

# Exploring potential locally available feedstuffs for diversifying pig's feeds in dry land area: Fruits, Tubers and seeds groups

## Abstract

The study aimed at exploring locally available feedstuffs that are commonly used and their potential for diversifying pig's feeds in dry land area. There were 3 potential locally available feedstuffs consisting of pumpkin (fruits), tamarind seeds (seed) and cassava (tubers) observed by using survey method. The survey was carried out in 13 of 22 districts of dry land area Nusa Tenggara Timur Province. Farmers, producer, collectors, traders, and agencies involved in planting, collecting, selling and trading feedstuffs were interviewed to collect primary data. Agricultural and Animal Departments and Statistics data were browsed to collect secondary data. Data of seasonal availability, price and nutritional content of each commodity were collected and descriptively analyzed. The results found were that the 3 feedstuffs explored are adaptable with dry land climate, commonly used in all districts, and feasible. Cassava tubers are available all through the whole year, pumpkin fruits and tamarind seeds are seasonally available in all districts. Cassava production is well recorded in all districts, tamarind seeds production is only well recorded in one district, but pumpkin production is not recorded in any district in NTT Province. Tamarind seeds contain high protein, pumpkin and cassava are low in protein but high in carbohydrate content.

**Keywords:** local feedstuffs, cassava, pumpkin, tamarind seed, dry land

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## Introduction

The southeast Indonesia region-grouped as Nusa Tenggara Timur (NTT)<sup>1</sup> Province, is dominated by dryland and climate, it has the highest pig population in 2015 (NTT in Figures, 2016). There are 1.8 million pigs (22% of national inventory) in 2014-2015 (NTT in Figures, 2015) with 430 thousand pig farmers' households, spread across the archipelago.<sup>2</sup> Although with low productivity<sup>3</sup> this pig sector plays a significant economic and socio-cultural roles in the region.<sup>4</sup> The less availability, variation, and high price of commercial feed were identified as such factors that limit local pig farmers in dryland to reach their pigs' potential.<sup>4,5</sup> However, in fact, there were known various locally feeds available and have been traditionally used, but unfortunately the knowledge of farmers in feeds' seasonal availability, nutritional contents and skill in utilizing and composing those feedstuffs were limited. Those factors have resulted in uncontrolled providing feed for pigs, consequently, resulting in poor performance of local farmers' pigs. This study is an attempt to explore the potency of potential commonly pig's feedstuffs, by mapping the seasonal availability, economic feasibility and nutritional content of common locally available feedstuffs ingredients in dryland of southeast Indonesia.

This study is important to educate pig farmers in using local feedstuffs and for feed manufactures to complement their effort in managing their pig's feed market in dryland regions. This survey is an early instrument towards production of local-based commercial pig feed or developing concentrate that will be fit with locally available feed ingredients in the dryland region. The purpose of the study is: to explore the availability of the most common locally pig's feedstuffs by evaluating their potential production and those feed ingredients, and economic feasibility. This article is part one of the two part articles in exploring potential locally feedstuffs that will be focused on common fruits, tubers and seeds used by farmers. The second part will be focus on stem and leaves from plant used for pigs.

## Materials and methods

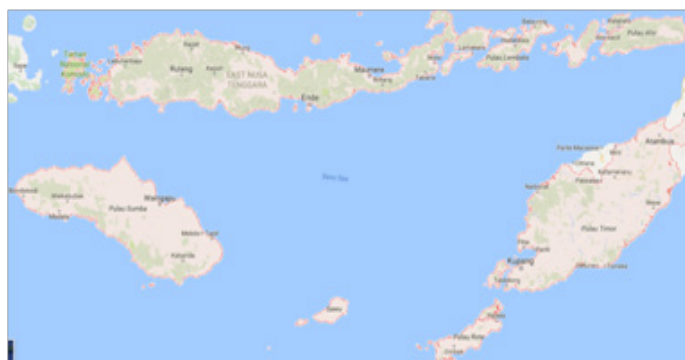
There were 6 commonly used locally available pigs feedstuffs observed in the whole study: *Corypha gebanga* stalk (called putak similar to sago), tamarind seeds, pumpkin, cassava, and moringa (leaves). The study was carried out by survey method in 13 of 22 districts (called kabupatens) spread in the 3 large/main islands in the central east part of Indonesia: Timor island (5 of 6 districts), Sumba island (2 of 4 districts) and Flores (6 of 8 districts). The 12 sample districts in each island are listed in Table 1 and map of the Southeast part of Indonesia grouped into NTT's Province is shown in Figure 1.

### The survey covered the following :

- Interview farmers and feedstuffs/foods producers on the field.
- Collect data at local markets to understand feed availability, identification of traders and collectors,
- Interview traders on price, producing region, market access logistics, and seasonality.
- Interview selected producers on production aspects, pricing, seasonality and their capacity.
- Interview Agency/Department and data collection on pig production, pricing, feed availability, key area of production (for pig and feeds), transport cost, marketing channels and logistics issues.
- Collecting secondary data from Province and district Agricultural departements
- Laboratory analysis of nutritional proximate.
- Collecting feeds samples at different islands or regions to allow local diversity in feeds analysis.
- Those all survey activities were carried out in the 12 sample districts as listed in Table 1 & Figure 1.

**Table 1** 12 sample districts selected in the study

Timor Island– 5 districts:	Flores Island – 6 districts	Sumba Island– 2 districts
Kupang City	West Manggarai	Southwest Sumba (SBD)
Kupang	Manggrai	West Sumba
South Central Timor (TTS)	East Manggarai	
North Central Timor (TTU)	Ngada	
Belu	Ende	
	Sikka	



**Figure 1** Map of NTT's province.

The variables observed consisted of agronomic requirement, production trend and seasonality, availability and locations, price and proximately nutrient content of each commodity.

## Results and discussion

The results of the survey are presented in briefly agronomic requirement, production trend and seasonality, availability and locations, price and proximately nutrient content of each commodity. There are 3 commodities consisting of: tubers, seed and fruits (one of each) plants explored in the discussion.

### Cassava

#### Agronomic requirement

Cassava (*Manihot esculenta*) is one of the tubers plants cultivated throughout all regions in southeast Indonesia. Cassava parts that are commonly used in the region are: the young leaves as vegetables and tubers as human food or for cattle, goats and pigs. In Timor and Sumba land, cassava varieties are not distinguished for vegetables whereas in Flores, there is a difference between varieties of cassava for vegetables and for producing tubers.<sup>2</sup>

Cassava tubers in the regions, can be harvested at the age of 18 months marked by the crack of the soil around the trees (one tree/clump can produce 4-10 cassava tubers). The harvest age of cassava in this region is longer (6 months) than harvest age common cassava or 8 months than high-yielding cassava in Indonesia

#### Production trend and seasonality

The peak production (harvest) of tubers generally occurs in August and then declined until December when the planting season/period (cycle) begins. Production of cassava tubers throughout selected regions is as shown in Table 2.

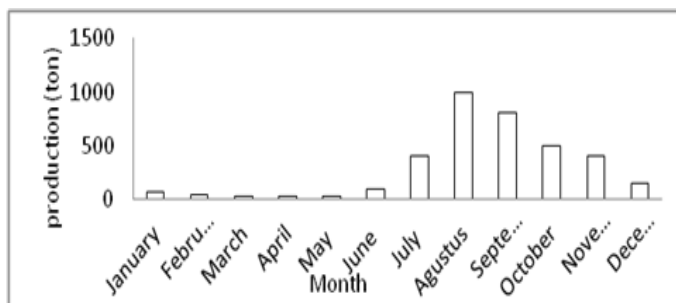
**Table 2** Production (tons) of tubers by district, 3years later<sup>(\*)</sup>

District	2013	2014	2015
Kupang City	463	973	1613
Kupang	50427	44169	32916
South Central Timor (TTS)	186830	76373	44021
North Central Timor (TTU)	100116	58726	53927
Belu	61461	62043	52270
West Sumba	18647	16500	20495
East Sumba <sup>2</sup>	26210	23584	27420
Central Sumba <sup>2</sup>	15027	5509	9344
Southeast Sumba (SBD)	60278	41073	40655
West Manggarai	16517	20346	15450
Manggarai	16025	16734	11276
East Manggarai	12845	21472	10539
Ngada	8331	42826	35543
Ende	27910	23791	24248
Sikka	94787	72063	61981
<b>Total production (ton)</b>	<b>816036</b>	<b>612848</b>	<b>539612</b>

<sup>(\*)</sup>NTT's Agricultural Statistics (2013-2015). Not included in survey sample<sup>2</sup>

#### Availability (locations)

The peak of cassava availability in whole regions is in August and then declines in October and is very low in late December when the rain intensity is high. It because tubers produced after exposure to rain water in the soil will taste bitter and damaged.<sup>6-8</sup> Cassava planting cycles generally begin in late December or early January when rainfall frequency is high because generally cassava planting season is still dependent on rain intensity. Harvesting is carried out after 18-20 months (1.5-2 years); it may influence nutrient content of cassava tubers.<sup>9</sup> Cassava production figures throughout regions is described in Figure 2.



**Figure 2** Cassava production figures in the Southeast region 2013-2015 (ton)

#### Price

Fresh cassava sales in the local market is relatively similar across the regions: Timor, Sumba and Flores. It is sold in a bundle of 3-5 tubers with a weight ranging from 2.5 - 3.0 kg at a price of IDR 10,000/bundle. Thus, the price of fresh cassava is IDR 3,500-4,000/kg and the dried is IDR 5,000/kg.

## Nutrient content

Nutrient content of cassava collectively from different districts in the NTT's regions is shown in Table 3.

**Table 3** The nutrient content of cassava<sup>(\*)</sup>

Cassava	DM	CP	Fat	CF	Ca	P	GE Kcal
Fresh	37.5	1.38	0.29	1.8	0.33	0.4	147
Tapioca	90	1	0.4	2	0.82	1.3	362

<sup>(\*)</sup>Laboratory of Faculty of Animal Husbandry-Nusa Cendana University Kupang-Indonesia, 2017. Collective sampled of from 3 Island regions (Timor, Sumba and Flores) cassava.

Table 3 shows that cassava is: high-carbohydrate, low crude fiber so it is suitable as low-fiber bulky.<sup>10</sup> The weakness of cassava is that it is low in protein and contains cyanide (HCN), which can cause food poisoning in pigs. Such ways to improve the value of cassava for pigs are by crushing and fermentation to eliminate the anti-nutritional substances<sup>11</sup> called Hydrogen cyanide (HCN)<sup>12</sup> and to increase the protein content by including a formula with protein concentrated feed.

## Discussion

Despite its seasonal availability in most areas, farmers have been able to regulate the availability by processing excess cassava to a dried form during peak season and by setting the planting time with the help of automatic watering. Cassava is worth considering as a feed for pigs because it is easy to obtain and produces in most area especially in Flores (west Manggarai, Ende, Ngada, and Sikka). It is so helpful because the peak season of cassava availability is during dry season when farmers experience a shortage of feed for pigs.

## Tamarind (*Tamarindus indica*) seed

### Agronomic requirement

Tamarind seeds are wastes of tamarind and is one of the non-timber products of forestry sectors in the surveyed region (NTT in Figures, 2014). Tamarind is a perennial, dicotyledonous and reproduces by seeds<sup>13</sup> and thrives in low and highland<sup>14</sup> and known as a tropical plant.<sup>15</sup>

Tamarind (*Tamarindus indica* L) is considered as the economic fruit trees of the future, because they are a type of tropical fruit tree from the legume family (*Febraceae*) that thrives in dry or wet climates.<sup>16</sup> Tamarind tree in the regions is an evergreen tree, it can reach to 24 m height and the trunk circumference can reach to 7 m. Tamarind tree in this region exists in two varieties, namely sweet (taste) tamarind and sour (taste) tamarind.<sup>14</sup> The fruit flavors can be predicted from the size of the fruit: sour taste tamarind's fruits and seeds are generally larger than the sweet taste tamarind. Based on the size of the tree, there are 2 groups of tamarind found in the region: large and small-sized tree. Large size tamarind trees produce fruit with generally big fruits, sour taste and big seeds, whereas the small size tree produces small fruits, sweet taste and small seeds.

### Production trend and seasonality

Production of tamarind seeds data are not separately recoded in the most parts of the region, farmers do not separate the seeds from the meat, they usually sell whole fruit after speeling the outer hulk. Therefore, the production figure bellow were calculated using

generally composition stated by de Caluwé, et al.,<sup>15</sup> that the seeds weight are 30-40% of the total weight of tamarind fruit. The result of these calculations per region is shown in Table 4.

**Table 4** Calculated tamarind seeds production per district in 2013-2015 (ton/year)<sup>(\*)</sup>.

Region	Production of tamarind seed (tons/year)		
	2013	2014	2015
Kupang City	NA	NA	NA
Kupang	1002	625	400
South Central Timor	39000	407.8	962
North Central Timor	3170	1937	1939
Belu	1128.7	752.4	481.1
West Sumba	NA	NA	NA
Southwest Sumba <sup>2</sup>	NA	NA	NA
Sikka	1412.3	1910	1552.3
Ende	NA	NA	NA
Ngada	NA	NA	NA
East Manggarai	NA	NA	NA
Manggarai	NA	NA	NA
West Manggarai	NA	NA	NA

<sup>(\*)</sup> Calculated from 30% of total tamarind fruit production in NTT region from NTT in Figures /District (2013-2015). NA: Not available/not recorded

Table 4 shows that production of tamarind seeds tends to decline during 2014-2015. A climate anomaly in NTT region in those years is the suspected factor influencing tamarind productivity. Sudden heavy rain with wind during the rainy season at the tamarind blooming time are the most suspected factors.<sup>17</sup> Production records indicate that the highest potential production and well recorded of tamarind seeds is in Timor area, mainly in South Central Timor districts that have complete production records.

### Availability (locations)

Facts show that tamarind tree grows in all regions and the name of tamarind is listed as a commodity of non-timber in forestry sector on the list of Central Bureau of Statistics throughout all districts. However, not all districts include data on the existence of the commodity. Of the 12 districts, only five of them regularly record production and highest availability.

### Price

Seeds are the main wastes from tamarind fruit which cover 30-40% of tamarind weight used to feed humans and pigs. Utilization of tamarind seeds as feed for pigs is most common in South Central Timor district. Utilization of tamarind seeds in pig's feed by farmers in this district has increased since the mid 1990s (roughly 1994-1995) and started to be given a price tag since the early 2000s (2002-2003).

Change in prices of tamarind main products and waste in the region was slow, at IDR 1,000/kg tamarind with seed and IDR 2,000/kg tamarind without seed in year 1970 to IDR 7,000/kg and IDR 8,000/

kg respectively in year 2016. Whereas the price of raw tamarind seeds (Figure 3) in year 2003 is IDR 500/kg to IDR 2,000/kg and roasted tamarind seeds (Figure 4) is from IDR 1,000/kg to IDR 3,000/kg. The increase of those main products and waste of tamarind seeds occurs once per year then stable throughout the year.

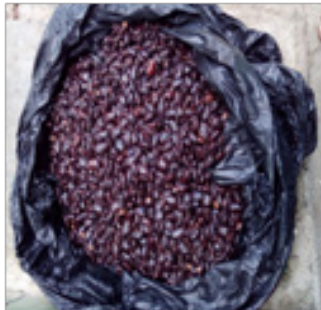


Figure 3 Raw tamarind seeds.

### Nutrient content

The content of proximate nutrients of tamarind analysis in the region is shown in Table 5.

Table 5 indicates that tamarind seeds are protein and energy sources<sup>18</sup> CP content and the energy of its seeds is equivalent to CP and energy of mung beans<sup>19</sup> Although the CF content is higher than Putak

Table 5 The nutrient contents of raw and roasted tamarind seeds in NTT(\*)

Tamarind seeds	Nutrient content (%)				GE (MJ)	Tannin mg/100g
	DM	CP	Fat	CF		
Raw	91,5	16,2	7,06	17,7	17,96	300,0
Dry roasted	98,7	18,1	3,85	10,0	18,95	248,8

(\*)Laboratory of Faculty of Animal Husbandry- Nusa Cendana University, 2016

### Discussion

Potential regions for increasing the use of tamarind seeds as feed for pigs are the 6 districts on Timor land and Sikka Districts. Motivation is required for the farmers to separate the flesh and the seed, so the price of tamarind flesh increases and there is an additional revenue from the sale of seeds. Appropriate technology that can be used in processing tamarind seeds into a safe pig feed is by roasting, accompanied by the separation of skin from the seeds' flesh and the grinding of seeds' flesh into smaller particles or acid seed flour.

### Pumpkin /Yellow Squash/ Wax Squash (*Cucurbita maxima*)

#### Agronomic requirement

Pumpkin (*Cucurbita maxima*) is a trailing or climbing herbaceous plant from *Cucurbitaceae* family. It is an annual plant that can bear fruit 4 times per production season (4 months) in the availability of adequate water. Pumpkin is a dicotyledon, propagated by seed, and could be cultivated mono and polyculture. Yellow pumpkin is known throughout Indonesia, apparently because its flesh is yellow and its rind will be yellow after ripening (Figure 5). Pumpkin in REGION is also known as "Wax Squash" maybe because its flesh looks rigid and feels chewy just like wax after cooking/boiling. Pumpkin could live in low to moderate tropical climate lands with moderate fertility levels,

CF, however tamarind seeds' CF is classified to be easily digestible (digestible fiber) and serves as a prebiotic for the carbohydrate-digesting microorganisms. Fat in tamarind seeds is considered high and known to be rich of unsaturated fatty acids (unsaturated fatty acids) containing omega 3,6 and 9 which are useful for improving the reproduction performance of sows, improving anti-body elements in the mother's milk thus increase immunity development in newborn piglets. The weakness of tamarind seeds as feed for pigs is the tough seeds' flesh and in the outer seeds' skin contains tannin that is difficult to digest and can cause constipation in pigs' digestive tract. Roasting to help the separation of skin from the seeds' flesh continued by grinding of the flesh is a way to increase the benefit value of tamarind seeds as feed for pigs.<sup>20-23</sup>



Figure 4 Dry roasted tamarind seed.

also could bear fruit in dry and moderate water content soil. At 20 regencies in REGION that depend on rain water, pumpkin is usually intercropped with corns, planted in the same hole or among corns at the start of rainy season. But farmers in Kupang city and district have changed pumpkin cropping pattern to become all year round (using irrigation or immediately after rice harvest (usually in June/ July) by utilizing leftover water in the rice fields), so as to ensure the availability of pumpkins in both regions. The name of high-yielding variety is "SUPREMA F1" which can bear 2,500 fruits (7–8 tons) per hectare per season, which are 1,000–1,500 fruits at peak production (first harvest) and 500–1,000 fruits at the last production (fourth harvest). Pumpkin fruit is composed of: rind, flesh, and connective tissue between flesh and seeds (Figure 5). The most common edible part of the fruit is the flesh, while the seeds are fried into snack; and the connective tissue is discarded or fed to pigs in fresh/raw or cooked.

Pumpkin commonly grown by farmers in NTT consists of two varieties, namely: *Bokor* or *crème* (flat round shape) and *Kelenting* (oval shape) just as in Figure 6, where *bokor* type is the most widely cultivated. Recently, a high-yielding variety has been developed by farmers in Kupang city and district which is classified as *bokor* because of its flat round shape. The size of *bokor* shape pumpkin commonly produced by farmers in Region is traditionally 15–20cm in diameter and 3–5kg in fresh weight; while *kelenting* is 10–15cm in diameter, 25–30cm in length and 3–5kg in weight. They can bear



fruit 2 times/production season with 3–5 fruits per plant depending on the length of rainy season which affects the growth period and vine length. The high-yielding variety developed in Kupang city and district has a diameter of 15–18cm with a weight of 3–4kg and can be harvested 6–8 times during four-month production period (Figure 7).

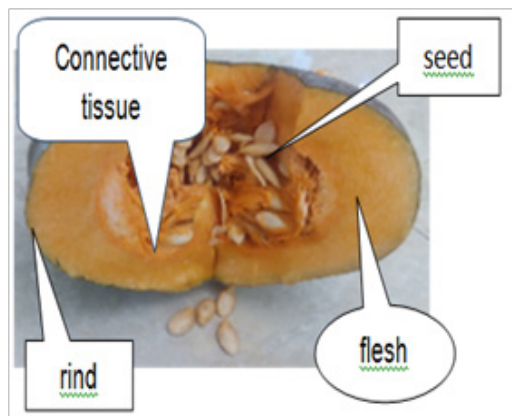


Figure 5 Structure of pumpkin.

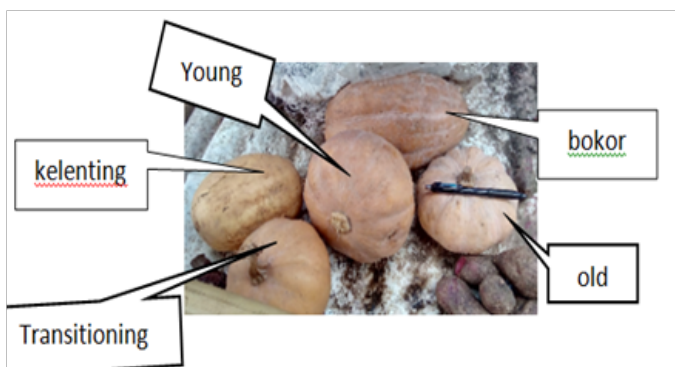


Figure 6 Types of pumpkin in region.



Figure 7 Region's pumpkin color change.

### Production trend and seasonality

Traditionally grown pumpkins are of local variety and they are seasonal because they depend very much on rain, meanwhile high-yielding variety pumpkin can bear fruit in rainy and dry seasons. Comparison of pumpkin's planting time and systems between local and high-yielding variety (SUPREMA F1) in Region are briefly shown in Table 6.

Local pumpkin could potentially be expanded because it has adapted to region climate and its productivity can be improved with proper watering and fertilizing. High-yielding variety pumpkin can be planted in areas with sufficient water supply. There is no statistical data of pumpkin production in region because of two reasons:

the volume of production does not meet the standard or quota of commodity recording and the production is seasonal as a result of traditional cultivation and rain dependence. According to farmers, pumpkin collectors and sellers, the production in each region has increased over the last 3 years and it has increased since 2013 when high-yielding variety pumpkin was developed. Pumpkin production data throughout the region can't be listed in this report, but the data that can be presented is a projection based on interviews with farmers, collectors and sellers where pumpkin is still in trade.

### Availability (locations)

Pumpkins harvested from traditional planting are only found in 8 traditional markets in the region, namely: Kefa market (TTU), SoE (TTS), Oesao (Kupang district), Oeba and Kasih market (Kupang city), Bajawa market (Ngada), Ende market and Tambolaka market (SBD) with limited numbers of sellers and fruits (3–20 sellers and 3–25 pieces). The highest number is found in Kupang city and Kupang district (20–40 sellers with 5-25 pumpkins) and in SBD (5–10 sellers with 5–20 pumpkins). Peak production of pumpkins in all regions usually takes place in June with the range of 5,000–10,000 pieces. It then declines until the end of year. In December, the volume is very limited and the pumpkins are from intentionally stored ones which are kept by collectors who wait for pumpkins shortage to get higher price. Collectors usually buy pumpkins in large quantities during peak production time and store them (because pumpkin can last up to 6 months) for sale during pumpkin shortages to get higher price. Based on interviews with farmers, collectors, sellers as well as farmers acting as collectors and as sellers who still selling pumpkins until December 2016 at the 8 markets, production projection/pumpkins availability at those regions is shown in Table 7 & Figure 8.

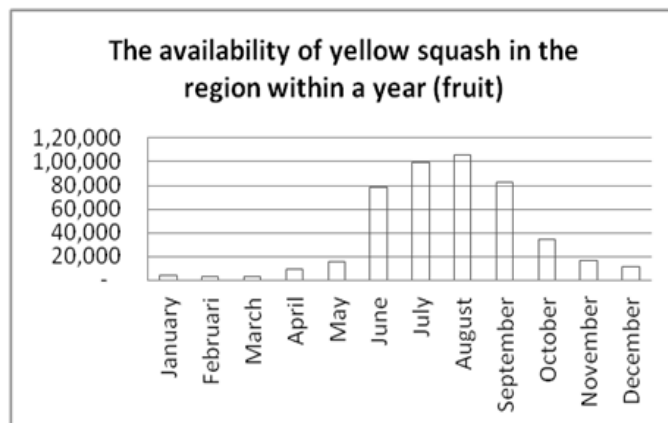


Figure 8 Projection of the total availability of Pumpkin from the 7 traditional markets in region.

### Price

The price of pumpkin in the region is based on the size (diameter) of the fruit and its availability. Fruit with larger diameter is more expensive than smaller one (Table 8). On same conditions, the pricing of pumpkin at all markets is relatively the same. The behavior of collector/seller in collecting and setting price is also relatively the same. They collect many fruits during production overflow (harvest time), store them, then sell them when the availability is low, so that they gain more profit. Price trends during the last 3 years according to farmers, collectors and sellers is relatively stable following the fuel price stability.

### Nutrient content

The average nutrient content of pumpkin found in region regions is shown in Table 9.

Based on its nutrient content, pumpkin has some advantages,

namely: high water content, high energy and low crude fiber; while its disadvantages are low protein and fat. Pumpkin nutritive advantages as pig feed are: palatable, low in crude fiber, easily digested, and containing sugar and vitamins so that it is suitable as bulky feed which are low in fiber and easily digested.

**Table 6** Comparison of pumpkin's planting time and system in region.

Indicator	Local pumpkin <sup>1</sup>	SUPREMA FI <sup>2</sup>
Planting time	At the start of rainy season, at the same time of corn planting season	At the start of dry season (usually in April) and all year round
Planting system	In the same hole with corn seeds, or between rows of corns	Specific field/garden and rain fed rice field
Age and frequency of harvest	3 - 4 months and < 2 times of harvest	3 - 4 months and 6 – 8 times of harvest
Productive age	2 – 3 months; < 2 times of fruiting (depends on water and soil fertility)	6 - 8 months (depends on productivity)
Yield/plant	< 6 fruits (from 2x of harvest)	30 - 40 fruits (from 6 - 8x of harvest)

Exists in all district and city.<sup>1</sup> Only in Kupang's district and city.<sup>2</sup>

**Table 7** Projection of pumpkins availability at the 7 regions in region's district/city (in pcs)\*

Month	Kupang city	Kupang	TTS	TTU	Ngada	Ende	SBD
January	1500	500	300	500	400	500	400
February	1200	600	200	250	300	600	300
March	1000	400	150	250	200	400	300
April	800	200	200	300	5000	200	2000
May	1000	700	500	600	7500	700	5000
June	15000	5000	10000	15000	13000	5000	15000
July	20000	7000	15000	15000	15000	7000	20000
August	30000	10000	20000	20000	7000	10000	9000
September	25000	10000	15000	10000	5000	10000	8000
October	10000	5000	5000	6000	500	5000	3000
November	6000	2000	1000	3000	200	2000	2000
December	4000	2000	500	2000	100	2000	500

\*Calculated according to the number of farmers, collectors and sellers who always get involved every year

**Table 8** Variations in the price of pumpkin at 8 traditional markets in region<sup>(1)</sup>

Diameter (cm)	Selling season	Price (IDR) at each level	
		farmer	collector
<15	Production peak	1000	2000
	In between	2000	3000
	Production end	3000 <sup>(2)</sup>	4000
15	Production peak	2500	3500
	In between	3500	4500
	Production end	5000 <sup>(2)</sup>	6000
20-22	Production peak	4000	5000
	In between	5000	6000
	Production end	6000 <sup>(2)</sup>	7500

<sup>(1)</sup>Data source: farmer, collector and seller. Selling season follows Figure 8

<sup>(2)</sup>Only found in the district and city of Kupang

**Table 9** Nutrient content of region's fresh pumpkin\*

Material	Nutrient Components (%)				Ca	P
	DM	CP	Fat	CF		
Fresh pumpkin	8.8	1.05	0.2	1.2	0.34	0.6

(\*)Average figure of 3 Island (Timor, Sumba and Flores). Laboratory of Faculty of Animal Husbandry-Undana, 2017.

## Discussion

Pumpkin is not listed in statistical data as one of agricultural sector commodities. Logical explanation for that which has been put forward is because the ever recorded production volume of region's pumpkin did not reach the minimum threshold of statistical recording of a commodity. However, pumpkin has been long known as one of human foodstuffs either as vegetable or substitute for rice in the region community. Pumpkin shoots are more common and in more demand as a vegetable than chayote shoots. Pumpkin has double or even multifunction, purposes namely: as vegetables, rice meal replacement, ingredient for making cake, and as pig feed when pumpkin's production is excessive or when there are some fruits or parts of it that are not worth eating. Some of the advantages of the pumpkin is: able to adapt to region's climate and soil fertility (high-yielding variety is being developed so that pumpkin could be available throughout the year), has long been familiar with the region community as food for humans and pigs. Protein deficiency (as a feed) can be complemented with food concentrate or supplement. Production increase will occur if there is an increase in the use of pumpkin as pig feed. It is hoped that by then the volume can reach the minimum threshold of statistical recording of a commodity.

## Comparison and analysis

Facts show that agronomic wise and agro-climatically 6 plants have adapted to region's climate and have been cultivated by farmers across regions. Four types of commodities namely: gewang (producer of putak), tamarind, leucaena and moringa can grow naturally without the need of fertilizer and they reproduce quickly without intensive human involvement. The productivity of those 4 commodities would increase if there is intensive human involvement. Cassava requires human involvement and little fertilization; pumpkins require more intensive human involvement and adequate fertilization. Tamarind, leucaena and moringa can grow in any soil conditions but they are not resistant to standing water or bog.

The 5 commodities can be consumed by humans and pigs, but only three commodities namely pumpkin, cassava and moringa are commonly used as human food in the region. Gewang, producer of putak, grows well in lowlands, a bit humid and not rocky soil. It is somewhat resistant to puddle so that it can grow well in rice field. Pumpkin and cassava are very productive in medium and lowlands.

The availabilities of 4 commodities (putak, leucaena seeds, pumpkin and moringa) are not recorded in any statistical data in all districts/cities; the data of tamarind seeds is only found in TTS' statistical data; while the data of cassava is recorded properly in all region districts.

The productivity and availability of (local) pumpkin and cassava are greatly affected by intensity and duration of rainy season; while putak, leucaena and moringa can be harvested throughout the year, and tamarind pods are produced only during summer. Special processing

of tamarind seed is just being carried out in TTS and Kupang district. Tamarind production and tamarind seeds potential are recorded to be highest in Sikka and Lembata districts. The price of the 5 feeds have increased over the last 3 years in which such increases occur only annually instead of monthly. The price of each 5 feeds (putak, pumpkin, cassava, tamarind seeds and moringa leaf) in the markets is relatively uniform throughout the regions where it is being sold, while the price of leucaena seeds depends solely on the supplier because there are no specific collectors of leucaena seeds. Leucaena seeds' price is expensive at this time so that it is uneconomic for pig feed.

Basically, the processing of all 5 feeds can be done without using high technology, though processing stages of each feeds are different. Moringa leaf processing is the easiest because it can be given directly without any process; followed by pumpkin because it only needs to be sliced. Cassava should be peeled, sliced and washed; Putak should be sliced or ground into flour; Leucaena should be roasted and ground; and tamarind seeds should be roasted, peeled, then milled before being fed to pigs.

Nutrition wise, pumpkin and cassava can be fed as bulky feed in large quantities (40-50%); moringa leaves are used as protein source supplement; leucaena seeds are used just as protein supplement in small amounts ( $\leq 10\%$ ); tamarind seed as protein source feed can be given as many as 40-50% for all ages, while putak only as bulky feed or source of fiber can be given in the amount of 20-30% (in powder form) or 10-20% (in small slice) for adult pigs only.<sup>24-26</sup>

## Conclusions and recommendations

All 3 feedstuffs have adapted to the region's climate, only pumpkins need a little fertilizer to increase productivity. The availability of pumpkin and cassava during dry season is very low in most regions, only Kupang's district and Kupang city which have been able to maintain year-round availability of pumpkin by developing high-yielding pumpkin variety "SUPREMA F1". Tamarind seed is known throughout the regions, but its intensive use as pig feed is only known in mainland Timor.

All 3 feedstuffs have nutrient content worthy as pig feed, pumpkin and cassava can be used as bulky feed, source of carbohydrate and energy for all age pigs.

The intensity of human involvement is needed to increase the productivity of pumpkin, cassava. Government attention is needed to increase the number and utilization of tamarind seed in the form of tamarind conservation and dissemination of tamarind seed's benefits and economic value as feeds in order to give awareness to tamarind's farmers (especially in Flores land) to separate tamarind flesh and tamarind seed so that the price of tamarind flesh will increase and the farmers will receive added value from selling tamarind seeds. Based on its availability and the habits of the community, for the time being tamarind seed is recommended to be used intensively only in Timor land and Flores,

## Recommendations

It seems that cassava, pumpkin and tamarind seeds are the top three local commodities that have potential should that be proceeded by further development of feed that fits or complement locally available feed ingredients in Southeast region of Indonesia

## Cassava

Cassava is recommended as it can be found around region, particularly in Timor and Flores islands which produce 637.000 tons

in 2015. Cassava is commonly used as pig feed in Sikka, TTU, Belu and Lembata. The limiting factor for cassava is its HCN content which requires farmers' time to cook it before feeding.

### Pumpkin

Pumpkin is recommended for Timor (large number of farmers); Sumba (growing demand of pig for cultural events) and Flores (main Pig's supplier for Sumba). Pumpkin provide opportunity for further intervention as it is available during the year and some farmers already aware about pumpkin as animal feed. The availability of improved pumpkin cultivar, its low price (IDR 350–1200/kg at the time of survey), enhance this opportunity for pumpkin, particularly as it is also available during the dry season. It is estimated that approximately 1.8 ton of pumpkin are available in Timor and Sumba annually, particularly from Kupang City, Kupang district, TTU, Ngada and SBD.

### Tamarind seeds

Tamarind seeds is recommended for Timor (large number of farmers) and Flores (large number of animal). Tamarind seed is occasionally used as pig feed in Timor and Flores. In TTS (Timor Island) farmers has been accustomed to feed their pig with tamarind seeds and sell tamarind flesh to local collector. Tamarind seed is reasonably cheap (IDR 2500/kg at the time of survey) but same as cassava, the limiting factor for tamarind is its shells which requires farmers time to crush and grill it before feeding.

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### Conflicts of interest

The Author declares there is no conflicts of interest.

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