SPATIAL LINKAGES OF THE AGRICULTURAL SECTOR IN NORTH MALUKU IN INDONESIA: AN INTERREGIONAL INPUT-OUTPUT (IRIO) APPROACH

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Abstract: The purpose of this study was to analyze the linkages between the agricultural sector and other sectors in North Maluku and the linkages between the North Maluku agricultural sector and other economic sectors in 33 provinces in Indonesia. The data used is the 2016 Indonesia Interregional Input-Output (IRIO) Table data. Linkage analysis, forward linkages effect ratio (IDP) and backward linkages effect ratio (IDK) analysis in the IRIO approach were used to answer the research objectives. The results of the analysis show the forward and backward linkages of the agricultural sector in North Maluku with the highest rank in the food crops and livestock subsector. The IDP and IDK results show that food crops and fisheries are stronger in encouraging the development of downstream industries, while livestock is stronger in encouraging the development of upstream industries in North Maluku. The North Maluku agricultural sector that has the highest total forward linkages between regions is the plantation subsector with North Sumatra Province. The highest total backward linkage is the crop subsector with East Kalimantan. The results of this study should have implications for the evaluation process, and policy formulation of the North Maluku Regional Government. Especially the development of the agricultural sector as an input and output provider aspect. The government is expected to focus on cooperation policies between regions related to trade and market expansion in the agricultural sector.

Keywords: sectoral linkages, regional linkages, agricultural sector, Interregional Input-Output (IRIO)

Abstrak: *Tujuan penelitian ini adalah menganalisis keterkaitan antar sektor pertanian dengan sektor lainnya di Maluku Utara dan keterkaitan antara sektor pertanian Maluku Utara dengan sektor ekonomi lainnya pada 33 provinsi di Indonesia. Data yang digunakan adalah data Tabel Interregional Input-Output Indonesia (IRIO) tahun 2016. Analisis keterkaitan, analisis Indeks Daya Penyebaran (IDP) dan Indeks Derajat Kepekaan (IDK) dalam pendekatan IRIO digunakan untuk menjawab tujuan penelitian. Hasil analisis menunjukkan keterkaitan ke depan dan ke belakang sektor pertanian di Maluku Utara dengan peringkat tertinggi adalah subsektor tanaman pangan dan peternakan. Hasil IDP dan IDK menunjukkan bahwa tanaman pangan dan perikanan lebih kuat dalam mendorong pengembangan industri hilir, sedangkan peternakan lebih kuat mendorong pengembangan industri hulu di Maluku Utara. Sektor pertanian Maluku Utara yang memiliki keterkaitan total ke depan tertinggi antara wilayah adalah subsektor perkebunan dengan Provinsi Sumatera Utara Keterkaitan total ke belakang yang paling tinggi adalah subsektor tanaman dengan Kalimantan Timur. Hasil penelitian ini selayaknya bisa berimplikasi pada proses evaluasi, perumusan kebijakan dari Pemerintah Daerah Maluku Utara. Khususnya pengembangan sektor pertanian sebagai aspek penyedia input dan output. Pemerintah diharapkan bisa berfokus pada kebijakan kerjasama antara wilayah terkait perdagangandan dan perluasan pasar sektor pertanian.*

Kata kunci: *keterkaitan sektoral, keterkaitan wilayah, sektor pertanian, Interregional Input-Output Indonesia (IRIO)*

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INTRODUCTION

The agricultural sector plays an important role in developing a country's economy, this is because the agricultural sector in aggregate is considered effective in reducing poverty when compared to other sectors. Khan et al. (2019) stated that the agricultural sector has an important role in job creation. So special support and attention from the government are needed, this is because the government plays an important role in advancing agricultural development and increasing agricultural sector productivity growth (Morley et al. 2019). According to Lamiaa and Saad (2022), strengthening the relationship between the agricultural sector and other sectors can improve the performance of the agricultural sector on the development of all existing sectors or the economy as a whole.

The contribution of the agricultural sector to the formation of Indonesia's GDP from 2018 to 2022 shows that there is a decrease of 0.28 percent, even though the agricultural sector is an important sector that provides food, raw materials, and employment opportunities for most Indonesians (BPS Indonesia, 2023). Indonesia has undergone a structural transformation of the economy over the past few decades resulting in a shift from the agricultural sector to the industrial and service sector (Word Bank, 2016). Awaliyyah et al. (2020) explained that the transformation of the economic structure occurred due to the transition of labor from a sector with low productivity to a sector with high productivity, this change was aimed at the transition of the agricultural sector to the service sector.

This labor shift is a reflection of the dynamic and negative growth of the agricultural sector. Christiaensen et al. (2011) with the existence of extractive industries from the transition of economic structure, the effect of reducing poverty in the agricultural sector will be lower than non-agriculture. According to Lombardozzi (2019), making industrialization policies based on the inter-sectoral transformation that is synchronized with the agricultural sector without considering the quality of human resources will cause problems with labor transition, thereby impacting the productivity of the agricultural sector.

North Maluku Province has abundant natural resource potential, including having fertile soil and a good tropical climate for agriculture, so that various crops can be planted and cultivated (BPS North Maluku,

2022). According to (Diana et al. 2018), agriculture is a leading sector in North Maluku Province. So the agricultural sector is one of the sectors that play an important role in economic performance in North Maluku (Subur and Nuraini, 2022). The potential of a region's agricultural sector is an important factor that encourages the government to make policies to support sustainable agricultural development. The government needs to create an integrated policy of upstream to downstream in supporting the development of a sector or industry (Evalia et al. 2022). Apart from the agricultural potential of an area, what also needs to be considered is how the relationship between the agricultural sector and other sectors. Both linkages in the area and linkages with other regions, because this is very important in maintaining the balance of the potential of each region. The balance between regions is important because it can build symmetrical linkages, reduce disparities between regions, and ultimately be able to strengthen regional economic development as a whole (Indryani and Mun'im, 2022).

This study aims to analyze the linkage between the agricultural sector and other sectors in North Maluku and the linkage between the agricultural sector of North Maluku and other economic sectors in 33 provinces in Indonesia. According to (Miller and Blair, 2009), the right model to explain the existence of a trade transaction activity or linkage between sectors and regions is the Interregional Input-Output model. Based on that, the most relevant model that can be used to answer the objectives of this research is the Interregional Input-Output (IRIO) approach.

METHODS

The data to be used in this study is secondary data, namely the Inter-Regional Input-Output Table (IRIO) Indonesia based on producer prices according to 34 Provinces and 52 Industries in 2016 (Million Rupiah) sourced from the Central Bureau of Statistics (BPS) Indonesia.

The analysis method used in this study is the IRIO approach. The IRIO approach is a development of the single IO model that only shows the structure of input-output transactions between sectors in one region. The single IO model cannot describe the inter-sectoral input-output transactions between regions. According to Miller and Blair (2009), the appropriate model to

explain the existence of trade transactions or import-export activities between regions is the Inter-Regional Input-Output (IRIO) model. Based on this, the most appropriate model to use in answering the objectives of this study is the IRIO approach. This approach has several forms of analysis that are commonly used in general, namely, linkage analysis, and impact analysis. Linkage analysis is used to answer the objectives of this study, which in economic activity there are activities from various sectors. A sector will be considered a key sector if the sector has a high linkage, both forward linkage and backward linkage.

Based on the framework of product flows between 3 sectors and between regions A and B shown in Table 1, the matrix of technical coefficients of trade transactions can be simplified into matrix Z as follows.

$$Z = \begin{bmatrix} Z_{ij}^{AA} & Z_{ij}^{AB} \\ Z_{ij}^{BB} & Z_{ij}^{BA} \end{bmatrix} \quad (1)$$

Further from the matrix Z can be derived into submatrix A or the following matrix of technical coefficients.

$$A^* = \frac{A_{ij}^{AA} \mid A_{ij}^{AB}}{A_{ij}^{BA} \mid A_{ij}^{BB}} \quad (2)$$

Based on the input coefficient matrix equation, the Leontive inverse matrix $(I - A^*)^{-1}$ can be calculated using the notational form of the following matrix.

$$(I - A^*)^{-1} = G = \frac{G_{ij}^{AA} \mid G_{ij}^{AB}}{G_{ij}^{BA} \mid G_{ij}^{BB}} \quad (3)$$

Based on the notation of equations (1), (2), and (3), the equations from the analysis of interrelations between sectors and between regions can be made into the following equations.

$$BL_{ij}^{AA} = \frac{n \sum_{i=1}^{n} G_{ij}^{AA}}{\sum_{i=1}^{n} \sum_{j=1}^{n} G_{ij}^{AA}} \quad (4)$$

$$FL_{ij}^{AA} = \frac{n \sum_{j=1}^{n} G_{ij}^{AA}}{\sum_{i=1}^{n} \sum_{j=1}^{n} G_{ij}^{AA}} \quad (5)$$

$$BL_{ij}^{BA} = \frac{n \sum_{i=1}^{n} G_{ij}^{BA}}{\sum_{i=1}^{n} \sum_{j=1}^{n} G_{ij}^{BA}} \quad (6)$$

$$FL_{ij}^{BA} = \frac{n \sum_{j=1}^{n} G_{ij}^{BA}}{\sum_{i=1}^{n} \sum_{j=1}^{n} G_{ij}^{BA}} \quad (7)$$

Where BL^{AA}_{ij} is the backward direct and indirect linkage of sector j in province A with other sectors in province A. FL^{AA}_{ij} is the direct and indirect linkage to the future of sector I in province A with other sectors in province A. BL^{BA}_{ij} is the backward direct and indirect linkage of sector j in province A with other sectors in province B. FL^{BA}_{ij} is the direct and indirect linkage of the sector I in province A with other sectors in province B. j is sector j in the economic structure for backward linkage and i is sector i in the economic structure for future linkage. A is North Maluku Province. B is another province within the scope of the IRIO Table. G_{ij} is an element in the Leontive inverse matrix.

Then to see the degree or ratio of forward and backward linkages for a sector in the economic structure, it can be seen using two types of index measures, namely, spreadability and spread sensitivity. Referring to equation (3), the equation of the two indices can be made as follows.

Table 1. Product Transactions between 3 Sectors between 2 Regions

			Buyer Sector j						Final Demand		Total Output
			Region A			Region B					
			1	2	3	1	2	3			
Seller Sector i	Region A	1	Z_{11}^{AA}	Z_{12}^{AA}	Z_{13}^{AA}	Z_{11}^{AB}	Z_{12}^{AB}	Z_{13}^{AB}	F_1^{AA}	F_1^{AB}	X_1^A
		2	Z_{21}^{AA}	Z_{22}^{AA}	Z_{23}^{AA}	Z_{21}^{AB}	Z_{22}^{AB}	Z_{23}^{AB}	F_2^{AA}	F_2^{AB}	X_2^A
		3	Z_{31}^{AA}	Z_{32}^{AA}	Z_{33}^{AA}	Z_{31}^{AB}	Z_{32}^{AB}	Z_{33}^{AB}	F_3^{AA}	F_3^{AB}	X_3^A
	Region B	1	Z_{11}^{BA}	Z_{12}^{BA}	Z_{13}^{BA}	Z_{11}^{BA}	Z_{12}^{BA}	Z_{13}^{BA}	F_1^{BA}	F_1^{BB}	X_1^B
		2	Z_{21}^{BA}	Z_{22}^{BA}	Z_{23}^{BA}	Z_{21}^{BA}	Z_{22}^{BA}	Z_{23}^{BA}	F_2^{BA}	F_2^{BB}	X_2^B
		3	Z_{31}^{BA}	Z_{32}^{BA}	Z_{33}^{BA}	Z_{31}^{BA}	Z_{32}^{BA}	Z_{33}^{BA}	F_3^{BA}	F_3^{BB}	X_3^B
Primary Input			V_1^{AA}	V_2^{BA}	V_3^{BA}	V_1^{BA}	V_2^{BA}	V_3^{BA}			
			V_1^{BA}	V_2^{BA}	V_3^{BA}	V_1^{BA}	V_2^{BA}	V_3^{BA}			
Total Input			X_1^A	X_2^A	X_3^A	X_1^A	X_2^A	X_3^A			

Source: Miller and Blair (2009)

$$\alpha_j = \frac{\sum_{i=1}^{n} G_{ij}^{AA}}{\frac{1}{n}\sum_i \sum_j G_{ij}^{AA}} \quad (8)$$

$$\beta_i = \frac{\sum_{j=1}^{n} G_{ij}^{BA}}{\frac{1}{n}\sum_i \sum_j G_{ij}^{BA}} \quad (9)$$

Where α_j shows the spreading power index of sector j in the economy. β_i shows the index of the degree of sensitivity of sector i in the economy.

Based on the results of the analysis if the value of the sector spread power index j is greater than one ($\alpha_j > 1$), then relatively the final demand of sector j in spurring production growth is greater than average, then this sector is strategic in increasing economic growth. Likewise, the index of sensitivity degrees in sector i, if $\beta_i > 1$ sector i can be said to be a strategic sector because relatively sector i can meet final demand above the average ability of other sectors (Daryanto and Hafizriada, 2010).

Figure 1 shows the framework as a stage in this study. The decline in the contribution of the agricultural sector is an impact of a change in the economic paradigm in which a structural transformation is carried out. This change is considered good in encouraging economic growth for developing countries. directly this change encourages increased industrialization in various aspects of economic activity. However, the most important thing to note in this economic activity is the availability of inputs for each industry, where the agricultural sector is the main input provider in industrial activities. Using data from Indonesia's 2016 Interregional Input-Output Table for analysis of the linkages of the agricultural sector in order to see the role of the agricultural sector in the framework of

structural transformation. the extent of the role of the agricultural sector in the economy, this sector is still the basis for supporting the economy. Therefore, the government needs to pay attention to the development of the agricultural sector in every region that has great potential in terms of resources.

RESULTS

Linkages between the Agricultural Sector and other Sectors in North Maluku

Based on the results of the analysis conducted from the calculation of the Leontive inverse matrix, the measure of forward and backward linkages between the resulting sectors can be said to be direct and indirect relationships. This measure of linkage can also be said to be the overflow or total linkage of one sector to other sectors in an economy. Direct and indirect linkages forward and backward can be represented as the amount of demand and supply of a sector (agricultural sector) with other sectors in the economy of a region (North Maluku).

Forward and Backward linkages in the future will show the amount of increase in output or total supply for demand between (supply) of the agricultural sector for production activities of other sectors in the North Maluku economy if there is an increase in final demand in the agricultural sector by one unit (million Rupiah). The direct and indirect linkages show the amount of increase in total inputs between those that will be absorbed (demand) by the agricultural sector from other sectors in production activities if there is an increase in final demand in the agricultural sector by one unit (million Rupiah).
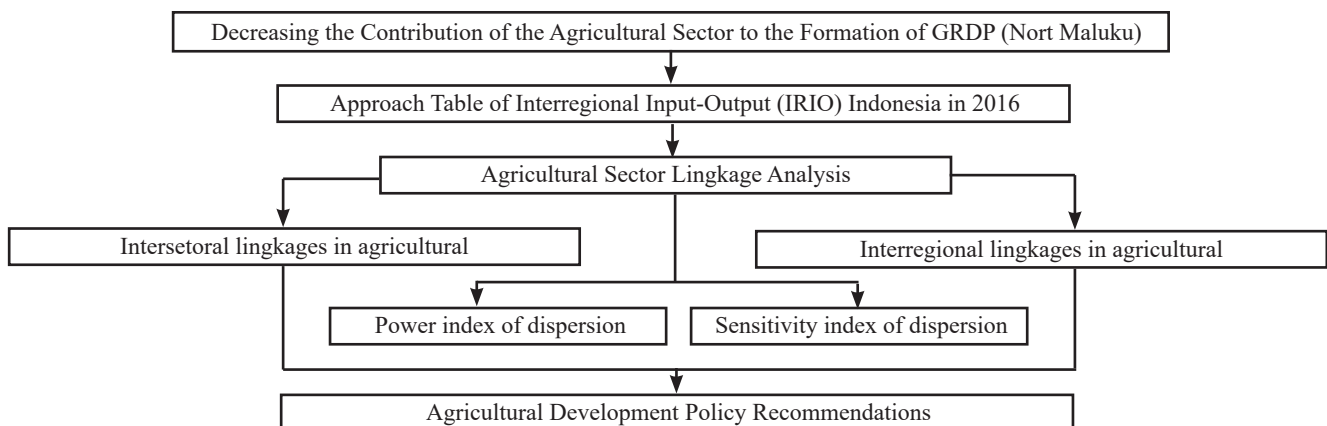

Figure 1. The Framework of this Research

Based on the description from Table 2, it can be said that for direct and indirect future linkages of the agricultural sector in North Maluku, the highest rank is the food crop subsector with a linkage value of 1.9101. This means that if there is an increase in final demand from the food crop subsector by 1 million Rupiah, it will increase the total supply for demand between 1,9101 million Rupiah for production activities, both in the food crop subsector itself and for other sectors in the North Maluku economy. As for direct and indirect backward linkages of the agricultural sector in North Maluku, the highest rank is animal husbandry with a linkage value of 1.3641. This means that if there is an increase in final demand from farms by 1 million Rupiah, it will increase the total absorption of intermediate inputs from farms by 1.3641 million Rupiah for production activities.

These results are also evidenced by Loizou et al. (2019) where the agricultural sector, directly and indirectly, affects other sectors, both from the total output, employment, and household income in the research area. The results show that agriculture is an important driver of economic growth across the region. Meanwhile, according to (Baig et al. 2021), the relationship between sectors in economic growth together with the human capital index has a unidirectional relationship in the long term ranging from economic growth, industry, human capital, and investment to agricultural growth. Through the measure of the linkage of the agricultural sector, the distribution capability and distribution sensitivity of the agricultural sector in the North Maluku economy can also be seen by calculating the distribution power index and sensitivity power index.

Figure 2 is a representation of the value of the spreading power index and sensitivity power index divided into 4 quadrants, for domestically oriented grouping of superior sectors or subsectors. Logarithma and Wulandari (2022) measure sectors or industries that excel in the economy of a region can be done by looking at the spreading power index and sensitivity power index that is more than one (> 1). Quadrant 1 shows sectors or subsectors that are superior in terms of output and input with a domestic base orientation because they have more than one IDP and IDK value.

Table 2. Linkages between the Agricultural Sector and other Sectors in North Maluku

Sector	Forward Linkage		Backward Linkage	
	Value	Rank (52)	Value	Rank (52)
Food	1.514	9	1.191	36
Horticulture	1.036	33	1.148	40
Plantation	1.179	21	1.157	39
Farm	1.252	16	1.364	16
Agricultural Services	1.031	36	1.068	43
Forestry	1.264	15	1.074	44
Fishing	1.910	5	1.144	41

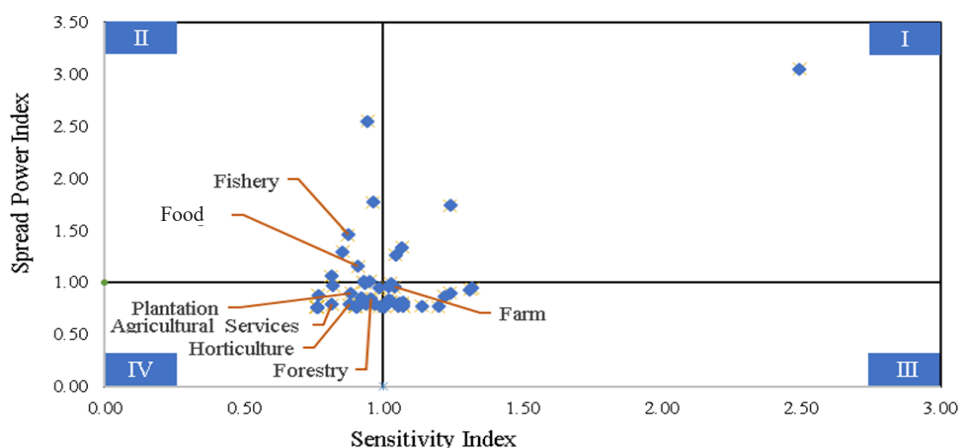Source: IRIO Indonesia table 2016 processed (2023)

Figure 2. Index of dispersion and sensitivity between the agricultural sector and other sectors in North Maluku

Quadrant 2 indicates a sector or subsector that is superior in terms of input because it has an IDP value of more than one. Quadrant 3 shows sectors or subsectors that are superior in terms of output because they have more than one IDK value. While quadrant 4 shows sectors or subsectors that are not superior in terms of input and output for domestic base orientation because they have IDP and IDK values of less than one.

Based on the placement of the agricultural sector or subsector shown in Figure 2, it can be said that the agricultural sector of North Maluku in this case the food and fisheries subsector is a superior subsector in terms of inputs, with each IDP value being 1.16 and 1.46. The livestock subsector is the superior subsector in terms of output, with an IDK value of 1.04. Meanwhile, the horticulture, plantation, agricultural services, forestry, and fisheries subsectors are subsectors that are not superior in terms of input and output for domestic base orientation.

Pellegrini (2022) states that measuring the direct and indirect effects of agricultural sector expansion across regions can be important for our understanding of the aggregate impact of a policy's strategy on economic growth, welfare, and employment in agriculture. So according to (Baig et al. 2021), policymakers must improve the performance of the agricultural sector through increasing public investment in agricultural education, modern technology, and physical and social infrastructure development if they want to achieve good economic growth. Smith et al. (2017) suggest setting the agenda for sustainable development targets for countries that embrace economic growth, social inclusion, and environmental protection. Governments should pay greater attention to cross-sector linkages such as finance, agriculture, energy, and transportation.

Forward Linkages between the North Maluku Agricultural Sector and Other Sectors in 33 Provinces in Indonesia

Based on the Leontif inverse matrix analysis in the IRIO Indonesia Table, the linkage of the agricultural sector in this study is not only analyzed from the aspect of the linkage between the agricultural sector and other sectors in North Maluku but also analyzed from the linkage between the agricultural sector of North Maluku and other sectors in 33 Provinces in Indonesia. The linkage

seen is a representation of the spillover of the North Maluku agricultural sector which is interregional-based, in this case, the form of the spillover is seen in total to all economic sectors (52 subsectors or industries) from 33 provinces in Indonesia. There are two forms of linkages in the interregional base, namely forward and backward linkages to the front, and forward and backward linkages to the back.

Based on Table 3, it can be seen that for the direct and indirect future linkages of the food subsector (A) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 16 provinces with linkage values above the average (> 1.41). The provinces are (1) Aceh, (6) South Sumatera, (8) Lampung, (13) Central Java, (14) Yogyakarta, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (22) South Kalimantan, (26) Central Sulawesi, (27) South Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (31) Maluku, (33) West Papua, and (34) Papua. While the other 17 provinces are provinces with linkage values below average (<1.41), these provinces include (2) North Sumatera, (3) West Sumatera, (4) Riau, (5) Jambi, (7) Bengkulu, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (12) West Java, (15) East Java, (16) Banten, (20) West Kalimantan, (21) Central Kalimantan, (23) East Kalimantan, (24) North Kalimantan, (25) North Sulawesi, and (30) West Sulawesi Utara.

Direct and indirect linkages in the future of the horticulture subsector (B) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 14 provinces with linkage values above the average (> 1.11). The provinces are (1) Aceh, (2) North Sumatera, (3) West Sumatera, (8) Lampung, (12) West Java, (13) Central Java, (15) East Java, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (25) North Sulawesi, (27) South Sulawesi, (29) Gorontalo, and (31) Maluku. While the other 19 provinces are provinces with linkage values below average (< 1.11), these provinces include (4) Riau, (5) Jambi, (6) South Sumatera, (7) Bengkulu, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (14) Yogyakarta, (16) Banten, (20) West Kalimantan, (21) Central Kalimantan, (22) South Kalimantan, (23) East Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, (28) Southeast Sulawesi, (30) West Sulawesi, (33) West Papua, and (34) Papua.

Table 3. Value of Direct and Indirect Future Entanglement between the North Maluku Agricultural Sector and other Sectors in 33 Provinces in Indonesia

Province	Value of Linkages in the Agricultural Subsector						
	Food	Holticulture	Plantations	Livestock	Agricultural Services	Forestry	Fisheries
1	1.55	1.14	2.01	1.45	1.10	1.55	1.27
2	1.23	1.19	2.63	1.54	1.09	1.54	1.18
3	1.27	1.18	1.54	1.09	1.05	2.00	1.10
4	1.08	1.04	2.56	1.09	1.08	1.70	1.12
5	1.20	1.11	2.15	1.10	1.07	1.87	1.05
6	1.71	1.07	1.96	1.18	1.09	1.37	1.22
7	1.40	1.10	1.64	1.00	1.00	1.11	1.25
8	1.54	1.23	1.72	1.27	1.09	1.47	1.13
9	1.07	1.06	1.86	1.20	1.05	1.35	1.54
10	1.01	1.04	1.20	1.07	1.03	1.00	1.26
11	1.00	1.00	1.00	1.00	1.02	1.00	1.01
12	1.37	1.12	1.21	1.21	1.09	1.14	1.11
13	1.75	1.21	1.25	1.30	1.09	1.20	1.12
14	1.59	1.10	1.22	1.22	1.00	1.45	1.07
15	1.36	1.19	1.19	1.27	1.07	1.28	1.09
16	1.21	1.02	1.07	1.33	1.05	1.00	1.04
17	1.42	1.17	1.27	1.46	1.14	1.06	1.07
18	2.08	1.34	1.62	1.58	1.09	1.32	1.21
19	1.72	1.13	1.44	1.38	1.11	1.00	1.19
20	1.28	1.08	2.40	1.24	1.09	1.31	1.13
21	1.14	1.04	2.23	1.13	1.06	1.58	1.19
22	1.59	1.03	1.73	1.48	1.11	1.28	1.37
23	1.09	1.09	2.48	1.50	1.11	1.52	1.18
24	1.17	1.03	1.30	1.06	1.05	2.24	1.66
25	1.34	1.18	1.35	1.64	1.09	1.24	1.38
26	1.70	1.06	1.44	1.15	1.04	1.86	1.31
27	1.92	1.12	1.75	1.34	1.11	1.02	1.46
28	1.42	1.06	1.11	1.06	1.04	1.00	1.45
29	1.52	1.14	1.58	1.25	1.09	1.33	1.17
30	1.34	1.04	2.29	1.03	1.07	1.46	1.27
31	1.59	1.18	1.39	1.03	1.07	1.09	1.66
33	1.52	1.04	1.20	1.25	1.03	1.27	1.91
34	1.51	1.04	1.35	1.25	1.04	1.26	1.91

Source: IRIO Indonesia table 2016 processed (2023)

Direct and indirect linkages in the future of the plantation subsector (C) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 13 provinces with linkage values above the average (> 1.64). The provinces are (1) Aceh, (2) North Sumatera, (4) Riau, (5) Jambi, (6) South Sumatera, (8) Lampung, (9) Bangka Belitung Islands, (20) West Kalimantan, (21) Central Kalimantan, (22) South Kalimantan, (23) East Kalimantan, (27) South Sulawesi, and (30) West Sulawesi. While the other 20 provinces are provinces with linkage values below average (< 1.64), these provinces include (3) West Sumatera, (7) Bengkulu, (10) Riau Islands, (11) Jakarta, (12) West Java, (13) Central Java, (14) Yogyakarta, (15) East Java, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (24) North Kalimantan, (25) North Sulawesi, (26) Central Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (31) Maluku, (33) West Papua, and (34) Papua.

Direct and indirect linkages in the future of the livestock subsector (D) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 13 provinces with linkage values above the average (>1.25). The provinces are (1) Aceh, (2) North Sumatera, (8) Lampung, (13) Central Java, (15) East Java, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (22) South Kalimantan, (23) East Kalimantan, (25) North Sulawesi, and (27) South Sulawesi, while the other 20 provinces are provinces with linkage values below average (<1.25), these provinces include (3) West Sumatera, (4) Riau, (5) Jambi, (6) South Sumatera, (7) Bengkulu, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (12) West Java, (14) Yogyakarta, (20) West Kalimantan, (21) Central Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (30) West Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua.

Direct and indirect linkages in the future of the agricultural services subsector (E) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 16 provinces with linkage values above the average (> 1.07). The provinces are (1) Aceh, (2) North Sumatera, (4) Riau, (6) South Sumatera, (8) Lampung, (12) West Java, (13) Central Java, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (20) West Kalimantan, (22) South Kalimantan, (23) East Kalimantan, (25) North Sulawesi, (27) South Sulawesi, and (29) Gorontalo. While the other 17 provinces are provinces with linkage values below average (< 1.07), these provinces include (3) West Sumatera, (5) Jambi, (7) Bengkulu, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (14) Yogyakarta, (15) East Java, (16) Banten, (21) Central Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, (28) Southeast Sulawesi, (30) West Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua.

The direct and indirect linkages of the forestry sub-sector (F) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 13 provinces with a linkage value above the average (> 1.36). The provinces are (1) Aceh, (2) North Sumatera, (3) West Sumatera, (4) Riau, (5) Jambi, (6) South Sumatera, (8) Lampung, (14) Yogyakarta, (21) Kalimantan Central, (23) East Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, and (30) West Sulawesi, while the other 20 provinces are provinces with linkages below

the average (<1.36), these provinces including (7) Bengkulu, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (12) West Java, (13) Central Java, (15) East Java, (16) Banten, (17)) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (20) West Kalimantan, (22) South Kalimantan, (25) North Sulawesi, (27) South Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (31) Maluku, (33) West Papua, and (34) Papua.

The direct and indirect linkages of the fisheries sub-sector (G) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 10 provinces with a linkage value above the average (> 1.28). The provinces are (9) Bangka Belitung Islands, (22) South Kalimantan, (24) North Kalimantan, (25) North Sulawesi, (26) Central Sulawesi, (27) South Sulawesi, (28) Southeast Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua. While the other 23 provinces are provinces with linkages below the average (<1.28), these provinces include (1) Aceh, (2) North Sumatera, (3) West Sumatera, (4) Riau, (5) Jambi, (6) South Sumatera, (7) Bengkulu, (8) Lampung, (10) Riau Archipelago, (11) Jakarta, (12) West Java, (13) Central Java, (14) Yogyakarta, (15) Java East, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (20) West Kalimantan, (21) Central Kalimantan, (23) East Kalimantan, (29) Gorontalo, and (30) West Sulawesi.

Backward Linkages between the North Maluku Agricultural Sector and Other Sectors in 33 Provinces in Indonesia

The second aspect of the linkages between North Maluku's agricultural sector and other sectors in 33 provinces in Indonesia are direct and indirect linkages backward. The linkages that are formed are representations of the overflow of output for each sector in the economy of 33 provinces in Indonesia which are allocated as inputs to the production activities of the North Maluku agricultural sector.

Based on Table 4, it can be seen that for direct and indirect backward linkages of the North Maluku food sub-sector (A) with all sectors in 33 provinces in Indonesia, there are 13 provinces with a linkage value above the average (> 1.16). The provinces are (1) Aceh, (2) North Sumatera, (4) Riau, (6) South Sumatera, (12) West Java, (13) Central Java, (15) East Java, (20) West

Kalimantan, (23) East Kalimantan, (27) South Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua. While the other 20 provinces are provinces with linkages below the average (< 1.16), these provinces include (3) West Sumatera, (5) Jambi, (7) Bengkulu, (8) Lampung, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (14) Yogyakarta, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (21) Central Kalimantan, (22) South Kalimantan, (24) North Kalimantan, (25) North Sulawesi, (26) Central Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, and (30) West Sulawesi.

Table 4. Value of backward linkage between the North Maluku agricultural sector and other sectors in 33 provinces in Indonesia

Province	Value of Linkages in the Agricultural Subsector						
	Food	Horticulture	Plantations	Livestock	Agricultural Services	Forestry	Fisheries
1	1.19	1.18	1.28	1.33	1.17	1.16	1.18
2	1.21	1.15	1.29	1.47	1.28	1.17	1.15
3	1.13	1.14	1.17	1.24	1.15	1.11	1.12
4	1.17	1.10	1.15	1.41	1.13	1.04	1.09
5	1.15	1.15	1.13	1.32	1.21	1.13	1.14
6	1.28	1.30	1.31	1.46	1.49	1.14	1.14
7	1.16	1.11	1.21	1.43	1.18	1.10	1.21
8	1.14	1.10	1.17	1.38	1.19	1.12	1.15
9	1.12	1.04	1.24	1.23	1.08	1.09	1.05
10	1.11	1.11	1.08	1.18	1.10	1.05	1.03
11	1.14	1.05	1.00	1.14	1.14	1.00	1.16
12	1.17	1.19	1.24	1.34	1.26	1.27	1.14
13	1.25	1.20	1.29	1.61	1.27	1.20	1.17
14	1.07	1.09	1.09	1.37	1.06	1.04	1.12
15	1.18	1.22	1.21	1.33	1.26	1.20	1.11
16	1.12	1.05	1.06	1.22	1.18	1.08	1.06
17	1.15	1.12	1.14	1.26	1.14	1.13	1.08
18	1.15	1.10	1.12	1.33	1.14	1.11	1.27
19	1.16	1.15	1.20	1.31	1.12	1.11	1.14
20	1.22	1.16	1.27	1.52	1.18	1.16	1.15
21	1.15	1.12	1.20	1.55	1.19	1.11	1.16
22	1.12	1.14	1.19	1.43	1.15	1.12	1.22
23	1.33	1.31	1.41	1.32	1.44	1.16	1.29
24	1.11	1.11	1.29	1.16	1.11	1.17	1.18
25	1.15	1.10	1.14	1.41	1.27	1.11	1.08
26	1.13	1.12	1.14	1.26	1.10	1.21	1.14
27	1.17	1.17	1.08	1.49	1.24	1.14	1.14
28	1.09	1.03	1.11	1.18	1.10	1.08	1.07
29	1.10	1.12	1.11	1.26	1.14	1.11	1.10
30	1.15	1.05	1.06	1.30	1.08	1.02	1.06
31	1.26	1.13	1.14	1.16	1.08	1.12	1.24
33	1.19	1.15	1.16	1.36	1.07	1.08	1.15
34	1.19	1.15	1.16	1.36	1.07	1.08	1.15

Source: IRIO Indonesia table 2016 processed (2023)

Direct and indirect backward linkages from the horticulture subsector (B) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 15 provinces with a linkage value above the average (>1.13). The provinces are (1) Aceh, (2) North Sumatera, (3) West Sumatera, (5) Jambi, (6) South Sumatera, (12) West Java, (13) Central Java, (15) East Java, (19) East Nusa Tenggara, (20) West Kalimantan, (22) South Kalimantan, (23) East Kalimantan, (27) South Sulawesi, (33) West Papua, and (34) Papua. While the other 18 provinces are provinces with a linkage value below the average (<1.13), these provinces include (4) Riau, (7) Bengkulu, (8) Lampung, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (14) Yogyakarta, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (21) Central Kalimantan, (24) North Kalimantan, (25) North Sulawesi, (26) Central Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (30) West Sulawesi, and (31) Maluku.

The backward direct and indirect linkages of the plantation sub-sector (C) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 14 provinces with a linkage value above the average (>1.18). The provinces are (1) Aceh, (2) North Sumatera, (6) South Sumatera, (7) Bengkulu, (9) Bangka Belitung Islands, (12) West Java, (13) Central Java, (15) East Java, (19) East Nusa Tenggara, (20) West Kalimantan, (21) Central Kalimantan, (22) South Kalimantan, (23) East Kalimantan, and (24) North Kalimantan. While the other 19 provinces are provinces with linkages below the average (< 1.18), these provinces include (3) West Sumatera, (4) Riau, (5) Jambi, (8) Lampung, (10) Archipelago Riau, (11) Jakarta, (14) Yogyakarta, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (25) North Sulawesi, (26) Central Sulawesi, (27) South Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (30) West Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua.

The direct and indirect backward linkages of the livestock sub-sector (D) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 14 provinces with a linkage value above the average (>1.34). The provinces are (2) North Sumatera, (4) Riau, (6) South Sumatera, (7) Bengkulu, (8) Lampung, (13) Central Java, (14) Yogyakarta, (20) West Kalimantan, (21) Central Kalimantan, (22) South Kalimantan, (25) North Sulawesi, (27) South Sulawesi, (33) West Papua, and (34) Papua. While the other 19 provinces are provinces with linkages below the average (<1.34), these provinces include (1) Aceh, (3) West Sumatera, (5) Jambi, (9) Bangka Belitung Islands, (10) Riau Islands, (11) Jakarta, (12) West Java, (15) East Java, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (23) East Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (30) West Sulawesi, and (31) Maluku.

The backward direct and indirect linkages of the agricultural services sub-sector (E) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 11 provinces with a linkage value above the average (> 1.18). The provinces are (2) North Sumatera, (5) Jambi, (6) South Sumatera, (8) Lampung, (12) West Java, (13) Central Java, (15) East Java, (21) Central Kalimantan, (23) East Kalimantan, (25) North Sulawesi, and (27) South Sulawesi. While the other 22 provinces are provinces with linkages below the average (<1.18), these provinces include (1) Aceh, (3) West Sumatera, (4) Riau, (7) Bengkulu, (9) Bangka Islands Belitung, (10) Riau Islands, (11) Jakarta, (14) Yogyakarta, (16) Banten, (17) Bali, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (20) West Kalimantan, (22) South Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (30) West Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua.

The direct and indirect backward linkages of the forestry sub-sector (F) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 13 provinces with a linkage value above the average (> 1.12). The provinces are (1) Aceh, (2) North Sumatera, (5) Jambi, (6) South Sumatera, (12) West Java, (13) Central Java, (15) East Java, (17) Bali, (20) West Kalimantan, (23) East Kalimantan, (24) North Kalimantan, (26) Central Sulawesi, and (27) South Sulawesi. While the other 20 provinces are provinces with linkages below the average (< 1.12), these provinces include (3) West Sumatera, (4) Riau, (7) Bengkulu, (8) Lampung, (9) Archipelago Bangka Belitung, (10) Riau Islands, (11) Jakarta, (14) Yogyakarta, (16) Banten, (18) West Nusa Tenggara, (19) East Nusa Tenggara, (21) Central Kalimantan, (22) South Kalimantan, (25) North Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, (30) West Sulawesi, (31) Maluku, (33) West Papua, and (34) Papua.

The direct and indirect backward linkages of the fisheries sub-sector (G) of North Maluku Province with all sectors in 33 provinces in Indonesia, there are 15 provinces with a linkage value above the average (>1.14). The provinces are (1) Aceh, (2) North Sumatera, (7) Bengkulu, (8) Lampung, (11) Jakarta, (13) Central Java, (18) West Nusa Tenggara, (20) West Kalimantan, (21) Central Kalimantan, (22) South Kalimantan, (23) East Kalimantan, (24) North Kalimantan, (31) Maluku, (33) West Papua, and (34) Papua. While the other 18 provinces are provinces with linkages below the average (<1.14), these provinces include (3) West Sumatera, (4) Riau, (5) Jambi, (6) South Sumatera, (9) Bangka Belitung Islands, (10) Riau Islands, (12) West Java, (14) Yogyakarta, (15) East Java, (16) Banten, (17) Bali, (19) East Nusa Tenggara, (25) North Sulawesi, (26) Central Sulawesi, (27) South Sulawesi, (28) Southeast Sulawesi, (29) Gorontalo, and (30) West Sulawesi.

Based on the results described in Tables 4 and 5, it can be said that in total North Maluku Province has the highest direct and indirect forward linkages with 33 other provinces in Indonesia for the food and horticulture sub-sector is West Nusa Tenggara Province, the plantation sub-sector is with the Province of North Sumatera, livestock is with the Province of North Sulawesi, agricultural services is with the Province of Bali, forestry is with the Province of North Kalimantan, and fisheries is with the Provinces of West Papua and Papua. Then for the value of direct and indirect backward linkages of the North Maluku agricultural sector with 33 other provinces in Indonesia, the highest for the food, horticulture, and plantation sub-sectors is with East Kalimantan Province, livestock is with Central Java Province, agricultural services is with Central Java Province. South Sumatera, forestry is with West Java Province, and fisheries is with East Kalimantan Province.

These results indicate that there are different linkages between agricultural sectors and between regions for North Maluku Province and 33 provinces in Indonesia so the level of linkage is very important to note. According to Muchdie and Imansyah (2019) ignoring the relationship between regions in the input-output model will result in significant errors in spatial spillover or spillover effects between regions which is important in building the economy of a region. According to Cark et al. (2021), the added value of the agriculture and food sector should not only be built from the development of

local or regional supply chains but can be developed through the infrastructure of alternative food systems between regions or regions.

Managerial Implications

The results of this study should have implications for the process of evaluation, formulation, and policy making in encouraging the success of regional economic development through increased transaction or trade activities between regions, especially agricultural commodities. This potential needs to be a concern for local governments considering that the agricultural sector is a source of input providers for the manufacturing industry. The government is expected to not only focus on production policies but more than that the marketing or trade aspects of agricultural products are also considered important. Development in the aspect of input providers for the agricultural sector can be in the form of increased production and for output absorption can be in the form of market expansion. Based on the results in this study, market expansion for agricultural commodities is considered efficient when there is inter-regional cooperation, especially inter-regional trade transaction activities.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Fisheries is a sub-sector that has the highest total forward linkages compared to other sub-sectors in the North Maluku agricultural sector, while backward linkages are the livestock sub-sector. Based on the spreading power index and the sensitivity index the food and fisheries subsector has a superior orientation from the input side, meaning that if the government wants to increase access to supply in the aggregate, the food crops and fisheries sub-sector deserves priority. The livestock sub-sector has a superior orientation in terms of output, meaning that if the government wants to increase access to aggregate demand, the livestock sub-sector deserves to be prioritized in the development of the North Maluku agricultural sector.

Based on the correlation value between North Maluku's agricultural sector and the economic sector in 33 other provinces in Indonesia. The North Maluku food crops and horticulture sub-sector has the highest total forward linkage value with West Nusa Tenggara Province. The

plantation sub-sector has the highest total forward linkage value with North Sumatera Province, the livestock sub-sector with North Sulawesi Province, the agricultural services with Bali Province, the forestry sub-sector with North Kalimantan Province, and the fisheries sub-sector with West Papua and Papua Provinces. Total linkages to the food, horticulture, plantation, and fishery sub-sectors. North Maluku has high linkages with East Kalimantan Province. The livestock subsector has the highest linkage value with Central Java Province, agricultural services with South Sumatera Province, and the forestry subsector with West Java Province.

Apart from the results and conclusions of this study, there are still some limitations of this study that need to be considered. These limitations include the actualization of inter-sectoral input and output flows between regions in this study that only describes the sectoral aspects in general and not in the form of commodities. Another limitation is that the flow of inputs and outputs in the results of this study does not represent the production activities of a sector but rather the trade activities between sectors between regions.

Recommendations

An inter-sectoral and inter-regional approach can separate the potential of each sub-sector in North Maluku agriculture to clarify the feasibility of developing sustainable agricultural development. Based on the findings in this study, the efforts that can be made by the North Maluku government, especially related agencies, are (1) if the government wants to increase access to aggregate demand in the regional economy, the development of the livestock sub-sector is feasible. Increasing access to aggregate supply in the regional economy means that the development of the food crops and fisheries sub-sectors is feasible. (2) The development of a sector oriented towards inter-regional input-output transactions can also be carried out, the plantation and forestry sub-sector is feasible to develop considering the high value of future linkages with West Sumatera and North Kalimantan.

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