Potential production and utilization of agricultural and food industry wastes as animal feed in Manokwari Regency

Triswi W. Widayati, Budi Santoso, B W. I. Rahayu, Djoko Rahardjo, Bambang Tj. Hariadi
Department of Animal Science, University of Papua, Manokwari

Email: t.widayati@unipa.ac.id

Abstract. The purpose of this study was to know the potential of agricultural waste production and its benefits as animals feed in Manokwari. Data was collected from oil palm and rice areas, 2 traditional markets and 3 food industries in Manokwari Regency. The data collected consisted of data on the daily potential of each waste, the nutritional content of each waste and its benefits as a determinant component of the cost of pig and goat feeds. The results showed that the three most commonly found agricultural wastes were rice straw, oil palm frond, and rice bran with production of 104,876.71, 42,147.95, 11,586.60 kg/day, respectively, while food industry waste, namely tofu pulp, fish waste and banana peel with production of 2,400, 1,000, 127.50 kg/day respectively. The crude protein content of agricultural waste varied from 2.2-15.8%, while food industry waste varied from 0.97 to 31.2%. The use of agricultural and the food industry wastes as a grower period pig feed provided the margin profit per kg of live weight was IDR 39,618.83, while the grower kacang goat was 4,127.53. Based on this study it was concluded that agricultural and food industry wastes were potentially economically as pigs and goats feeds in Manokwari.

1. Introduction
Awareness of several countries on the importance of waste treatment has increased in the last ten years. The processing of natural resources which initially only emphasized the aspect of production has been addressed by including the processing of by-products or wastes into something that has a use value. In previous study of agricultural waste in the United States stated by Venkat in 2011 showed that annual vegetable waste in America is as much as 13.63 million of metric tonnes and has an economic value of 159.57 billion dollars [1]. Countries that have high demand for livestock products such as Japan, South Korea and Taiwan have increased the value of agricultural waste by converting the waste into animal feed [2].

Papua has the availability of waste which is very potential for livestock development. According to data from BPS (2017) shows that the production of forage and agricultural/plantation waste in the province of West Papua amounted to 42,442,750 tons of an area of 4,244,275 ha and so far it has not been used optimally [3]. While the food industry waste is also produced from several home industries such as tempe or tofu factory, taro chips, rice mills and restaurants.

In the aspect of animal husbandry in Papua, there is a special preference for pigs. For Papuan, pigs not only have economic value as savings, but also have cultural and social values. Economically, pigs have a relatively high sale value with the range of prices for finisher pigs at 5-8 million. Cultural values when pigs are used as a dowry, while social values when pigs are used as a means of payment of fines.
in case of conflict in the community. The obstacle that occurs in the community in raising pigs is the continuous availability of feed. Pigs as non-ruminant livestock compete against human food. In addition, commercial feed in Manokwari has a high price (around IDR. 11,000/kg), so this makes it difficult for farmers to develop livestock.

Unlike the case with pigs, goats have their own market segment in Papua. There are community needs, especially Muslims who need goats for religious ceremonies. The population of goats in Manokwari Regency has decreased in the last 2 years. In 2017 the goat population of 12,000 heads decreased to 6,774 heads in 2016 [4] [5]. The difficulty in raising goats is more difficult to find grazing land that can be used by goats for grazing. Therefore, it is expected that through processing agricultural and the food industry wastes into complete feed not only provides feed that has high nutrition according to the requirements of livestock, but also farmers get feed easily and affordably in order to have adequate profits from their livestock businesses. The purpose of this study was to determine the potential of agricultural waste production and its use as non-ruminant and ruminant feeds in Manokwari.

2. Materials and Methods
Data were collected from oil palm and paddy fields, 2 traditional markets and 3 food industries in Manokwari Regency. The data collected were the potential daily production of each waste, the nutritional content of each waste and its use as a determinant component of the cost of feed for pigs and goats.

Four male local pigs with an initial body weight of 22.63 ± 2.53 kg were arranged in a completely randomized design with 4 treatments and 4 replications. The animal were housed in four individual cages. The four treatments were P1: 100% commercial ration (control) P2: combination of 25% agricultural and food industry by-products and 75% commercial ration; P3: combination of 50% agricultural and food industry by-products and 50% commercial ration; P4: combination of 75% agricultural and food industry by-products and 25% commercial ration.

Three female goat aged ± 1-year-old with an initial body weight (BW) of 19.8 ± 2.72 kg were used in a 3 × 3 Latin Square design. Goats were housed in three individual cages that facilitated separate collection of feces and urine. Goats were fed agricultural and feed industry wastes based-complete block twice daily as presented in Table 3. Feeds and water were available ad libitum. Before the start of the experiment, goats were dewormed with 10 mg/kg BW of Kalbazen and given B-complex. Each period of the experiment lasted 14 days and was comprised of 8 days for diet adaptation, 5 days for digestibility study. Data collected from those experiments were analyzed descriptively using tabulation.

3. Results and Discussion
Attention to managing agricultural and industrial waste in Manokwari Regency will increase environmental value and added value for agricultural and industrial products. In addition, the treatment of waste which was previously only wasted as animal feed is expected to be one of the solutions for livestock development in Manokwari which is generally hampered by the availability of continuous feed and has a high price. Potential agricultural and food industry wastes in Manokwari Regency can be seen in Table 1. The data in Table 1 shows that some of the waste has high protein, namely fish waste, soybean curd waste. The three most commonly found agricultural wastes were rice straw, oil palm frond, and rice bran with production of 104,876.71, 42,147.95, 11586.60 kg/day, respectively, while food industry waste, namely tofu pulp, fish waste and banana peel with production of 2400, 1000, 127.50 kg/day respectively.

According to Sihombing (2006) that feedstuffs with crude protein content of ≥ 20 can be used as a source of protein for pig rations [6]. Some food waste which is protein source of feedstuffs according to the proximate results in Table 1 were tofu waste and fish waste.
### Table 1. Potential agricultural and industrial wastes in Manokwari

| No | Local wastes           | Potential (kg/day)³ | Nutrients Content |
|----|------------------------|---------------------|-------------------|
|    |                        |                     | DM (%) | CP (%)¹ | GE (kcal/kg)¹ | ME (kcal/kg)² |
| 1  | Soybean curd waste     | 2,400.00            | 14.31  | 23.85  | 4,950.57      | 3,906.00      |
| 2  | Soybean skin           | 55.50               | 15.96  | 15.10  | 4,022.23      | 3,174.00      |
| 3  | Fish waste             | 1,000.00            | 29.41  | 31.21  | 3,432.94      | 2,709.00      |
| 4  | Mung bean skin         | 83.40               | 16.8   | 2.89   | 4,022.23      | 607.00        |
| 5  | Rice bran              | 11,586.60           | 89.57  | 7.35   | 4,055.39      | 3,200.00      |
| 6  | Bananas skin           | 127.50              | 29.41  | 6.97   | 4,243.64      | 607.00        |
| 7  | Taro skin              | 11.40               | 26.45  | 4.26   | 3,648.96      | 2,879.00      |
| 8  | Vegetables waste       | 546.00              | 9.84   | 15.80  | 3,683.99      | 2,907.00      |
| 9  | Restaurant waste       | 2,056.06            | 35.84  | 13.72  | 4,202.00      | 3,315.00      |
| 10 | Rice Straw             | 104,876.71          | 26.3   | 6.80   | NA            | NA            |
| 11 | Palm Oil               | 42,147.95           | 22.5   | 4.38   | 3,960.00      | NA            |
| 12 | Casava waste           | 3,295.07            | 15.2   | 2.20   | NA            | NA            |

Prices of feed ingredients and feed formulations using agricultural waste and the food industry for pigs can be seen in Table 2. Based on the price aspect as shown in Table 2, rice bran has the highest price considering that this feed material was only available during the rice harvest season and was much in demand by farmers as animal feed not only pigs but also chickens, ducks and ruminants. The data in Table 2 shows that treatment P1 is the type of feed that has the most waste composition which was 75% compared to P2 and P3.

### Table 2. The Composition of Pig Rations (%) In Grower Period

| Ingredients            | Prices (IDR/Kg) | P1  | P2  | P3  |
|------------------------|-----------------|-----|-----|-----|
| Fish waste             | 1,250           | 10.8| 7.2 | 3.7 |
| Soybean curd waste     | 800             | 28.1| 18.8| 9.5 |
| Taro skin              | 1,400           | 14  | 9.5 | 5   |
| Vegetables waste       | 1,500           | 6   | 3.9 | 1.9 |
| Rice bran              | 3,000           | 16  | 10.5| 4.9 |
| Commercial ration*     | 11,000          | 25  | 50  | 75  |

Price of Ration (IDR/kg) 3875.8 6246.9 8617.75
Price Reduction (%) 64.77 43.21 21.66

Feed material from waste which is formulated as complete feed for goats can be seen in Table 4. The cheapest complete feed formulated from agricultural waste was P1, because this complete feed without the addition of microbial mixtures.
Table 3. The composition of Goat Ration (%) in grower period

| Ingredients             | Prices (IDR/Kg) | P1  | P2  | P3  |
|-------------------------|-----------------|-----|-----|-----|
| Hay                     | 2,500           | 12  | 12  | 12  |
| Palm Oil                | 2,500           | 25  | 25  | 25  |
| Casava Weste            | 3,333           | 23  | 23  | 23  |
| Soybean curd waste      | 800             | 17  | 17  | 17  |
| Molasses                | 29,667          | 20  | 20  | 20  |
| Urea                    | 3,000           | 1.5 | 1.5 | 1.5 |
| Premix                  | 500             | 1.5 | 1.5 | 1.5 |
| Microbes                |                 |     |     |     |
| L.plantarum             | 3,000           | 0   | 1.5 | 1.5 |
| S. cerevisiae           | 3,000           | 0   | 1.5 | 1.5 |
| P. aeruginosa           | 3,000           | 0   | 1   | 2   |
| A. baumannii            | 3,000           | 0   | 1   | 2   |

| Price of Ration (IDR/kg) | 7813.49 | 7963.49 | 8023.49 |
| Price Reduction (%)      | 28.97   | 27.60   | 27.06   |

The amount of live weight produced by pigs and goats fed on a agricultural and food industry waste based feed can be seen in Table 4. Table 4 shows that even though the ration with 75% waste feedstuffs (P3) gives the worst ration efficiency value, it is still able to provide a higher profit of IDR 39,618.83 per kg live weight compared to pigs which 100% used commercial feed, that was IDR 27,704.02. This indicates that the agricultural industry and the food industry wastes has good potential to be used as animal feed for pigs and goats. Only in the future need to be improved in terms of compatibility. One way to increase palatability is by giving flavour that is useful for flavour enhancement [7].

Table 4. Role of Agricultural Waste as animal feed on Profit Margins

| No | Animal      | Type of Ration | Feed Consumption (kg/day) | Weight gain (kg/day) | FCR | Price in Live Weight(*) | Cost of Feed/kg | Cost of Feed consumption | Margin per kg live weight |
|----|-------------|----------------|---------------------------|----------------------|-----|------------------------|-----------------|--------------------------|--------------------------|
| 1  | Grower Pig  | Tp1            | 1.695                     | 0.739                | 2.96| 46,187.50              | 3,875.80        | 6,568.67                 | 39,618.83               |
|    |             | Tp2            | 1.727                     | 0.671                | 2.64| 41,937.50              | 6,246.90        | 10,786.40                | 31,151.10               |
|    |             | Tp3            | 1.809                     | 0.723                | 2.79| 45,187.50              | 8,617.75        | 15,587.96                | 29,599.54               |
|    |             | Commercial     | 1.942                     | 0.785                | 2.49| 49,062.50              | 11,000.00       | 21,358.48                | 27,704.02               |
|    |             | Average        | 33,456.49                 |                      |     |                       |                 |                         |                          |

2  Grower Goat

| No | Animal  | Type of Ration | Feed Consumption (kg/day) | Weight gain (kg/day) | FCR | Price in Live Weight(*) | Cost of Feed/kg | Cost of Feed consumption | Margin per kg live weight |
|----|---------|----------------|---------------------------|----------------------|-----|------------------------|-----------------|--------------------------|--------------------------|
|    | Tp1     | 0.598         | 0.11                      | 5.44                 | 8,800.00 | 7,813.49        | 4,672.47        | 4,127.53                 | 4,127.53                 |
|    | Tp2     | 0.97          | 0.12                      | 4.98                 | 9,600.00 | 7,963.49        | 7,724.59        | 1,875.41                 |                          |
|    | Tp3     | 0.565         | 0.04                      | 14.13                | 3,200.00 | 8,023.49        | 4,533.27        | -1,333.27                |                          |

Average 1,556.56

*) live weight of pig = ADG of grower pig x Rp. 62500
Live weight of goat= ADG of grower goat x Rp. 80.000
Goats fed on agricultural and food industry wastes based-complete feed block added by a mixture of microbial \( P. \) aeruginosa and \( A. \) baumanii with concentrations of 1\% (P2) produced the highest body weight gain followed by fed on P1 and P3.

The weight gain of the kacang goat fed P1 and P2 was higher than the results of a study conducted by Ella et al. (2001) and Martawidjaja et al. (2001) were 66.31 \( \text{g/head/day} \) and 55 \( \text{g/head/day} \), respectively [8] [9]. The high body weight gains in goats fed P2 is related to the low ratio of acetate and propionate. The lower ratio of acetate and propionate will increase body weight gain [10]. Propionate acid is carried to the liver and converted to glucose which can be stored in the form of glycogen or can be converted to L-glycerol-3-phosphate and used for triglyceride synthesis.

4. Conclusion
The three most commonly found agricultural wastes were rice straw, oil palm frond, and rice bran with production of 104,876.71, 42,147.95, 11586.60 \( \text{kg/day} \), respectively, while food industry waste, namely tofu pulp, fish waste and banana peel with production of 2400, 1000, 127.50 \( \text{kg/day} \) respectively. The crude protein content of agricultural waste varied from 2.2-15.8\%, while food industry waste varied from 0.97 to 31.2\%. The use of agricultural and the food industry wastes as a grower period pig feed provides the greatest margin profit per kg of live weight was IDR 25,004.24 and 41,581.94, while the grower kacang goat was 4,127.53. Based on this study it was concluded that agricultural and food industry wastes were potentially economically as pigs and goats feeds in Manokwari.

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