (Harris, 2001) will enable us to easily derive conclusion and recommendation. Multivariate analysis particularly Principal Component Analysis or (PCA) was a tool commonly used to derivea new uncorrelated and covariate factors (Gaspar *et al.*, 2007). Reducing factors that did not show strong correlation with other components and mapping components and factors in two-three dimensional graphs will be easily interpreted. This will sufficient in deriving conclusion. This research was aimed to value and define social-economical factors in pig farming systems at Manokwari using

agglomerative hierarchical clustering (AHC) and principal component analysis (PCA).

MATERIALS AND METHODS

Materials

Field research sites and respondent samples

Field studies were done on six districts of Manokwari regency (Iyai, 2008), i.e. Northern Manokwari district, Eastern Manokari district, Western Manokwari district, Warmare district, Prafi district and Masni district (Figure 1). We categorized pig farming systems into four pig keeping systems with numbers of observations (N=50) as follows; free-range pig keeping system:Obs17, Obs 18, Obs32, Obs33, Obs34, Obs-35, Obs36, Obs37, Obs38, Obs39, Obs44, Obs-45,Obs46, Obs47, Obs48, Obs49, Obs50 (n=18). Restrained pig keeping systems:Obs21, Obs22, Obs24, Obs25, Obs27, Obs28 (n=6). Semi-penned pig keeping system:Obs1, Obs2, Obs3, Obs-4, Obs5, Obs6, Obs7, Obs8, Obs9, Obs12, Obs-15, Obs29, Obs30, Obs31, Obs40, Obs43 (n= 16). Penned pig keeping systems:Obs10, Obs11, Obs13, Obs14, Obs16, Obs19, Obs20, Obs23, Obs26, Obs41, Obs42 (n=11). Besides, with regard to urban and remote areas, Obs1 up to Obs20 were urban areas farmers, while Obs21 up to Obs50 were rural or remote areas farmers. We made this purposively by considering the prone effect of this underline phenomenon.

Methods

Participatory situation analysis (PSA) was employed in approaching pig farmers (Conroy, 2005). Interviews using questionnaire were done to collect related information concerning zonation, wealth status, commercial-economical raised breed, litter size, distances to market, distances to town, and land size. Due to multivariable data, multi variate analysis (MVA) was used. The MVA is used in detecting patterns of complex data set and exploresthe meaning of the patterns. In MVA we performed principal component analysis (PCA) (Harris, 2001; Jolliffe, 2002), i.e. respondents responded to the components. PCA helps in depicting relational parameters, seeking uncorrelating between parameters and graphing two and three dimensional graphics. Prior to PCA, clustering analysis using Agglomerative Hierarchical Clustering (AHC) used to classify similarity and/or dissimilarity amongst variables or groups of variables into a binary tree diagrams. In Principal component analysis (PCA) we incorporated seven factors (factor 1, factor 2, ..., factor 7) consisted of zonation, i.e. urban and rural places where farmers were living, wealth status was defined by looking at the resources the farmers had in terms of land, crops, livestock and other livelihood activities (on farm and off-farm income generation). Breed raised was defined by looking at the types of breeds reared by farmers. Litter size was number of borned piglets per sow per farrowing. Distances to market was defined by calculating the distance from farmers' house to the nearest market (km). Distance to town was defined by calculating distance where farmers are living to the town (km). Town was involved because sold pigs were done to the town, i.e. Manokwari. Land sizewas defined by calculating land that had by farmers (ha). Zonation, distance to market and landsize were the social features. Whereas, wealth status, breed raised, litters size were economical features.

Data analyses

Prior to PCA One-way analysis was used to find the dynamic of data. Multiple comparison were made using Duncen. The counted data such as zone, wealth status and breed used were analysed using percentages.Variables were analysed using The PCA was applied to find new uncorrelated factors. Pearson correlation was used in deriving conclusion of components. In statistical analysis, qualitative and quantitative data were recorded and stored in Excel database 2003. All data were analyzed using principal component analysis software of XLSTAT (2009), instead of using Canoco and PCord (Ter Braak and Smilauer, 2003), to understand relationship amongst factor components. Discussions made were based on urban and rural farmers' circumstances.

RESULTS AND DISCUSSION

Social and economical compoents

Social and economical variables (components) were analysed (Table 1). Twenty pig farmers live at urban areas and 30 live at rural areas. From this the farmers who had specialities as free-range pig farmers in urban and rural areas were 2 (4%) and 17 (34%), respectively. Restrained pig farming system was dominated by rural pig farmers, i.e. 4 (8%). Semi-penned specialist was dominated by urban compared to rural, i.e. 7 (14%) and 4 (8%), respectively. In penned pig keeping system, specialities also dominated at urban compared to rural, i.e. 11 (22%) and 4 (8%), respectively.

Distance to market (km), in average, was felt by free-range farming system (12.89±6.28 km) followed by restrained (7 km), semi-penned (3.7±2.49km) and penned farming systems (2.4 ±1.03km). Another social component was the distance to town. Distance to town with the farest length was farmers representing restrained pig farming (44 km).

They were mostly living at SP-08 Masni. They did not have close or nearest market. Then several pig farmers were from free-range pig farming (23.10±7.06 km). Semi-penned and penned were seeking the nearest distance to market, i.e. 15.11 ±17.41 km and 10.48±13.47 km, respectively. This is in logical meaning where intensif or semi-commercial pig farmers had taken into account the distance to market.

Distance to market will spend money and other resources. In one hand, land size was higher at farmers with restrained specialist, i.e. 3 ha, followed by free-range specialist, i.e. 2.94

Table 1. Social and Economical Components of Respondents at Several Pig Farming Systems

Components	Pig Farming Systems							
	FRPKS (n=17)		RPKS (n=6)		SPPK (n=11)		PPKS (n=15)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Social variable								
Zone								
Urban	2 (4)		0		7 (14)		11 (22)	
Rural	17 (34)		4 (8)		4 (8)		4 (8)	
Distance to Market	12.89[a]	6.28	7[b]	0	3.7[bc]	2.49	2.4[c]	1.03
Distance to town	23.10[a]	7.06	44[b]	0	15.11[ac]	17.41	10.48[c]	13.47
Landsize	2.94[a]	0.22	3[a]	0	2[b]	0.89	1.67[b]	0.89
Economical variable								
WealthStatus								
Poor	16 (32)		3 (6)		3 (6)		2 (4)	
Middle	3 (6)		1 (2)		8 (16)		7 (14)	
Well-Off	0		0		1 (2)		5 (10)	

Components	Pig Farming Systems							
	FRPKS (n=17)		RPKS (n=6)		SPPK (n=11)		PPKS (n=15)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Economical variable								
Breedraised								
Local	5 (10)		0		4 (8)		5 (10)	
import	0		0		5 (10)		3 (6)	
Local×Import	4 (8)		3 (6)		4 (8)		5 (10)	
Local×Wildpigs	10 (20)		1 (2)		2 (4)		2 (4)	
Littersize	5.31	1.73	6	1.15	7	2.28	4.93	2.71

±0.22 ha. Higher number of landsize was given by the local government for exodus farmers from outside Papua. Farmers with semi-penned and penned were likely to have small landsize due intensification.

Economical variables were wealth status, breed raised and litter size. The result on Table 1. Shown linear tendency towards pig farming systems, i.e. many free-range farmers were poorer than that of semi-penned and penned farmers. Another finding was shown with regard to breed raised by farmers. Free-range pig farmers tend to use most local×wild pigs. Import and import ×local breeds were also chosen by semi-penned and penned pig farmers. This also has shown that both two pig farming systems had altered their breed types to the high productivity breed.

Agglomerative Hierarchical Clustering of Socio-Economic Profile

In the Figure 1. we were trying to graph the variability of pig farmers based on important socio-economical components. It seems that based on that the small-scale pig farmers were complex and shown high variability. In using Agglomerative Hierarchical Principal, clustering was done commenced at the individual or observation sample data. This is apparently contrary with divisive techniques, e.g. TWINSPAN analysis (Ter Braak and Smilauer, 2003). In TWIN-SPAN, clustering is begun with all samples (sites) in one cluster divide this into more cluster. Socio-economic components in urban and rural pig farmers, in particular Manokwari Papua Barat province, could be classified into three classes. The dot-ted-line, in the Figure 1., shown that more than 60% of all observations shaping these three classes had high similarity. Explanation combined from Figure 1. and Table 1. had certain im-

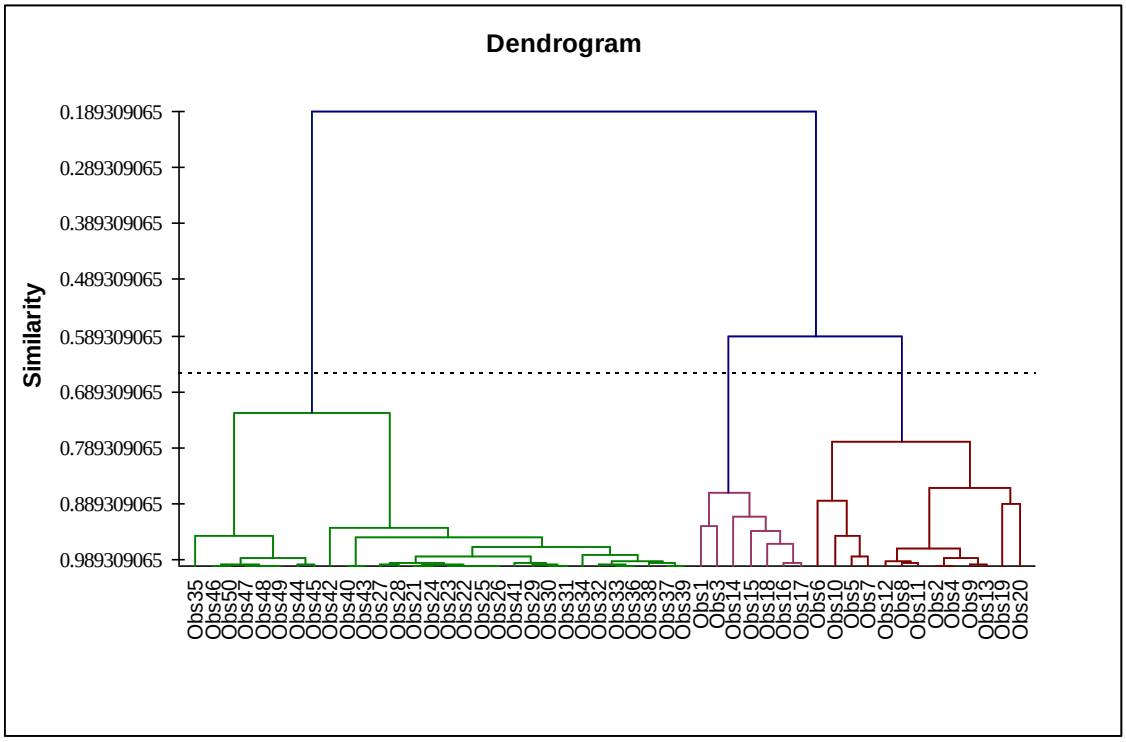

Figure 1. Agglomerative Hierarchical Clustering of Socio-Economical Aspects of Pig Farmers in Manokwari. Dotted-line Shown Truncation

cation. First of all, it seems that components of socio-economical aspects were varied. This differs compared to developed countries having intensive pig farming systems that the findings could be slightly similar which depends only on land size (ha) or size of farming. In other word, farms have clear pattern. Secondly, the more complex of components compiling the characteristics, the more homogeneity are the types of pig farming systems (Table 1). For example, the first class was compiled by several determinant components that made farmers have to take into account by combining these components.

The variouse socio-economical components performed and spreaded in pig farmers (Figure 1.) proved that in using socio-economical aspects, components are vary and changable. The changability of used components depends on strongly interests of farmers (Palmer and Aislie, 2007), for instances in using specific breeds producing high number of litter size and times of farrowing rate. Economical-oriented farmers prone to consider such components (Deka *et al.*, 2007; Dai Peters, 2005), and like wise. As for many local Papuan pig farmers, socio-economical components are lagged behind. However, it is not the cases of for non-Papuan such as Batak, Manado and Toraja. They had benefited from this livelihood due to sold pig breeds.

Based on this finding as well, the class could be grouped into 3 classes. The first class comprised of distances to town, zone, land size owners, reared breed, distance to market. Wealth status was classified into second class and litter size was into the third class as well (Figure 2). Socio-economic profiles of pig keeping systems were relatively similar. The first and second class were slightly shown similar class. Observations of 1,3,14, 15,16,17 and 18 were clustered in the first class. Average of distances to centroid was 3.635. Observations of 2,4,5,6,7,8,9,10,11,12, 13,19, and 20 were clustered in second class and distance to centroid was 3.080. Observations of 21 to observation 50 were clustered into the third class. Average distance was 1.335 close or vari-

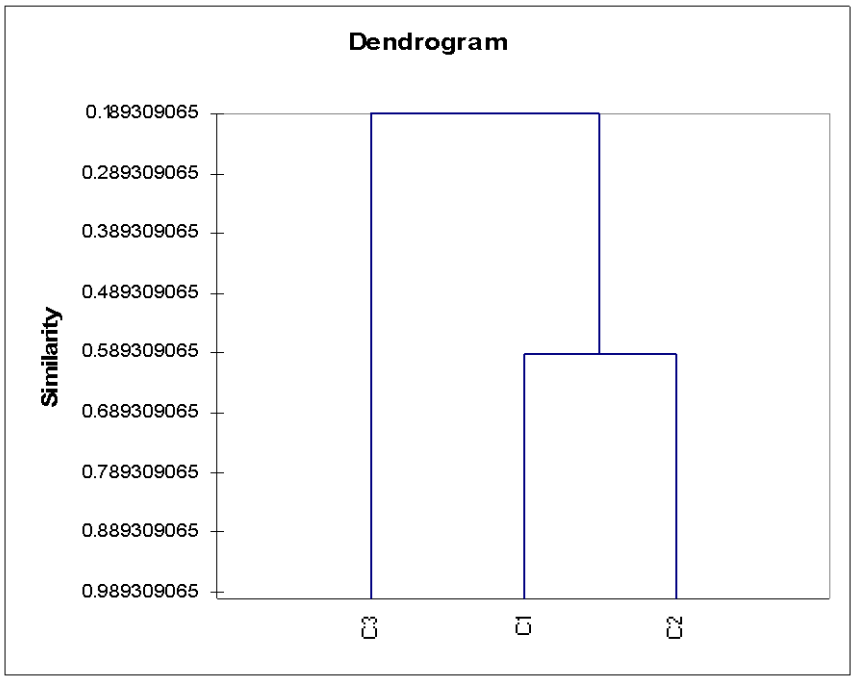

Figure 2. A Binary Clustering Tree of Classified Socio-Economic Factor

ance within class for instance between the first and the second (C1 to C2) was slightly near compared to the third one. There was a severely distance variances, i.e. 130.392. Other distances for the first and second components were 17,521 and 13,345, respectively. Average distance to centroid tells as about the Euclidian distances between the class centroid for the various descriptors.

In a few numbers of pig farmers, the findings of several factors that slightly varied were found in the first class, i.e. distances town (km), zone (urban and rural), land size (ha), breed (local, cross-breed and wild boar), and distance to market (km). This means that these factors prone being similar with respect to several pig farmers. We found several cases could occur at some remote and urban areas (Hiraishi *et al.*). We suppose that land size (ha), breed raised have severe determinant factors in inducing decision making of farmers having accesses to the resources. Distance to town, zone, and distance to market were slightly contributing only in few findings (Table 2).

Wealth status was found similar in several pig farmers and grouped in the second class. In fact these farmers in this class were classified into urban pig farmers, with whom market access exist and likewise for remote pig farmers, e.g. farmers at SP-08. Although living at urban areas, connecting producers and consumers or markets were lagging behind. Besides, access to loans of banks was lack behind such as informed by Iyai (2008).

Observations of Table 2., 20 up to 50 had grouped in factor of litter size. In the third class, it seems that litter size had many similar cases found in many pig farmers. Similar cases also occured in Zimbabwe as stated by Chiduwa*et al*., (2008). Besides, remote or rural areas' pig farmers had similar factor, i.e. litter size. For rural pig farmers, litter sizes were in a range of 5-7 piglets as reported by Iyai (2008a). Litter size studied by Iyai (2008b) had no different between urban and rural areas, i.e. 5.5±2.13 and 5.8±2.33, respectively. While in urban, we assumed that access to local markets might have

Table 2. Summary of Clustering Socio-Economical Components, Distance to Centroid and Its Variances

Class	1	2	3
Objects	7	13	30
Sum of weights	7	13	30
Within-class variance	17.521	13.345	130.392
Minimum distance to centroid	1.761	1.587	1.335
Average distance to centroid	3.635	3.080	10.312
Maximum distance to centroid	5.233	8.187	15.595
Observation	Obs1,Obs3, Obs14, Obs15, Obs16, Obs17, Obs18	Obs2,Obs4,Obs5, Obs6,Obs7,Obs8, Obs9,Obs10, Obs11,Obs12,Obs13,Obs19,Obs20	Obs21, Obs22, Obs23, Obs24, Obs25, Obs26, Obs27, Obs28, Obs29, Obs30, Obs31, Obs32, Obs33, Obs34, Obs35, Obs36, Obs37, Obs38, Obs39, Obs40, Obs41, Obs42, Obs43, Obs44, Obs45, Obs46, Obs47, Obs48, Obs49, Obs50
Factor	Distance to town, zone, land size, breed raised and distance to market	Wealth status	Litter size

positive effect for wealth status, besides distance to town, zone, land size, raised breed and distance to market.

Distribution of Socio-Economical Components in PCA

The principal component is useful data reduction technique which works by reducing intercorrelation amongst components. The advantages of PCA are twofold, i.e. PCA is able to reduce multicolinearity (Soemartini, 2008) and able to present data with simple structure without losing the essence in it. In PCA we produced a new variable that have new combination of components. Eigenvalue/lambda (λ) is used to measure of the fraction of variation explained in the data set. The Eigenvalue(λ) and percentage variance (variability) of the F1 axis was 3.347 and 41.832% respectively. The proportion of the variance is merely the Eigenvalue for that axis divided by the total variance, i.e. the sum of the diagonal of the cross-product matrix.

The values of Eigenvectors (*x*) are containing a set of scores that shows the weight of each variable, i.e. components on each axis of PCA (Hurnik *et al.*, 1994; Jolliffe, 2002). The eigenvectors vary between -1 to +1 and if the value of the Eigenvector for a specific variable is close to absolute of 1, it is more important to weight on the axes (Medasghi, 2001). Variables of factors drawn from pig farmers are shown in Table 3. Values of Eigenvectors in particular F1 had shown severe positive weighting. Wealth status and litter size had negative values. However others were positive in the first axis. In the second axis, litter size was the real weighting. Others found had lowest numbers, i.e. in zones, wealth status, breed raised, distance to town and land size.

Socio components are zone, distance to market, distance to town and the owner of land size. The zoneswere shown high value from the first axis, i.e.in urban and rural areas. Distances to market and distances to town are the two considerable components that shaped pig farmers' decisions. Economical factors are wealth status, breed raised and litter size. Wealth status determines capability of farmers to manage their pig farms (Peters, 2001; Iyai, 2008).

Table 4. shown that the coefficient of correlation r (Pearson's r) reveals the relationship between the PCA scores and individual variable used to construct the axes (Goldberg and Rachel; Hurnik *et al.*, 1994). The table of correlation coefficient can be quite helpful in providing a quick interpretation of the ordination. Axis of F1 has higher coefficient correlation (Pearson (n)). Pearson (n) correlation (Fig. 3.) shown that components of zone, breed raised, distance to market, distance to town and land size had severely positive values and wealth status and litter size had like-wise, negative values.

Table 3. Eigenvalue and Eigenvectors in Principal Component Analysis

	Principal Component Analysis:					
	F1	F2	F3	F4	F5	F6
Eigenvalue λ	3.347	2.024	1.195	0.675	0.395	0.054
Variability (%)	41.832	25.297	14.933	8.440	4.935	0.679
Cumulative %	41.832	67.129	82.062	90.502	95.437	100.000
Eigenvectors:						
Zone	**0.494**	0.158	0.129	-0.199	-0.010	**0.698**
Wealth status	-0.227	0.157	**0.712**	0.248	0.517	-0.101
Breed raised	**0.364**	0.006	**0.361**	**0.642**	-0.517	-0.001
Litter size	-0.148	**0.664**	-0.146	0.082	-0.077	0.029
Distance_Market	**0.355**	-0.017	-0.502	**0.505**	0.325	-0.274
Distance to town	**0.440**	0.222	0.226	-0.463	-0.188	-0.651
Land size	**0.456**	0.132	0.006	-0.066	**0.559**	0.053

Table 4. Pearson Correlation of Components

	Correlations between variables and factors					
	r_{F1}	r_{F2}	r_{F3}	r_{F4}	r_{F5}	r_{F6}
Zone	0.905	0.225	0.141	-0.164	-0.006	0.163
Wealth status	-0.416	0.223	0.778	0.204	0.325	-0.024
Breed raised	0.665	0.009	0.395	0.527	-0.325	0.000
Litter size	-0.271	0.945	-0.160	0.067	-0.048	0.007
Distance_Market	0.650	-0.025	-0.549	0.415	0.204	-0.064
Distance to town	0.804	0.316	0.247	-0.380	-0.118	-0.152
Land size (ha)	0.835	0.188	0.006	-0.054	0.351	0.012

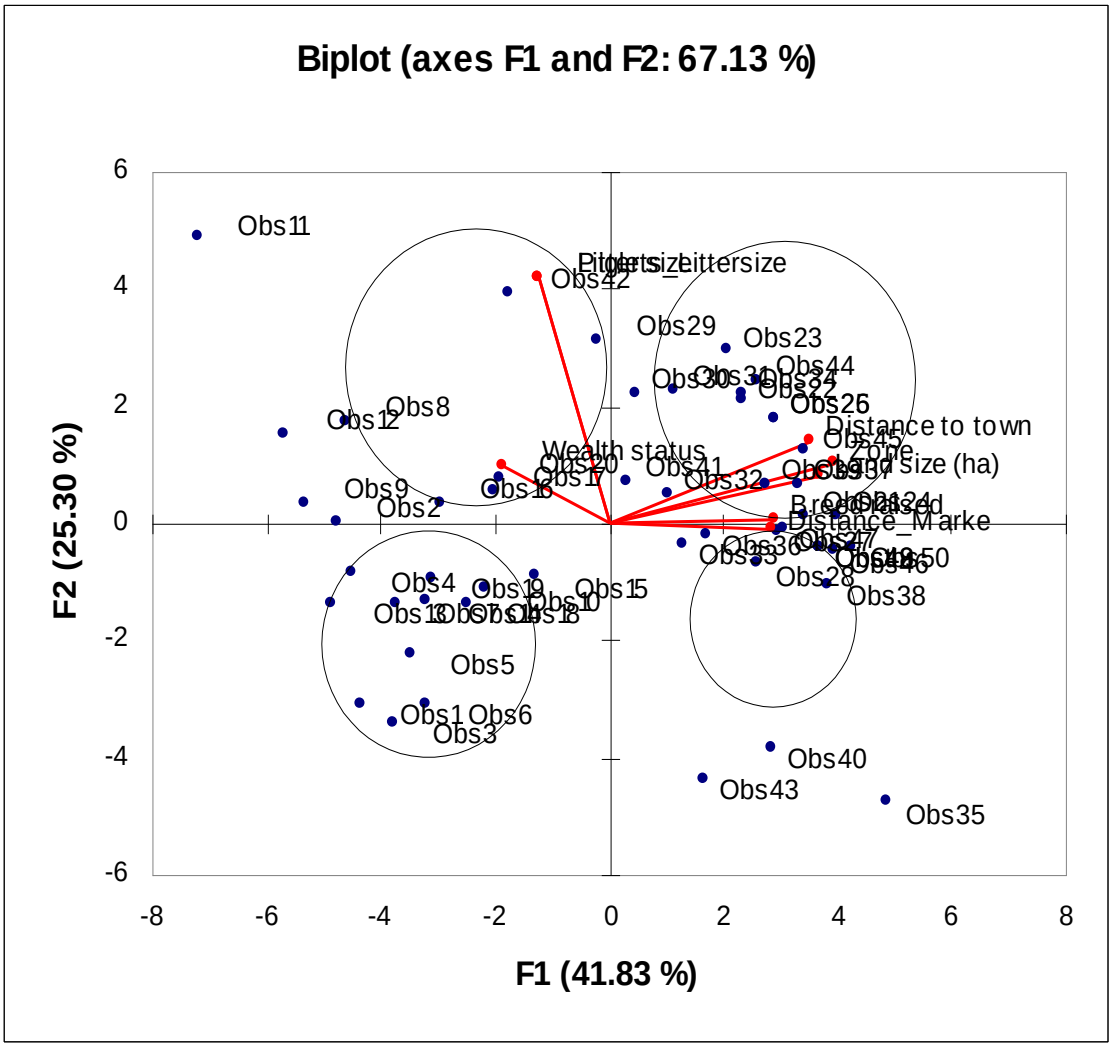

Figure 3. Distribution of Observation and Factors in The Two First PCA Axes

In axes two, component of r_{F2} had higher positive value in litter size (r_{F2} = 0.945) than distance to town (r = 0,316), zone (r = 0.225), wealth status (r = 0.223), land size (r = 0.188) and breed-raised (r = 0.009). Distance to market had negative correlation or dispersed far from axis two (F2).

Figure 3. i.e. biplot graph is used to plot components/or ordination and observation/or species ordination I one ordination diagram. In

plots are the nearest observations placed. Besides, in Biplot we could find intercomponent distances and interobservation distances. In clustering analysis (CA), the first class comprised of distances to town, zone, land, size, breed reared, distance to market. Wealth status is classified into second class and litter size is into the third class (Figure 2). The findings were that in quadrant I components were independent with quadrant II, i.e. litter size and wealth status. In quadrant I, many observations were dispersed near several components, i.e. distance to town, distance to market, breeds, zones and land size.

Observations dispersed close to those components had nearest relationship. This means that those observations had association with. Based on social and economical consideration, many observations/or farmers really depended on distances of markets or town (Pattiselanno and Iyai, 2005), through which farmers will be easily had access to the local markets (Piters, 2001; Deka *et al.*, 2007). Their consideration is really logic in economical thought. Using breed, e.g. local /or native and crossbred pigs become primary concerns of pig farmers nowadays (Liano and Siagian, 2002). Others are that zones, i.e. places (urban and rural) where farms are set up have several consequences. By considering that land size in urban areas that prone to decrease, it forces farmers to seek other important and strategic areas that will be adequate and appropriate for expanding their farming productivities, such as opening villages-based pigs.

As known that litter size are the important component of pig productivity. The higher number of litter size per farrowing of sows (Lanada *et al.*, 2005) would show the more annual sow productivity (ASP). As Iyai (2008) also reported that litter sizes in Manokwari were slightly lower than that of Indonesian situation (Liano and Siagian, 2002) and in Asia such as in Thailand (Nakai, 2008), in India (Phookan *et al*., 2006) and in Vietnam (Lemke *et al*., 2006). Higher number of litter size will be worthwhile and farmer will be benefited from that (Nakai, 2008). Beside for marketing, some piglets will be back in use for breeding replacement.

In quadrant III observations of 4, 19, 15, 13, 7, 5, 1, 6, 3 were not associated with several components in quadrant I. Similar findings could be seen in several observations occurred in quadrant IV. Several observations, i.e. observations of 35, 40 and 43 were independent or had not associated with components in quadrant II.

CONCLUSION

Based on socio-economic components of pig farmers information, profiles of pig farmers can be grouped into three classes. The first class is distance to town, zone, distance to market, land size and breed raised. The second and third subsequently were welath status and litter size. In principal component of the first axis (r_{F1}) correlation of several components shows strong positive relation, such as zones, breed raised, distance to market, distance to town and land size, whereas, wealth status and litter size are negative (dispersed far from component). In second axis (rF2) the strong correlation is shown in litter size. The rest have average values and negative correlation is in the distance to market. Valued that zone, wealth status, distances to market, distance to town are components that have association with farmers' thought in developing their pig farming systems in Manokwari. Few farmers do not wisely consider these components become the important and strategic components in improving their productivities. Economically, it is needed to prove in terms of net incomes gained from economic pig productivities.

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REFERENCES

Al-kandari, Noriah M., Ian T. Jolliffe. 2005. *Variable selection and interpretation in correlation principal component*. Environmetrics. 2005: 16: 659-672.

Chambers, Robert, 1989. Farmer First. *Farmer innovation and agricultural research*. In Chambers, Robert, Arnold Pacey and Lori Ann Thrupp (Ed). Intermediate Technology Publications. 103-105. South-ampton Row, LondonWC1B 4HH, UK.

Chiduwa, G., M. Chimonyo and T.E. Halimani, 2008. *Herd dynamic and contribution of indigenous pigs to the livelihood of rural farmers in a semi arid area of Zimbabwe*. Tropical Animal Health Production 40: 125-136.

Conroy, and Czech, 2005. *Participatory livestock research*; a Guide. ITDG publishing. Warwickshire. UK.

D. Peters, Nguyen Thi Tinh, M. T. Hoan, N. T. Yen, 2005. *Rural income generation through improving crop-based pig production systems in Vietnam: diagnostics, interventions, and dissemination*. Agricul-ture and human value (2005) 22: 78-85.

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

Gasper, P., F.J. Mesias, M. Escribano, A. R. de Ledesma, F. Pulidilo. 2007. *Economic and Management Characterization of Dahesa Faros; Implication for their sustainability*. Agroforestry System (2007). 71: 151-162.

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

Hiraishi, Takeshi, Y. Otsuka, K. Nakaro, T. Matchida. *Type Analysis of Agriculture Information System by Principal Analysis*. Niigata Univ. Graduate School, Ninocho. 8050, Ikarashi, Niigata, 950-2181. Japan.

Hurnik, D., I.R. Dohoo, A. Donald, N.P. Robinson. 1994. *Factor Analysis of swine farm management practice on Prince Edward Island*. Preventive Veterinary Medicine. 20 (1994). 135-146.

Isebrand, J.G., Thomas R. Crow. 1975. *Introduction to uses and interpretation of principal component analysis in forest biology*. USDA Forest Service. General Technical Report. NC 17.

Iyai, Deny A., 2008a. *Innovation possibilities in pig keeping systems in Manokwari, Papua Barat province Indonesia*. MSc. Thesis. Wageningen University.

Iyai, D.A. 2008b. *Karakteristik peternakan babi rakyat dan isu pembangunan peternakan babi berkelanjutan di kabupaten Manokwari, provinsi Papua Barat Indonesia*. Preliminary report. Manokwari. Papua Barat.

Jolliffe, I.T. 2002. *Principal Component Analysis*. Second Edition. Springer.

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, Eugene B., Jenny-Ann L.M. Lee, S. J. Moore, B. S. Chotiwan and A. A. Taveros, 2005. A longitudinal study of sows and boars raised by smallholder farmers in the philippines. Journal of Preventive Veterinary Medicine. 70 (2005) 95-113.

Lemke, U., B. Kaufmann, L.T. Thuy, K. Emrich, A. Valle Zarate. 2006. *Evaluation of small-*

holder pig production systems in North Vietnam: pig production management and pig performances. Livestock science. 105 (2006) 229-243.

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

Mesdaghi, 2001.*Vegetation description and analysis*; A practical approach.

Nakai, S. 2008. *Reproductive performance analysis of native pig smallholders in the hillside of Northern Thailand*. Trop Anim Health Prod.

Ocompo, L.M., P. Leterme and A. Buldgen. 2005. *A survey of pig production systems in the rain forest of the pacific coast of Columbia*. Tropical Anim Health Prod. 37 (4), 315-326.

Palmer, A.R. and A. Ainslie. 2007. Using rainuse efficiency to explore livestock production trends in rangelands in the Transkei, South Africa. *African Journal of Range and Forest Science.* 2007. 24 (1):43-50.

Pattiselanno, F. and D. A. Iyai, 2005. *Peternakan Babi di Manokwari; mempertahankan tradisi dan meningkatkan taraf hidup*. Salam. No.13. Desember 2005.

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

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, A., S. Laskar, A. Aziz, and R.N. Goswami, 2006. Reproductive performance of indigenous pigs of the Brahmaputra valley of Assam. *Tamilnadu Journal of Veterinary and Animal Science*. 2 (4) 121-125, July - August 2006.

Soemartini, 2008. *Principal Component Analysis sebagai Salah Satu Metode untuk Mengatasi Masalah Multikolinearitas*. Skripsi. Jurusan Statistika. FMIPA UNPAD. Jatinangor, Jawa Barat.

Ter Braak, Cajo J.F., P. Smilauer. 2003. *Introduction to Canoco*. Centre for Biometry, WageningenUniversity.

Wabacha, J.K., J.M. Maribei, C.M. Mulei, M.N. Kyule, K.H. Zessin, and W. OluochKusura, 2004. Characterisation of smallhoder pig production in Kikuyu Division, Central Kenya. *Journal of Preventive Veterinary Medicine*. 63 (2004) 183-195.

XLSTAT. 2009. *XLSTAT Version 2009*. 1.02. Microsoft Excel®. Copyright Addinsof.