The Impact of Trade Liberalization on Rice Production and The Environment in Java

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1. The Share of Agriculture in the Indonesian Economy

Within more than twenty years (1975 –1996) the Indonesian economy has transformed from an agrarian type into an industrial type economies. In 1975 agriculture contributed 30.2% to GDP which was almost equal to other sector's contribution to the GDP, i.e. industry 33.5% and services 36.3%. From year to year the role of agriculture had been declining and in 1996 its role had reached to a point of only 15.4%, while the industrial sector's share to GDP increased to 40.0% and the service sector reached 44.6%. However, from the employment point of view, in 1996 agriculture still provided 46.0% of employment for the Indonesian labor force and the other sectors shared 54% of the total employment. (See Table 1).

The transformation of the economy was in accordance with the long term 25 year development plan. In the first five year plan (1967 – 1972) the emphasis of development was to develop the agricultural sector, then it was followed by the second five year development plan of 1972 – 1977 with the development of light industries that processed the agricultural products. The third five year development plan 1977 – 1982 was to develop the industrial sectors with a strong agricultural sector developed earlier as the basis for development. In the fourth five year plan 1982 – 1987 development plan, industrial sector was the target of the plan. Finally in the fifth five year development plan 1987 – 1992 Indonesia became an industrialized

country. During the third five year plan Indonesia was expecting a take off for the economy and in 1984 it was the achievement of the food self sufficiency target.

2 Production, Hectarage and Yield

Table.2 presents rice production, hectarage and yields in Indonesia from 1995 to 2001.Rice production has been increasing at a very low rate of 0.65% from the average of 50,074,233 tons between 1995 –1977 to 50,539,454 tons between 1998 – 2001 as a result of increases in area harvested of 2.83% from the average of 11,383,022 Ha in 1975-1997 to 16,711,257 Ha in 1998-2001, but accompanied by a decrease in rice yield by 2,05% from 4.40 Kg/Ha of dried husked rice in 1975-1997 to 4.31 Kg/Ha in 1998-2001.

Table 1: Agricultural Share of Indonesia's GDP, 1975 – 1996

Year	1975	1985	1995	1996
Sectoral share % GDP:				
Agriculture	30.2	23.2	16.2	15.4
Industry	33.5	35.9	39.1	40.0
Services	36.3	40.9	44.7	44.6
Share of total employment (%):				
Agriculture	62	56	48	46
Other Sectors	38	44	52	54

Source: Central Bureau of Statistics

More detailed figures after the recession of 1977 show that the harvested area of rice crop increased by 5.3% from 11.4 million Ha in 1977 to 11.73 million Ha in 1998, while the production of unhusked rice decreased by 0.28% from 49.38 tons to 49.23 million tons for the same period of 1997 to 1998. In the following three years, 1999 to 2001 the area harvested had been decreasing from 11.96 million Ha,

11.79 million Ha, and 11.5 million Ha respectively; a decrease of about 1.42% within three years. The decrease in hectarage was followed by the decrease in rice production in the same direction, namely from 51.89 million tons in 1999 to 51.9 million tons in 2000, and finally to 49.6 million tons in 2001.

Table 2
Production, Area Harvested, and Productivity, 1990 – 2001
(Dried husk rice)

Year	Production (ton)		Area harvested (Ha)		Yield (ton/Ha)	
1990	45,178,751		10,502,357		4.30	
1995	49,744,140		11,438,764		4.35	
1996	51,101,506		11,569,729		4.42	
1997	49,377,054		11,140,574		4.43	
1998	49,236,692		11,730,325		4.20	
1999	50,866,387		11,963,204		4.25	
2000	51,898,852		11,793,475		4.40	
2001	49,590,342		11,332,128		4.40	
Average:		% change		% change		% change
1995-97	50,074.233		11,383,002		4.40	
1998-01	50,398,068	0.65	11,704,783	2.83	4.31	2,05

Source: Central Bureau of Statistics, Jakarta.

Rice production in Indonesia is actually about enough to meet the demand for rice although the capita rice consumption for the Indonesian people is relatively high which are about 130kg/capita/year. Table 3 shows that the per capita rice production has been fluctuating around 135 to 151 kg per year, whereas the rice consumption has been around 120 to 130 kg of rice, but in fact Indonesia has been importing big amount of rice. So the problem must not be a shortage of rice, but more on the trade and management.

Table 3
Rice Production and per capita Production, 1983-1999

Year	Production (1000 ton)	Population (1000)	Per capita production (kg/capita*)
1983	24,006	155,469	138.97
1984	25,932	158,531	147.22
1985	26,542	161,655	147.77
1986	27,014	164,839	147.49
1987	27,253	168,086	145.92
1988	28,340	171,398	148.81
1989	29,072	177,362	147.52
1990	29,366	179,829	146.97
1991	29,047	182,940	142.90
1992	31,356	186,043	151.69
1993	31,318	189,136	149.02
1994	30,317	192,217	141.95
1995	32,334	195,283	149.02
1996	33,216	198,343	150.72
1997	31,206	201,390	139.46
1998	31,118	204,393	137.02
1999	31,294	207,437	135.77

*) The volume of rice used for seed. feed and waste have been deducted from the production figure.
Source: Central Bureau of Statistics and BULOG.

3. Rice Production and Imports

A comparison between rice productions and imports are presented in Table.4. The average rice production was in fact decreased by 1.83% from 32,252 tons/Ha in 1995 and 1997 to 31,661 tons/Ha between 1998 to 2001, and the average of rice import increased at a high rate by 118.83% from 1,503 between 1995 to 1997 to 3,289 tons between 1998-2001. The average figures during the more normal years was an increase in rice production by 1.62% between 1999 to

2002 and a decrease in rice import by 17.87% for the same normal period.

Table.4
Indonesia: Rice Production and Imports, 1995 – 2001

Year	Production (1000 tons)		Imports (1000 tons)	
1995	32,334		3,104	
1996	33,216		1,090	
1997	31,206		406	
1998	31,118		6,077	
1999	32,148		4,183	
2000	32,040		1,512	
2001	31,891		1,404	
2002	32,614		3,703	
Average:		% change		% change
1995 -1997	32,252		1,503	
1998 -2001	31,661	1.83	3,289	118.83
1999 -2002	32,173	1.62	2,701	(-17.87)

Source: Central Bureau of Statistics, Jakarta

In summary, the role of rice production can be measured by the self sufficiency ratio and import dependency ratio. Self sufficiency ratio is the ratio between net rice production and the total of net rice production minus export plus import, while import dependency ratio is the ratio between total import and total net production minus export plus import.

Table.5 shows the import dependency and the self sufficiency ratios for rice in Indonesia from 1995 to 2002. It appears that the import dependency ratio increased from 5.1% between 1995-1997 to 10.3% between 1998 – 2002., while the self sufficiency ratio decreased from 94.9% between 1995-1997 to 89.7 % between 1998-2002.

4. Characteristics of the Rice Farmer

Rice production is commonly done by small farmers with less than 1.00 Ha of land. This situation is reflected by the figures presented in Table 3.6. From the total of 261 farmer respondents 57% are farmers with less than 0,5 Ha of operated land, 31% operated between 0.5 to 1.0 Ha of land, and the rest about 12% operated 1.1 Ha of rice or more. Because of relatively small size of the operated land or land holdings of farmers in

Table 5
Rice: Production, Import, Import Dependency Ratio, and Self-Sufficiency Ratio 1995-2002

Year	Gross Production (1000 ton)	Net Production (1000 ton)	Import (1000 ton)	Import dependency Ratio (%)	Self-Sufficiency Ratio (%)
1995	32,334	29,101	3,014	9.4	90.6
1996	33,216	29,894	1,379	4.4	95.6
1997	31,206	28,085	456	1.6	98.4
1998	31,118	28,006	6,077	17.8	82.2
1999	32,148	28,933	4,183	12.6	87.4
2000	32,040	28,836	1,512	5.0	95.0
2001	31,891	28,702	1,404	4.7	95.3
2002	32,614	29,352	3,703	11.2	88.8
Average :					
1995-97	32,252		1,616	5.1	94.9
1998-2002	31,962		3,376	10.3	89.7
Average: Normal period					
1995-96	32,775		2,197	6.9	93.1
1999-2002	32,173		2,701	8.4	91.6

Note: Total export was zero for the whole period 1995 - 2002

Source:
1) Production from CBS for 2002 forecast figure (Aram III).
2) Net production is gross production less 10% for seed, lost, feed act.
3) Rice Import 1995 – 1997 from Bulog, Rice Import 1998 – 2002 from *The Rice Report*, latest figure, 25 March 2003
4) Volume of rice trade 1997 – 2002 from *The Rice Report* , latest figure, 25 March 2003

the studied village, a production policy is very much connected with the food security of the farmers and the families. The rice production per se will not be sufficient to fulfill the need of the farmer's family and to support their living. This is open of the reasons why most farmers are in fact only part time farmers. Other jobs outside of rice production are done by most of them. From the discussion with farmers respondents it is learnt that to be able to support at the subsistence level of a family, one and half hectare of rice field will be sufficient, but less than that other source of income is really needed.

Table 6
Size of land operated by farmers in selected villages Of Java, December 2002/ January 2003

Villages	< 0.5 (Ha)	0.51 – 1.0 (Ha)	1.1 – 1.5 (Ha)	>1.6 (Ha)	Total (Ha)
Central Java province					
Pucangan	60	6	1	1	68
Kebagoran	40	-	1	1	42
West Java province					
Gegesik Wetan	20	57	12	12	101
Panggang Sari	28	19	1	2	50
Total	148	82	15	16	261
	(57%)	(31%)	(6%)	(6%)	(100%)

Source: Primary data

Table 7. also provides information that most farmer respondents would earn low level of earning from the rice sector, because their rice field was not totally well irrigated. Only 1% of the farmer respondents operated land with technically irrigation system, while the rest 61% with semi technical irrigation system and 38% with rain fed rice field. The rain fed rice farmers certainly could not plant their land twice a year with rice, but they commonly planted non rice food crop in the dry season after planting rice during the wet season. Only

those provided with good irrigation system could plant twice rice crops followed with one non rice food crop such as cassava, sweet potatoes, soybeans, mongo beans etc. Some farmers in the well technical irrigated area still complaining that some times the water from the irrigation canal does not reached their plot. Why this happens, some of them mentioned that the supply of water at the upper region is not well taken care.

Table 7.
Types of Irrigation of Agricultural Land in The Selected Villages of Java, December 2002/January 2003
(Number of respondents)

Villages	Technical (person)	Semi Technical (person)	Rain fed (person)	Total (person)
Central Java province				
	2	9	57	68
Pucangan	-	24	18	42
Kebagoran				
West Java province				
	-	86	15	101
	2	39	11	50
Gegesik Wetan				
Panggang Sari				
Total (person)	4	158	101	261
	(1%)	(61%)	(38%)	(100%)

Source: Primary data

If the agricultural policy and development policy remain the same as now, the future of rice plantation in particular and the agricultural sector in general would be very deem for Indonesia. There are very

few young farmers, and even the younger generation, becomes more reluctant to work in the agricultural sector. Agriculture is not attractive for them. Table 3.8 presents the number of years a farmer has spent his time in rice farming. Among the 261 farmers, only 15 or 6%of them has worked for less than 3 years in rice farming, while the rest 20% have worked between 4 to 5 years and 74% ked for more than 6 years. Another point is that the youngest age of the farmer is only 35 years old. Looking at this tendency, it seems that the future of Indonesian agriculture will be very deem, unless the government could pay more attention towards this sector, otherwise Indonesia will be a net importer of all kinds food, fruits and vegetables in the future.

Table 8
Experience of Farmers in Paddy Farming
in Selected Villages of Java, December 2002/January 2003

Villages	< 3 years	4-5 years	> 6 years	Total
Central Java province				
	1	16	51	68
Pucangan	-	11	31	32
Kebagoran				
West Java province				
	9	20	72	101
Gegesik Wetan	5	5	40	50
Panggang Sari				
Total	15	52	194	251
	(6%)	(20)%	(74%)	(100%)

Source: Primary data

3.5 Costs of Production

Another aspect that needs to be discussed in rice production is the costs of it. The typical costs structure of rice production in Indonesia is shown at Table 3.9. This table indicates that the gross returns in operating one hectare of rice field by the end of 2002 was Rp 6.7 million or equivalents to US$ 753 at Rp 8,850/US$ exchange rate, but then I increased to Rp 7.5 million or US$ 853. The cost of production per Ha of rice production was 79% of the gross returns in 2002, but it might increase to 86% in 2003 due to the rise in fossil fuels prices in early 2003. The net income received by the farmers was actually low in 2002 and even much lower in 2003; i.e. about 21% and 14% respectively.

Looking at the cost components of rice production, labor cost contributes between 42-46% of the total costs of production, followed by rental cost (23 - 28%) and capital interest (7 – 11%). So the other agricultural inputs together contributed only 29% of the total costs of rice production. The proportion for labor cost of about 42-46% of the total costs is reasonable as compared to that of other sectors. Please be noted that the labor costs had included both the family and the non family labors. Since most farmers were small scale farmers with the average operated lands of approximately 0.5 Ha, they tend to use more family labors than the non family labors. This situation is exacerbated by the fact that the supply of agricultural laborers has been declining for the last decades due to the modernization and improvement in education in the rural sector.

The high percentage of land rent relative to the total costs of rice production (23- 28%) are probably caused by the scarcity of the agricultural land in relation to the total population of Java. Java is in fact only 7% of the total land area of Indonesia but it is densely populated with 54% out of 210 million people of Indonesia in 2002.

The capital cost is also relatively high, because farmers usually have no access to the rural banks but are facilitated by private creditors who take high rate of interest (about 20% per season or approximately for 4 months).

Table 9
The Structure of Farm Budget Before and After the Rise in Oil Prices as January 2nd 2003 (Rp/Ha)

No.	Items	Before Oil Price Rises (2002)		After Oil Price Rises (2003)	
		Rp 000	% *)	Rp 000	% *)
1	**Gross Returns**	**6,663**	**100**	**7,551**	**100**
2	**Expenditures**	**5,292**	**79**	**6,476**	**86**
-	Seeds	207	(100)	207	(100)
-	Urea fertilizer	259	4	259	3
-	SP-36 fertilizer	131	5	132	4
-	KCL fertilizer	65	3	65	2
-	Pesticides	160	1	210	1
-	Farm laborers	2,220	3	2,960	3
-	Tractors	281	42	350	46
-	Land rents	1,450	5	1,450	5
-	Taxes, Water fees,	150	28	150	23
-	etc.	369	3	694	2
	Interests for farm credits		7		11
3	**Net income**	**1,371**	**21**	**1,075**	**14**

Source: HKTI cited in *Kompas*, Saturday, 18 January, 2003, p. 23

Rental system is a sort of guaranteed income for the land owners without any risks of not receiving income from rice farming activities. For the tenants, the land rent becomes part of the production costs, which in turn will demand a higher rice price in the rice market. This is one of the reasons why the Indonesian rice cannot compete with the imported rice, although it is known that the rice productivity in Java (over 4 tons/Ha) is one of the highest among the Asian rice producers.

Among the cost components, the costs of agricultural inputs only contribute around 12 to 13% of the total costs of rice production. The abolition of government subsidies for pesticides and fertilizers will increase the price of these inputs should reduce the use of them which formerly were used over the recommended doses. In fact the use of chemical fertilizers is relatively constants, or by reducing a bit the chemical fertilizers and increase insignificantly the use of organic fertilizers. However, farmers attempt to maintain the constant doses of fertilizers to avoid the rice production from falling. Although fertilizers and pesticides only contribute about 13% of the total costs, farmers always consider them as the main costs that determine the total rice productivity. Farmers very seldom count the labor costs which mainly consist of the family labors. So in the discussion, farmers always demand the ratio of 2:1 for the price of rice compared to the price of fertilizers.

Under the situation of low rice price and high prices of agricultural inputs such as for fertilizers and pesticides, the Department of Agriculture made an estimate that the demand for fertilizers for the 2003 fiscal year will be quite a lot, i.e. 4,800,000 tons of urea, 900,000 tons of ZA, 400,000 tons NPK, and 1,400,000 tons SP36.

7. Environmental Aspect of Rice Production

a. The multifunctional of rice production

F. Agus, et. all, have studied and valued the multifunctional of rice field besides producing rice, such as in flood mitigation, conservation of water resources, erosion reduction, rural amenity, food security, organic waste disposal, income and employment generations. Environmental degradation caused by land conversion particularly from agricultural uses to industrial and other development purposes and urban developments occur not only within the area under conversion, but also to the surrounding areas due to the externalities. (F.Agus, et.al, 2002)

b. The soil resources

Rice field has two main functions as source of nutrient and as proponent of the plant where it can grow and store the ground water. Soil damage may happen when the soil loss its nutrient and other organic matters, or when there is compound or toxic matter in the root area, or soil is saturated due to water logging, or due to erosion. Those damages may reduce the soil capacity to support plants to grow since it loses the ability to provide enough nutrients for the plant and in turn it will reduce the soil productivity.

Indonesia is a country with tropical wet climate with average rain fall over 1500 mm per year. This situation is not beneficial since under this climate the process of soil damage due to organic changes, mineral decay, and nutrient wash quickly occur. Besides, the continuation of planting rice on the field without proper management together with a custom of burning the plant residues in the harvesting area will also speed up the washing process of the nutrient.

The rice cultivation developed in Indonesia is *a one season crop* and planted monoculturally. Therefore, it requires high nutrient to gain the optimum yield. The application of macro fertilizer such as Urea, SP-36, and KCl are essentially needed to obtain the high yield. The use of inorganic fertilizer has been increasing from time to time. In contrary, the use of organic fertilizer as source of complex nutrient (including micro nutrient) becomes lower or even unused at all since it cannot give quick response for the maximum yield and also it is very bulky. For the wet rice field area, the population of organism which can change the organic matter is small, therefore the providing rate of nutrient and organic matter are also low. In cultivation with irrigation system of a huge area, the intensity of rice planting is high. Exploitation of the land become more intensive, but the application of organic fertilizer is very limited. Micro nutrient to push the production is very seldom to be added. As a result, the land becomes saturated due to lack of micro nutrient such as Zn, Mo, Cu, etc. The application of SP-36 where the source of P is mostly found from natural resource which contains metal

such as Pb or Cd, will accumulate and increases in the soil. In the flooded soil, Pb and Cd will not be harmful to the plant, but in dry field, for example in the converted land area from rice field area to other non-rice crops, the metal will be absorbed and contaminates the yield. A study resulted by the Soil and Agro climate Research Institute shown that in the wet rice with more than 100 years the contamination of Pb, Cd, and pesticides are meaningless, while in the recently occupied dry land the contamination of Cd is at a higher rate that the standard.

c. Land conversion

The fact that the price of the imported rice is lower than the price of rice produced in the country and also the fact that the government pay less attention to provide incentives for farmer to produce rice have become the burden to farmers if they continue producing rice. This situation push agricultural farmers, especially the rich farmers who own one hectare of land or more, they tend to sell or convert their agricultural land to other purposes. Plenty of agricultural lands have converted to housing, manufacturing industry, roads, or even only selling the part of the soil as input for brick and roof tile industry. The government regulation on the development and the management of land field conversion as stated in the Presidential Decree No. 33 year 1990 on Land Use for Industrial Estate Development which prohibit the conversion of fertile rice field area, and also through the Letter of State Minister of National Development Planning/Head of BAPPENAS No. 5334/MK/9/1994 on the changes in rice field with technical Irrigation to non-agricultural purposes, do not effectively work since the government cannot guarantee the rice farmers to earn high incomes compared to the other uses of lands. Consequently, by converting the rice field, the function of the rice field as water pond or as a mini dam to restraint water which could function as flood control, as water reservoir, as erosion and heat controls, are destroyed. Furthermore, rice field conversion is permanent in nature, meaning that once the rice field is converted to other non-agricultural usage, it will be irreversible. (Sumaryanto *et al* 2001). Look at Table. 10.

Table 10.
Conversion Pattern and Land Use after Conversion
1989-1996 (Ha)

Rice field	Housing	Industry	Road	Others	Total	Non rice
West Java						
Technical	46.00	48.20	2.16	1.48	97.84	2.16
Semi technical	56.02	18.25	2.14	5.61	82.02	17.98
Simple	3.13	26.70	6.56	0.02	36.41	63.59
Rain fed	49.11	27.44	0.08	1.50	78.13	21.87
East Java						
Technical	22.83	34.60	25.53	14.67	97.63	2.37
Semi technical	33.16	55.05	6.71	4.08	99.00	1.00
Simple	4.66	0.50	0.20	0.30	5.66	94.34
Rain fed	47.83	37.13	1.00	12.03	97.98	2.02

Source: Sumaryanto et.al., 1995

The target of the government of Indonesia to fulfill the national food self-sufficiency has been achieved in 1984. To achieve the self sufficient of food during the last three decades, new irrigation area was enlarged up to 108 – 114 thousand hectares per year (Hardjoamidjojo, 1994). After achieving the self sufficiency target, the government then tried to speed up the economic growth through the industrial development. But as a contrary, the commitment to develop the agricultural sector becomes less. As a result a high rate of rice field conversion to other uses increases, especially to non agricultural sectors such as for real estates, offices, road, etc.

Table 11
Estimated Rice Field Converted to Other Uses in Java, 1987 -1993

Province	Years	Total (ha)	Average (Ha/year)
West Java	1987-1991	37,033	7,046
Central Java	1981-1986	40,327	6,721
Yogyakarta	1986-1990	2,910	224
East Java	1987-1993	57,996	8,285

Source: Sumaryanto et al., Konversi Lahan Sawah ke Penggunaan Lain (*Rice Land Conversion to Other Uses*), 2000.

Table 11 presents the annual average of rice field converted to other uses in different provinces in Java. The absolute figures indicate that East Java between 1987 and 1993 had the largest annual average of wet land converted to other uses (8,285 ha/year), then followed by West Java that was 7,148 ha/year between 1987 and 1991, then Central Java, and Yogyakarta. However it would be more informative if the figures were stated in percentage term.

In terms of percentage, the total rice land converted to other uses can be estimated by comparing figures in Table 11 and Table 12 and the percentage rate of rice land conversion are presented in Table 13. Using method of extrapolation where it is assumed that the absolute rice land conversion to other uses were constant during the periods of 1990 to 2000.

Table 12
Area of Wet Land by Type of Irrigation in Java and Indonesia, Year 2000 (in Ha)

Province/Island	Technical	Semi-technical	Non-technical	Total
DKI Jakarta	860	655	1,000	2,515
West Java	397,106	113,886	275,931	786,923
Central Java	380,985	133,420	203,149	717,554
Yogyakarta	18,336	23,664	8,193	50,193
East Java	671,468	113,919	124,662	910,049
Banten	58,114	14,827	43,393	116,334
Total Java	1,526,869 (69%)	400,371 (41%)	656,328 (39%)	2,583,568 (53.03%)
Total Indonesia	2,212,853 (100%)	976,515 (100%)	1,682,892 (100%)	4,872,260 (100%)

Source: *Agricultural Survey, Land Area by Utilization in Indonesia*, BPS, Jakarta, 2000

Table 13
Rate of Land Conversion to Other Uses in Java 1990 - 2000

Province	Average (Ha/year)	Annual Rate of Conversion
West Java (1997 – 2000)	7,046	6,65%
Central Java (1987 – 2000)	6,721	10,8%
Yogyakarta (1990 – 2000)	224	4,3%
East Java (1993 – 2000)	8,285	5,9%

Source: Table 11 and 12.

d. Erosion.

Fertile soil is soil which contain high nutrient in the top soil. Soil erosion will carry out nutrient and other organic matters needed by plants. Besides, soil erosion will reduce the ability of land to restrain water. Based on Sutono *et al (2001)* the activities done by farmers in the field potentially causes the highest erosion is at the mud step, but most of the farmers have anticipated it by reducing or lowering the in and out water flow to the rice field. The low level of water flow on rice field will reduce the rate of erosion as well as flood water that covers the surface of paddy field will also protect soil from the damage caused by rain fall. Sutono *et al (2001)* showed that the rate of soil erosion from paddy field is lower than the rate of soil erosion for other farming activities including for the forest area in a watershed (Table 14). From this table it is shown that rice field reduces the erosion rate by 2.39 ton/ha/year compared to that for forest and 111.41 ton/ha/year compared to the non farming system

Table 14
Total Erosion in Some of Type of Land Utilization in the River Basin Sheet

Location	Soil Erosion (ton/ha/year)			
	Rice Field	Agric non-Rice Field	Forest	Housing
Kali Garang River Basin (Central Java)	9.53	57.21	11.20	0.70
Citarik Sub-River Basin (WestJava)	1.40	176.53	4.50	-
Average	5.46	116.87	7.85	-

From the above data it is learnt that land for rice farming contributes the smallest amount of erosion compared to other activities such as non-rice agricultural, forest and housing. Therefore, the increasing number of land conversion due to the

low price of rice will have impacts on the increasing rate of erosion.

e. Irrigation

One thing that is often forgotten in the conversion of rice field to other use is without considering the multifunction of the irrigation system. A lot of irrigation investments had been spent by the government becomes worthless due to these conversions. To illustrate the amount of money spent by the government as a subsidy can be seen in the table below. During the I Five Year Plan until the IV Five Year Plan, subsidy for the fertilizer and irrigation increase from year to year, and the subsidy given to irrigation was always higher that toes for fertilizer. (See Table 15).

Table 15
Government Subsidy for Rice Production
Through Fertilizer and Irrigation
1968 – 1988 (billion Rupiah)

Period	Fertilizer	Irrigation
I Five Year Plan	412	1 704
II Five Year Plan	2 426	2 426
III Five Year Plan	2 898	4 100
IV Five Year Plan	3 972	4 826
TOTAL	9 708	13 056

Source: Varley, 1995

Based on Sumaryanto *et al (2001)* more than 95% of technical irrigation land in West and East Java were converted to housing, road, and industrial estate. If we look at the water supply side provided by the technical irrigation system, we can say that those conversions create very high cost since the opportunity to produce rice in the highly productive irrigated land, since in the area technically irrigated system can be planted twice for rice and once for other crop or vegetable.

The amount of water for irrigated land can be well adjusted by constructing a dam as irrigated water supply, while the amount of water for the rain fed land system mainly depend on the amount of rain fall. During dry season, rain fed land becomes very dry while the irrigated land still can be utilized. In the rainy, the opportunity to plant other crops will be very restricted therefore the land will be used mainly for rice. The existence of rice field affects the surrounding environment.

The endurance of water to be hold is depend on the capacity of the bund and the rate of percolation-infiltration of water into the soil. Therefore, in the early stage of rice field preparation, soil has been continuously processed to be muddy and the lowest layer soil becomes a solid layer. After the solid layer shaped, the rate of percolation-infiltration becomes lower and the land will be flooded for the rice plant purposes. The resistance of the surface water will reduce the rate of water loss into the river. Gatot *et al* (2001) found that the rice filed area in Kali Garang River Basin from 20% to 25% will reduce the water discharge by 5% - 11% with the prolong response time between 18 – 42 minutes.

Urea, SP-36, KCl or pesticides are badly needed to support the rice production. The flooding water in the top surface contains the agrochemical residue such as pesticides, fertilizers, heavy metals. Nursyamsi *et al* (2001) found that water of a shallow well in the rice field area contains more ammonium, nitrate, or sulfate compared to well in the forest area (Table 3.16). Besides, if there is fertilizer or other agrochemical dissolving through percolation flow, it will be filtered by deep soft soil particles. With that condition, the percolation water absorbed in the ground as aquifer will remain clean. So as if there were a permanent flood, it would continuously supply water although in a low capacity.

Table 16
The Average content of Nitrate, Ammonium and Sulfate in the Shallow Well of Rice Field and Forest Area (mg/L)

Location	Nitrate	Ammonium	Sulfate
Citarik Sub River Basin			
- Shallow Well in Rice Field Area	6.87	6.08	26.53
- Shallow Well in Forest Area	1.12	0.31	1.64
Kaligarang River Basin			
- Shallow Well in Rice Field Area	1.82	0.71	16.43
- Shallow Well in Forest Area	0.92	0.00	1.28

Source: Nursyamsi, *et al* (2001)

The solid land surface of the rice field will restrain a high rate of deep water. The water then will vertically flow and absorbed into the aquifer.

Based on the description above, it is understood that rice field will be able to increase the debit and quality of water aquifer. If there is land conversion, the function of land as rain water catchments becomes low and the rate of percolation-infiltration will also be low. The lack of flooding water in the soil surface which also functions as *mulsa*, may cause the kinetic energy of rain.water strike directly on the land surface.

Table 17
The Amount of Erosion in Some Types of Land Used in River Basin Area

Location	Land Erosion (ton/ha/year)			
	Rice field	Non-Rice Agriculture	Forest	Settlement
Kali Garang River Basin (Central Java)	9.53	57.21	11.20	0.70
Citarik Sub-River Basin (West Java)	1.40	176.53	4.50	Na
Average	5.46	116.87	7.85	Na

Note: Na: Not Available

Table 18
The Content of Heavy Metal and Pesticides in the Land and Rice

Location	Land		Rice		
	Pb	Cd	Pb	Cd	Pesticides
Wetland Rice (>100 year)	11.12	0.06	Nd	Nd	Nd
Rain fed Rice (<10 year)	Na	0.36	Na	0.15	Na

Note: Nd : Not detectable Na: Not Available

f. Air quality

Rice is a kind of plant with needle shape type and the plant is relatively short (≤ 1 m). It may cause the evapotranspiration rate to be relatively low. The water floods on the land surface can be maintained and the water can absorb the sunlight. Therefore the air in the surrounding area will not be too hot and the humidity rate is relatively high. This humidity may reduce the evapotranspiration rate to the surrounding area, so the rate of water flow will decrease. In contrary, the permanent flooding may cause the rate of decomposition of organic matter in the soil imperfectly. In some condition this may create methane gas (CH4) that is released into the

air. The level of methane gas release to the air is relatively low if the level of water is not too high (± 5 cm) and the content of organic matter in the land is low too.

g. Biodiversity

The monoculture rice filed will reduce the number of biodiversity. The index number of biodiversity will be reduced since the number of species which can survive in the rice field ecosystem is low. The practice of inorganic fertilizer will not encourage the development of flora and fauna or even the soil microorganism. The loss of some species in the ecosystem may create some specific species which has high ability to adapt. As a result, the organism of pest will grow and attack the rice crop. The number of pest always increases as a result of manipulation done by the farmers to maintain the rice crop. To prevent the pest, farmers spray the pesticides on the rice filed, but the other organism which has the same behavior will be destroyed too. The population of non-target organism which may has a function as predator will also decrease. The new pest will rise and if the rice field converted further for other purposes will create a new problem since there is a change in the ecosystem and even may harm the ecosystem stability in the surrounding area. Darmawan and Yusdja (1993) found that the total area of rice field pest invasion increased from year to year during 1986 – 1990.

Table 19
The Total Invasion Pest Area of Rice Field in Indonesia, 1986 – 1990 (Ha)

Type of Pest	1986	1987	1988	1989	1990
Pest	308,125	300,798	463,994	405,232	479,401
Disease	32,491	40,719	78,527	71,674	74,502
Total Pest	340,616	341,517	542,521	476,906	553,903

Source: Darmawan and Yusdja, 1993

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