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Impacts of Removing Fertilizer Subsidy and Procurement Program on the Indonesian Rice Economy

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HIGHLIGHTS

The Indonesian government has been subsidizing rice production to achieve self-sufficiency and to raise farm incomes. The government policies include the guaranteed minimum rice price to farmers, subsidy on fertilizer, and public investment policy.

The government is under increasing financial pressure due to a reduction in oil revenue, which is the primary source of export earnings and government revenue. This increases a concern about continuing government subsidy programs for rice.

The objective of this study is to examine the effects of alternative government policies on the Indonesian rice economy. The alternative policies include 1) removing the fertilizer subsidy; 2) removing the government procurement program for minimum rice price; and 3) a free trade under which no government intervention is allowed. An econometric simulation technique based on a dynamics partial equilibrium model is used. Parameters of the model are estimated with time-series data from 1970 to 1991, using the nonlinear 3SLS estimator.

Without considering the cost of the government policies, eliminating the government procurement program would lower social welfare more than the reduction in fertilizer subsidy. A higher level of social welfare and food security would be reached under the current policy.

Impacts of Removing Fertilizer Subsidy and Procurement Program on the Indonesian Rice Economy

Muharto Muharto, Won W. Koo,
and Seung-Ryong Yang*

Agriculture is the largest sector in Indonesia's economy, accounting for about 25 percent of the Gross Domestic Product and 60 percent of total employment. Food crops account for about two-thirds of total agricultural output, and rice accounts for about 50 percent of food crop production in value. This implies that rice is the single most important crop in Indonesian agriculture and economy.

Indonesian government has been subsidizing rice production to achieve self-sufficiency and to increase farm income. The government has promoted self-sufficiency for food security. The government rice policies include supply control (of storage and imports), minimum price guarantees to farmers, and subsidies on fertilizer.

While self-sufficiency in rice was accomplished in 1984 as a result of the government policies, accumulation of stock beyond the desired level increases the concern about handling and storage costs. Because of a large difference between high domestic and low world prices, exporting the surplus is not a solution. Inefficient resource allocation due to the government policies is another concern. Rosegrant et al., (1987) reported that Indonesian farmers tend to use fertilizer above the optimal level. In addition, the policies insulating the domestic market from the world market keep the domestic rice price above the world price, which may result in welfare loss to the consumers. The government is under increasing financial pressure due to a reduction in oil revenue, which is the primary source of export earnings and government revenue and, in turn, of agricultural policies. These problems increase a concern about continuing rice subsidy policies.

The objective of this study is to determine the impacts of removing the fertilizer subsidy and government procurement program in Indonesia on domestic rice production, consumption, import, and prices. This study also examines the effect of policy alternatives on consumer and producer surplus, which can be used to measure the economy's overall social welfare under alternative policies.

This paper is organized as follows. The second section reviews Indonesian rice policies. The third section develops an econometric model for policy simulations and procedures. The

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fourth section discusses empirical results and implications, followed by the concluding section.

Rice Policies in Indonesia

During 1945 to 1966, a low and stable rice price was important for political stability. Rice was imported to maintain the rice price at a stable level. Due to the limited foreign exchange, however, the import often could not meet the domestic deficit and, thus, the government established a quota system that collects rice directly from the farmers through regional trade restrictions. Since the regional rice trade was not allowed, regional prices differ substantially with higher prices in deficit regions and lower prices in surplus regions.

In 1959, the government enacted an agricultural program based on village "Padi Centers" to increase rice production. Each center stored seeds and fertilizer and provided farmers with technical assistance and credit. This program did not succeed mainly due to a lack of management and fund (Masyhuri 1986).

Production continued to decrease and imports topped 1.04 million tons in 1963. Rice prices increased 9 times from 200 rupiah (Rp) to 1800 rupiah (Rp) per kilo gram (kg) during 1965 and continued to rise in spite of the currency revaluation from Rp 1000 to Rp 1.00 in 1966, which resulted in political chaos that year. The inflation rate topped 650 percent in 1966 (Baker 1985). Therefore, the government set a policy priority on the low rice price for economic and political stability (Mears 1981). The temporary logistic agency, KOLOGNAS, was replaced by BULOG, a Food Stock Authority, whose first task was to stabilize the rice price in the domestic market (Mears 1981).

A comprehensive rice price policy was introduced in 1970. The policy consisted of the following elements: 1) a floor price to guarantee a minimum price for producers; 2) a ceiling price to assure a reasonable price for consumers; 3) a sufficient range between these two prices to provide traders and millers reasonable profits from holding rice between crop seasons; and 4) appropriate price relationship in domestic and international markets. In addition, the government introduced the fertilizer subsidy program for producers to increase their income from rice production.

Econometric Models and Procedures

This study uses a dynamic partial equilibrium model. The model is estimated with the time series data by using the three-stage least squares (3SLS) estimator. The estimated model is simulated to evaluate the impact of policies on prices, consumption, production, imports, and social welfare.

Model Specifications

The demand schedule can be derived through a utility maximization subject to the budget constraint. This study specifies the demand for rice as a linear function of income and prices of goods in the consumption bundle as:

$$(1)\quad D_t = a_0 + a_1 I_t + a_2 P^r_t + \Sigma_j a_j P_{jt} + \varepsilon_t,$$

where a's are parameters, I_t is the per capita disposable income divided by the consumer price index (CPI), P^r_t is the deflated retail price of rice, P_{jt} is the deflated retail price of substitute in consumption, and e_t is an error term. This model includes wheat flour and corn as substitutes in consumption.

Agricultural production is defined as the product of area harvested and crop yield. A producer's acreage decision generally depends upon the prices of rice and competing crops as

$$(2)\quad A_t = f(P_t,\ P_{1t}, \ldots P_{nt}),$$

where P_t is the price of rice and P_{nt}, h=1,...,n, are prices of competing goods in production.

However, acreage decisions do not respond immediately to innovation or policy changes, mainly because of biological constraints on agricultural production. To incorporate the dynamic aspect in farmers' acreage decisions, the Nerlove's lag model is used as follows:

$$(3)\quad A_t^* = \beta_0 + \beta_i P_t + \Sigma_h \beta_h P_{ht},$$

$$(4)\quad A_t - A_{t-1} = \theta(A_t^* - A_{t-1}) + \varepsilon_{st}, \text{ and } 0 < \theta < 1,$$

where A_t^* denotes the desired acreage, ß's are parameters, and θ is an adjustment coefficient. Combining Equations (3) and (4) yields

$$(5)\quad A_t = \theta ß_0 + \theta ß_1 P_t + \Sigma_h \theta ß_h P_{ht} + (\theta-1) A_{t-1} + \varepsilon_{at}.$$

Since season average prices at time t are not known when producers make planting decisions, these prices are replaced by the lagged prices, P_{t-1} and P_{ht-1} assuming the naive expectation. Rice competes with corn for limited land. Thus, the price of corn is included in the model. Finally, producers respond to the market price and to the government procurement price, which guarantees the floor price for farmers. However, the government procurement price is announced before the first crop season starts. Thus, the government procurement price would be the current price. The empirical model for harvested acreage is rewritten as

$$(6)\quad A_t = b_0 + b_1 P^f_{t-1} + b_2 P^g_t + b_3 P^s_{t-1} + b_4 A_{t-1} + \varepsilon_{at}$$

where P^f_{t-1} is the rice price received by farmer at time t-1, P^g_t is the government procurement price at time t, and P^s_{t-1} is the farm corn price at time t-1.

Yield, as the average productivity with respect to land, can be specified as a function of fertilizer use and continuing farming technology. Thus, the rice yield model is specified as

$$(7) \quad Y_t = c_0 + c_1F_t + c_2Y_{t-1} + \varepsilon_{yt}$$

where c's are parameters and F_t is the level of fertilizer used at time t.

As an input demand, the fertilizer use in this study is treated as an endogenous variable. From production theory, the fertilizer use is specified as a function of the fertilizer price and the rice price. To incorporate the dynamic aspects in a farmer's decision about fertilizer usage, the partial adjustment model is used to specify the input demand as:

$$(8) \quad F_t = d_0 + d_1P^z_{t-1} + d_2P^f_{t-1} + d_3F_{t-1} + \varepsilon_{ft},$$

where d's are parameters and P^z_{t-1} is the fertilizer price at time t-1.

The import demand for rice can be expressed as a function of the difference between the domestic and world prices. A greater difference would bring more imports. In addition, since the government does not allow private imports to protect the domestic rice industry, the government stock would be important in determining the import demand. With a linear relationship, the import demand model adjusted to the previous error in import behavior (i.e., partial adjustment) is specified as

$$(9) \quad M_t = e_0 + e_1(P^r_t - P^w_t) + e_2ES_{t-1} + e_3M_{t-1} + \varepsilon_{mt},$$

where P^w_{tt} is the world price of rice and ES_{t-1} is the ending stock at time t-1.

The marketing margin, which is the difference between the farm and retail prices, is determined by the quantity marketed and marketing cost, such as wage, transportation cost, and so on. Assuming the marketing cost is constant in real terms, marketing margin is expressed as

$$(10) \quad MM_t = f_0 + f_1Q_t + \varepsilon_{mmt},$$

where Q_t is the quantity marketed.

Along with the six behavioral equations in (1), (6), (7), (8), (9), and (10), four identity equations are specified such as

$$(11) \quad Q^d_t = D_t*POP_t$$

$$(12) \quad Q^s_t = A_t * Y_t$$

$$(13) \quad Q^d_t = Q^s_t + ES_{t-1} - ES_t + M_t$$

$$(14) \quad MM_t = P^r_t - P^f_t$$

where POP_t is the population size. The first identity defines the total demand for rice, while the second identity reflects the total supply of rice. The identity equation in (13) indicates the equilibrium condition between supply and demand. The last identity defines the price relationship between farm and retail prices.

These six structural equations and four identities are used to estimate structural parameters. Because of simultaneity and nonlinearity in identity equations, the nonlinear 3SLS estimator is used in SAS. The estimator is consistent and asymptotically more efficient when errors are correlated across equations (Judge et al.).

Data

Annual data from 1970 to 1991 were used to estimate the model. Data for harvested area, yield, demand for fertilizer, fertilizer price, farm prices of rice and corn, farm price index, consumer price index, and population are taken from various issues of the Statistical Yearbook of Indonesia (Indonesian Central Bureau of Statistics). Consumption, government procurement price, government stock, and consumer prices of rice, wheat flour, and corn are collected from BULOG. Imports, exports, and prices are collected from various issues of Trade Yearbook (Food Agriculture Organization).

Policy scenarios

The Indonesian rice model is simulated over 10 years from 1991 to 2000 under the following four scenarios:

(1) Model 1 assumes a continuation of the current government procurement and subsidy on fertilizer price. The fertilizer price is assumed to change at its 1970-1991 trend.

(2) Model 2 assumes a removal of the subsidy on fertilizer price. The fertilizer price is assumed to increase by 45% in 1994 from 1993 and continue to increase at the trend after 1994. The government maintains its procurement program in this scenario.

(3) Model 3 assumes that the government procurement program is eliminated after 1994. However, the fertilizer subsidy remains under the scenario.

(4) Model 4 assumes no government procurement program and liberalization of rice imports.

All simulations are dynamic in the sense that values of the endogenous variables in the present period are used as inputs for the next year. These simulations commonly assume that disposable income increases at 5 percent annually. Government procurement price increases at 10 percent annually. The other exogenous variables increase at the previous trends (Tables A1 and A2).

Empirical Results

The estimated equations are reported in Table 1. The estimated parameters have signs consistent with economic theory, and many coefficients differ significantly from zero at the 5 percent level. R^2s indicate that the empirical models explain variations of dependent variables reasonably well.

In the acreage equation, both producer and government procurement prices have positive effects, but are not significant at a 5 percent level. This may be due to multicolinearity between these two prices. In addition, corn does not appear as an important alternative in production. However, the lagged variable is significantly positive, implying that rice production tends to be a repetitive behavior.

Neither output nor input prices are significant in determining the fertilizer use at the 5% level. The insignificant fertilizer price coefficient seems to reflect the fact that the government subsidy accounts for about 20 percent to 74 percent of fertilizer price during the sample period. Again, the fertilizer use largely depends on the previous year's use.

However, the fertilizer use has a positive effect on yield. The yield is autoregressive, which implies that rice yield persists due to continuous cropping patterns and/or to fertilizer and moisture remaining from previous years.

The demand for rice is positively related to income and negatively related to the own-price as theory suggests. Coefficients for wheat and corn prices are positive, indicating these two commodities are rice substitutes. However, own- and cross-price elasticities and income elasticity calculated at means are all inelastic (Table 2).

In the import demand equation, the price difference has a positive sign, implying that either increasing the domestic price or decreasing the import price will increase import demand. The lagged government stocks are negatively related to the rice import as expected. The positive sign of the lagged-dependent variable in this equation implies that Indonesia has increased rice imports gradually over the past decades.

TABLE 1. THE 3SLS ESTIMATES FOR SUPPLY OF AND DEMAND FOR RICE*/

	Endogenous Variables					
Explanatory Variables	Area (A_t)	N Fert. Used (F_t)	Yield (Y_t)	Demand (D_t)	Import (M_t)	Mark. Margin (MM_t)
Const.	2007.62	-17.895	.475	844×10^{-4}	1087.96	-44.85
	(1.28)	(-.56)	(6.28)	(5.60)	(3.02)	(-3.35)
P^{FR}_{t-1}	325.86	12.96				
	(1.01)	(1.72)				
P^{s}_{t-1}	688.42					
	(-1.83)					
P^{g}_{t}	222.65					
	(.95)					
A_{t-1}	.746					
	(5.97)					
P^{f}_{t-1}		-9.974				
		(-.79)				
F_{t-1}		.954				
		(8.58)				
F_t			399×10^{-5}			
			(6.11)			
Y_{t-1}			.6527			
			(11.12)			
I^t				12.62		
				(5.75)		
P^{CR}_{t}				-14×10^{-3}	187.35	
				(-1.74)	(1.54)	
P^{WF}_{t}				427×10^{-5}		
				(1.61)		
P^{C}_{t}				179×10^{-4}		
				(2.33)		
P^{W}_{t}					187.35	
					(1.54)	
ES_{t-1}					- .597	
					(-2.98)	
M_{t-1}					.623	
					(3.98)	
S_t						335×10^{-5}
						(5.30)
Adj. R	.858	.955	.995	.950	.656	.587
DW	2.577	2.112	2.187	1.745	2.272	2.811

*/t-values in parentheses.

TABLE 2. THE DEMAND ELASTICITIES FOR RICE, INDONESIA

Item	Demand	
	Domestic	Import
Rice price	-0.37	0.81
Wheat price	0.14	
Corn price	0.30	
World rice price		-0.80
Income	0.35	
Stock		-0.99

The marketing margin appears to increase with the quantity marketed. This seems to imply inefficient marketing performance or uncompetitive structure.

Policy Simulation Results

Policy simulation results are reported in Table 3. Simulated results for 1995 and 2000 are compared to actual numbers in 1993. Under the current policies (Model 1), production increases mainly due to an increase in acreage in 1995 and 2000. However, demand for rice increases more than the increase in production, resulting in an increase in imports. Both producer and consumer prices rise.

The results from removing the fertilizer subsidy (Model 2) and government procurement (Model 3) are similar. Domestic production decreases relative to the current policy. Production decreases more without the fertilizer subsidy than without the government procurement, due to a significant reduction in yield. As a result, market prices are projected to be higher under no fertilizer subsidy.

Rice consumption is also projected to decrease under Models 2 and 3 compared to Model 1. However, the production decreases more than the decrease in consumption. As a result, import demand increases more without the fertilizer subsidy.

Import liberalization (Model 4) decreases production and increases consumption with a decrease in domestic prices. Under this scenario, import increases by more than three times in 1995 and seven times in 2000. The self-sufficiency rate decreases marginally under Models 2 and 3 and significantly under Model 4.

TABLE 3. PROJECTION OF AREA, YIELD, PRODUCTION, IMPORT CONSUMPTION, AND PRICES UNDER FOUR SCENARIOS

	Scenario			
	1	2	3	4
Base Year (1993):				
Production (1,000 tons)	.....	28,534	.....	
Area (1,000 ha)	.....	10,467	.....	
Yield (ton/ha)	.....	2.73	.....	
Consumption (1,000 tons)	.....	26,394	.....	
Net Import (1,000 tons)	.....	998	.....	
Prices				
Producer	.....	663.34	.....	
Consumer	.....	690.84	.....	
1995:				
Production (1,000 tons)	28,740	28,271	28,664	27,484
Area (1,000 ha)	10,801	10,820	10,764	10,446
Yield (ton/ha)	2.66	2.61	2.66	2.63
Consumption (1,000 tons)	26,871	26,462	26,787	28,860
Net Import (1,000 tons)	1,293	1,301	1,295	4,399
Prices				
Producer	741.23	770.45	747.24	600.36
Consumer	770.33	798.18	776.06	636.13
2000:				
Production (1,000 tons)	31,001	29,898	30,225	22,385
Area (1,000 ha)	11,915	12,154	11,469	10,071
Yield (ton/ha)	2.60	2.46	2.64	2.22
Consumption (1,000 tons)	29,078	28,126	28,430	31,476
Net Import	1,488	1,516	1,504	11,553
Prices				
Producer	888.87	961.02	938.61	706.06
Consumer	925.38	995.33	972.95	750.61

The Impacts on Social Welfare

The changes in price and quantities of rice supplied and demanded influence welfare of producers and consumers. Table 4 shows the impacts of changes in rice policy on social welfare.

Removing the fertilizer subsidy (Model 2) increases producer surplus and decreases consumer surplus compared to Model 1. The same results are obtained with a removal of the government procurement program. These changes in consumer and producer surplus are mainly because the supply schedule of rice shifts inward as a result of removal of the policies. Producers are better off and consumers are worse off under both cases. However, when import is liberalized without the procurement program, producers lose and consumers gain, mainly because of decreases in the price of rice.

TABLE 4. PROJECTION OF FOUR SCENARIOS ON SOCIAL WELFARE, INDONESIA, 1993 and 2000

Item	Scenario 1	2	3	4
	..... billion Rp			
Base year:				
Producer surplus	.....		18,000	.....
Consumer surplus	.....		22,791	.....
Import cost	.....		591	.....
1995:				
Producer surplus	20,253	20,690	20,344	15,808
Consumer surplus	24,563	23,820	24,409	28,302
Import cost	846	880	853	2,798
2000:				
Producer surplus	26,274	27,345	26,963	15,116
Consumer surplus	31,043	29,042	29,675	36,333
Import cost	1,155	1,261	1,224	8,672

The sum of producer's and consumer's surplus is the largest with the current rice policies, but the differences in total surplus are not significant across alternative policy scenarios. This welfare analysis does not include the expenses associated with the policies. If the expenses are taken into account, the import liberalization option will give the largest net benefit to the economy. The net benefits under the other alternative scenarios are consistently lower than that under the current rice policies in both years.

With limited foreign exchange, the import cost may be an important criterion to evaluate alternative policy effects. In both 1995 and 2000, the current policies consistently cost the least.

Summary and Conclusions

This study examined the impacts of alternative policies on the Indonesian rice economy. Alternative policies considered are 1) removing the fertilizer subsidy 2) eliminating the government procurement program, and 3) increasing the import liberalization of rice. A dynamic partial equilibrium model is developed and estimated with time-series data from 1970 to 1991 using the nonlinear 3SLS estimator.

The important findings from the simulated results are as follows. First, removing the fertilizer subsidy would decrease production and increase rice imports. The self-sufficiency of rice would decline under this policy. However, the producer would be better off, and consumers would be worse off. Net

social welfare in this policy option is lower than under the current policy.

Second, eliminating the government procurement program has similar effects to those under no fertilizer subsidy. However, this scenario lowers the net social welfare more than the welfare reduction under no fertilizer subsidy option. Eliminating this program does not appear as a potential policy alternative.

Third, liberalizing rice imports in Indonesia would not be a desirable option from the perspective of food security and social welfare. Import liberalization would reduce rice production and increase imports. The self-sufficiency rate would drop to about 82 percent. Producers lose and consumers gain under this scenario. However, the net social welfare is the lowest among alternatives without considering the cost of the government programs.

Finally, under the current policy of fertilizer subsidy and minimum price guarantee for the farmers, self-sufficiency of rice can be maintained at about 96 percent of domestic consumption. Rice imports would take about 4 percent of the domestic consumption. The largest net social welfare would be reached under this policy.

The analysis in this study is based on a partial equilibrium model. Thus, feedback effects between the rice sector and other farm sectors are not considered. Simultaneous responses may exist among crops.

This study also assumes that the world rice market is exogenous to the Indonesian rice market. However, the Indonesian imports may be large enough to influence the international prices, which in turn determine the imports and domestic prices. Endogenizing the world market in the Indonesian rice simulation model may provide more valuable results.

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APPENDIX

TABLE A1: VARIABLES USED IN SUPPLY EQUATIONS

Year	Area Harvested[1)]	Yield[2]	Fertilizer Used[3)]	Fertilizer Price[4)]	Producer Price Rice	Producer Price Corn	Producer Price Govt (Rice)
1970	7,865.1	1.59	20.6	26.6	42	23	37
1971	8,324.2	1.61	26.3	26.6	41	24	37
1972	7,897.6	1.63	33.2	26.6	49	33	37
1973	8,403.5	1.70	37.1	40.0	77	45	52
1974	8,528.4	1.74	34.0	40.0	87	57	69
1975	8,478.2	1.74	36.7	60.0	102	78	97
1976	8,368.8	1.81	37.4	80.0	124	89	108
1977	8,359.5	1.82	52.9	70.0	128	71	110
1978	8,929.3	1.88	53.6	70.0	133	61	120
1979	8,803.5	1.94	62.6	70.0	166	106	156
1980	9,005.1	2.14	87.4	90.0	189	93	172
1981	9,381.9	2.27	100.8	90.0	212	110	191
1982	8,988.5	2.43	117.9	90.0	230	130	210
1983	9,162.2	2.50	107.6	100.0	275	135	233
1984	9,763.6	2.54	116.5	100.0	285	136	264
1985	9,902.0	2.56	112.9	100.0	288	147	279
1986	9,988.6	2.59	115.0	125.0	291	150	279
1987	9,922.6	2.63	124.8	125.0	352	169	307
1988	10,138.2	2.67	123.5	136.0	382	193	364
1989	10,521.2	2.76	123.7	165.0	475	223	399
1990	10,502.4	2.80	124.8	185.0	467	218	430
1991	10,300.4	2.82	124.1	210.0	517	228	474

[1)] 1000 hectares.
[2)] ton per-hectare.
[3)] kilogram(kg) per-hectare.
[4)] in Rp/kg.
[5)] Rp/kg.

TABLE A2: VARIABLES USED IN DEMAND EQUATIONS

Year	Cons. Per-Capita[1]	Total Expend. For Cons.[2]	Consumer Price[3]			Net Import		Govt Stock[6]
			Rice	Corn	Wheat	Total[4]	Price[5]	
1970	104.6	2,578.7	47	25	54	956	58	530
1971	104.6	2,847.7	45	24	60	503	95	531
1972	103.3	3,308.7	49	27	63	748	87	168
1973	111.9	4,804.1	83	48	84	1,639	85	569
1974	109.3	7,343.8	100	59	88	1,057	137	887
1975	106.8	8,731.5	111	67	106	668	195	731
1976	112.0	10,572.3	128	83	131	1,293	143	541
1977	114.2	12,481.0	133	80	137	1,989	145	462
1978	115.5	15,184.5	140	81	139	1,833	138	1,075
1979	121.5	19,513.7	170	122	170	1,914	194	783
1980	124.6	27,502.9	198	130	214	2,003	215	1,667
1981	126.6	35,560.0	226	144	256	525	242	2,217
1982	133.1	41,670.3	255	198	274	300	220	1,666
1983	139.1	49,231.0	304	196	317	1,160	292	1,588
1984	134.2	54,066.5	331	198	381	364	326	2,754
1985	137.2	57,201.4	322	219	433	- 405	288	2,725
1986	141.8	63,355.3	345	228	461	- 241	267	2,128
1987	142.0	71,988.9	387	260	532	14	368	1,508
1988	146.7	81,045.3	469	297	600	295	445	746
1989	141.4	88,752.3	487	309	672	12	497	1,883
1990	149.4	97,192.2	525	349	776	29	463	1,432
1991	145.7	103,509.7	562	370	795	179	446	953

[1] kilogram per-capita per year.
[2] Million Rp.
[3] Rp/kg.
[4] 1,000 tons.
[5] Rp/kg.
[6] 1,000 tons.