evelopment_on_agriculture_and_household_incomes_in_Indonesia.pdf

by Firmansyah

The impact of irrigation infrastructure development on agriculture and household incomes in Indonesia

7th ASAE Conference, Hanoi
2011

Firmansyah*
Diponegoro University, Indonesia
PhD Candidate in School of Economics and Finance, Curtin University, Australia

Helen Cabalu
Associate Professor in School of Economics and Finance, Curtin University, Australia

Abstract

This study develops Computable General Equilibrium (CGE) model of the Indonesian economy to analyze the impact of agricultural infrastructure development, in particular irrigation, on national and sectoral outputs and households incomes. This research methodology develops and uses an Indonesian social accounting matrix database. The results show that the total economic output and welfare increase, and the more irrigated agricultural sectors i.e. paddy sector have greater output increase than the less irrigated sectors when the increase of investment on irrigation infrastructure also followed by the increase on paddy productivity. Household groups of agricultural workers and households of non-agricultural, low level income workers in rural areas, experience a higher increase in incomes than the other house hold groups.

Keywords: Indonesia, agriculture, irrigation, computable general equilibrium

INTRODUCTION

Background

Agriculture has played an important role in Indonesia's economy. The agricultural sector absorbed 41.2 per cent of the total work force (Asian Development Bank, 2010a), contributed 21.6 per cent of the value of total non-oil/gas exports, and accounted for 12.8 per cent of the national GDP in 2010 (Badan Pusat Statistik, 2011). Agriculture is a major provider of food for Indonesia's population totaling to approximately 230 million people in 2008. It is also an important provider of raw materials for the food processing industry. Hence, the domestic agricultural sector plays a significant role in maintaining food security.

The agricultural sector contributes significantly in reducing poverty in Indonesia. The World Bank (2007) states that three quarters of the poor in developing countries live in rural areas and most depend on agriculture for their main livelihood. Indonesia is no different. In 2008, 52.3 per cent of the poor earned their livelihood from the agricultural sector (Badan Pusat Statistik, 2009a). In the same year, around 63.4 per cent of Indonesia's poor population resided in rural areas (Badan Pusat Statistik, 2009a).

The food crops sub-sector is the largest contributor to the total output of Indonesia's agriculture sector. In 2010, 50.4 per cent of the agricultural sector output was accounted for by food crops products (Badan Pusat Statistik, 2011).

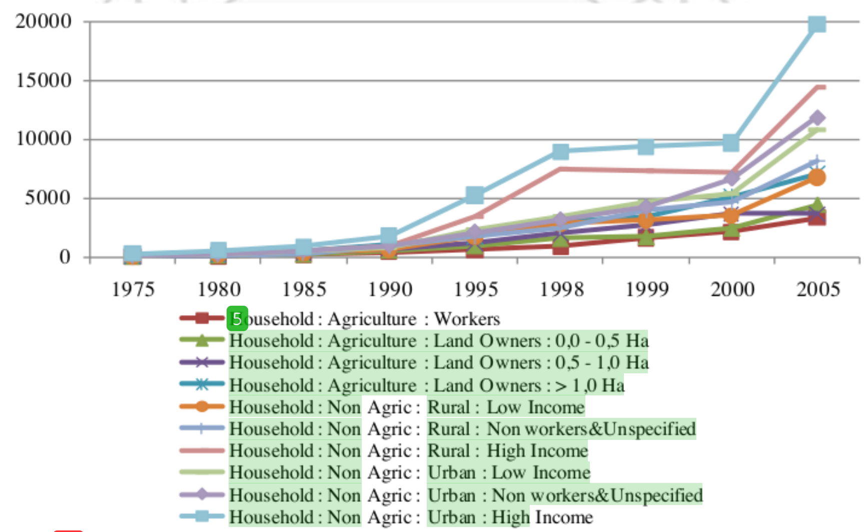
The Food and Agricultural Organization (FAO) emphasizes the importance of agriculture and rural development in reducing hunger and poverty. The first Rome Declaration on World Food Security of 1996 states that food insecurity is caused mainly by poverty, and sustainable progress of poverty reduction efforts is very important to improve access to food (Food and Agricultural Organization, 2009).

The issue of income inequality also accompanies the poverty issue in Indonesia. Farmers' income level is an important factor that determines the level of their welfare. Between 1975 and 2005, income per capita levels of all household groups has been increasing (Figure 1). However, with the increase, the distribution of household income widened over this period, although with a much more rapid widening in non-agricultural than in the agricultural households.

The World Bank (2007) confirms that agriculture could be one of the greatest sources of growth to reduce poverty. It identifies instruments in using agriculture for development. One of these instruments is increased access to household assets, which determines one's ability to participate in agricultural markets. The report identifies three core assets namely land, water and human capital.

Water is an important input to farming, and irrigation plays a significant role in increasing agricultural productivity. From the data published by the Badan Pusat Statistik (2010), it is known that the share of irrigated wetland area is 60.8 per cent, and non-irrigated wetland area is 39.2 per cent of the total national wetland areas in 2009. According to Pesandaran et al. (2004), around 80 per cent of national rice production is produced from irrigated wetland. In 2005, irrigated agricultural land is only 16.3 per cent of total agricultural land area (World Bank, 2010).

Figure 1. Income per capita of household groups 1975-2005 (thousands Rp)



Source: Badan Pusat Statistik. 2007. *Sistem Neraca Sosial Ekonomi Indonesia 2005*. Jakarta: Badan Pusat Statistik

Construction of irrigation and water facilities in Indonesia has been on an upward trend since the 1970s, although there was a period in which the maintenance of irrigation infrastructure and water resources was not undertaken by the government. Between the 1970s and the late 1980s, the government prioritized the development of water resource and infrastructure, and this spurred economic growth and reduced poverty. Table 1 shows the economic growth and the poverty levels of Indonesia.

In the late 1980s and 1990s, the Indonesian government failed to maintain irrigation infrastructure and water resources. The government failed to achieve cost recovery. It proved arduous to change government policy, and then in 1998 the new government embarked on a sector reform. This reform aimed at sustainable management of resources and infrastructure, and emphasized a demand-responsive and decentralized service delivery. In the next period after the implementation of regional autonomy system in 2000, the Government of Indonesia implemented several reforms. This signaled the serious intent of reform on irrigation management and water resources by the government in line with decentralization and regional autonomy (World Bank, 2011). This reform was implemented through numerous government laws, Presidential Decree No 3/1999 and Government Regulation No 77/2001 which focused on the delivery of irrigation to farmers' associations and issuance of Law No 7/2004 concerning the management of water resources and Government Regulation No 20/2006 which regulates specifically Article 41 of the Law No. 7 /2004, which is about development and management of irrigation.

Table 1. Economic growth and poverty levels of Indonesia

Year	Economic Growth (%)	Poverty	
		Total (million)	Percentage of population
1976	6.89	54.2	40.1
1980	9.88	42.3	28.6
1987	4.93	30	17.4
1990	7.24	27.2	15.1
1996	7.82	34.01	17.47
1998	-13.13	49.5	24.23
2000	4.92	38.7	19.14
2005	5.69	35.1	15.97
2008	6.01	34.96	15.42
2009	4.55	32.53	14.15

Source: Badan Pusat Statistik. 2009b. *Statistik Indonesia tahun 2009*. Jakarta: Badan Pusat Statistik

Note : 1. A new standard to measure poverty has been adopted since December 1998. Data 1976-1996 based on the old standard, the 1996-2008 figures based on the revised standard

2. Time reference for all data is February, except for 1998 (December) and 2006-2009 (March). Started in 1999, data presented excluded East Timor

The need for irrigation infrastructure not only requires the construction of new irrigation but also maintenance of the damaged irrigation network. During the past decades, the development of irrigation areas in Indonesia increased by only about 50 per cent, from 3.5 million ha in 1950 to 5.2 million ha in 2000, while in the same period, irrigation around the world increased more than threefold, from 80 million ha in 1950 to 270 million ha in 2000 (Pasandaran, 2007). Meanwhile, not all of irrigation is able to function properly due to the damage. The amount of irrigation damage in 2002 reached 22.4 per cent of the total of existing irrigation networks. The damage has disrupted the supply of irrigation water for 1.5 million ha of agricultural land (Pasandaran, 2007).

Hence, in the current government's Public Works Strategic Plan 2010-2014, the focus was on the development of irrigation through (Ministry of Public Works, 2010):

- Construction of irrigation network covering 500,000 ha, and perform maintenance covering 2.3 million ha; and
- Building a network of ground water irrigation, which covers 1,050 ha and perform maintenance covering 43,840 ha.

Research objective and motivation

Around 63.4 per cent of Indonesia's poor population[1] resides in rural areas, while 52.3 per cent of the poor earned their livelihood from agriculture in 2008 (Badan Pusat Statistik, 2009a). This indicates that efforts to alleviate poverty, unemployment and food insecurity are closely linked to agriculture and rural development. Improvement of irrigation as an agricultural infrastructure is one way to improve productivity and performance in the agricultural sector.

The main objective of this study is to examine the welfare effects and quantify the impact of irrigation development policies on Indonesia's national and sectoral outputs,

---

[1]Based on Central Bureau of Statistics of Indonesia, the population of poor people who have an average expenditure per capita per month under the Poverty Line. The poverty line, which consists of two components namely Food Poverty Line (2100 kcal, minimum requirement per capita per day) and the Poverty Line Non-Food (the minimum requirements for housing, clothing, education, and health). The total number of the poor in Indonesia is about 14.15 per cent of total population in 2009 (Badan Pusat Statistik, 2009b). According to the indicator of population living below $ 1 per day which used in the Millenium Developments Goals (MDGs), Indonesia had achieved the MDGs target by 2008. By this indicator, the number of poor people in Indonesia was about 7.5 percent in 2008, below the MDGs target of 10 per cent in 2015. Based on the indicator of population living below $ 2 per day, the proportion of the poor people in Indonesia was still very high, about 49 per cent in 2008 (Bappenas and UNDP, 2007).

especially the agricultural sector, households' income and other economic parameters. We develop a computable general equilibrium model and develop social accounting matrix as a database.

AGRICULTURE, IRRIGATION DEVELOPMENT AND POVERTY: LITERATURE REVIEW

Meier (1995) states that agriculture has an important role in a country's development for four reasons: (1) it supplies primary food and raw materials for other sectors in the developing economy; (2) it provides a surplus from saving and tax that can be invested to other developing sectors; (3) it involves buying other consumable products from other sectors, in order that it increases demand in developing sectors' products by rural residents; and (4) the obliteration of foreign exchange reserve constraint through export or import substitution.

Related to food security, Lipton and Ravallion (1995) state that a relationship exists between high agricultural growth rate periods and poverty reduction in rural areas and food security appreciation. High agricultural growth leads to: 1) low food price for urban consumers and net-food rural buyers; 2) increasing probability to generate income for food producers and enhance employment for rural workers (therefore decrease rural-urban movement), thus leading to urban real wages increasing; and 3) positive spillover effects of inter-sectoral migration, trade and productivity improvement. Dao (2004) examines the impact of increased productivity of agricultural workers (through increased number of physical capital or human capital per worker in the form of training) on reducing rural poverty in developing countries. Ligon and Sadoulet (2007) conclude that the growth of agricultural income has a beneficial effect on the expenditures of poor households, while the benefits of growth in non-agricultural income are much less for a family in the lower deciles. They state that agricultural income growth is more effective in reducing poverty than growth in other sectors. Agriculture as the best source of growth to reduce poverty is also confirmed by the World Bank (2007). The World Bank also states that standard of living of subsistent farmers can be increased by productivity improvement of staple crops farms, that requires big investment on soil and water management and agricultural research.

Regarding water resources, Dao (2009) states that internal renewable resources such as internal river flows groundwater rainfall and total annual freshwater withdrawals for irrigation and livestock production do contribute positively to agriculture growth in developing countries.

Huang et al. (2005) examine China's economy and find that irrigation contributes to increases in yields for almost all crops and in income for farmers in all areas. They state that the importance of crop income in poor areas and the strong relationship between crop revenue and irrigation provides evidence of the importance of irrigation in the past and future poverty alleviation in China. For Ethiopia, Gebregziabher *et al*. (2009) show that there are important differences between farmers with and without access to irrigation, regarding socio-economic and demographic characteristics, off-farm labor allocation, and levels of income. They state that irrigators hire more labor and have lower participation in off-farm activities, indicating the relative labor absorption potential of irrigated farming as compared to rainfed farming. Irrigators have more diversified income sources and significantly higher non-crop farming income, which includes income from dairying, poultry and bee keeping.

Namara et al. (2009) note that in many developing countries, water is a major factor constraining agricultural output and income. Improved agricultural water management can contribute to poverty reduction through several pathways: 1) improves production and productivity, enhances employment opportunities and stabilizes income and consumption; 2) encourages the utilization of other yield-enhancing inputs and allows diversification into high-value products, enhances nonfarm outputs and employment, and fulfils multiple needs of households; and 3) contributes either negatively or positively to nutritional status, health, societal equity and environment. The net impact of agricultural water management interventions on poverty may depend individually and/or synergistically on the working of these pathways.

METHODOLOGY: DATA AND MODEL

The data

This study develops a model which uses the 2005 Social Accounting Matrix (SAM) of Indonesia as the basis of its database. The original 2005 SAM was extended to accommodate a more disaggregated agricultural sector, particularly the food crops including paddy, non-paddy food crops, sugarcane and other estate crops. It also includes several sectors related to agriculture, such as agricultural services, rice milling, food, fertilizer, pesticide and irrigation building. The classification of sectors and commodities for this model is shown in Table 1. The SAM that constitutes the core database of the model is summarized in Appendix 2.

The basic structure of the model is represented schematically in Figure 2. The column headings represent agents in the economy where demand comes from, i.e:

(1) domestic producers divided into I industries;

(2) investors divided into I industries;

(3) ten representative households;

(4) an aggregate foreign purchaser of exports;

(5) an 'other' demand category, broadly corresponding to government; and

(6) changes in inventories.

Households are disaggregated into 10 types, differentiated by income level and origin. The composition of income and expenditure differs by group. Table 2 displays the classification of households.

Table 1: Commodity and industry classification

No	Sector/commodity	No	Sector/commodity
1	Paddy	13	Wood and wood products
2	Non-paddy food crops	14	Paper, paper products, transport equipment, machine and iron
3	Sugarcane	15	Fertilizer
4	Other estate crops	16	Pesticide
5	Livestock	17	Electricity, Gas, Water, Construction and Other Chemical and cement
6	Forestry and hunting	18	Irrigation building
7	Fishery	19	Transportation
8	Agricultural services	20	Trade, restaurant and hotel
9	Mining	21	Bank and insurance
10	Rice milling	22	Government
11	Food	23	Other services
12	Textile, wearing apparel and leather		

Figure 2: The Model Flows Database

		Absorption Matrix					
		Producers	Investors	Household	Export	Other	Change inInventories
	Size	← I →	← I →	← H →	← 1 →	← 1 →	← 1 →
Basic Flows	↑ C×S ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	↑ C×S×M ↓	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
Taxes	↑ C×S ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
Labour	↑ O ↓	V1LAB					
Capital	↑ 1 ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Other Costs	↑ 1 ↓	V1OCT					

C = Number of Commodities
I = Number of Industries

S = 2: Domestic, Imported,
O = Number of Occupation Types

M = Number of Commodities used as Margins

H = Number of Households

Note: Each cell in the illustrative absorption matrix in Figure 2 contains the name of the corresponding data matrix. For example, V2MAR is a 4-dimensional array showing the cost of M margins services on the flows of C goods, both domestically produced and imported (S), to I investors.

Source: Wittwer, Glyn. 1999. WAYANG: a general equilibrium model adapted for the Indonesian economy,*ACIAR project no. 9449*.Adelaide: Centre for International Economic Studies, University of Adelaide.http://www.monash.edu.au/policy/oranig.htm (accessed November 2, 2009)

Table 2. Households classification

No	Households classification	Code
	Agricultural	
1	Employees	HH1
2	Operator, Land Owner 0.000 - 0.500 Ha	HH2
3	Operator, Land Owner 0.500 - 1.000 Ha	HH3
4	Operator, Land Owner >1.000 Ha	HH4
	Non Agricultural	
	Rural	
5	Lower Level; Non Agriculture Self Employed, Clerical, Retail Sales,	HH5

	Personal Services, and Transport & Manual Workers	
6	Non Labor Force and Unclassified Household	HH6
7	Higher Level; Non Agriculture Self Employed, Clerical & Sales, Services, Managers, Supervisors, Technicians, Teachers, and Non Civilians	HH7
	Urban	
8	Lower Level; Non Agriculture Self Employed, Clerical, Retail Sales, Personal Services, and Transport & Manual Workers	HH8
9	Non Labor Force and Unclassified Household	HH9
10	Higher Level; Non Agriculture Self Employed, Clerical & Sales, Services, Managers, Supervisors, Technicians, Teachers, and Non Civilians	HH10

The model

CGE modelling is still believed to be the most powerful tool in analyzing welfare effects of economy-wide policy changes, i.e. the policy that is heavily determined by market or sectoral interdependence (Mitra-Kahn, 2008). Several researchers have applied CGE to analyze effects of change in policies in the agricultural sector, particularly for Indonesia. Among them are Cabalu et al (1997), Erwidodo et al (1999), Abimanyu (2000), Oktaviani and Drynan (2000), and Haryono (2008).

A number of applied CGE models have also been developed solely for Indonesia. These include, among others, INDORANI (developed in 2000 by Gadjah Mada University in collaboration with COPS, Monash University), WAYANG (developed in 1999 by Center for Strategic International Studies in collaboration with COPS, Monash University), INDOCEEM (developed in 2002 by the Indonesian Ministry of Energy and Mineral Resources and LPEM, University of Indonesia), INDOF (2000), and AGRINDO (2008) (developed by Bogor Institute of Agriculture), and AGEFIS (developed in 2008 by Ministry of Finance and CEDS, Padjadjaran University). These models were based on ORANI (Dixon, et al., 1982; Powell, 1991), ORANI-F (Horridge *et al.*, 1993), and ORANIGRD (Horridge, 2002), the framework of the Australian economy.

The model developed in this study is a static CGE model that implements a similar structure ofequations based on the ORANI-G of the Australian economy (Horridge, Parmenter and Pearson, 1998). It also follows features of WAYANG (Wittwer, 1999) and AGEFIS (Yusuf etal, 2008). WAYANG is a model of the Indonesian economy which is based closely on ORANI-G, but adds an innovative treatment of agricultural technology, a 'top-down' regional extension, multiple households, and a small budgetary extension. AGEFIS is yet to be the first Indonesian fully-SAM-based CGE model solved by GEMPACK.

As an overview, the theoretical structure of the model is summarized as follows (Yusuf et al., 2008):

1. The production structure of the economic sectors is based on nested Leontief production function for intermediate input and value added, with the value added production function specified as a CES (constant elasticity of substitution). There are two primary production factors in the model, i.e. capital and labor.
2. The demand for investment goods is based on Leontief production function.
3. The household sector maximizes a Cobb-Douglas utility function.
4. The optimization of import and domestic goods composition is conducted by an economic agent via Armington specification.
5. The household receives income from the ownership of production factors, as well as from transfers from a range of other institutions (government, companies and foreign).
6. The government receives their income from indirect tax, direct tax, returns to factor ownership and transfer from other institution such as the rest of the world. The government spends the budget for consumption, to subsidize commodities and to a transfer to other institutions such as households.

The multi-input, multi-output production specification illustrated by the nesting shown in Appendix 2 and the demand of investment goods illustrated in Appendix 3.

SIMULATION RESULT

The development of irrigation infrastructure and the increase of agriculture productivity (especially paddy) are the vital instruments for national food security and eradication of poverty programs in Indonesia, that cannot be implemented in the short run. Not only these programs take time to implement, but we can expect economic agents to take some time to fully adjust from the changes. For this reason we believe that a long run closure of the model is the appropriate closure under which to model the effects of the investment of irrigation infrastructure and productivity improvements in the paddy sector. In the long run closure the factor is full employment and capital and labor mobile among sectors.

Investment in irrigation development involves an increase in the number of new irrigation buildings and areas, improvement of damaged irrigation networks and maintenance of existing irrigation networks continuously. This requires an adequate funding for agricultural infrastructure development, and a strong commitment from both central and local governments. The simulation represents an increase in the government investment expenditure for agricultural infrastructure by 30 per cent and 1 per cent improvement in the productivity of agricultural production, particularly the paddy sectors which use irrigation extensively[2]. Hence, the two simulations conducted are as follows: SIM1 represents an increase of the government investment in agricultural infrastructure by 30 per cent, and SIM2 represents a combination of SIM 1, i.e., the increase of infrastructure investment and increased productivity of paddy production (as the largest irrigation user) by 1 per cent.

Macroeconomic and industry results

A 30 per cent increase in government investment on irrigation (SIM1) results in a 0.265 per cent increase in real GDP. A combination of 30 per cent increase in government investment on irrigation and 1 per cent increase of productivity of paddy (SIM2) lead to an increase in real GDP by 0.295 per cent. The increase in real GDP from the expenditure side is driven by the increase in consumption, which originates from the increase in investment itself.

The increase in investment in irrigation encourages imports while exports fall. So is the impact of the SIM2. The increase in demand of capital goods for development and demand for machinery in the agricultural sector increase imports because most high technology goods are imported. Irrigation construction sector and rice farming are not export-oriented sectors.

Table 3. Macroeconomic effects of a 30 per cent government investment on irrigation and 1 per cent increase in paddy productivity

Description	SIM1	SIM2

[2]The 30 per cent increase in government investment in irrigation is based on the average increase in government spending for irrigation during 2005-2010 (Ministry of Finance Republic of Indonesia, 2011) and productivity in paddy is based on the average growth of productivity during 2005-2010 (Kementerian Pertanian, 2011).

Consumers price index	0.544	0.502
GDP deflator	0.644	0.62
Household expenditure	1.158	1.174
Price of export	0.460	0.466
Price of import	0	0
Price of investment	0.333	0.339
Transfer to household from central government	0.544	0.502
Real GDP	0.265	0.295
Real consumption	0.614	0.672
Real export	-2.298	-2.329
Real import	0.838	0.831
Real investment	3.524	3.524

Source: Simulation results

Long run activity of the production sectors is projected to contract in both SIM1 and SIM2. In addition, the non-agricultural sectors do not require irrigation, in general, the decline in sectoral output is also a reflection of the fact that the industry's input costs are rising by the implementation of SIM1 and SIM2. Paddy sector which used irrigation most is projected to contract in SIM1. It is associated with the non-optimal use of irrigation, which is not supported by sufficient intensification technology. Extension of wetland area, especially outside Java Island, does not meet the speed of development of agricultural infrastructure. In SIM2, the output of paddy increases. It shows that the influence of technological efficiency which is reflected in the increase of productivity in the paddy sector is more effective than the development of irrigation.

Table 4. Impact of a 30 per cent government investment on irrigation and 1 per cent productivity of paddy increase on industrial output (%)

No	Sector/commodity	Output		Cost of production	
		SIM1	SIM2	SIM1	SIM2
1	Paddy	-0.370	0.282	1.188	0.135
2	Non-paddy food crops	-0.204	-0.189	1.199	1.164
3	Sugarcane	-0.934	-0.905	1.030	1.049
4	Other estate crops	-0.488	-0.461	1.200	1.189
5	Livestock	-0.377	-0.361	0.936	0.942
6	Forestry and hunting	0.370	0.338	0.585	0.597
7	Fishery	-0.034	-0.023	0.596	0.607
8	Agricultural services	-1.659	-1.922	0.781	0.796
9	Mining	-0.760	-0.792	0.282	0.290
10	Rice milling	-0.251	0.420	1.088	0.467
11	Food	-0.777	-0.748	0.688	0.682

12	Textile, wearing apparel and leather	-1.386	-1.409	0.490	0.498
13	Wood and wood products	-2.042	-2.087	0.579	0.590
14	Paper, paper products, transport equipment, machine and iron	-0.777	-0.800	0.390	0.397
15	Fertilizer	-1.260	-1.318	0.731	0.745
16	Pesticide	-1.453	-1.495	0.483	0.493
17	Electricity, Gas, Water, Construction, Other Chemical and cement	-0.202	-0.215	0.375	0.383
18	Irrigation building	28.146	28.142	0.807	0.822
19	Transportation	-0.448	-0.458	0.548	0.559
20	Trade, restaurant and hotel	-0.720	-0.709	0.903	0.896
21	Bank and insurance	-0.088	-0.090	0.435	0.445
22	Government	-0.439	-0.433	1.024	1.027
23	Other services	0.019	0.014	0.440	0.450

Source: Simulation results

Households' income

Table 5 shows that SIM1 exerts a relatively negligible effect on distribution of nominal household's income. The HH1 (agricultural employees) and HH5 (non agricultural, rural, lower level) households benefit most from this policy. This happens because the work force in both groups of households are most likely to temporarily move or undertake as a new profession to be construction workers.

Table 5: Impact of increase of the irrigation development and paddy productivity on household'sincome (per cent)

Households	SIM1	SIM2
HH1	0.094	0.104
HH2	0.073	0.109
HH3	0.063	0.083
HH4	0.058	0.084
HH5	0.091	0.093
HH6	0.070	0.123
HH7	0.061	0.089
HH8	0.075	0.109
HH9	0.085	0.102
HH10	0.058	0.118

Source: Simulation results

As a result of SIM2, all households in general experience an increase in income. However, the distribution of the increasing of income is different from SIM1. Some rural non-agriculture and urban households are projected to enjoy a larger income increase than the rural agricultural households. This indicates that the benefit from the improvements of agricultural production, especially paddy, more prevalent in distribution channel and trade.

SUMMARY

The objective of this study was to examine the effects of simulation namely, irrigation development (investment) and an increase in irrigation investment along with increased productivity of paddy farming on the economy and household incomes in Indonesia using a static Computable General Equilibrium model.

The development of irrigation infrastructure and the increase paddy productivity in the long run will increase economic growth. This supports the hypothesis of endogenous growth. In aggregate level, it can be concluded that the increase in irrigation infrastructure and productivity of paddy farming cannot raise exports, and domestic consumption remains a key driver in economic growth.

The output of paddy as users of irrigation will not increase if the development of irrigation is not accompanied by improvement of agricultural efficiency (productivity) and the more equitable distribution of irrigation into new agricultural areas.

The increase in investment of irrigation development and the increase of paddy productivity have a positive impact on household income due to the increase in purchasing power of farm workers households. However, these results should be addressed with caution, because the households that are also at the lower levels of income have a lower positive change in income (consumption) than other households.

REFERENCES

Abimanyu, A. 2000. Impact of agriculture trade and subsidy policy on the macroeconomy, distribution, and environment in Indonesia: A strategy for future industrial development. *The Developing Economies*, 38(4): 547- 571. http://www.fiskal.depkeu.go.id/ (accessed September 24, 2009)

Asian Development Bank. 2010a. *Key indicator of developing Asian and Pacific countries 2000, volume 31*. http://www.adb.org/Documents/Books/Key_Indicators/2000/ default.asp (accessed April 20, 2010); Asian Development Bank. 2010b. *Key indicator for Asia and the Pacific 2009: Country tables*. http://www.adb.org/ documents/books/key_indicators/ 2009/Country.asp (accessed April 20, 2010)

Badan Pusat Statistik. 2007. *Sistem Neraca Sosial Ekonomi Indonesia 2005*. Jakarta: Badan Pusat Statistik

_________ .2009a. Profil kemiskinan di Indonesia Maret 2009. *Berita Resmi Statistik, BPS No: No. 43/07/Th. XII, 1 Juli 2009*. http://www.bps.go.id/brs_file/kemiskinan-01jul09.pdf (accessed March 2, 2010)

_________ .2009b. *Statistik Indonesia tahun 2009*. Jakarta: Badan Pusat Statistik

_________. 2010. *Land Area by Utilization 2009*, Jakarta: Badan Pusat Statistik.

_________. 2011. *Pendapatan Domestik Bruto Atas Dasar Harga Konstan 2000 Menurut Lapangan Usaha (Miliar Rupiah)*.http://www.bps.go.id/tab_sub/view.php?tabel= 1&daftar=1&id_subyek=11&notab=3 (accesed 14 June 2011)

Bappenas and UNDP. 2007. *Let speak out for MDGs: Achieving the Millennium Development Goals in Indonesia 2007/2008*. http://p3b.bappenas.go.id/docs/ MDGs%20Report%202007/id_mdgr2007_advocacy_english_181207_3.pdf (accessed November 19, 2009)

Cabalu, H., N. Doss, P. Kenyon, I. Kerr, and P. Koshy. 1997. *Indonesian agribusiness and agro-industry to the year 2020*. Perth: Institute for Research into International Competitiveness, Curtin University.

Dao, Minh Quang. 2009. Poverty, income distribution, and agriculture in developing countries. *Journal of Economic Studies*, 2(36): 168 – 183. http://www.emeraldinsight.com.dbgw.lis.curtin.edu.au/journals.htm?issn=0144-3585&volume=36&issue=2&articleid=1793067&show=pdf (accesed 3 June 2011)

Dixon, P.B., B.R Parmenter, J. Sutton and D.P. Vincent. 1982. *ORANI: A multisectoral model of the Australian economy*. Amsterdam: North Holland

Erwidodo, R. Stringer, and G. Witter. 1999. The agriculturalization of Indonesia: In aftermath of the socioeconomic crisis, *Working Paper 99.05*. Adelaide: ACIAR

Indonesia Research Project. http://www.adelaide.edu.au/cies/papers/iwp9905.pdf (accessed November 2, 2009)

Food and Agriculture Organization. 2009. *World Food Summit, 13-17 November, 1996: Rome declaration on world food security*. Rome. http://www.fao.org/docrep/003/w3613e/w3613e00.HTM. (accessed November 12, 2009)

Gebregziabher, Gebrehaweria Regassa E. Namara and Stein T. Holden. 2009. Poverty reduction with irrigation investment: An empirical case study from Tigray, Ethiopia. *Agricultural Water Management*, 96 (12):pages 1837-1843.http://www.sciencedirect.com.dbgw.lis.curtin.edu.au/science?_ob=MImg&_imagekey=B6T3X-4WP4BGS-4-1&_cdi=4958&_user=41361&_pii=S037837740900167X&_origin=search&_zone=rslt_list_item&_coverDate=04%2F30%2F2010&_sk=999029995&wchp=dGLzVzbzSkWB&md5=03669ffc02830f903513ea6311aca300&ie=/sdarticle.pdf (accessed 20 June 2011)

Haryono, D. 2008. *Dampak industrialisasi pertanian terhadap kinerja sektor pertanian dan kemiskinan perdesaan: Model CGE recursive dynamic*. PhDdiss., Institut Pertanian Bogor. http://www.damandiri.or.id/ (accessed 13 November, 2009)

Horridge, J. 2002. *ORANIGRD: A recursive dynamic version of ORANIG*. Quoted in Haryono, 2008, 61

Horridge, J., B.R. Parmenter and K.R. Pearson. 1993. ORANI-F: A general equilibrium model of the Australian economy. *Journal Economic and Financial Computing*, 3:71-140. Quoted in Oktaviani and Drynan, 2000, 3.

Huang, Qiuqiong, Scott Rozelle, Bryan Lohmar, Jikun Huang, Jinxia Wang. 2005. Irrigation, agricultural performance and poverty reduction in China, Food Policy 31: 30–52 Elsevier Ltd.http://www.sciencedirect.com.dbgw.lis.curtin.edu.au/science?_ob=MImg&_imagekey=B6VCB-4GWJ8MW-1-8&_cdi=5950&_user=41361&_pii=S0306919205000485&_origin=search&_zone=rslt_list_item&_coverDate=02%2F28%2F2006&_sk=999689998&wchp=dGLbVzW-SkzV&md5=7ad21c5cd6ba225d7e4dd9033f3273ff&ie=/sdarticle.pdf (accesed 3 June 2011)

Kementerian Pekerjaan Umum. 2010. *Rencana strategi Kementerian Pekerjaan Umum*. http://www.pu.go.id/punetnew2010/subindex.asp?pid=0201 (accesed 20 June, 2011)

Kementrian Pertanian. 2011. *Rencana aksi pemantapan ketahanan pangan 2005-2010 Ministry of Agriculture*. http://pustaka.litbang.deptan.go.id/bppi/lengkap/bpp05004.pdf (acessed 3 June 2011).

Ligon, E. and E. Sadoulet. 2007. *Estimating the Effects of Aggregate Agricultural Growth on the Distribution of Expenditures*. Background paper for the World

Development Report 2008. http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1191427986785/ (accessed 5 JUne 2011)

Lipton, M., and M. Ravallion. 1995. Poverty and policy. In *Handbook of Development Economics Vol IIIB* , eds. J. Behrman and T.N. Srinivasan. Amsterdam: Elsevier Science B.V.Quoted in Erwidodo, R. Stringer, and G. Witter. 1999, 9.

Meier, G.M. 1995. *Leading issues in economic development*. New York: Oxford University Press.

Ministry of Finance Republic of Indonesaia. 2011. *Budget Statistics 2005 – 2011*. http://www.anggaran.depkeu.go.id/Content/10-10-04,%20Data%20Pokok%20APBN%202011_Inggris_rev2.pdf (accessed 20 June 2011)

Mitra-Kahn, B.H. 2008. Debunking the myths of computable general equilibrium models. *SCEPA Working Paper,* 2008-*1*. http://www.newschool.edu/cepa/publications/workingpapers/ (accessed November 14, 2009)

Namara , Regassa E., Munir A. Hanjra, Gina E. Castillo, Helle Munk Ravnborg, Lawrence Smith, Barbara Van Koppen. 2009. Agricultural water management and poverty linkages. *Agricultural Water Management*, 97(4): 520-527.http://www.sciencedirect.com.dbgw.lis.curtin.edu.au/science?_ob=MImg&_imagekey=B6T3X-4WP4BGS-4-1&_cdi=4958&_user=41361&_pii=S037837740900167X&_origin=search&_zone=rslt_list_item&_coverDate=04%2F30%2F2010&_sk=999029995&wchp=dGLzVzb-zSkWB&md5=03669ffc02830f903513ea6311aca300&ie=/sdarticle.pdf (accessed 20 June 2011)

Oktaviani, R., and R.G. Drynan. 2000. *Third Annual Conference on Global Economic Analysis, June* 28^{th} *–* 30^{th}*, 2000*: *The impact of APEC trade liberalisation on the Indonesian economy and agricultural sector*. web.ipb.ac.id/~intercafe/wp-content/ (accessed 15 Oktober 2009)

Powell, A.A. 1991. A brief account of activities over the period 1^{st} January 1988 to 31^{st} December 1990, with a prospectus for further developments. *IMPACT Project Report*, No. R-08. Monash: Centre For Policy Studies, Monash University. Quoted in Abimanyu, 2000, 551.

Pesandaran, Effendi. 2005. *Reformasi irigasi dalam kerangka pengelolaan terpadu sumber daya air*. http://pse.litbang.deptan.go.id/ind/pdffiles/ART3-3a.pdf (accessed 29 April 2011)

_________. 2007. Pengelolaan infrastruktur irigasi dalam kerangka ketahanan pangan nasional. Analisis Kebijakan Pertanian: 2(5): 126-149. http://pse.litbang.deptan.go.id/ind/pdffiles/ART5-2a.pdf (accessed 20 June 2011)

The World Bank. 2007. *World development report 2008: Agriculture for Development*. Washington DC: The World Bank.

_________. 2010. *Countries and economies*. http://data.worldbank.org/country (accessed 29 April 2010)

_________. 2011.Indonesia - Water resources & irrigation sector management program region East Asia and Pacific Region. *Updated project information document (PID: Report No: AB313* http://www-wds.worldbank.org/external/default/WDSContentServer/ WDSP/IB/2003/09/23/000094946_03091104031345/Rendered/PDF/multi0page.pdf(accessed 20June 2011)

Wittwer, Glyn. 1999. WAYANG: a general equilibrium model adapted for the Indonesian economy, *ACIAR project no. 9449*. Adelaide: Centre for International Economic Studies, University of Adelaide. http://www.monash.edu.au/policy/oranig.htm (accessed November 2, 2009)

Yusuf, Arief Anshory, Djoni Hartono, Wawan Hermawan, Yayan. 2008. AGEFIS: Applied General Equilibrium for FIScal Policy Analysis. *Working Paper in Economics and Development Studies*, No. 200807. Bandung: Center for Economics and Development Studies, Department of Economics, Padjadjaran University

Appendix

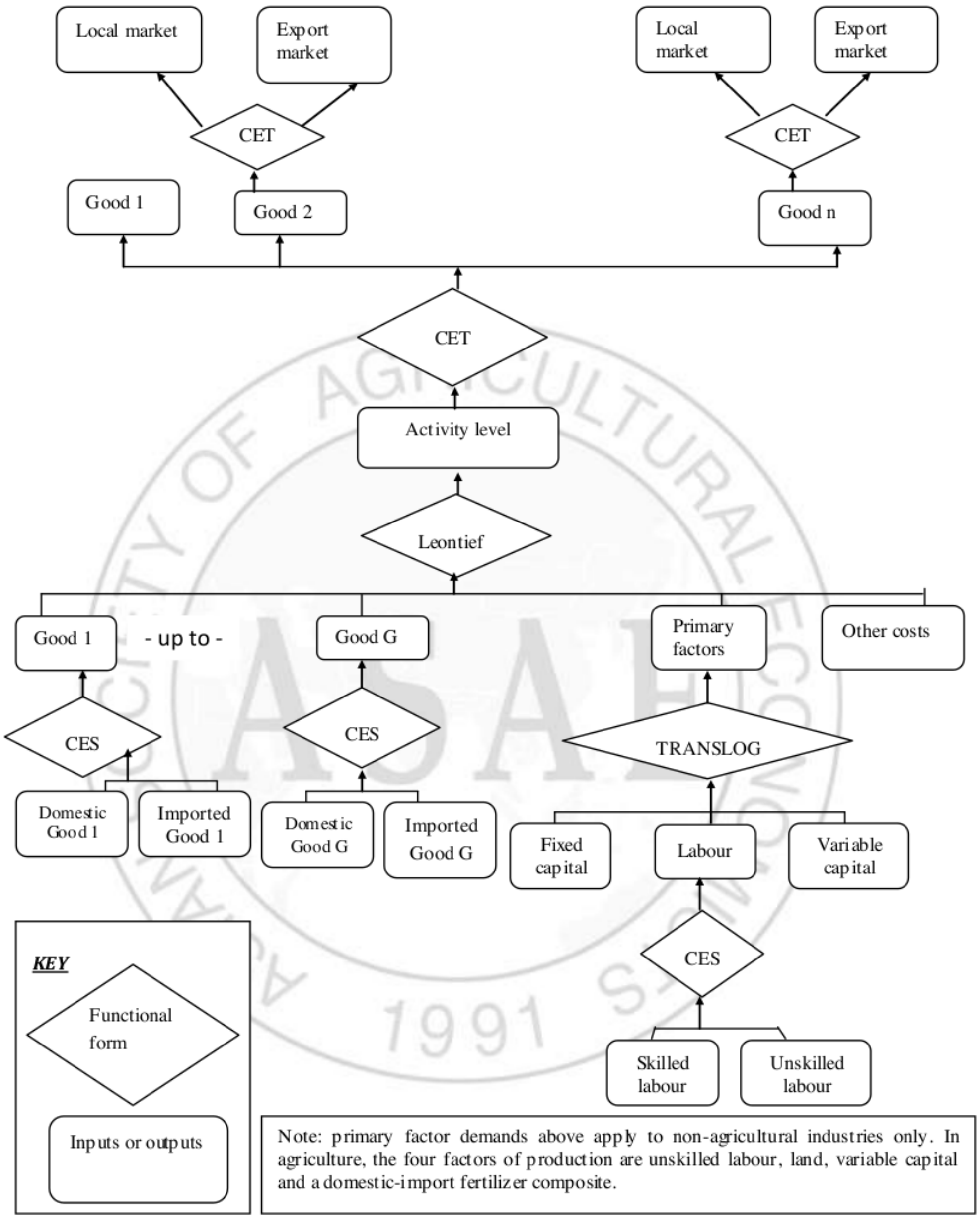
Appendix 1: Summary of Social Accounting Matrix (SAM 2005, Rp Trillion)

Sektor	PFP	HH	COR	GOV	AGRI	MIN	MAN	SER	MAR	CA	IT	SUB	FA	TOT
PFP	-	-	-	-	227.0	161.1	490.2	489.7	-	-	-	-	11.0	1,379.0
HH	837.3	54.3	14.5	72.6	227.0	161.1	490.2	489.7	-	-	-	-	21.0	2,367.7
COR	391.1	-	35.4	-	-	-	-	-	-	-	-	-	16.2	442.8
GOV	26.0	11.4	184.2	21.2	-	-	-	-	-	-	93.3	(81.5)	5.2	259.7
AGRI	-	155.9	-	1.7	353.4	0.0	157.9	36.3	-	0.8	-	-	9.7	715.7
MIN	-	0.0	-	0.1	0.0	208.7	127.1	0.3	-	3.1	-	-	77.9	417.2
MAN	-	412.3	-	12.5	38.6	6.4	1,829.5	156.9	-	275.6	-	-	434.2	3,165.9
SER	-	305.6	-	59.8	4.6	4.3	67.7	1,045.5	309.3	1.9	-	-	47.7	1,846.4
MAR	-	-	-	-	70.5	4.3	234.8	0.0	-	-	-	-	-	309.6
CA	-	39.7	124.4	69.6	-	-	-	-	-	-	-	-	47.7	281.4
IT	-	-	-	-	3.7	6.6	61.2	21.8	-	-	-	-	-	93.3
SUB	-	-	-	-	-	-	(81.5)	(0.0)	-	-	-	-	-	(81.5)
FA	124.8	9.7	84.3	22.2	18.2	25.8	278.8	95.9	-	-	-	-	-	659.7
TOT	1,379.2	988.7	442.8	259.7	942.9	578.3	3,655.9	2,336.1	309.3	281.4	93.3	(81.5)	670.7	11,856.8

Note: FFP = primary factor of production; HH = household; COR = corporate sector; GOV = government
sector; AGR = agriculture; MIN = mining; MAN = manufacturing; SER = services; MAR = margin; CA = capital account; IT = indirect tax; SUB = subsidy; FA = foreign account; TOT = total

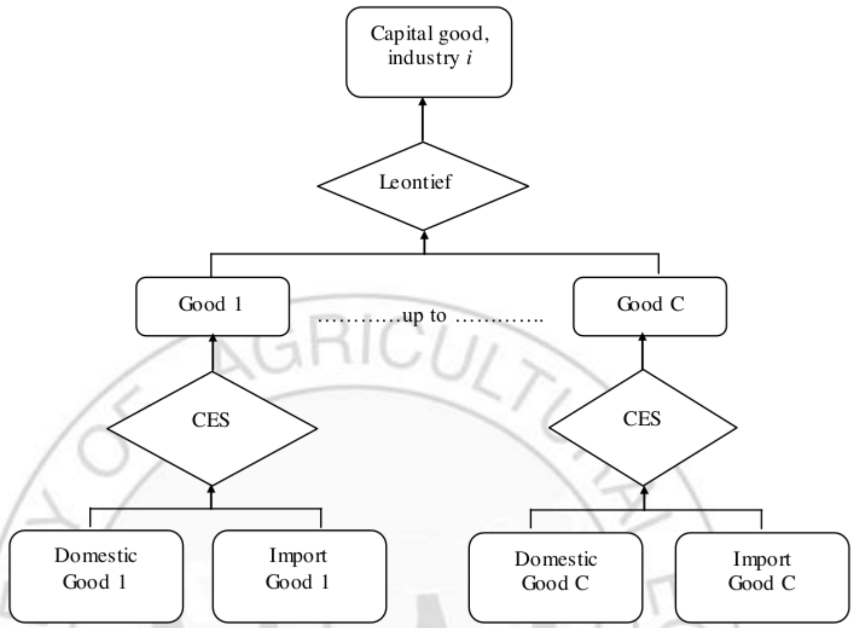
Source: Badan Pusat Statistik. 2007. *Sistem Neraca Sosial Ekonomi Indonesia 2005*. Jakarta: Badan Pusat Statistik

Appendix 2: Structure of production



Source: Wittwer, Glyn. 1999. WAYANG: a general equilibrium model adapted for the Indonesian economy, *ACIAR project no. 9449*. Adelaide: Centre for International Economic Studies, University of Adelaide. http://www.monash.edu.au/policy/oranig.htm (accessed November 2, 2009)

Appendix 3: Structure of investment demand



Source: Wittwer, Glyn. 1999. WAYANG: A general equilibrium model adapted for the Indonesian economy, *ACIAR project no. 9449*. Adelaide: Centre for International Economic Studies, University of Adelaide. http://www.monash.edu.au/policy/oranig.htm (accessed November 2, 2009) evelopment_on_agriculture_and_household_incomes_in_Ind...

ORIGINALITY REPORT

20%	18%	10%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	serialsjournals.com Internet Source	2%
2	pt.scribd.com Internet Source	2%
3	espace.curtin.edu.au Internet Source	1%
4	media.neliti.com Internet Source	1%
5	Firmansyah, Shanty Oktavilia, Evi Yulia Purwanti, Reikha HabibahYusfi. "The Impact of Poultry Imports Liberation on Income Inequality in Indonesia", E3S Web of Conferences, 2018 Publication	1%
6	vuir.vu.edu.au Internet Source	1%
7	citeseerx.ist.psu.edu Internet Source	1%
8	rune.une.edu.au Internet Source	

		1%
9	www.emeraldinsight.com Internet Source	1%
10	www-wds.worldbank.org Internet Source	<1%
11	dokumen.site Internet Source	<1%
12	onlinelibrary.wiley.com Internet Source	<1%
13	escholarship.org Internet Source	<1%
14	Rose Tirtalistyani, Murtiningrum Murtiningrum, Rameshwar S. Kanwar. "Indonesia Rice Irrigation System: Time for Innovation", Sustainability, 2022 Publication	<1%
15	fr.ircwash.org Internet Source	<1%
16	sherekashmir.informaticspublishing.com Internet Source	<1%
17	tind-customer-agecon.s3.amazonaws.com Internet Source	<1%
18	Journal of Economic Studies, Volume 36, Issue 2 (2009-05-24)	<1%

Publication

19	ir.library.oregonstate.edu Internet Source	<1 %
20	digilib.mercubuana.ac.id Internet Source	<1 %
21	www.oregoninsurance.org Internet Source	<1 %
22	"Genetics, Biofuels and Local Farming Systems", Springer Science and Business Media LLC, 2011 Publication	<1 %
23	Joarder, M. A. M., and P. W. Miller. "The Experiences of Migrants Trafficked from Bangladesh", The Annals of the American Academy of Political and Social Science, 2014. Publication	<1 %
24	Vivarelli, M.. "Innovation and employment in Italian manufacturing industry", Research Policy, 199610 Publication	<1 %
25	repofeb.undip.ac.id Internet Source	<1 %
26	online.agris.cz Internet Source	<1 %
27	text-id.123dok.com Internet Source	<1 %

28	www.forgottenbooks.com Internet Source	<1 %
29	www.ukm.my Internet Source	<1 %
30	api.research-repository.uwa.edu.au Internet Source	<1 %
31	mdpi-res.com Internet Source	<1 %
32	repository.dl.itc.u-tokyo.ac.jp Internet Source	<1 %
33	www.cear.kz Internet Source	<1 %
34	www.retrac.seameo.org Internet Source	<1 %
35	www120.secure.griffith.edu.au Internet Source	<1 %
36	www2.kings.edu Internet Source	<1 %
37	Mohamad Ali Fulazzaky. "Participation of farmers in irrigation water management in Indonesia: a review", Irrigation and Drainage, 2017 Publication	<1 %
38	Philip D. Adams, Brian R. Parmenter. "An applied general equilibrium analysis of the	<1 %

economic effects of tourism in a quite small, quite open economy", Applied Economics, 2006
Publication

39	core.ac.uk Internet Source	<1 %
40	docplayer.net Internet Source	<1 %
41	fmwww.bc.edu Internet Source	<1 %
42	lp3e.fe.unpad.ac.id Internet Source	<1 %
43	ojs.amhinternational.com Internet Source	<1 %
44	opac.ll.chiba-u.jp Internet Source	<1 %
45	research-repository.griffith.edu.au Internet Source	<1 %
46	www.ajtmh.org Internet Source	<1 %
47	www.downtoearth-indonesia.org Internet Source	<1 %
48	Jenifer Huang McBeath, Jerry McBeath. "Environmental Change and Food Security in	<1 %

China", Springer Science and Business Media LLC, 2010

Publication

49	hdl.handle.net Internet Source	<1 %
50	SpringerBriefs in Environmental Science, 2014. Publication	<1 %

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		