Analysis of Low-cost Nutritious Model Diet in the Rural Area of Sulawesi Cocoa Belt Using Robust Factor Analysis

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Abstract

It will be difficult for cocoa farmers in Indonesia not to engage in deforestation and crop conversion if production remains low and income from cocoa insufficient to meet the food needs of farmer households. A study conducted to examine model diet and an analysis of low-cost nutritious model diet of the cocoa sector in the rural area of Sulawesi cocoa belt. The food prices data is gathered based on primary data from 96 rural markets of 24 sub-district in Sulawesi cocoa belt then used to create a model diet and processed using multivariate factor analysis to make it easier to conduct a study the influential variables and further research analysis with the help of Minitab 20.3. The cocoa farming in Sulawesi cocoa belt demonstrate that the cocoa business is currently unsustainable, even if merely for supplying the needs of the cocoa farmer household to cover of low-cost nutritious model diet with the average deficit around IDR 4,899,617 when the income from cocoa production is compared to the need for a low-cost nutritious model diet.

Key Words: Cocoa Farmers, Robust Factor Analysis, Sulawesi Island.

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Introduction

Cocoa production has risen in the previous thirty years, with almost all of it coming from four West African countries: Côte d'Ivoire, Ghana, Cameroon, and Nigeria. Ten years ago, the National Government of Indonesia revealed ambitions to become the world's largest cocoa producer through Gerakan Nasional (GERNAS) KAKAO or cocoa national movement. Despite government investment programs, production has halved in ten years to around 200,000 tonnes in 2019/2020, and Indonesia has been gradually losing its position among the world's top cocoa producing nations, even though production (grinding) capacity remains listed at 780,000 metric tons at the moment.

Cocoa-related deforestation is concentrated in a few countries in Sub-Saharan Africa and Southeast Asia. Indonesia, a cocoa producer in Southeast Asia, has one of the greatest deforestation rates in the world, with crop production accounting for 31% of overall deforestation between 1990 and 2008. Cocoa cultivation on an estimated 1.7 million hectares of land resulted in 0.7 million hectares of deforestation during this period, accounting for 9% of overall deforestation attributable to crop cultivation. During Indonesia's cocoa boom, the majority of cocoa plantations were established in thinned forests on Sulawesi Island, which accounts for more than 70% of the country's total cocoa production. Historically, deforestation from cocoa production in these places has been fuelled by a variety of factors especially the absence of government policies that encourage production expansion. This is worsened further by a lack of inputs, deteriorating soil, and farmers' need to access newly deforested soils for nutrients. Cocoa belt on Sulawesi Island is jurisdictionally spread over 4 cocoa center provinces, i.e.: South, South-East, Central, and West Sulawesi Province; with a total cocoa farm of 885,566 ha (Direktorat Jenderal Perkebunan, 2020).

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Beside deforestation issue by cocoa sector, many Indonesian cocoa farmers also have left the sector due to low earnings. Some have found other income sources in the agricultural sector e.g., by planting palm oil or food/cash crops (rice, corn, cassava, soybeans, and peanuts), others have left agriculture and the countryside entirely for the booming cities. It will be difficult for cocoa farmers in Indonesia not to engage in deforestation and crop conversion if production remains low and income from cocoa insufficient to meet the food needs of farmer households. As a result, a study was conducted to examine food prices based on the recommended low-cost nutritious model diet in the rural area of Sulawesi cocoa belt.

Methods

The food prices are gathered based on primary data from 96 rural markets of 24 sub-district in Sulawesi cocoa belt, obtained from four rural markets in each sub-district. The retail food price survey was conducted at the end of December 2021, the units of purchase were converted to kilograms.

Food prices are then used to create a model diet based on the national nutritional adequacy rate of 2,100 kcal (Badan Ketahanan Pangan, 2015), and the model diet should include an adequate amount of calories based on World Health Organization (WHO) recommendations and meet other nutritional recommendations (WHO/FAO, 2003) such as:

- A minimum of 10% of calories from protein (with a suitable amount of protein coming from "better quality" sources such as legumes and animal-origin foods);
- 15%–30% of calories from fat; and
- Carbohydrates provide 50-75% of the calories.

With the help of Minitab 20.3, data from the food prices cluster and model diet were processed using multivariate factor analysis to make it easier to conduct a study the influential variables and further research analysis.

Results and Discussion

Food Prices Model Diet

The model diet, provided in Table 1, is based on a desk analysis of national dietary recommendations and a comparison with worldwide WHO standards. The model diet comprises of typical national food items in the protein, fat, and carbohydrate categories, with suggested amounts per 100 grams. This model diet is then validated and changed through interviews conducted in the survey region to guarantee compliance with local food preferences and the country's degree of development. Next, takes this verified model diet to rural market pricing to obtain typical food item costs in order to compute the model diet's anticipated cost.

Table 1. Model diet for Sulawesi cocoa belt

Food Groups	Food Items	Gram	Daily Intake			
			Calorie	Protein	Fat	Carbohydrate
1. Cereals and grains	Rice	296	1056.72	24.86	5.03	228.22
2. Prepared cereals	Instant noodles	21	79.80	1.68	2.94	11.34
3. Roots and tubers	Cassava	10	15.40	0.10	0.03	3.68
4. Starchy fruit or vegetable	Sago	25	88.75	0.15	0.28	21.40
	Banana	59	63.72	0.59	0.47	14.34
5. Pulses, legumes, beans and nuts	Chickpeas	20	6.80	0.48	0.06	1.44
6. Eggs	Egg	29	44.66	3.60	3.13	0.20
7. Meats & Fish	Chicken	50	149.00	9.10	12.50	0.00
	Fresh fish	50	37.00	5.15	0.70	2.05
	Dried fish	15	28.95	6.30	0.23	0.00
8. Green leafy vegetables	Cassava leaves	10	5.00	0.62	0.11	0.71
	Spinach	10	1.60	0.09	0.04	0.29
9. Other vegetables	Tomato	10	2.40	0.13	0.05	0.47
	Carrots	5	1.80	0.05	0.03	0.40
10. Fruits	Mango	20	10.40	0.14	0.00	2.46
	Papaya	20	9.20	0.10	2.40	2.44
11. Oils & fats	Palm oil	40	353.60	0.00	40.00	0.00
12. Sugar	Sugar	20	78.80	0.00	0.00	18.80
13. Protein foods	Tofu	20	23.00	1.94	1.70	0.50
	Fermented soybean	30	45.00	4.20	2.31	2.73
Total			2101.60	59.28	72.01	311.46
Model Diet Percentage				13.39%	16.26%	70.35%
WHO requirement				>10%	15-30%	55-75%

Factor analysis is used to search for or identify the underlying factor(s) or latent constructs that can explain the intercorrelation between the variables in this confirmed model diet and presented in Table 2 under Minitab software calculation with varimax rotation.

According to Factor1, chickpeas is a variable that influences other variables together with instant noodles, cassava, chicken, and dried fish; however, rice have no effect because they have a negative value. A negative sign for loading has no bearing on the strength of the variable's relationship to the factor. However, it indicates that the variable is inversely related to the factor (Asnawi et al., 2012). Furthermore, Factor2 demonstrates that fermented soybean, tofu, and sugar prices have an impact on other variables. This can also be seen in Figure 1's loading plot.

Table 2. Rotated factor loadings and communalities of food prices model diet

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Communality
Rice	-0,496	-0,254	0,161	-0,035	0,375	-0,256	-0,494	0,788
Instant noodles	0,724	-0,315	0,105	-0,298	-0,352	0,100	-0,051	0,860
Cassava	0,629	0,132	-0,292	0,229	0,126	0,233	-0,055	0,624
Sago	0,019	0,099	-0,015	0,077	-0,873	-0,017	-0,012	0,779
Banana	0,174	0,030	-0,958	-0,132	-0,032	-0,099	-0,017	0,979
Chickpeas	0,781	-0,010	-0,038	0,153	-0,275	-0,078	-0,059	0,720
Egg	0,311	0,023	0,004	0,535	0,191	0,677	0,102	0,889
Chicken	0,504	-0,068	0,645	0,076	-0,257	0,068	-0,367	0,885
Fresh fish	0,354	0,080	0,306	0,428	-0,713	0,018	0,078	0,923
Dried fish	0,632	0,440	-0,221	-0,015	0,134	-0,082	-0,042	0,668
Cassava leaves	0,097	-0,078	0,118	0,936	-0,104	0,000	-0,055	0,919
Spinach	-0,139	0,077	0,049	0,419	-0,290	0,780	-0,126	0,912
Tomato	-0,261	0,047	0,202	0,233	0,632	0,082	-0,532	0,855
Carrots	0,209	-0,044	-0,035	-0,113	0,020	0,014	-0,881	0,837
Mango	0,053	0,188	0,232	-0,214	0,132	0,849	0,060	0,880
Papaya	-0,013	0,313	0,178	0,678	-0,076	0,156	0,163	0,646
Palm oil	0,174	0,030	-0,958	-0,132	-0,032	-0,099	-0,017	0,979
Sugar	0,385	0,671	-0,047	0,048	-0,075	0,374	-0,122	0,763
Tofu	-0,063	0,880	-0,026	0,027	-0,007	-0,007	0,185	0,814
Fermented soybean	0,005	0,954	-0,007	0,097	-0,117	0,119	-0,029	0,948
Variance	30,079	26,815	26,665	23,181	22,872	21,409	15,657	166,679
% Var	0.1500	0.1340	0.1330	0.1160	0.1140	0.1070	0.0780	0.8330

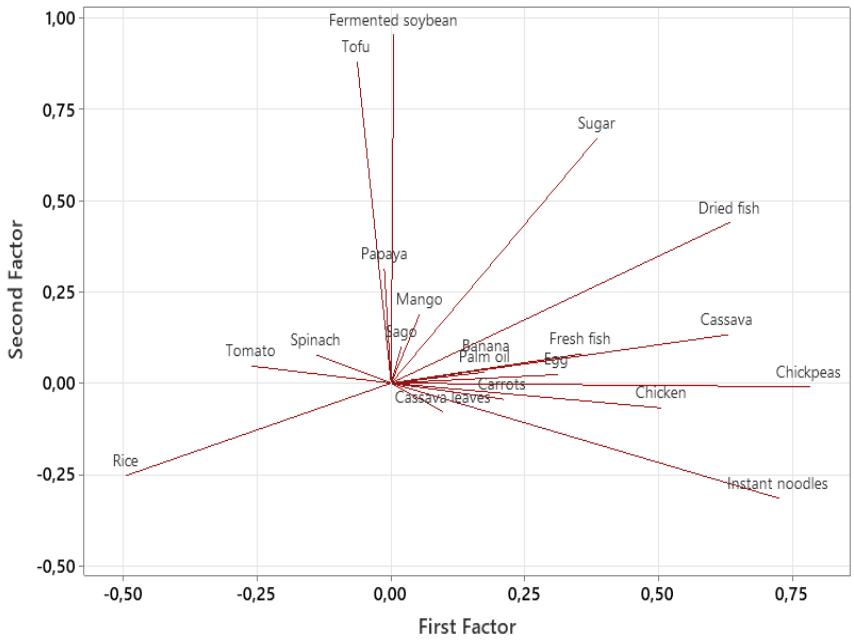

Figure 1. Loading plot of food prices model diet variable

As illustrated in Figure 2, chickpeas, instant noodles, cassava, chicken, and dried fish prices are extremely low in the rural market of Tammero'do and slightly lower in the rural market of Malunda; and vice versa in the rural market of Kasimbar, where prices are extremely higher. The rural markets of Batu Putih have a higher price for fermented soybean, tofu, and sugar, whereas the rural markets of Malunda have a cheaper price.

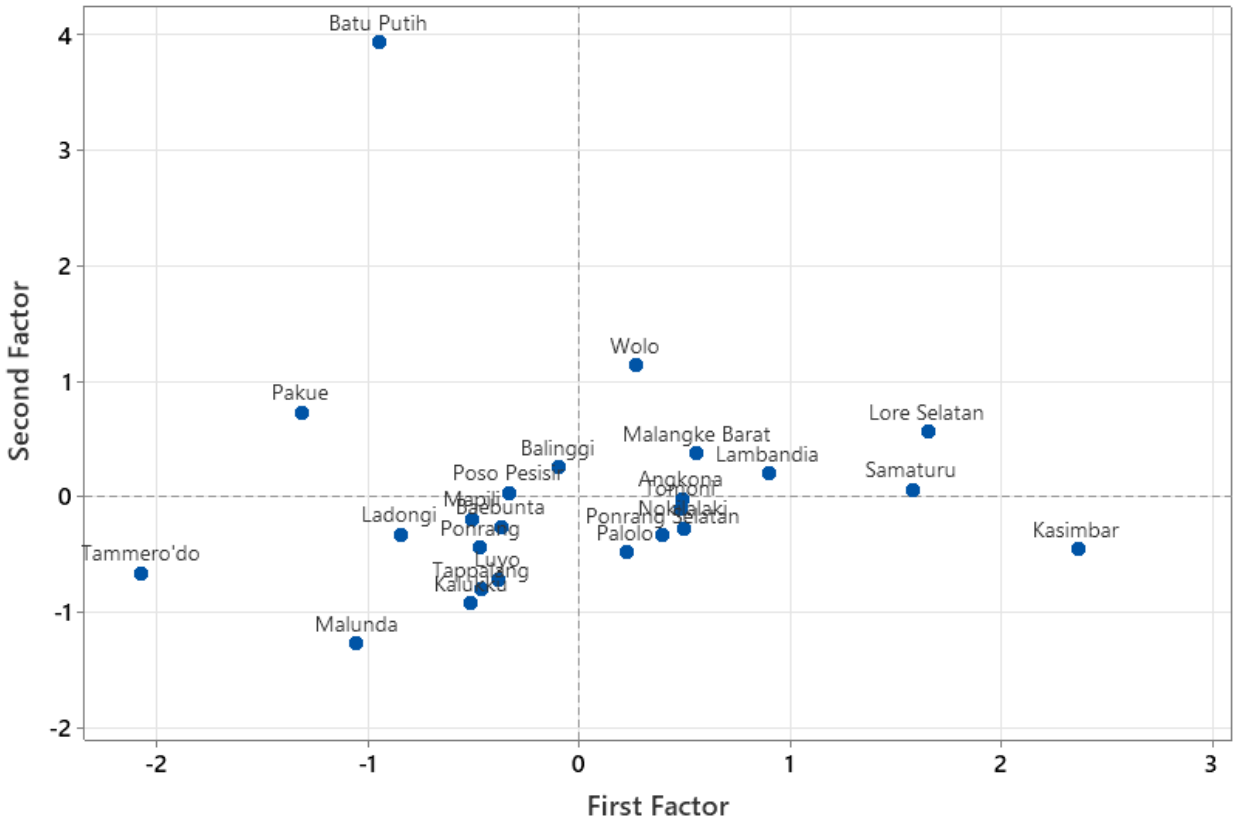

Figure 2. Plot of factor score

Cost of the Validated Model Diet in Sulawesi Cocoa Belt

Cost of the validated model diet based on field survey with annual cost for household for family of five presented in Table 3 and show that the annually average cost per cocoa farmer household to complete the model diet is IDR 20,552,998; with the lowest cost of IDR 17,536,470 (Malunda Sub-district) and the highest cost of IDR 23,857,955 (Lore Selatan Sub-district).

How crucial farmer income is, and after determining how much it costs to simply satisfy the low-cost nutritious model diet, it is possible to determine if the cocoa farming business can meet it. Annual income is derived by multiplying average production by the average price of dried cocoa beans in 2021. The price of dried cocoa beans is derived from the international market price (ICCO, 2022) and converted using an 80% farm-gate price (Tsowou and Gayi, 2019; NewForesight, 2018), furthermore cocoa farmer receiving average IDR 27,786 per kg of dried cocoa bean. With an average productivity of 563.35 kg per household (Direktorat Jenderal Perkebunan, 2020), one household earned IDR 15,653,381 which is the income from cocoa farming is insufficient to simply cover the low-cost nutritious model diet. To put it another way, the cocoa business is currently unsustainable, even if merely for supplying the needs of the cocoa farmer household model diet in Sulawesi cocoa belt.

Table 3. Cost of the validated model diet in Sulawesi cocoa belt

Provinces	District	Sub-distric	Cost of the Model Diet (IDR)			
			Daily per capita	Monthly per capita	Annually per capita	Annually per household
South Sulawesi	Luwu	Ponrang	10,088	302,638	3,631,659	18,158,294
		Ponrang Selatan	11,605	348,155	4,177,855	20,889,275
	Luwu Utara	Malangke Barat	11,049	331,461	3,977,531	19,887,657
		Baebunta	10,929	327,880	3,934,564	19,672,821
	Luwu Timur	Angkona	11,443	343,284	4,119,404	20,597,019
		Tomoni	12,071	362,129	4,345,546	21,727,731
West Sulawesi	Polewali Mandar	Mapili	10,270	308,114	3,697,363	18,486,813
		Luyo	10,045	301,339	3,616,068	18,080,339
	Mamuju	Kalukku	11,134	334,035	4,008,415	20,042,073
		Tappalang	10,669	320,066	3,840,791	19,203,957
	Majene	Malunda	9,742	292,275	3,507,294	17,536,470
		Tammero'do	10,183	305,495	3,665,940	18,329,700
Central Sulawesi	Sigi	Nokilalaki	12,953	388,582	4,662,988	23,314,939
		Palolo	12,575	377,236	4,526,828	22,634,142
	Poso	Poso Pesisir	11,912	357,362	4,288,347	21,441,733
		Lore Selatan	13,254	397,633	4,771,591	23,857,955
	Parigi Moutong	Kasimbar	12,276	368,287	4,419,447	22,097,236
		Balinggi	10,954	328,608	3,943,295	19,716,475
South-East Sulawesi	Kolaka Timur	Ladongi	11,898	356,938	4,283,252	21,416,261
		Lambandia	11,299	338,972	4,067,661	20,338,305
	Kolaka	Samaturu	11,598	347,939	4,175,268	20,876,341
		Wolo	12,069	362,060	4,344,718	21,723,590
	Kolaka Utara	Batu Putih	12,585	377,560	4,530,718	22,653,590
		Pakue	11,438	343,154	4,117,847	20,589,235

Conclusion

According to the findings of the model diet analysis with factor analysis reveals that chickpeas, instant noodles, cassava, chicken, dried fish, fermented soybean, tofu, and sugar prices are a variable that influences other variables. It is possible to state that Kasimbar is the most expensive sub-district and Tammero'do is the least expensive sub-district; even though based on calculation and complete analysis showing that all area should be prioritized for future development and action plan. When the income from cocoa production is compared to the requirement for a low-cost nutritious model diet, the average deficit occurs around IDR 4,899,617 and demonstrate that the cocoa business is currently unsustainable, even if merely for supplying the needs of the cocoa farmer household model diet.

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