Research Article

Technology Mitigation of Pigs Parasites Contamination Using Laleken and Free-Range Systems Applied by Highland Farmers

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Abstract | This study aims to compare the pig rearing model between the laleken system and the free-range system on the possibility of preventing contamination of water, vegetables and soil around the yard by parasites from pig feces and urine. The study was conducted in Minyambouw District, Arfak Mountains Regency on 30 local pigs with a body weight of 10-15 kg and a minimum EPG of 2000, before and after the application of laleken. Stool samples come from fresh feces. Water samples were collected from pools around the farmer's house in both systems, vegetable samples were collected from three points ± 0 m, ± 1 m, and ± 2 m apart from the fence and soil samples were collected at three points ± 1 m apart, ± 10 m apart, ±25 m from the house with three replications. The second stage of collection was carried out on day 0 and day 30 after laleken was applied. Sample examination with native method, McMaster and sedimentation. Quantitative data are presented in mean ± standard deviation. The results of the comparison of the two systems were analyzed using the t-test. All pigs were superinfected by *Ascaris* spp, *Trichuris* spp and *Strongyloides* spp parasites with a mean EPG of 2185.56. The prevalence of parasitic eggs of *Ascaris* spp, *Trichuris* spp and *Strongyloides* in water, vegetables and soil ranged from 62.96% to 98.15%. Laleken system can reduce environmental pollution by parasites 89.28% to 100%.

Keywords | Pigs, Laleken, Papua, Parasites

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INTRODUCTION

Pigs place the first animal agriculture raised in the world (Eliakunda et al., 2015; de Greef et al., 2011; Kanis 2003; Baxter and Edwards 2017). Pigs will produce many piglets and have three parturition times by average 8-12 piglets born (Ouma et al., 2013; Muhanguzi et al., 2012; Mbaso and Kamwana 2013; Tekle et al., 2013; Iyai et al., 2018; Montsho and Moreki 2012; Holt et al., 2019). Pigs (*Sus scrofa* sp) are livestock that are easily found in Papua and have many meanings in the social and cultural livings of the Papuan people. Apart from being a symbol of wealth, pigs can also be used to solve customary problems in Papua such as paying a fine for a case, paying a dowry, a funeral ceremony and celebrating a bountiful garden harvest (Pattiselanno and Iyai, 2005).

Most of the patterns of rearing pigs in Papua are carried out semi-intensively or traditionally, namely by means of public display (Pattiselanno and Iyai, 2018). This pattern of maintenance opens up opportunities for various environmental problems such as contamination of water, soil and agricultural products by pig waste, which in turn can endanger human health (Terry and Khatri 2009; Jonge et al. 2008; Camerlink and Turner 2017; Wischner et al. 2009; Petit and van der Werf 2003).

Pig livestock waste such as feces and urine can be categorized as environmental pollutants. This is because the parasites contained in the feces and urine of livestock have the ability to pollute the environment, especially water and soil, which in turn is dangerous for humans who live around them (Sudiarto, 2008). Damriyasa et al. (2013) suggested that soil samples from the Arfak Mountains and Baliem Valley were positive for soil-transmitted helminths (STH) eggs such as *Ascaris* spp and *Trichuris* spp (Wabacha et al. 2004). One of the factors that support the presence of STH in the soil from these two locations is thought to be due to the traditional pig rearing pattern that allows pigs to roam. This maintenance pattern reduces the quality of environmental sanitation which will have an impact on the health of farmers and the wider community who live around them (Pedersen 2017; Muhanguzi et al., 2012; Mugonya et al., 2021; Ouma et al., 2013; Chau et al., 2017; Petit and van der Werf 2003; Iyai 2010; Kijlstra and Eijck 2006; Holt et al., 2019).

Laleken is a tribe term and language defined as pig farming production practiced by Dani tribe in Central Highland of Papua, i.e. Wamena (Cargill et al., 2015; Soplanit et al. 2021; Siagiaan 2010; Cargill et al., 2009; Cargill and Mahalaya 2014; Wahyuni et al., 2020; Mahalaya 2010). Laleken is a plot of land that is fenced off as a place for pigs to spend the day playing and eating high protein grass (Cargill et al., 2014). In laleken, certain plants or plants are usually planted, such as *Peurasia cephaloides*, *Centrosema* sp, *Colopagonium* sp and *Ipomoea batatas* or other plants that can be eaten by pigs. The pattern of rearing pigs with the laleken system allows the pigs to be in a controlled environment all day long, so it is believed that the possibility of pigs as a source of environmental pollution (Wea et al., 2017, Terry and Khatri 2009; de Barcellos et al., 2013; Petit and van der Werf 2003) does not occur. Until now, no research has been conducted that compares the level of environmental pollution caused by pigs reared with the Laleken system with the traditional system. This study aims to compare the pig rearing model between the laleken system and the free-range system on the possibility of preventing contamination of water, vegetables and soil around the yard caused by parasites originating from pig feces and urine.

MATERIALS AND METHODS

This research was conducted in three villages in Minyambouw District, Arfak Mountains Regency, namely Upload Village, Sigim Village and Sinaitosi Village. The research is divided into two stages. In the first stage, sample collection was carried out before treatment and in the second stage, sample collection was carried out by comparing the legal system with the traditional (traditional) system. A total of 30 local pigs weighing 10-15 kg were placed intentionally based on village origin. All pigs used were positive for worm parasites based on the McMaster method of faecal examination with eggs per gram (EPG) of at least 2000 (Sambodo et al., 2020). Each system contains 5 pigs for each village. The variables observed in this study were the diversity and prevalence of environmental polluting parasites originating from the feces and urine of pigs in water, vegetable and soil samples before treatment and between laleken and traditional rearing systems. Identification of helminth parasite eggs based on (Midha et al., 2018).

Stool samples come from fresh feces that have just been secreted. The collection of water, vegetable and soil samples in this study was carried out according to Tymezyna et al. (1999) with three repetitions. Water sample collection was carried out in water puddles around the farmer's house in both patterns of pig rearing. Water samples were taken as much as 250 ml for each point of water puddles. Vegetable samples were taken as much as 250 g, collection of vegetable samples was done by cutting the part of the stem that borders the ground. The collection of vegetable samples was carried out at three points, each ± 0 m, ± 1 m, and ± 2 m from the guardrail. Soil sample collection was carried out at three points, namely in the area around the house with a distance of ±1 m, ±10 m, ±25 m respectively from the house. Soil samples were taken as much as 50 g at a depth of 2-5 cm using a sterilized spatula. The sample collection in the second stage was carried out on day 0 and day 30 after the laleken system was applied. The method of examining the types of worm eggs in feces is carried out using the native method (Purwaningsih et al., 2017) and on water, vegetables and soil using the sedimentation method (Hadidjaja 1990).

Data Analysis

Quantitative data are presented in mean ± standard deviation. The results of the comparison of the two systems were analyzed using a t-test comparison (t-test) using (Field et al., 2012) the SPSS program at a significance level of 5% (Ott and Longnecker 2001).

RESULTS AND DISCUSSION

Study Area and Design Laleken

Minyambouw District is one of the districts included in the administrative area of Arfak Mountains District (Figure 1). Geographical Location of Arfak Mountains Regency, as follows: Northern part: 0°55' South Latitude; Southern Part: 1°40' South Latitude; West: 133°10' East Longitude; East: 134°05' East Longitude.

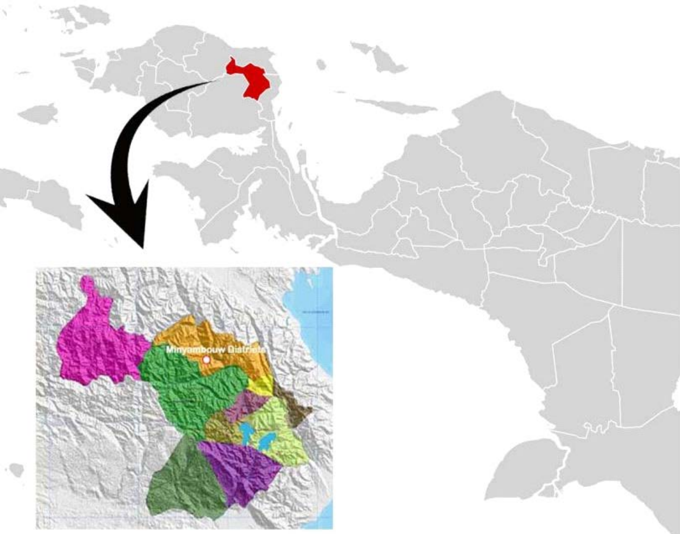

Figure 1: Pegunungan Arfak Regency.

In terms of physiography, the district with the highest percentage of area included in the *extremly steep* (very steep with a slope of >40%) is Minyambouw (73.83%). Soil structure in Arfak Mountains Regency consists of alluvial species (18.7%), Mediterranean (2.44%), red-yellow podzolic (10.41%), gray-brown podzolic (7.57%), complex soil (complex of soil) (49.21%), latosol (4.5%), and organosol (7.17%). The average annual precipitation is 260.82 mm, the average rainy days per month is 20.92 days. The minimum air temperature is 27.08 °C, while the maximum temperature is 27.80 °C with an average air temperature of 27.49 °C, the average humidity is 84.07%. (Wambrauw et al., 2015; Kabupaten Arfak 2016).

Laleken is a traditional term for a plot of land that is fenced off (Cargill et al., 2009; Siagiaan 2010; Soplanit et al., 2021; Cargill et al. 2015), where certain plants or plants can be planted, such as *Peurasia cephaloides*, *Centrosema* sp, *Colopagonium* sp and *Ipomoea batatas* or other plants that can be eaten by pigs. Laleken can be divided into smaller parts so that they can be used to rotate pigs from one license to another (Figure 2). Rotation is carried out when the pigs have eaten half (50%) of the plants or plants in one laleken. After the pigs are transferred to another laleken, then the abandoned laleken is immediately replanted, so that when the pigs return to the (abandoned) laleken it has grown back and the pigs can eat it again. The replanting process continues every time the rotation is carried out (Cargill and Mahalaya 2014).

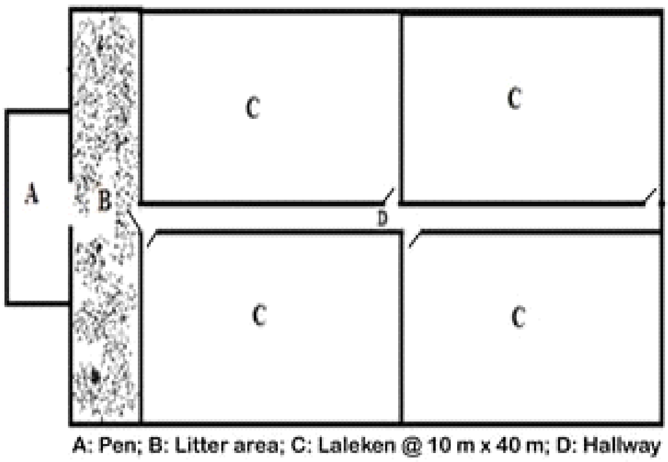

Figure 2: The logon design with 4 large Laleken.

STH Parasite Type and EPG Value

The mean EPG value in pigs used in this study was 2185.56. The types of STH parasites and the average EPG observed in pig feces samples in this study can be seen in Table 1. All research pigs were superinfected, where the host that had been infected with one type of parasite was infected by another type of parasite (Nowak and May, 1994). The types of parasites obtained are in accordance with the results of research by Nugroho et al. (2016) which states that there are at least 20 types of internal parasites in pigs in Papua, including *Ascaris Suum*, *Trichuris ransomy* and *Strongyloides*.

Based on the standard of parasitic infection according to Thienpont et al. (2003) then the infection of all parasites in the study pigs was classified as a moderate infection level (number of eggs 500-5000/g feces). The severity of the infection can be evaluated by a score, although it is highly dependent on the worm species, as egg production varies from day to day.worm *Ascaris* , can produce a large number of eggs, sometimes up to thousands of worm eggs and *Ostertagia* found in the host, but the results of stool examination do not show severe infection due to the small number of eggs.

The number of parasitic eggs in pig feces is strongly influenced by the number of parasites contained in the pig's body and the characteristics of each parasite include reproduction time and mode of transmission. STH parasite *Strongyloides* is the type of parasite with the highest number of eggs that infects pigs with the fastest reproductive time. The larvae of 3 *Strongyloides* become adult female worms which are present in the intestines in about 4 days, with reproduction starting soon after, detected by the presence of eggs and/or larvae in the feces (Viney and Lok 2015).

Table 1: Types of STH parasites and mean EPG infecting research pigs

Species of helminths	Village Unggah		Village Sigim		Village Sinaitosi	
	L	T	L	T	L	T
Ascaris spp	840±30,82	850±55,05	800±10,05	870±12,25	820±18,08	830±22,00
Trichuris spp	1250±18,32	1200±30,30	1160±25,22	1240±30,03	1180±19,23	1200±14,04
Strongyloides spp	4500±14,81	4540±15,02	4420±10,10	4350±17,40	4720±44,04	4570±18,08

Explanation: L: laleken; T: traditional

Table 2: Prevalence (%) of parasitic egg contamination in water, vegetables and soil

Species of Parasites	Water	Vegetables				Soil			
		Plot 1	Plot 2	Plot 3	Average	Plot 1	Plot 2	Plot 3	Average
Ascaris spp	79,63	100,00	66,67	44,44	70,37	100,00	94,44	100,00	98,15
Trichuris spp	77,77	83,33	77,77	50,00	70,37	94,44	94,44	88,89	92,59
Strongyloides spp	87,04	83,33	55,56	50,00	62,96	94,44	94,44	94,44	94,44

Table 3: Average EPG on the 30th day in water puddles with and without laleken

Samples	Parameters					
	Ascaris spp		*Trichuris* spp		*Strongyloides* spp	
	L	T	L	T	L	T
Water puddle	29,63±22,23[b]	337,04±20,20[a]	35,19±15,79[b]	353,70±15,67[a]	0,00±0,00[b]	305,55±15,79[a]
Vegetable						
Plot 1	16.67±17,17[b]	100.00±18,23[a]	22.22±23,34[b]	122.22±20,22[a]	0,00±0,00[b]	100.00±0,00[a]
Plot 2	0,00±0,00[b]	44.44±50,48[a]	0,00±0,00[b]	38.89±14,14[a]	0,00±0,00[b]	33.33±0,50[a]
Plot 3	0,00±0,00[b]	11.11±17,08[a]	0,00±0,00[b]	22.22±12,12[a]	0,00±0,00[b]	38.89±12,13[a]
Average	5,56	51,85	7,41	61,11	0,00	57,41
Soil						
Plot 1	16.67±13,27[b]	583.33±55,00[a]	50.00±45,47[b]	600.00±5,50[a]	50.00±20,22[b]	538.89±25,25[a]
Plot 2	27.78±20,21[b]	350.00±20,25[a]	44.44±16,75[b]	327.78±17,15[a]	16.67±17,17[b]	222.22±22,21[a]
Plot 3	11.11±17,18[b]	355.56±5,00[a]	22.22±67,98[b]	555.56±28,79[a]	16.67±15,67[b]	283.33±34,33[a]
Average	18,52	429,63	38,89	494,45	27,78	348,15

The different superscripts between columns T and L in the same parasite are significantly different

Ascaris suum takes approximately 6-7 days after infection to release the first eggs (Ballweber, 2001). After a series of *moltings*, *Trichuris suis* can be found in the intestinal lumen. The prepatent period is 6 to 7 weeks (Laber et al., 2002).

The high number of eggs of the *Strongyloides* spp parasite is thought to be influenced by other modes of transmission, namely transmamari or through milk. Infective 3 larvae that are transmitted via the transmammary route may stop their development and migration in the mammary gland, and then reactivate when the mother suckles (Viney and Lok, 2015). This allows the pigs to have been infected since they were still suckling the mother, which is also suspected to be positive for *Strongyliodes* spp.

Believed to be a type of parasite STH found in this study will determine the type of parasitic contamination in the environment. While the number of eggs counted, in addition to affecting the level of infection in pigs, is also believed to affect the level of pollution in the environment, where the greater the number of parasitic eggs contained in the feces of pigs, it will increase the burden of pollution caused in the environment. Eggs *A. suum* in the feces was positively correlated with the concentration of eggs in the soil used for pigs to move. The highest egg concentrations in soil were found in areas frequently used by pigs (Lindgren et al., 2020).

Prevalence of STH Pollution in the Environment

The results of the examination of water, vegetable and soil samples can be seen in Table 2. All types of worm parasites that infect pigs also contaminate water, vegetables and soil. These results are in accordance with the research of Tymcyna et al. (2015) and Kochanowski et al. (2017) which states that the soil and water in pig farms and surrounding areas are infected with eggs and larvae of worms of the genus *Strongylidae* and *Trichostrongylidae*, eggs of nematodes of the genus *Trichuris*, eggs of *Ascaris suum* and oocysts of the genus *Eimeria.*

The Effect of the Laleken System on Prevention of Environmental Pollution

The average EPG on day 30 of water, vegetable and soil samples from the pig pen without and with the laleken system can be seen in Table 3. In all samples, the average EPG experienced a significant decrease after the laleken system. applied. In waterholes, parasites of *Ascaris* spp were reduced by 91.21%, *Trichuris* spp. by 90.05% and *Strongyloides* spp. by 100%. In vegetables, parasites of *Ascaris* spp were reduced by 89.28%, *Trichuris* spp. by 87.88% and *Strongyloides* spp. by 100%. In soil, parasites of *Ascaris* spp were reduced by 95.69%, *Trichuris* spp. by 92.14% and *Strongyloides* spp. by 92.02%.

This is believed to be due to the limited activity of pigs, where before the laleken system was implemented, pigs were free to roam anywhere so that they became a source of contamination in water, vegetables and soil. Parasitic positive pigs will be a source of spread in the herd and in the environment. Animals with high positive numbers indicate widespread transmission within the herd and if infected pigs are transferred to pastures or other pens, the pigs are more likely to carry the infection with them (Katakam et al., 2016).

The decrease in the amount of EPG in all types of samples is believed to be caused by several factors, including temperature fluctuations (Cargill and Mahalaya 2014; Cargill et al., 2009; Siagiaan 2010; Soplanit et al., 2021). In outdoor conditions, the average embryonization and survival of *A. suum* and *T. suis* were influenced by season (temperature), soil type and vegetation (Pittman et al., 2015; Boyko and Brygadyrenko, 2020; Katakam et al., 2016; Baies et al., 2022; Kim et al., 2012; Whitehead et al., 2022; Midha et al., 2018). The rate of dehydration in *A. suum* and *T. suis* will increase as an exponential function of the increase in ambient temperature. High temperature combined with severe dehydration of faecal samples may be a major factor in mortality for *A. suum* eggs and *T. suis* during the summer (Larsen and Roepstorff, 1999). Added by Kim et al. (2012) that embryonation of *A. suum* is very limited at 5°C. On the other hand, at a temperature of 35°C egg embryonation experienced a more pronounced acceleration than 25°C. The laleken system has an effect on lowering water, vegetable and soil pollution around the yard caused by *Ascaris* spp, *Trichuris* spp and *Strongyloides* spp from pig feces and urine (Mahalaya 2010; Cargill and Mahalaya, 2014; Cargill et al., 2009; Soplanit et al., 2021).

DISCUSSIONS

Water pollution can occur due to the entry of feces, urine and pig waste, either directly or indirectly through soil gaps into water sources. Lindgren et al. (2020) found eggs of *A. suum* and, to a lesser extent, *T. suis* in the area around the pigsty, which had previously been used for swine activity and/or for disposing of pig waste. Referring to the results of research supported by previous research, it is believed that the type of parasite found in water puddles comes from parasites found in pig feces (Kochanowski et al., 2017). This proves that pigs that are positively infected with parasites have the ability to contaminate water puddles around the area where pigs are active. The prevalence of water pollution is thought to be influenced by the number of eggs counted in pig feces. Although not significantly different, the *Strongyloides* spp species, which was the highest in faecal EPG, had the highest prevalence of pollution in water puddles as well.

Besides being influenced by the number of parasitic eggs in faecal EPG, the prevalence of water pollution contamination is thought to be influenced by the survival ability of an egg in water (Lindgren et al., 2020; Widayati et al., 2020; Kim et al., 2012; Baies et al., 2022; Kochanowski et al., 2017; Pittman et al., 2015). This can be seen in the *Ascaris* spp species where the number of parasitic eggs in the polluted faeces EPG is lower than the number of eggs of the polluting parasite *Trichuris* spp, but has a higher prevalence. Ascarid worm eggs (nematodes) are known to be very resistant and very resistant to unfavorable environmental conditions. Eggs *A. suum* from pigs are commonly used as an indicator of pathogen inactivation in pig waste (Katakam et al., 2016). In addition to temperature, pH and ammonia levels affect the viability of A. *suum* eggs.

The highest prevalence of pollution in vegetables is at point 1 and the farther away the vegetables are from the fence, the lower the prevalence of pollution (Table 2) or in other words, the higher the concentration of pollutants in an area, the higher the level of pollution. These results are in accordance with the opinion of Roepstorff et al. (2001) and Katakam et al. (2012) that the average transmission of A. suum decreased in areas farther away from the pigsty. The results showed that the eggs of the parasite were able to move up to a distance of two meters from the boundary of the laleken fence or the limit of active pigs. The movement and distribution of these eggs is thought to be influenced by the movement of water flow due to rain. The development and survival of the infective stage of *A. suum* depends on the microclimate and the rate of transmission which may be related to biotic and abiotic factors. Eggs *A. suum* released in the fall may have a much higher survival rate because they are transported rapidly into the soil by rain and earthworms (Roepstorff et al., 2001).

In addition to rainwater, egg distribution is also thought to be strongly influenced by soil texture and topography. Based on visual observations in the field, the location of the vegetable gardens around the cages on average has a sandy clay texture and a slightly sloping relief shape. The slope is included in the slope of 8-15%. Soil texture greatly affects the infiltration capacity (Lindgren et al., 2020; Alberto et al., 2010; Fragoso et al., 2016; Salem et al., 2015; Adjei-Nsiah 2006). Soil with a fine texture has a low infiltration capacity so that if it rains, surface runoff will quickly occur (Dunkell et al., 2011; Pratama and Yuwono, 2016; Alberto et al., 2010). The difference in slope will affect the rate of infiltration that occurs, a flat slope will be easier for water to infiltrate while a gentle slope will be difficult for infiltrated water and tends to become runoff (Strauch et al., 2016; Ariani and Haryati, 2020).

The high prevalence of soil pollution at the three sample collection points is thought to be influenced by the routine or movement of pigs in these areas. This shows that the movement and distribution of parasites is strongly influenced by the movement of pigs as hosts. The movement of pigs which is only limited to the area around the farmer's house causes the spread of feces to accumulate only in that area. This is what causes the high prevalence of parasitic contamination at these three points. The movement of pigs throughout the pen (area) may result in the spread of eggs through the legs (Katakam et al., 2016, 2012).

CONCLUSIONS

The laleken system is able to reduce water, vegetable and soil pollution around the farming land of the farmers caused by *Ascaris* spp, *Trichuris* spp and *Strongyloides* spp resulted from pig feces and urine. The decrease in the amount of EPG in all types of samples caused by several factors, including temperature fluctuations. In outdoor conditions, the average embryonization and survival of *A. suum* and *T. suis* were influenced by season (temperature), soil type and vegetation.

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ETHICAL STATEMENT

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).

CONFLICT OF 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.

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NOVELTY STATEMENT

The health and hygiene status from parasite of raising pigs can be done using the free range system model by adopting local wisdom.

AUTHORS' CONTRIBUTION

TWW, ATS, AS, OY, DAI, PS, IS done concept, run, analyze field data, and write the final manuscript.

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