



WORKING PAPER 98.08

**THE IMPACTS OF TRADE LIBERALIZATION ON
FOOD PRODUCTION AND FARM INCOME: A
MULTILEVEL MODELLING APPROACH**

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between

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CASER/CSIS/CIES/ANU
joint research project on
policy analysis of linkages between
Indonesia's agricultural production, trade and
environment

Rapid economic growth in Indonesia has been accompanied by significant structural changes, including for its agricultural sector and its unique natural environment. Recently questions have been raised about the impact of Indonesia's agricultural, industrial, trade and environmental policies on sustainable rural development. The nature of interactions between the economic activities of different sectors and the environment are such that an intersectoral, system-wide perspective is essential for assessing them. An international perspective also is needed to assess the impact on Indonesia of major shocks abroad, such as the implementation of the Uruguay Round agreements, APEC initiatives, or reforms in former centrally planned economies. There is increasing pressure on supporters of liberal trade to demonstrate that trade reforms at home or abroad affecting countries such as Indonesia will not add to global environmental problems (e.g., deforestation, reduced biodiversity). Again, this requires system-wide quantitative models of the economy and ecology, because typically there are both positive and negative effects at work, so the sign of the net effects ultimately has to be determined empirically.

To begin to address these issues, the Australian Centre for International Agricultural Research (ACIAR) has generously provided funds for a collaborative 3-year project (to mid-1999) involving the University of Adelaide's Centre for International Economic Studies (CIES) as the lead institution, Bogor's Centre for Agro-Socioeconomic Research (CASER) which is affiliated with the Ministry of Agriculture, Jakarta's independent Centre for Strategic and International Studies (CSIS), and the Economics Division of the Research School of Pacific and Asian Studies (RSPAS) at the Australian National University in Canberra. Being based on Indonesia with its rich diversity of environmental resources (and on which there are relatively good data) and its rapid economic growth, the project could also serve as a prototype for similar studies of other developing countries in Southeast Asia and elsewhere.

The key objective of the project is to assess the production, consumption, trade, income distributional, regional, environmental, and welfare effects of structural and policy changes at home and abroad particularly as they will or could affect Indonesia's agricultural sector over the next 5-10 years. Among other things, the analysis will focus both on the effects of economic changes on the environment, and on the impacts on Indonesia's agricultural production and trade of resource and environmental policy changes. The implications of regional and multilateral trade liberalization initiatives and Indonesia's ongoing unilateral trade reforms will be analysed, along with other potential domestic policy changes and significant external shocks such as the entry of China and Taiwan into the World Trade Organization. The analysis will draw on and adapt computable general equilibrium (CGE) models such as the national INDOGEM Model (built as part of an earlier ACIAR project) and the global GTAP Model.

The project is being undertaken in close collaboration with the Indonesian Ministry of Agriculture and ministries involved in trade, planning, and the environment. A Research Advisory Committee has been established to encourage close collaboration of representatives from those and other ministries.

ACIAR INDONESIA RESEARCH PROJECT

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SUMMARY

This paper presents an analysis of the impact of various trade policy options on food sector performance and farm incomes in Indonesia using the *Multilevel Analysis Tool for Agricultural Policy* (MATA model). MATA is a dynamic-recursive model using non-linear mathematical programming. The results indicate that, at the aggregate level, agricultural market liberalization will not have a significant effect on rice production, indicating the low substitution between rice and other crops and high competitive advantage of rice in the lowland farming system in Java. In contrast, the impact of market liberalization on soybean production is substantial. The liberalization of soybean trade seems to be incompatible with the current policy objective of self sufficiency in this crop. These results suggest that maize is more competitive than soybeans. The study's results suggests that market and trade liberalization have a negative impact on agricultural income at the farm level, particularly in the case of small farms. The decrease is less pronounced if rice is excluded from the trade liberalization. This study highlights the importance of technical innovation in order to counteract the adverse effects of trade liberalization and to maintain rural incomes during the trade liberalization process. Efforts for increasing off-farm employment are critically important to compensate the negative income effects of market liberalization. This is particularly true in densely populated areas in which cultivated land is scarce.

THE IMPACTS OF TRADE LIBERALIZATION ON FOOD PRODUCTION AND FARM INCOME: A MULTILEVEL MODELLING APPROACH

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I. INTRODUCTION

Indonesian agriculture is facing a number of simultaneous problems due to both internal and external factors. This means that agricultural policies are becoming much more complex. Considering the complication of agricultural policy objectives which are frequently not fully compatible one with another, decision making process is becoming more and more difficult. To identify the best or the less worse compromise between these alternative choices, policy makers need analytical tools which are able to assess the potential effect of their decisions in such a complex policy setting.

This paper presents an analysis using a multilevel modeling approach of the impact of various trade policy options on food sector performance and farm income. The second section highlights the “MATA” model followed by discussion on the agro-ecological zoning and farm classification in the Java’s lowland, and Indonesia’s food policy changes since rice self sufficiency has been achieved. Section three presents the application of the MATA model to analyze the impacts of trade liberalization on food crop production and farm income. A brief conclusion is presented in section four.

II. A MULTILEVEL MODELLING APPROACH

2.1. The “MATA” Model

The model described in this paper is the “MATA” model: “*A multilevel Analysis Tool for Agricultural Policy*”. The MATA model was originally developed by researchers at CIRAD (France), and documented in a great details in, among others, Deybe and Gerard (1994), and Gerard et al. (1994). The extension of the model for addressing agricultural policy issues in Indonesia has been initiated through a collaborative research project between CIRAD, CGPRT Center, and CASER¹. Examples of policy analysis using the model are found, among others, in Marty, et al. (1995), Gerard and Erwidodo (1996), Gerard and Erwidodo (1997), Erwidodo and Gerard (1997), and Gerard and Versapuech (1997).

¹ CIRAD: Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, France; CGPRT center: Regional Coordination Center for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops, Bogor, Indonesia; CASER: Center for Agro Socioeconomic Research, Agency for Agricultural Research and Development, Bogor, Indonesia.

Mata is a set of models designed to simulate the policy impacts from ex-ante point of view. It calculates policy effects on, among others:

- Agricultural production, farm income and environment
- Consumer nutrient intake and welfare
- Processing industries
- Macro-economic indicators such as employment and external trade

MATA estimates the effects of major agricultural policies, as well as external shocks on: (a) the welfare and behavior of different economic actors, namely farmers, processors and consumers, and (b) agricultural sector performance. MATA main features include: (i) a micro-macro modeling approach, (b) a dynamic and recursive approach which allow representation of commulative effects through time and evaluation of short and long term impacts, (ii) risk measures of agricultural activities.

MATA consists of three modules, namely: (i) a macro-economic module, (ii) production or farming system module, and (iii) commodity chain module. The macro-economic module describes the environment in which farmers, processors and consumers decision take place. The production module represents farming activities, while the commodity chain module represents processing industry and consumer behavior. Since it consists of modules, the MATA model is a flexible tool.

Through the macroeconomic module a large variety of macroeconomic scenarios can be defined and tested. It includes changes in international markets-as represented by change of the world prices, changes in population, income and economic growth, as well as changes in the environment of labor, credit, and factor markets. Because MATA is essentially a sectoral model, endogenous change of the macro-economic variables does not occur in the simulation (Gerard, 1997). In other words, the macro-economic variables are treated as exogenous variables which can be changed and combined in the definition of simulation scenarios.

The production module is based on a detailed representation of farming systems through production opportunities and constraints faced by farmer. Opportunities and constraints are determined by agro-climatic and socio-economic conditions for each farm type. The regional levels of some endogenous variables are calculated using scale parameters representing the share of each farm type in the region. The model reproduces farmers' behavior, evaluates their response to policy changes, and calculate the impacts on the farm income and production. A lot of attention is given to represent market imperfection. Risk is taken into account as an important factor in farmer's decision. The model assumes that farmer's decisions are taken on the basis of expectations of gross margins and potential deviations for each activity.

The commodity chain module represents consumer and processor behaviors of agricultural products. It evaluates consumer welfare and nutrient intake, indicates employment and level of activity in agro-processing industries, and calculates endogenous prices for the products. Consumers are split in homogenous group of households, considering the level of income, spatial location and preferences. It assumes that each type of

representative consumer is maximizing utility represented by a linear expenditure systems. The processing activity is formalized through technical coefficients representing input requirement for producing the final products, and is assumed to be driven by the demand side. The module calculates the employment level of each processing industry.

2.2. The Farming System or Production Module

The following presentation will be on the production module since the simulation results presented in this paper are derived mainly from this module, given a macro-economic environments described in the macro-economic module. The commodity chain module has not been well tested and it needs further works for determining alternative functional forms to better represent consumer and processing industry's behaviors.

In contrast to most of the agricultural sector models, which do not provide satisfying representation of farm household behavior, the production module of the MATA model is based on precise representation of farming systems by taking accounts opportunities and constraints they face on which the objective function is set. Opportunities and constraints are determined by agro-climatic conditions, socioeconomic and by each farmer endowment on fixed factors and liquidity. Part of these general conditions are influenced by macro-economic variables and agricultural policy measures. To take this into account, the farming system module is linked with a macroeconomic module determining the socio-economic environment in which farmers' decisions take place (see [Figure 1](#)).

Farmer's behavior for each farm type is represented using non-linear mathematical model². It is assumed that each farmer acts as to maximize his wealth utility under various constraints. The wealth is defined as the total value of assets at the end of year, including land, equipment, livestock, cash and savings. A detail formulation of the model is found in Deybe and Gerard (1994), and Gerard et al. (1994). In order to consider farmer's risk attitude, it is assumed that farmer's wealth utility increases with expected wealth and decreases with its variance (Markowitz, 1959). The constraints faced by farmer include:

- land availability,
- input requirement and its availability
- mechanization and traction requirements
- labor availability and requirements
- animal availability and feed requirement
- credit and financial availability for investment
- cash flow

Most of these constraints are formalized on seasonal basis. Decision process leads to land allocation among crops and techniques, livestock's activity level, investment and borrowing, labor allocations between farm and off-farm activities ([Figure 2](#)). In order to consider time lags in agricultural production, information imperfection of agricultural markets and the risk associated the decision, the decision process is assumed to be based on

² The model is written and solved with GAMS (General Algebraic Modeling System) software. GAMS is an optimization package for solving linear, non-linear, and mixed integer problems.

expectation of prices and yields. At the end of each period real prices and yield are computed using a random coefficient on the average value. The production level is then calculated with “real variables”, as well as end of period farm endowment. In that way, the results of each year are used as exogenous parameters for the next period. Such methodology was used for a France’s agricultural model by Boussard and Gerard (1992). Two recursive links are considered in the model. On one side, past results of the farm and current state of the financial market determine liquidity constraints, consumption and fixed input endowment, and on the other side computed prices are used to correct next period rentability and risk expectations (Gerard, 1991). Different possibilities for formulating price expectation have been proposed in the literature.

The model is recursive and dynamic to allow each year to be linked with past years and thus to take into account the importance of the past results in current decisions which partly determines actual endowment of the farm in terms of liquidity and factor ownership. Farming systems models are linked together on labor and land markets at the village level, agricultural product markets at national level.

All these model specificities allow to address the policy and external effects both at farm level and, after aggregation on all types of farms, at regional and national levels. It also gives immediate impact and time lag effects. These two features are important. First, farm heterogeneity situation leads to different impacts of a given policy on farm revenue. It is useful to evaluate these differences in order to compensate the worse impacts by appropriate measures. Second, because all the reactions of the agents are not instant and their behavior can have delayed impacts, it is important to be able to evaluate both short and long term effects.

To get regional estimation of a given measure, results at farm level are scaled up using scale parameters defined by the typology. Regional production and employment are thus quantified.

2.3. Production Zoning and Farm Classification

Since the proposed model aims to better represent existing farming system and farmers’ behavior, the first critical step is to identify the production zones, the main farming systems in each zone, and the types of representative farmer. After the typology has been built to find out representative farms, some of them are selected according to the policy questions at hand and policy measures to be tested. As mentioned before, a non-linear mathematical programming models are then built to represent each selected farm’s objective function and behavior taking accounts the opportunities and constraints they are facing.

Multi-factor analysis was used to map an agro-ecological zoning of food crop production in Jawa’s lowland based on a set of variables crossing agro-climatic and socio-economic variables. Additional factors using farm level data are defined to achieve better representation of the farming systems. The farming typology built in that way allows to better reflect the different production factor endowment under which the farmers make their decisions. There are essentially three different agro-ecological area for food crops: (1)

irrigated wetlands, (2) rainfed areas, usually in more sloppy areas, and (3) dryland areas, which are most of the time uplands, where maize and cassava often replace rice as the main crop. There also three climatic periods corresponding to three cropping seasons can be identified: (1) a wet season, (2) a first dry season, and (3) a second dry season³.

Indonesian agriculture is characterized by diversity of the bio-physical and socio-economic conditions. Farming in Java and the outer islands differs considerably. In Java, agriculture is very intensive because of the abundant availability of water and the very small average size of farm holding (0.56 ha). In Java the diversity of farm is high for which one can distinguish irrigated versus rainfed agriculture, lowland versus upland conditions, and also flatland versus hillside cultivation. To simplify this exercise in estimating the impact of liberalization, we propose to focus on Java lowland. Java represents 60% of the total population, and only 7% of the landmass of the archipelago. Java produces about 60% of the food crops in Indonesia, and especially the lowlands with 90% of the rice and 60% of the soybean productions of Java.

There are three different types of agro-ecological production area for food crops, namely: (1) irrigated lowlands, with more or less water, (2) rainfed areas, non irrigated, usually in more sloping areas and (3) dryland areas, which are mostly uplands, where maize and cassava are the main food crops. Also, based on rainfall, three cropping seasons can be identified: a wet season and two dry seasons. It is to say that water availability is the main constraint to cultivation of food crops. It is not only influences the number of cropping seasons possible during one year, but also the type of crops and the level of yields. Thus, we can further differentiate irrigated areas based on the water availability and the level of water management: high, intermediate and low level of water management. Irrigated areas are classified into technically irrigated and simple irrigated areas. In the technically irrigated areas water comes from infrastructures such as dams and canals with high water control, while in simple irrigated areas water comes mainly from small rivulets and streams with low water control.

The irrigated land with a high level of water control obtain the highest level of yields in Java. Concentrated mainly in the rich volcanic and alluvial soils of lowland Java, the characteristic cropping pattern consists of two crops of rice, often followed by a secondary crop or vegetables during the second dry season. A third non-rice crop seems to be far more common than a third rice crop, due to water availability, labor constraints and crop breaks to control pests. Farmers in irrigated areas use high yielding varieties of rice, as well as large quantities of fertilizer. Yields reach more than 5.5 tons per ha.

In the area with moderate water control, water availability allows often 2 crops of rice, but with lower yield level than in the sawah with high water control especially during the first dry-season. A third crop is also common. In areas with low water control secondary crops are more developed. During the wet season, poor drainage makes the cultivation of non-rice crops nearly impossible. In these areas, traditional varieties of rice can be found. The presence of small streams allows rice cultivation during the other seasons.

Farmers in rainfed areas have to wait for the monsoon to grow rice. This entails considerable more risk than in irrigated areas. As the water control is low, high yielding

³ A more detail description found in Marty (1995), and Marty et al. (1997)

variety for rice are less used. The level of fertilizer is also lower and the yields seldom reach more than 4.5 tons per hectare. Rice cannot be grown during the dry season and the soybean is a common crop. The second dry season is usually not cultivated due to drought.

The differences in rice yields between high, moderate and low level of water control are not substantial. However, the cropping patterns are more diversified in areas with moderate and low water control. A secondary crop, which needs a lesser amount of water, is more profitable and less risky. The soybean yield varies between 800 and 1400 kg per ha, depending on soil conditions, water availability at the beginning of the crop and input used by farmers.

In larger irrigated farms, animal traction and hand tractors are used. It is still not the case in the rainfed areas. Hand tractors are often rented by rich farmers or by a local firm, sometimes owned by groups of farmers. This mechanization allows farmers to plant the second crop earlier and thus improve potential yields of the third season crops that, if planted earlier, will get more rain. Animals are of little importance in most of Java lowlands and represent less than 10% of farmers wealth. In contrast, off-farm income is an important part of household income. Around 20 and 30% of time of farmers is being spent on other activities than agriculture. These non agricultural activities are highly diversified and depend mainly on the proximity of urban areas and the capital availability. It can be some regular work, in services or production, or some seasonal activities such as drivers or construction workers.

Table 1 presents 9 main farm typologies found in Java's lowland (F1-F9), based on endowment, type of land, cropping management and production. The area controlled by households is between 0.3 and 2.4 ha. Some farmers rent part or all of operated land. Farmers in rainfed areas control less land than farmers in irrigated areas. As mentioned before, rice is the dominant crop in low wetlands, especially in areas of high level of water control where it occupies more than 90% of the total cultivated area. Off-farm income is more than 1/3 of total income for the poorest farmers. The income per active person varies in a scaleable range from 1 to 7.

These nine types are not the only existing ones in Java lowlands, the diversity of farmers being far greater, but they cover the main characteristics of farming⁴. They show the kind of result we can obtain with the MATA model and leave open the possibility of further detailed analysis. The selected farmers produce 95% of lowland rice, 100% of lowland maize and soybean of Java, and they are a large part of the Javanese agricultural workforce. The results obtained are thus not negligible even at the national sectoral level.

⁴ One major limitation of this exercise is the set-aside of sugar cane production. The profitability of sugar cane seems to be closely related to farm location, proximity to sugar mill factory, existence of constraint on labor, etc. (Collier, 1993). Moreover the policy on sugar cane was difficult to represent in this model, because sugar cane runs over 18 months while MATA is designed on the basis of an annual asset base (some area is presently still under sugar cane production quota).

Table 1. Main Lowland Farming Systems and Their Characteristics in Java

Farming System Characteristics	Technical irrigated with high level water control			Simple irrigated with moderate to low water control				Rainfed	
	F1	F2	F3	F4	F5	F6	F7	F8	F9
Area Controlled (ha)	2.4	1.05	0.95	1.2	0.7	1.2	0.7	0.35	0.35
Active person	3.2	3.2	3.6	2.5	2.7	2.5	2.7	2.0	3
Type of land	irt	irt	irt	irt	irt-irs	irt	irt-irs	rai	rai-dry
Cultivated area (%)									
Rice	95	96	94	44	60	56	70	47	30
Soybean	2	1.5	1.3	36	36	8	6	3	2
Maize	0	0	0	19	4	36	24	30	29
Other	3	2.5	4.7	0	0	0	0	20	39
Mechanization	yes	yes	yes	yes	yes	yes	yes	no	no
Yearly net income per cap (million rp)	2.5	1	0.6	1.6	0.8	1.9	0.9	0.55	0.25
Off-farm income (%)	12	26	36	17	29	18	35	37	40
Animal in total wealth (%)	0.01	6.3	0.3	3.5	8.1	3.5	7	0.2	0.3

Notes:

land "controlled" is land "owned" + land "rented in" - land "rented out"

irt is "technical irrigated", **irs** is "simple irrigated", **rai** is "rainfed land" and **dry** is "dryland"

Sources: SYGAP Database, Kawagoe, T et al. (1990).

2.3. Indonesia's Food Policy Since 1984

Since reaching self-sufficiency in rice in 1984, Indonesia food policy have been turned to the development of secondary food crops, particularly soybeans and corn. The attention given to these commodities has been stimulated primarily by rapidly rising demands, and in turns their imports, as a results of rapid expansion on food and feed industry in Indonesia. The demand for soybeans and corn represents a combination of direct consumption demands, demands for oil and feed industries, the derived demand for food processing industries.

In 1986, the government of Indonesia proclaimed a policy objective of self-sufficiency in soybeans. To achieve the goal of soybean self-sufficiency, a series of production programs, largely consisting of area expansion, improved seed distribution and improved cultivation practices were mounted under special effort in the fiscal year 1986/1987. In line with these production programs, the government has been implementing trade and distribution policies which are aimed at protecting domestic soybean producer from free competition with its foreign competitors. Import tariffs and import licenses have been two major policy instruments, with BULOG appointed as the sole importer of soybeans.

In addition to production supports and subsidies, soybeans have long enjoyed high rate of protection. This policy set aimed at encouraging domestic soybeans and discouraging demand for imports. Since 1984 the government has implemented a series of intensification program for soybeans, utilizing area and production targets. These programs are basically similar with those adopted for promoting rice production, particularly INMAS and BIMAS. Upaya khusus (UPSUS), known as a special program to spur soybean production, was one which signifies improved yield and area expansion of soybeans. UPSUS for soybean is

special operation as the government sets the target of area expansion, and plays direct roles on program implementation and supervision, particularly on improved seed distribution and credit facilitation. The program, along with high price supports and trade restriction, has dramatically increased the planted areas of soybeans. The estimated harvested areas of soybeans increased from 732,620 ha in 1980 to 1,477,432 ha in 1995 or with average annual growth rate of 7.0 percent.

Government intervention through its intensification program were successful in increasing soybean areas and production. Many have argued, however, that although palawija crops were not ignored, but BIMAS palawija were never afforded the same degree of resources and research effort as rice. As a result, the growth rate of soybean production was not as fast as that of rice. Part of the neglect of palawija results from basic consumer attitudes. There is a distinct preference for rice, and a shift to rice consumption is regarded as an indicator of increasing welfare and higher social status. With the development of agroindustries and livestock sector, however, the demand for these crops are expected to increase.

Unlike in the case of rice⁵, BULOG intervention in domestic soybean market was relatively slight and indirect. During 1980-1992, government implemented a floor price on soybean. This policy instrument is considered ineffective, and therefore no longer used, since the farmgate prices of soybean were always well above the announced floor price. At present, controls over imports (and exports) and distribution are the principal means by which the government influences the soybean market. BULOG is the sole importer of soybeans but, in practice, issue importing and processing contracts (for meal crushing) to private sectors.

As sole importer, BULOG and its appointed trading companies have a monopoly on the importation and distribution of soybeans. As a results, the domestic price of soybean (and soybean meal) has always been well above the import parity price. This situation provides substantial economic incentives for soybean producer, BULOG and its trading partners, at the expense of consumer at large. In 1993, for example, Indonesian consumers paid 94% more than import parity price for soybeans (see [Table 2](#)). This taxes thousands of small-scale tahu and tempe producers and significantly increases costs to poultry and other livestock farmers. In short, eliminating the import restriction would benefit the economy as a whole, particularly small tahu and tempe producers, the food and feed industries and consumer in general.

Despite heavy restriction on imports, the import volume of soybean and soybean meal is continuously increasing. This because the increases in domestic production could not meet the accelerating demands for soybean and soybean meal as a results of, particularly, the fast growing feed and livestock industries. Imports of soybean increased from an average of 307,800 ton per annum during 1983-1985 to around 847,000 ton during 1993-1995, or with an average annual growth rates of 9.5%. Meanwhile, imports of soybean meal grew at more than 3.6% per annum, from 161,000 ton to 285,000 ton during the period.

⁵The main price-policy instruments used for rice are (i) floor prices, used to maintain a minimum market price received by farmers, (ii) various input, particularly fertilizer price, subsidies, (ii) ceiling prices which limit the amount that consumers must pay, and (iv) storage cost subsidies. Since 1985, the government has also implemented implicit export subsidies.

Table 2. Nominal Protection Rate for Domestic Soybeans, 1983-1993

Year	Border Price (US\$/Kg)	Import Parity Price (Rp/Kg)	Wholesale Price			NPR(%)
			Imported(Rp/Kg).....	Local	Average	
1983	0.28	279	406	457	432	54.8
1984	0.32	361	494	521	508	40.7
1985	0.26	317	504	515	510	60.9
1986	0.23	325	606	598	602	85.2
1987	0.22	398	717	698	708	77.9
1988	0.30	556	884	780	832	49.6
1989	0.33	642	839	766	803	25.1
1990	0.27	548	1042	948	995	81.6
1991	0.28	601	1105	974	1040	73.0
1992	0.27	603	1072	973	1022	69.5
1993	0.26	596	1154	1056	1105	85.4

Notes:

Import Parity Price is calculated using an estimated handling and transportation costs of 10% of the border price. Exchange rates (Rp/US\$) during 1983 to 1993 were: 906, 1026, 1110, 1283, 1644, 1686, 1770, 1844, 1950, 2030, 2087, respectively.

NPR is calculated using the formula: $NPR = [(Wholesale\ price - Parity\ price) / Parity\ price] * 100\%$

According to Simatupang et al. (1995), Indonesia is projected to import soybean to the amount of 1.3 million ton in 2000 and 1.9 million in 2010. They stated that trade liberalization along with phase out on fertilizer subsidy would decrease production of soybeans and corn but increase rice production. Compared to other crops, an adverse effect of trade liberalization would likely be more serious on soybean production, indicated by a negative production growth rate of -1.7 percent per annum. This negative growth rate combined with positive demand growth contribute to significant increase in soybean import in the near future.

In aggregate, income elasticity of demand for soybean was estimated at around 0.47 and price elasticity at 0.30. This makes soybeans demand about twice as sensitive to income and price changes as rice. These elasticities, combined with a very low household budget share for soybeans suggest that there is considerable latitude in policy for the use of prices in stimulating soybean production. However, domestic prices for soybeans have been far above world prices, already attracting attention from soybean exporters as the GATT negotiations

has been signed. Upward movement in price as a policy direction, appears exceedingly limited.

In summary, the government uses a mixture of policy instruments to influence soybean production and marketing, and BULOG is the key implementer of these policy decisions. In addition, the government devotes considerable resources to the development and dissemination of improved technologies. Some policy instruments can be considered as supply shifters while others encourage output expansion along supply functions.

III. IMPACT ANALYSIS OF TRADE LIBERALIZATION

3.1. Alternative Trade Liberalization Policy Scenarios

Trade and market liberalization will lead to changes in the level and variability of prices. According to economic theory, domestic prices will adjust to international prices except if transaction costs are too important or if the domestic production is sufficiently high in comparison with the world production to influence prices⁶. For rice during 1972-1989, the coefficient of variation of prices is 0.59 on the international market and 0.16 for the domestic market (Gerard and Erwidodo, 1996). Moreover, domestic prices are somewhat higher than international prices. The same may be said for soybean and maize in terms of price variability, while price levels of maize are similar to international prices and the price of soybean is around 50% higher than on the international market (Gonzales, et al., 1993). A set of alternative trade liberalization scenarios to be evaluated is presented in [Table 3](#).

The assumption used in [the base-run scenario \(S0\)](#) represents the actual and the likely trends to occur, namely: soybean and maize prices increase, respectively, at 5% and 2.5 % annually during Y1-Y4 period; labor wages for both farm and off-farm increase at 5% rate; off-farm activities opportunities increase at 5%; annual population growth rate is 2%; and finally, other prices (inputs and outputs) are held constant.

Input market liberalization scenario (S1) is used to test the model ability to reproduce real evolution of some endogenous variables after a policy change have taken place in the past few years. Considering the price of fertilizers in the base year (1992), we assume that input prices increase by 25% for urea, 80% for TSP within four years. These percentage increases would equalize the domestic and border prices of fertilizers.

Under soybean market liberalization (S2) we would expect a release of the import restrictions on soybeans. Following economic theory, such a release would equalize domestic and international prices. We assume that domestic price soybean decreases gradually by 40% (within four years) and stay constant at 0.6 of the base year price. Soybean prices on international market are more unstable than in the current domestic market. Because the risk on gross margins associated with soybean production is already high, due to yield variability and pests and diseases, it does not seem practical to increase it more in our scenario. The next

⁶ As Ellis (1998) remarked that for rice Indonesia faces a “large country, small world market problem” in all its dealing with the world rice market. Nevertheless we consider that Indonesia has no impact on world market rice price.

scenario (S3) is the same as S2, but it assumes soybean's yield increases by 50% due to technical innovation⁷.

At present, variability of yields (due pest and diseases) is a major characteristic of and a major constraint to soybean production in Indonesia. Scenario 4 (S4) assumes a reduction on risk on gross margin by 60% resulting from further technological improvement in farming practices. Scenario 5 (S5) is food market liberalization scenario without technological improvement, by assuming a release of the import restrictions on inputs, soybean and rice. In this scenario, in addition to those described in S1+S2, the price of rice is assumed to decline by 20% within four years. Finally, S6 is the same as S5 but combined with 50% increases in the yields of rice and soybeans resulting from technical innovations.

⁷ The actual soybean yields are much lower (60-70%) than potential yield. Assuming a 50% yield increase (from the base year yield) is therefore reasonable.

Table 3. Alternative Policy Scenarios

Scenario	Description
<u>S0</u>	<p><u>Base Run:</u></p> <ul style="list-style-type: none"> • Soybean price increases at 5% annual rate • Labor wages for both farm and off-farm increase at 5% rate • Off-farm activities increase at 5% • Annual population growth rate is 2% • Other prices (inputs and outputs) are held constant
<u>S1</u>	<p><u>Input Prices Liberalization: release of subsidies</u> Prices of inputs increase progressively with 25% for urea and 80% for TSP on Y1-Y4.</p>
<u>S2</u>	<p><u>Soybean Market Liberalization:</u> Following the release of quantitative restriction on imports, soybean price decreases gradually with 40% (on Y1-Y4)</p>
<u>S3</u>	<p><u>Soybean Market Liberalization with technical change:</u> Soybean price decreases by 40% and stays constant at 0.60*Y1, but yield of soybeans increase by 50%</p>
<u>S4</u>	<p><u>Soybean Market Liberalization with further technical change:</u> Soybean price decreases 40% and stays constant at 0.60*Y1, yield increase 50%, risk on gross margin decreases by 60%.</p>
<u>S5</u>	<p><u>Food Market liberalization:</u> S1 + S2, combined with the decreases of rice price of 20% and a risk increase of 10% due price variability.</p>
<u>S6</u>	<p><u>Food Market liberalization and technical change:</u> S5 combined with 50% increases in the yields of rice and soybeans</p>

3.2. Simulation Results and Interpretation

Analysis at Regional Level

Input market liberalization (S1) has insignificant impact on food crop production in general (see Figures 3, 4, 5). In fact the purpose of this simulation is mainly to assess the ability of the model to represent the production response after a shock. The inputs markets have been progressively liberalized in Indonesia since 1987 and the same impacts are observed in the model as in reality. This result strongly confirms that input price increases have no important effect on food crop production at aggregate level.

Table 4. Regional Rice Production Differences from the Base-Run

SCENARIO	Y3	Y4	Y5	Y6	Y7
RI-S0	0	0	0	0	0
RI-S1	0	1.916	12.932	14.48	39.888
RI-S2	0	-29.837	-48.718	-31.287	-17.525
RI-S3	0	-14.816	12.504	8.536	47.646
RI-S4	0	7600.251	7436.659	7144.845	7744.111
RI-S5	0	-17.277	-20.056	27.635	17.172
RI-S6	0	11181.7	10710.95	10510	11548.12

Table 5. Regional Soybean Production Difference from the Base-Run

SCENARIO	Y3	Y4	Y5	Y6	Y7
SOY-S0	0	0	0	0	0
SOY-S1	0	-4.442	-7.881	-7.003	-9.418
SOY-S2	0	-95.982	-144.472	-303.454	-289.901
SOY-S3	0	402.229	459.58	733.03	542.368
SOY-S4	0	858.142	898.186	1494.229	1172.208
SOY-S5	0	-108.768	-169.1	-317.172	-315.188
SOY-S6	0	402.166	480.906	791.048	651.978

Table 6. Regional Maize Production Difference from the Base-Run

SCENARIO	Y3	Y4	Y5	Y6	Y6
MA-S0	0	0	0	0	0
MA-S1	0	3.067	6.452	1.678	-15.897
MA-S2	0	242.089	471.26	773.86	939.858
MA-S3	0	-303.688	-859.089	-1061.86	-1211.89
MA-S4	0	-992.279	-1803.4	-2251.42	-2671.67
MA-S5	0	284.415	552.851	864.232	1061.473
MA-S6	0	-280.999	-822.157	-1101.8	-1418.71

Soybean trade liberalization (S2) has a big impact on soybean production. The total production of soybeans decreases substantially, around 830 000 tons over the four years simulation period ([Figure 4](#) and [Table 5](#)). In contrast, maize production increases by nearly 2.5 million tons over the same period ([Figure 5](#) and [Table 6](#)). The decrease of soybean price changes the relative profitability of soybean compared to maize. This result confirms that maize is more competitive than soybeans. Competitiveness of soybeans relative to maize is expected to increase only if technical innovations in soybean farming take place.

Technical innovations (S3), which would allow an increase of soybean yields by 50%, contribute substantial effects on production and farm income. First, increased profitability leads to more land allocated to soybeans compared with the base run. Second, the increase of yield allows a marked increase in production. No impact occurs in rice production ([Figure 3](#) and [Table 4](#)). Maize production decline slightly, allowing soybean production to increase ([Table 5](#) and [Table 6](#)). The test of further technological improvement, that is yield improvement coupled with a reduction in yield variability (S4) shows the importance of risk on farmers decisions for land allocation. In that case soybean production increases by more than 325%, rice production increases as well, and in contrast, maize production declines.

As shown in [Figure 3](#), food market liberalization scenarios (S5 and S6) show a negligible impact on rice production, underlining the absence of real competitors for this crop. Soybean production as well as its profitability declines, while the opposite occurs in maize production.

Analysis at farm level

As mentioned before, one interesting feature of the MATA model is that it allows us to undertake impact evaluation both at farm level and, after aggregation on all types of farms, at regional as well as national level. At farm level, the impacts of any policy change on resource allocation and household income for different type of farms are identified. [Annexes 1-9](#) present the evolution of agricultural income for each type of farm under various policy scenarios.

Input market liberalization, in general, reduces agricultural income, even though its magnitude varies between farm types (see [Annex 1-4](#) as illustration). The impact is low in the middle farm type with a high level of water control (farm-2). High percentage reduction of agricultural income occurs in the well-irrigated farms, around 13% in the wealthiest farm type (farm-1) and 23% for the smallest farm type (farm-3). In both cases the agricultural income is derived mainly from highly input consuming crops and crop substitution is low in this area. The middle farm type with high water control area (farm-2) is better able to adapt to the increase of inputs price. It compensates the lower profitability by increasing its cultivated area. This is possible because the wealthiest farmers rent out more land, preferring off farm activity in consequence of the decrease of farm profitability.

Large income reduction born by small farms in technical irrigated area (farm-3). The explanation is that they do not have enough liquidity to rent in more land, and they are highly

sensitive to risk. As a result, they have difficulties to change their activities according to the changing environment associated with inputs price liberalization. This is consistent with the reality observed in Java lowland during the past few years. The opportunities for off-farm activities give some compensation to small and landless farmers and allow them to avoid a sharp decrease of income. It means that the incentive to leave rural area becomes stronger with market liberalization. Similar situation occurs in the rainfed areas. Here again, off farm activities allow farmers to stabilize their income.

Liberalization of soybean trade has a big impact on agricultural income for those specialized in soybean production as secondary crops (farm 4 and 5). The decrease of income is around 10%. There is no significant impact on land allocation for rice. A decrease in land allocation for soybean is around 10% in farm-4 and 40 % in farm-5. In contrast, maize area increases with more than 100% in farm-4, and is nearly five folds in farm 5 (see annex). Finally, the analysis of the wealth patterns during five years shows that farmers, except the largest one (Farm-4), manage a slight increase of wealth even after soybean trade liberalization. This is because the biggest farms currently enjoy the highest benefits from the protection of soybean market.

For the farm types with a high level of water control, agricultural income stays unchanged after soybean trade liberalization. Rice area increases slightly (around 2%) whereas vegetable area increases more than 16% compared with the base run. Maize, which is currently not grown in this farming systems, appears to be one alternative to substitute out soybean. In the rainfed area, the agricultural income diminishes with 6.5 % compared with the base run. Soybean is given up, and the maize area increases with around 10%.

Simulation with the food sector liberalization scenario (S5) indicates the worse impact on agricultural income in general. Agricultural income decreases sharply, ranging from 20 and 50 % according to farm type (see [Figure 6](#) as an illustration). The worse effect is observed in the small farm with a high level of water control (Farm-3). The total wealth of these farms declines with almost 7% during the 5 year simulation period, showing a very difficult situation for these households. The existence of off-farm activity does not allow enough time reallocation to counter the effect of liberalization. Middle level and wealthier farmers with a high level of water control (farms 1 and 2) face also difficulties with the food sector liberalization, but they seem to be more able to adapt. Their agricultural income decreases with more than 30% compared with the base-run, but the farm wealth shows only a small decrease for the period. Both farms compensate the decrease in rice and soybean profitability in moving to maize and vegetables.

A dramatic decrease of agricultural income (around 40%) occurs in rainfed farming following the liberalization of the food sector (S5). The evolution of the wealth shows that the profitability of rainfed farming becomes questionable in this scenario. Soybean is given up and the vegetable area is slightly reduced, while corn is expanded as well as the intercropping rice-maize-cassava.

The scenario with technical improvements (S6) was included to evaluate the extent of which the negative impact of market liberalization is counteracted by technical improvements. The result shows that farmers in general, except those in rainfed area, are benefited from technical innovations. The farms from the rainfed area are not able to manage

a stable income compared to the base-run scenario. The decrease of income is nevertheless less than in the liberalization scenario without technical improvements. In contrast, some farm types are able to substantially increase their agricultural income. The middle size farm of the high level of water management (farm-4) increases its agricultural income by 27.8 %. This farm increases the rice area with more than 50%, renting out less land and allocating more time to farm activity. All the other farms manage an approximately stable agricultural income.

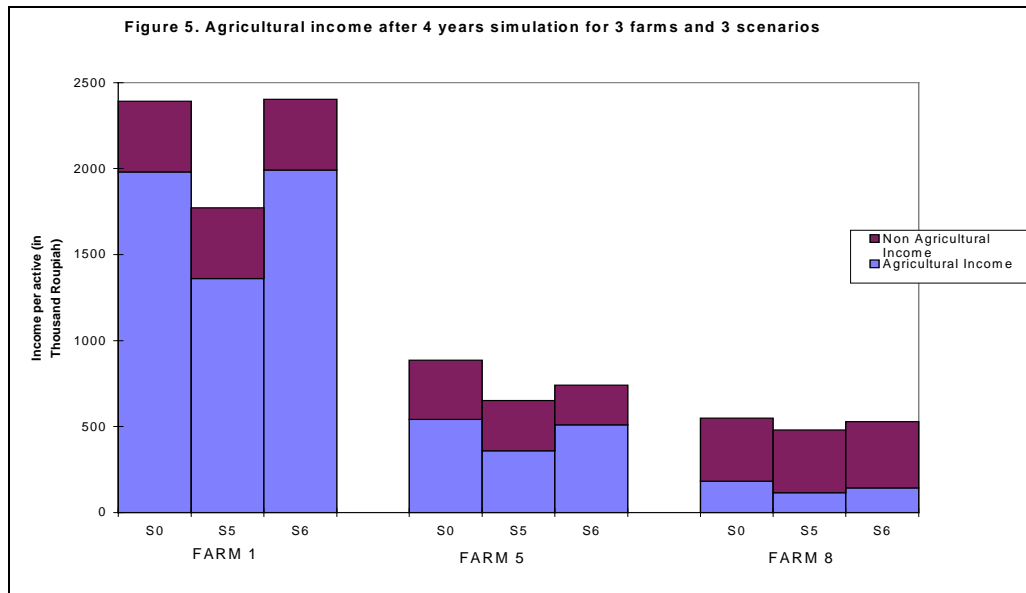


Figure 6. Farm Household Income After 4 Years Simulation

IV. CONCLUSION

This paper presents how a multilevel modeling framework can help the policy makers to better understand the impact of various policy options on agricultural sector performance.

The model described in this paper is the “MATA” model: “*A multilevel Analysis Tool for Agricultural Policy*”. The model, which is a dynamic-recursive model using a non-linear mathematical programming approach, consists of three modules, namely: (i) a macro-economic module, (ii) production or farming system module, and (iii) commodity chain module. The macro-economic module describes the environment in which farmers, processors and consumers decision take place. The production or farming system module represents farming activities, while the commodity chain module represents processing

industry and consumer behavior. Since it consists of modules, the MATA model is a flexible tool.

In contrast to most of the agricultural sector models, which do not provide satisfying representation of farmer's behavior, the production module of the MATA model is based on precise representation of farming systems by taking accounts opportunities and constraints on which the objective function is set. The opportunities and constraints are determined by agro-climatic conditions, socioeconomic and by each farmer endowment on fixed factors and liquidity. Since part of these general conditions are influenced by macro-economic variables and agricultural policy measures, the farming system module is linked with a macroeconomic module in which the socio-economic environment is described. As an illustration, this paper also presents the impact analysis of trade liberalization on food sector performance using the first two modules. Some interesting lessons from the analysis, among others, are as follows:

- At the aggregate level, agricultural market liberalization will not have a significant effect on rice production, indicating the low substitution between rice and other crops and high competitive advantage of rice in the lowland farming system in Java.
- In contrast, the impact of market liberalization on soybean production is substantial. The liberalization of soybean trade seems to be incompatible with the current policy objective of self sufficiency in this crop. The result confirms that maize is more competitive than soybeans. In more liberalized market, the competitiveness of soybeans relative to maize is expected to increase only if technical innovations on soybeans take place, that is in the form of an increase yield and a reduce risk on gross margin. Otherwise, maize would be widely grown instead of soybean.
- At farm level, impacts of market and trade liberalization are strongly negative on agricultural income. The decrease is less pronounced if rice is excluded from the trade liberalization. Technological improvement for rice and soybean are able to partially compensate the negative impact of trade liberalization on agricultural income. The farms in the irrigated area are even able to get a higher income as compared to the situation in the base-run. Increased off-farm job opportunities have a strong positive effect on household income.
- The worse effect is observed in the smaller farm households with a high level of water control. The total wealth of these farms markedly declines, showing a very difficult situation for these households. The existence of off-farm activity does not allow enough time reallocation to counter the effect of liberalization. Middle level and wealthier farmers with a high level of water control face also difficulties with the food sector liberalization, but they seem to be better adapt the situation.
- This study highlights the importance of technical innovations in order to counteract the adverse effects of trade liberalization, and to maintain rural income in a trade liberalization process. Innovation could be induced by a variety of sources. Among these, biotechnology may play a part, the research and extension efforts play another. This means that private investment in R & D in agriculture becomes the driving force in the dynamics of the agricultural sector.

- Finally, efforts for increasing off-farm employment are critically important to compensate the negative income effects of market liberalization. This is particularly true in the densely populated area in which cultivated land is scarce. In such a situation the development of off-farm activities in rural areas is expected to increase household income, prevent massive rural-urban migration. Our analysis shows that the positive effects of trade liberalization for farmers will be realized in the short-medium terms. The liquidity constraints and the existence of risk aversion prevent farmers from specializing in the more profitable crops.

REFERENCES:

- Altemeier K., Bottema T. (1991). Agricultural Diversification in Indonesia: Price responses and linkages for the food crop sector, 1969-1988; an outlook to 2000. The CGPRT Center, Indonesia, Working Paper 11, 136p.
- BINUS (Directorate of Foodcrop Economics and Postharvest Processing, Directorate General of Foodcrops) (1997). Supply and Demand for Foodcrops in Indonesia. Ministry of Agriculture, Jakarta, 445p.
- Collier, William L., Santoso K., Soentoro, Wibowo R. (1993). A New Approach to Rural Development in Java: Twenty Five Years of Village Studies. PT INTERSYS Kelola Maju, Jakarta.
- Ellis F. (1989). Future Rice Strategy in Indonesia: Rice Self-Sufficiency and Rice Price Stability. Indonesian Food Journal: 27-46.
- Erwidodo and F. Gerard (1997). Impacts of Agricultural Trade Liberalization on Food Crop Production and Farm Income: The Situation of Java's Lowland, Indonesia. Paper presented at CGPRT Center-CIRAD Seminar, 25-27 March 1997, UN/ESCAP, Bangkok.
- Gérard F., Boussard J.M., Deybe D. (1994). MATA: A multilevel analysis tool for agricultural policy. Working Paper URPA no23, CIRAD, Paris.
- Gerard F. and Marty I. (1995). Les Politiques d'accompagnement de la "Révolution Verte" en Asie: République de Corée, Indonésie, Philippines et Thaïlande. Revue d'économie du développement, 2/1995: 93-114.
- Gerard F. and Erwidodo., 1996, Consequences of agricultural trade liberalization on food crop production and farm income in Java lowland, Paper presented in the ASAE 2nd conference, August 6-9, 1996, Bali, Indonesia.
- Gerard, F. (1997). The Multilevel Analysis Tool for the Agricultural Sector: Advantage and Performance. Paper presented at CGPRT Center-CIRAD Seminar, 25-27 March 1997, UN/ESCAP, Bangkok.
- Gerard, F. and M. Versapuech (1997). Impact of Policy on Consumption and Employment in Java, Indonesia. Paper presented at CGPRT Center-CIRAD Seminar, 25-27 March 1997, UN/ESCAP, Bangkok.
- Gonzales, Leonardo A., Kasryno F., Perez, Nicostrato D., Rosegrant, Mark W. (1993). Economic Incentives and Comparative Advantage in Indonesian Food Crop Production, Research Report 93. International Food Policy Research Institute.
- Hermanto, Zulham, A., Suhartini, S.H (1992). In Jierwiryapant P., Hermanto, Roche F., and Bottema J.W.T (eds.) Local Soybean Economies and Government Policies in Thailand and Indonesia. CGPRT No. 27, Indonesia, 203p.

Marty I. (1994). Farming system typology in Japanan, East Java province, a principal component analysis approach. Working Paper URPA-CGPRT Center, 12p.

Marty, I., Gerard, F., Erwidodo, Lancon, F., and Deybe, D (1997). Increasing Indonesian Soybean Production: Testing Policies in a Lowland Farming System. In P.S. Teng et al. (eds): Applications of Systems Approaches at the Farm and Regional Levels. p309-324. Kluwer Acedemic Publisher, London.

Sudaryanto, T., Hermanto, Erwidodo, Pasandaran, E., and Rosegrant, M.W. (1992). Food Situation and Outlook for Indonesia. Report of IFPRI-CASER Research Collaboration. Center for Agro Socioeconomic Research, Bogor, Indonesia.

World Bank (1996).Indonesia Dimensions of Growth. Report No. 15383-IND, Washington D.C., World Bank