Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.13, No.4, 2023

Assessing Pig Production and Net Revenue in Reducing Poverty and Maintaining Food Security: Evidence from the West Papuan Farmers

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The research is financed by Asian Development Bank. No. 2006-A171(Sponsoring information)

Abstract
Pigs are a favorite animal for the Papuan because they are valuable in social, cultural, and economic. In supporting food security and poverty alleviation, the relationship between pig production, revenues, poverty reduction, and food security was computed. The study determines the factors that influence production and pig revenue to reduce poverty and support the food security of the farmers in Manokwari. Selected 150 farmers taken from three regencies in West Papua. Pig production, pig revenues, poverty gap, and food security were analyzed simultaneously using Two Stage Least Squares regression. The results showed that the feeding and the age of the breeder had a significant effect on the resulting production output. In terms of income, the price of tofu dregs and cheap quality rice significantly affect the amount of income. The encouraging thing is that although the pig farming business has not had a significant effect on the food security of the farmer's family, this business is able to keep the family of the breeder away from the poverty line. The pig farming business can be used as a means of alleviating poverty in the community by further increasing the need for alternative sources of food.
Keywords: Pig Production, Net Revenue, Food security, Poverty gap, TSLS
DOI: 10.7176/JBAH/13-4-01
Publication date: March 31st 2023

1. Introduction

Poverty in Indonesia and several developing countries in Asia has still always been a contentious issue leading to intelligent solutions sought, creative and strategic (Deutsch et al. 2020; Thurlow et al. 2019; Abbas et al. 2020; Browning et al. 2014). One of the areas in Indonesia statistically significant number of poor people is the Land of Papua (Iyai and Saragih 2015; Tirajoh et al. 2016). Since year of 2000, the land of Papua has two provinces, i.e. Papua and West Papua. Data shows that the number of poor households in Papua is 391,767 head (out of 480,578 head) or approximately 81.52% and in West Papua is 128,156 head (out of 170, 049 head) or approximately 75.36% (Papua Barat 2019). The spread of the poorer households are not only accumulated in the township, but are often found in urban areas (Widayati et al. 2018; Michael 2010; Warastuti 2001).

West Papua is a land with vast potential for the development of animal husbandry judging from natural resources such as land, agriculture production, farmers, and climates. According to statistics of the province of West Papua (2005) and the Monitoring and Evaluation Team of Livestock at West Papua province in year 2007, the production of forage and agricultural waste including plantation in the province of West Papua was 42,442,750 tons from an area of 4,244,275 ha which can be a potential source of animal feed. Some livestock commodities are generally kept in Papua are cattle, chickens, goats and pigs (Iyai and Yaku 2015). Pigs are the most popular commodity for the Papuan people. Pig populations in Papua alone amounted to 546,696 tail. It has the six rank in

the entire population of pigs in Indonesia.

Development of livestock sector become strategic if it is based on available local resources, farmers capacity and the needs. Although the national government's programs to achieve the target of self-sufficiency in meat through acceleration of the achievement of beef sufficiency (P2SDS) done, however local strategic of the commodities' development such as pigs should remain a priority for the region specifically to promote local food availability as a major preference.

The increase in livestock production cannot be separated from the role of the involvement of production input factors used, and socio-economic background. Both of these aspects can affect the dynamics of pig farm production. The parameters of pig production that are commonly measured include the number of sows, the amount of feed given, the amount of working time of the breeder, the number of workers, the age of the farmer as a business decision maker, the number of family members, the education of the farmer and the length of time the farmer has run his business (experience). Some other aspects that are not commonly studied are the amount of meat production from live pigs (kg/year) in livestock business. This will add a number of indicators of livestock production parameters. Revenue can come from on-farm business revenue and off-farm business revenue. The income aspects that are commonly studied can be in the form of breeding business income, labor wages, sow prices, energy source feed prices, protein source feed prices, and drug prices.

The dominant poverty factors measured are the poverty gap, total household income of breeders, number of dependents, number of working families, family education, and total sources of income for pig farmers. The poverty factor will have an effect on the ability of family food security. The indicators of household food security measured are the share index of food expenditure, household income, the age of the head of the family as the decision-making center, the price of staple food prices commonly consumed by farmers, such as rice, cassava prices, sweet potato prices, yellow tail fish prices, the price of side dishes, tofu, tempe (fermented soybean food), meat, etc. Household economic resilience is also measured by the availability of funds for non-food purposes such as health and education. All of this data will be the baseline data for indicators of current performances of pig farming achievement.

The data analysis approach in agriculture and animal husbandry uses many analytical tools such as linear regression and logistic regression, another data analysis application model that can be used is Two Stage Least Squares (2SLS) (Larue et al. 2020). 2SLS data analysis is a data analysis that is applied in calculating equation parameters simultaneously. This analytical model is used to replace the OLS method because of the existence of a correlated association between large endogenous variables and errors.

The use of TSLS regression analysis has not been widely used in the analysis of livestock production (Serrano et al. 2014; S Larue, et al. 2008; Labbé 2003), especially pig agribusiness related to food security and poverty reduction. Therefore, this paper will present the application of measuring livestock production, net income in relation to poverty reduction in pig farming using the Two Stage Least Squares analysis tool.

2. Conceptual Framework

2.1. Pig Farm Performances

Performance Pig farm performance has various parameters that are often used to assess livestock productivity (Ogunsipe et al. 2017; Camerlink and Turner 2017; Zebua and Siagian 2017; Tekle et al. 2013; Mbaso and Kamwana 2013; S Larue et al. 2008; Kupang 2004; Monim et al. 2020). Indicators such as capital, land, skills, marketing and others are seldom applied. These breeder resources will determine livestock production capacity with all production objectives such as breeding centers (Zebua and Siagian 2017; Alberto et al. 2010; Ouma et al. 2013), fattening centers (Ouma et al. 2013), and superior cement producing centers . There are many livestock and livestock production indicators developed by various researchers and pig companies to maintain the world's demand for meat. The factors that determine the production of pigs in the world are production facilities, labor, business scale (agribusiness), and socio-economic aspects.

The factors that determine On-Farm livestock production are the cost of facilities and infrastructure, socio-economic aspects, business scale, and socio-economics. The factors that determine Off-Farm livestock production are income outside households and farms. The ability to get off-farm cash will be a valuable input in increasing the input units used to maximize production and productivity.

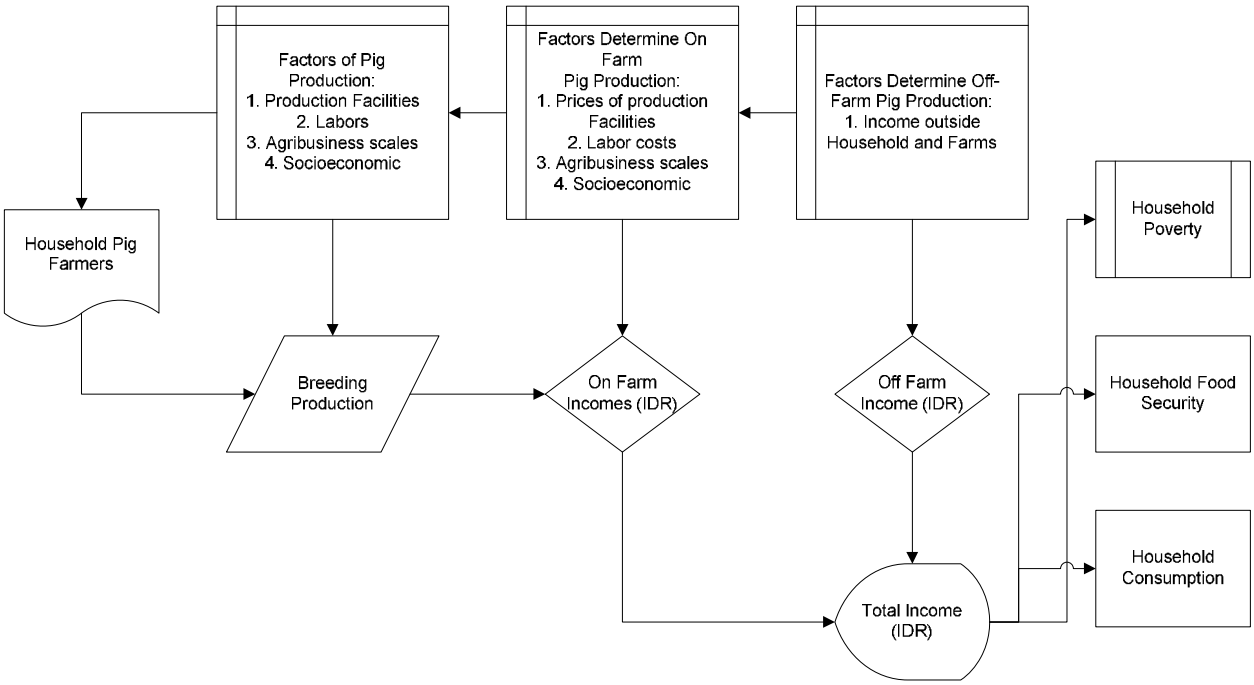

Figure 1. Logical framework theory applied in this study.

2.2. Poverty

The factors that determine poverty are the total income of the farmer's household, the number of dependents, the number of working families, family education, and family income sources. Poverty that is measured is using the poverty gap (Mayberry et al. 2017; Ponti et al. 2012; Belo 2019). The definition of poverty gap index is an analytical tool to measure the intensity of poverty. Intensity of poverty (Abbas et al. 2020; Christiaensen et al. 2011) determine a gap of poverty in population as a proportion of the poverty line.

2.3. Food security

There are many ways to measure the condition of food security (Ponti, Rijk, and Ittersum 2012; Murray et al. 2016; Christiaensen, Demery, and Kuhl 2011)(Ponti, Rijk, and Ittersum 2012; Baijukya, n.d.; Murray et al. 2016; Christiaensen, Demery, and Kuhl 2011), both qualitatively and quantitatively. The measurement of resilience chosen is to use the share index of food expenditure, with the aim of obtaining the proportion of food expenditure of the farmer's household compared to the total expenditure of his household (Vasco et al. 2018; Vega et al. 2013; Ilham and Bonar 2007; Tawaf and Lengkey 2007). The rationale for using this type of measurement is to measure the economic capacity of the family. A well-established household is assumed to be free from the basic necessities of life, namely food expenditure so that a prosperous household has a relatively small portion of food expenditure (<60%), and the household has sufficient funds to meet needs other than food such as education, investment, food, recreation or buying goods to increase family prestige (Ajmair and Akhtar, 2012).

3. Materials and Methods

3.1. Selected Sites and Farmers

In comparison of the urban and rural pig farmers in West Papua, three regencies of represented sites were chosen, ie Manokwari, Bintuni and Sorong. Astronomically, Manokwari Regency is located below the equator, between 0° 14' s and 130° 31' e. The geographical boundaries of Manokwari Regency are in the west by Tambrauw Regency, in the north by the Pacific Ocean, in the east by the Pacific Ocean and in the south by the Arfak Mountains Regency and South Manokwari. Astronomically, Sorong Regency is located at 00° 33' 42" – 01° 35' 29 " South Latitude and 130° 40' 49" – 132° 13' 48" East Longitude. Astronomically, Teluk Bintuni Regency is located between 1°57'50" - 3° 11'26" South Latitude and between 132°44'59" - 134°14'49" East Longitude. The administrative area of Bintuni Bay Regency has boundaries: South Sorong Regency and North Manokwari Regency; Fakfak Regency and Kaimana Regency in the South; South Sorong Regency in the West; Manokwari Regency, Wondama Regency and Nabire Regency in the East.

A total of 50 farmers were selected as respondents who were interviewed representing pig farmers in each of the above districts. Thus the total respondents obtained are 150 heads of families.

3.2. Measured parameters

Pig production, pig revenues, poverty gap and food security were analyzed simultaneously by Two Stage Least Squares regression (Widarjono 2008). The basic model used to construct each function in the Simultaneous Recursive Equation comes from pig farmer households. The stages of analysis are as follows.

1. Production Function

In seeking how the production system of raising pigs has been carried out by the Papuan people and seeing the role of the involvement of production inputs used as well as the socio-economic background that is able to influence the dynamics of production in pig farms, Regression equation *Two Stage Least Square* [*TSLS*] was applied, i.e.

Ln **PROD**= ln ao + a_1 ln Sow+a_2 ln Ration+ a_3 ln Lwh+ a_4 ln Labor + a_5 ln FarmerAge +a_6 ln FM + a_7 ln Educ + a_8 ln Expc + , where Prod: Total production (kg/y), Sow: Number of sows owned by the farmer (head/hh), Ratio: Amount of feed on offer (kg/d/UT), LWH: Outpouring of time Farmer's work (hr/d), Labor: Number of workers used for business, FarmerAge: Age of Farmer decision maker in business (y), FM: Number of Farmer's family members (people), Educ: Farmer's Education (y), Expc: The length of time the farmer has been running his business, a: intercept, and Ai: regression coefficient (estimated parameter)(i= 1-8), and : error terms.

2. Income Function

In analyzing the income from pig farming and socio-economic factors that affect the income of the pig breeding business, the regression equation function *Two Stage Least Square*is used, namely;

ln IncOnFarm = ln bo + b_1 ln PToffuWaste + b_2 ln PBranRice + b_3 ln PSweetPot+ b_4 ln PLQRice + **,** where IncOnFarm: Income of Pig Business, P.ToffuWaste: Price of tofu dregs (IDR./kg), P BranRice: Price of Bran (IDR./kg), PsweetPot: Price of Sweet Potato (IDR./ kg), PLQRice: Price of Low Quality Rice(IDR./kg), Bo: intercept, Bi regression coefficient (estimated parameter)(i= 1s/d 4) and

IncOnFarm: (Total Sales of Pig/y × Price of Pig (IDR0). -Total Cost

3. Poverty Function

In analyzing factors that affect poverty, the *Two Stage Least Square* was employed, namely;

Ln POV = ln c_0 **+ $c_1$ln IncOnFarm +** c_2 ln Incomeofffarm + c_3 ln FarmerAge + c_4 ln FM + c_4 ln Educ+ , where FarmerAge: Age of decision maker in business (y), FM: Family members (head), Educ: Farmer Education (y), and : error term.

In calculating the value of poverty, the Poverty Gap employed using the formula of **PG= [Incomeofffarm + ln IncOnFarm)/Number of members covered – West Papua poverty standard].** The poverty standard for West Papua 2021 is IDR. 688.000/head/month.

4. Food Security Function

To analyze the determinants of food security of pig farmer households, the following regression equation was applied, i.e.;

Ln FRE =ln d_0 **+ d_1 ln IncomeOnffarm +** d_2 Incomeofffarm + $d_3$ln EducEx + d_4 ln HealthEx + d_5 ln PriceRice + $d_6$ln Pcasava +d_7 ln Pfish + d_8 ln Pchicken + d_9 ln PTofu + d_{10} ln PTempe + , where FRE: Food Ratio Expenses (Total Expenses of Food divide total Family Expense), **IncomeOnffarm**: Income of Pig business (IDR/y), INP: Non-pig income (IDR/y), EducEx: Education fee, HealthExp: Health fee (IDR/y), PriceRice: rice price (IDR/kg), Pcasava: Cassava price (IDR/kg), Pfish: Price of yellow tail fish (IDR/kg), Pchicken: Price of Chicken (IDR/kg), PTofu: Price of Tofu (IDR/kg), PTTempe: Price of Tempe (IDR/kg) and *:* error terms.

In finding out the value of food security, the value is measured using the share of food expenditure and the food security index (Ilham and Bonar 2007) as follows:

, ω = $\frac{\textbf{House hold expences}}{\textbf{Total expences}}$**×100%,** where ω = share of food expenditure.

If the share of food expenditure is < 60% of the total expenditure, the household is food insecure. If the share of food expenditure 60% of the total expenditure is a house that is not food safe.

In finding out the relationship between production, income, food security and the poverty level of pig farmers, it is necessary to identify models to determine regression estimates. According to Widarjono (2008) the identification of simultaneous equations can be done using the order condition and rank condition methods. Identification of simultaneous equations with order conditions is a basic prerequisite (necessary condition) which will produce three possibilities, namely unidentified simultaneous equations (*unidentified*), identified simultaneous equations (*just identified*) and c) simultaneous equations are too identified (*over identified*) and identification of simultaneous equations with *order conditions* require some rules of the game. In this regard, it is necessary to first know the notation in *order condition*, namely M: the number of endogenous variables in the simultaneous model, m: the number of endogenous variables in a particular equation, K: the number of exogenous variables in the simultaneous model, and k: the number of exogenous variables in a particular equation.

Endogenous variables are variables whose values are determined in the model, while exogenous variables are variables whose values are determined outside the model. Identification of simultaneous equations using *order conditions* , namely;

1) simultaneous M equations are identified if they have at least M-1 variables (endogenous or exogenous) in the model. If the model is exactly M-1, then the model is identified (*identified*) and if it is more than M-1 then the model is too identified (*over identified*) and
2) the model identification test is based on an *order condition* or necessary condition (*necessary condition*) then the structural equation model is said to be identified as a simultaneous equation model if it meets the following criteria: (Kk) (m-1), where K = number of exogenous variables in the model, k = number of exogenous variables in the equation and m = number of endogenous variables in the equation.

The identification results consist of 3 (three) groups, namely (a) under identified, (b) exactly identified or just identified, and (c) over identified. The decision making is

a) If $K - k < m - 1$, then: under identified, if the equation is under identified (not identified), then the equation cannot be estimated. Therefore, under-identified equations cannot occur in simultaneous equations, then the equation must be changed or updated.

b) If $K - k = m - 1$, then exactly/just identified. If the equation is exactly/just identified, then the equation can be estimated.

c) If $K - k > m - 1$, then: over identified. If the equation is over identified, then the equation can be estimated. Based on the above equation, it can be rearranged the structural equation as outlined in Table 1.

Table 1. Identification of necessary condition in the fourth equations.

Equation	M-1	K-k	m-1	Identification
1.Production (M1)	3	26-8= 18	1-1=0	over
2. IncOnFarm (M2)	3	26-5=21	1-1=0	over
3. Food Security(M3)	3	26-10=16	3-1=2	over
4. Poverty (M4)	3	26-4=22	3-1=2	over

Based on Table 1., there are 4 structural equations, which consist of: (i) one production equation, (ii) one pig income equation, (iii) one food security equation and (iv) one pig breeder poverty level equation. Identification test results *order condition* is known that all equations are overidentified, then the model estimation method used is the *Two Stage Least Squares* (TSLS) method.

3.3. Hypothesis

Pig Production Activities will generate pig income (Income on Farm) which can alleviate people from poverty and increase the food security of pig farmers' households.

4. Result and Discussion

4.1. Livestock Production Performance

The first indicator to be measured is the production output of kilograms of body weight of pigs produced annually by each pig farmer. The values obtained in the three study areas show a range of values from 40 kg/head to 17.480 kg/family (=452.13 kg/family). Assuming every average body weight of 80 kg/pig can be kept by farmers, then the number of pigs that can be kept by farmers is 1 to 218 heads/breeder. This was also confirmed by Mbaso and Kamwana (2013); Eliakunda et al. (2015), and Muhanguzi et al. (2012). The amount of livestock output is linearly proportional to the number of female parents. The number of female parents kept by breeders was in the range of 1 head/head to 81 head/head (=11 head/head). This also shows that pig farmers in West Papua are able to raise >50 pigs (Widayati et al. 2018). The value of adequacy of feed given in quantity by each pig breeder is at the level (0-100% basal requirement of cattle per body weight) 35.37%-495% / animal body weight with an average value of = 161.93%.

Table 2. Performances of production and socio-economic of pig farmers.

No.	Parameters	Minimal	Maximal	Averages
1	Output (kg LW/y)	40	17480	452,13
2	Female parental size (head/hh)	1	81	11
3	Feed Sufficiency (%/kg berat badan)	35,37	495,00	161.93
4	Work hours allocation (hr/d/head)	1	6	3
5	Age (y)	27	80	44
6	Family size (head/hh)	1	11	4
7	Formal education (y, level)	1	16	11
8	Experience (y/hh)	4	40	11
9	Net income from pigs (IDR/y)	2,000,000	790,000,000	48,673,000
10	Net income non pigs (IDR/y)	18,000,000	760,000,000	81,896,000
11	Total revenue of family (IDR/y)	34,500,000.00	1,362,000,000	130,569,333
12	Food consumption ratio (%)	24	91	63

The ability to raise a number of pigs will be linearly positively proportional to the indicator of the farmer's working time to manage pigs. The value of this indicator is obtained which is in the value range of 1 hour-6 hours per day/breeder with an average of = 3 hours/household. The number of pigs kept by farmers correlates with the age of pig farmers who raise pigs. This indicator was found that farmers who raise pigs are in the age distribution of 27 years - 80 years with an average of 44 years. Communal lifestyle allows the number of family members living in farmer households in West Papua to be in the range of 1 person-11 person/head with an average of 4 people/head. In the aspect of education, the average formal farmer is 11 years old or equivalent to graduating from junior high school. The experience of farmers in raising pigs is in the range of 4 years to 40 years (=11 years). The experience of the farmer will determine the management ability, skills and work efficiency. This will lead to the level of effectiveness and productivity of work as measured by income.

The income of farmers from pigs (IDR/year) ranges from IDR 2,000,000-IDR. 790,000,000, with = IDR. 48,673,000. Meanwhile, non-pig income earned by pig farmers ranges from IDR. 18,000,000 to 760,000,000 (=IDR. 81,896,000). Thus, the total income of pig farming families in West Papua is in the range of IDR. 18,000,000-IDR. 1,362,000,000 (=IDR. 130,569,333).

This communal lifestyle has an effect on the ratio of food expenditure. The ratio of food expenditure for pig farmers in West Papua is in the range of 24%-91% with = 63%. This figure means that 63% of the income earned by farmers is used for food expenditure. Only a small amount of the remaining funds can be used for other purposes such as education, health, recreation or investment. Information related to food prices in West Papua in this study can be seen in table 3.

Tabel 3. Averages ownership of pig keeping size population.

Regency	Starter (Age 0-3 month)		Grower (Age 3 - 8 month)		Finisher (parents)	
	Male	Female	Male	Female	Male	Female
Bintuni (n=50)	1.83	2.67	2.00	2.78	1.12	2.00
Sorong (n=50)	6.11	7.73	4.61	5.80	2.71	4.32
Manokwari (n=50)	3.08	3.82	2.86	3.74	2.46	3.7
Papua Barat (N=150)	3.63	4.56	4.56	4.71	2.29	3.83

In order to evaluate whether the production practice that generates income on farm raising pigs is able to alleviate people from poverty and improve food security, a simultaneous regression is carried out involving the equation of production, income on farm, poverty function and food security at the same time.

The results of the analysis of the relationship between production, income, poverty levels and food security are presented in Table 4.

Table 4. Determinant Factor of Production, Pigs Revenue, Poverty gap and Food Security of Farmer Household in West Papua Province.

Variables in Production Activity	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Significancy**
Parental pig size	0.001	0.057	0.014	0.989	NS
Ransom	0.981	0.062	15.715	0	***
Labour Work Hours	-0.119	0.085	-1.404	0.163	NS
Labors	0.073	0.084	0.873	0.384	NS
Ages of farmers	0.355	0.057	6.176	0	***
Family member size	0.069	0.038	1.81	0.073	*
Education	0.016	0.033	0.478	0.634	NS
Experience	-0.05	0.041	-1.208	0.229	NS
R-squared	0.893		J-statistic		139
Adjusted R-squared	0.888		Prob(J-statistic)		0.000
Variables in Income On Farm	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Significancy**
Concentrate price	0.733	1.069	0.686	0.494	NS
Tofu dregs price	-3.677	0.282	-13.025	0	***
Paddy waste price	-0.16	0.368	-0.435	0.664	NS
Sweet Potato price	-0.312	0.932	-0.335	0.738	NS
Cheapest Rice price	4.921	0.781	6.303	0	***
R-squared	0.566		J-statistic		142
Adjusted R-squared	0.554		Prob(J-statistic)		0.000
Variables in Poverty Level	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Significancy**
Net income of pigs (IDR.)	0.126	0.025	5.098	0	***
Net income non pigs (IDR.)	0.783	0.024	33.1	0	***
Ages (y)	-0.082	0.096	-0.857	0.393	NS
Family member size	-0.999	0.034	-29.298	0	***

Education	0.001	0.032	0.024	0.981	NS
R-squared	0.947		J-statistic		142
Adjusted R-squared	0.946		Prob(J-statistic)		0.000
Variables in Food Security	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**	**Significancy**
Net income from Pigs (IDR./y)	0.042	0.035	1.197	0.233	NS
Net income non pigs (IDR./y)	0.197	0.109	1.804	0.074	*
Education cost (IDR./y)	0.01	0.021	0.493	0.623	NS
Health cost (IDR./y)	-0.022	0.017	-1.348	0.18	NS
Rice Prices (IDR./kg)	-5.466	2.024	-2.7	0.008	***
Cassava pice (IDR./kg)	7.67	2.856	2.686	0.008	***
Fish price (IDR./kg)	-1.322	0.315	-4.203	0	***
Chicken price (IDR./kg)	-1.287	0.883	-1.457	0.147	NS
Tofu dregs (IDR./kg)	-0.319	0.823	-0.387	0.699	NS
Tempe price (IDR./kg)	0.622	0.783	0.794	0.429	NS
R-squared	0.578		J-statistic		5.488
Adjusted R-squared	0.555		Prob(J-statistic)		0.000

*: significant in Confident Interval 90%, **: significant in Confident Interval 95%,, ***: significant in Confident Interval 99%, NS: Non Significant.

Production is measured by adding up the total weight of piglets produced by pig breeding in one year. From the results of the regression of the factors that affect production, it is known that the amount of ration affects the amount of production produced (CI 99%). On this basis, in developing the pig business in Manokwari, knowledge related to pig rations must be prioritized. The results of research from Widayati (2019) on pig farms in Manokwari Papua in 2014 showed the fact that only one in 7 farmers knew how to provide good nutrition for feed. One indicator that feed has good quality according to Haryanto (2009), Aritonang et al. (2018), Sitindaon et. al. (2013) is feed that has the right balance of PK and Energy (Ginting 2019; Silalahi 2020; Haryanto 2009). The materials used to feed pigs mostly use locally available materials such as tofu dregs, fish waste, mung bean and soybean skins (as a source of protein), rice bran, banana stems, plantain peels, taro peel, market waste and waste. stalls (as a source of carbohydrates). Only a few breeders use commercial feed as rations for livestock due to the high price and discontinuity of existence (Widayati, 2018, Santoso, 2020). Another factor that significantly affects production is the age of the breeder (CI 99%). According to the results of the study in Table 1, the age of the farmer greatly influences performance. Considering that pig business requires an outpouring of time and handling that requires quite a lot of energy, it is expected that the breeders are in a productive age (15 to 55 years). In table 2, it is shown that the average age of the breeder is 44 years old. This age is included in the productive age group (Yai 2011; Iyai et al. 2018; Nguthi 2007).

Table 5. Age structure of pig producer (N=150)

<20 years (%)	**20-29 years (%)**	**30-39 years(%)**	**40-49 years (%)**	**>50 years (%)**	**Total (%)**
0.00	6.00	48.00	38.00	8.00	100
0.00	6.00	40.00	30.00	24.00	100
0.00	2.00	12.00	30.00	56.00	100
0.00	4.67	33.33	32.67	29.33	100

The number of family members has a significant effect on the amount of pig production. According to the results of the Iyai (2011) study, livestock business in Papua generally involves family workers, so the number of family members who can be involved in helping the business will determine the sustainability of the business.

Pig income is obtained from the value of the sale of piglets obtained in the business for one year. Factors that have a significant effect on income are the price of pig feed, including the price of tofu dregs and the price of low quality rice. The fluctuating prices of these feeds in West Papua are related to scarcity and competition. As we know that tofu waste is a by-product of the tempe and tofu manufacturing industry (Hidayat 2012; Kata et al. 2020). The majority of the tofu industry uses imported soybeans as the raw material for making tofu, so the unstable price of this commodity will affect the price of its associated products as well. In addition to the price of tofu dregs, the price of low quality rice also significantly affects the income of farmers. The high price of commercial feed and the instability of the presence of commercial feed make farmers look for alternative feed for energy needs derived from low quality rice (Anggraini et al. 2017; Harahap et al. 2020; Ginting 2019; Madarisa et al. 2007). This type of rice is often traded in the local market at a relatively cheaper price than consumption rice.

The poverty rate is measured by looking at the distance between the income per capita of the family of farmers and the poverty line (Orthner et al. 2004; Angelsen et al. 2014; Abbas and Muhtarom 2018; Abbas et al. 2020; Christiaensen et al. 2011; Marcus 2015). The results of the regression analysis to see the effect of pig income on the poverty level showed that pig business income significantly increased the distance between farmer family

incomes and the poverty line (Sani et al. 2020; Iyai 2010). This could have implications for local government policies to make pig farming in Papua a tool for poverty alleviation.

Furthermore, it can be used to answer the question of whether pig farming can improve food security. It can be seen from table 4 that pig income has not affected food security. It can be seen from table 3 that on average the farming community still has a share of food expenditure of 63% of the total family. Which means that 63% of the total public expenditure is used to purchase food. The high increase in the consumer price index in West Papua shows that prices, including food prices, are still high in West Papua. Foodstuffs, in this case rice and fish, have a significant influence on the food security of West Papua farmer families. It is known that the Papuan people have rice as their staple food and fish dishes as their daily diet. So that this increase in food ingredients will affect the budget allocation for eating in the household. The role of the government is very necessary in controlling the prices of feed ingredients in an area.

By seeing that pig production activities in the Papuan community are able to contribute to increasing people's income which ultimately can reduce the poverty level of the community, it is appropriate for the government to use pig farming as a tool to save people from the threat of poverty. Only need improvement on the determinants of production, especially feed. According to the results of the study that feed has a significant effect on increasing production while public knowledge regarding feeding for pigs is not sufficient, it is necessary to conduct more in-depth training on feed management, especially by paying attention to the nutritional aspects of the feed. Another aspect that needs to be considered is the availability of adequate, cheap, and continuous animal feed. In the future development of pig farming, it is necessary to consider alternative feed sources from agricultural and industrial waste so that the feed supply is not dominated by one or two feed sources (Widayati, 2019).

It can be said that the pig farming business is able to contribute to reducing poverty in the community but has not been able to fully improve family food security. The important implication for local governments to be able to change the pig farming business is not enough just to increase the income of the community just to meet basic needs, but it needs to be transformed into a more modern, intensive and institutional business so that the pig farming business has a wider market, is available continuously and have competitive prices.

5. Conclusion

The factors that have a significant effect on the production of pig farming are feeding and age of the breeder. Factors that have a significant effect on income are the price of tofu dregs feed and low quality rice. In the aspect of food security, the influence of food prices, especially rice, cassava and fish prices as people's daily food, still dominates the food expenditure of the family of farmers so that the pig farming business has not been able to fully improve the food security of the farmer's household. In the aspect of poverty, the number of family members has a negative effect on efforts to reduce poverty, but the encouraging thing is that the income of pigs can play a positive role in keeping the family of farmers away from the poverty line. An important implication for local governments is to be able to change the pig farming business which is not only to meet basic living needs but needs to be transformed into a more modern, intensive and institutional business so that pig farming businesses have a wider market, are available continuously and have lower prices. compete.

Acknowledgement

We thanked staffs of regencies of agriculture and livestock boards for assisting, collecting, and sharing data. All communities and pig farmers are thanked. Statisticians from Papua University was grateful for consulting the statistical data analysis and research methods. We also thanked all blind reviewers for improving this manuscript to be readable and understandable.

Ethical Statement

Ethical approval

Consent has been obtained from all the participants for this research and the Animal Ethics Committee of Animal Science Faculty, The University of Papua coordinated by Budi Santoso (No. of Reference letter: SP-004/UN42.3/PP/2022).

Declaration for competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authors' contributors

Atus Sayori, Andoyo Supriantono, Trisiwi W. Widayati, Sangle Y Randa, and Deny Iyai designed, run the field researches and written the manuscript.

Funding statement
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

Novelty statement (Highlight)

1. Application of Simultaneous regression of Two Stage Least Square on computing effect of pig production, net revenue, poverty reduction and Food Security
2. These four equations of pigs production, net revenue, poverty reduction, and food security are over identified, having suitable for further analyses.
3. Significant findings are ransom, ages, sum of household size
4. Implication of this research will be applied on livestock related production.
5. Methods in promoting poverty and food security analysis can be done by incorporating pig production and net revenue simultaneously.

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