An Assessment of the Impact of Rice Tariff Policy in Indonesia: A Multi-Market Model Approach

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Abstract

Rice is of key importance to Indonesia's national and household level food security. The choice of tariff policy has important implications for consumers and producers with policy makers having to decide between the trade-offs implied for the various stakeholders. In this study we use a multi-market model to assess the impact of hypothetical rice tariff changes on household welfare and other variables of interest to rice policy-makers. A reduction in the rice tariff from 30 to 0% reduces rice supply and wheat demand and stimulates rice demand and soybean supply. Rice imports increase from 0.8 to 2 million tons. Rural households except for the Java-top income group, see incomes fall. In terms of purchasing power all households gain very significantly. Eliminating rice tariffs increases crop diversification and more so in those areas and for those income groups which started off least diversified. It is clear that the higher retail rice price resulting from a 30% ad-valorem tariff rate imposes significant cost on the 90% of Indonesian households, including most of the very poor households, who are net rice buyers. The implied income gains appear relatively modest but do accrue to middle and poorer households especially in Java. On the other hand an increase in the tariff from 30 to 50% eliminates rice imports, reduces soybean output and stimulates wheat demand. Rural households, except for the Java-top income group, see incomes rise although the effect is relatively modest. In terms of purchasing power households are all worse off.

Key words: Indonesia, multi-market model, household welfare, rice, tariffs, crop diversification.

JEL: Q11, Q18

1. INTRODUCTION [1]

Rice is the key staple crop for a large number of Indonesians in many parts of the country. At the national level rice accounts for nearly half of total daily per-capita calorie intake. It plays an important role in the domestic economy and in the food security of households, with poor households allocating about 30% of total expenditure to rice. Rice cultivation provides a livelihood for about 21 million farm households and for people with only primary education rice production equals 18% of total employment (Warr, 2005). Rice production is centred in Java (54% of output) followed by Sumatra (24%), Sulawesi (11%), Bali, East Timor and Nusa Tenggara (6%) and Kalimantan (5%) (FAO, 1998). Because it is such a key commodity in terms of food security and the wider economy it has and continues to receive considerable attention from policy-makers with much of the policy debate focussing on the pros and cons of rice market liberalization versus increased support for the rice sector.

In the early years of independence policies were aimed at achieving self-sufficiency in rice production. Initial efforts were unsuccessful and after two decades of independence, rice supplies had declined in per-capita terms. The campaign to increase rice production received more attention and was better managed once Indonesia embarked on its first five-year plan in 1969. Programs and polices that helped achieve rice self-sufficiency by 1984 included: the development and adoption of modern technology; the encouragement of active farmer participation through the Mass Guidance program (known as BIMAS); the provision of farm inputs at the proper time, location, quantity, quality and price, and price incentives for farmer through floor prices. Other important factors in bringing about rice self-sufficiency were physical infrastructure (both irrigation and roads) and institutional development. For the past quarter century, this policy package has proven successful in increasing rice production and securing self-sufficiency.

Such support as well as large investments in irrigation helped rice production to grow at an annual average rate of 4.6% over the 1969-1990 period. The efforts to promote domestic rice production resulted in Indonesia achieving self-sufficiency in rice in 1984 when per-capita production reached 234 kg. Moreover rice price stabilization, achieved primarily through market operations by the government agency for food logistics, BULOG, has, over the 1969-79 period substantially benefited economic growth (Timmer, 2006).[2]

The economic crisis of 1997/1998 led to a reassessment of the government's food policy. From July 1997 to September 1998 the average retail price of medium quality rice in urban areas rose by 207%. The rice price inflation had a significant negative impact on the welfare of the 90% of Indonesian households that are net rice buyers, and in particular on the very poor households most of which are part of this group (BAPPENAS et al., 2002b).[3] At the end of 1998, in response to the consequent widespread social unrest, the government and the World Bank agreed on a deregulation package aimed at lowering rice subsidies and

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[1] This paper was prepared as part of the "Linking Agriculture Policies to Poverty and Food Security" module of the FAO's *Roles of Agriculture Project* [www.fao.org/es/esa/roa], funded by the Japanese Government. Content and errors are exclusively the responsibility of the authors and do not necessarily reflect the position of the Food and Agriculture Organization of the United Nations or of the Indonesian Center for Agricultural Socio Economic and Policy Studies. The multi-market model developed for this study builds on Lundberg and Rich (2002) and Stifel and Randrianarisoa (2004). We are grateful to these authors for sharing their GAMS code with us.

[2] Timmer (2006) also points out that this benefit declined as rice became a smaller proportion of value added in the economy and in consumers budgets.

[3] On Java 45% of rural households do not own any land while another 20% own less than one-quarter hectare of land.

liberalizing the rice market. Imports were deregulated and a zero percent tariff on rice imposed (Warr and Thapa, 1999). At the same time the government set up programs to provide low price rice to poor households. For example, the *Raskin* program set up in 1998 provided 2.2 million metric tonnes annually to the poor at a cost of about 4.6 trillion Rupiah (Sidik, 2004).

Table 1: Rice Production, Area, Yield and Imports, 1990-2003

Year	Production 1000 MT	Area 1000 Ha	Yield MT/Ha	Per-Capita Production Kg/Ha	Net Imports 1000 MT	Imports as share of Domestic Production
1990	30,134	10,502	4.30	165	69	0.00
1991	29,807	10,282	4.35	161	201	0.01
1992	32,176	11,103	4.34	171	603	0.02
1993	32,137	11,013	4.38	168	-325	0.00
1994	31,110	10,734	4.35	160	474	0.02
1995	33,179	11,439	4.35	168	3,236	0.10
1996	34,085	11,570	4.42	170	2,201	0.06
1997	32,935	11,141	4.43	162	313	0.01
1998	32,841	11,730	4.20	159	2,962	0.09
1999	33,928	11,963	4.25	163	4,720	0.14
2000	34,616	11,793	4.40	164	1,358	0.04
2001	33,657	11,500	4.39	157	642	0.02
2002	34,344	11,521	4.47	158	1,827	0.05
2003	34,737	11,477	4.54	158	1,646	0.05

Source: FAOSTAT

After 1998 retail rice prices declined but were still 168% higher in 2001 than in 1996 and in real terms the price of rice was higher than it had been for the last fifteen years (BAPPENAS et al., 2001).[4] Nevertheless the government became increasingly concerned over the impact that the crisis and the significant amount of imports that flowed into the country in 1998 and 1999 - also due to the El-Nino induced drought - had on farmers. Consequently the government introduced an import tariff of Rp 430/kg, equal to an ad-valorem rate of 30%, in 2000. Moreover since January 2004 rice can only be imported one month before and two months after the peak harvest season, while during the off-season imports are open but subject to red lane inspections (USDA, 2004). As a result of these policies rice prices were about 40-50% above import prices from 2000 until at least 2004 (Warr, 2005).[5]

The arguments in support of increased protection of the rice sector are based on the need to counteract developed country subsidies to rice growers and exports, on limiting exposure to a thin and unstable world rice market, and on the need to stimulate production to reduce imports (BAPPENAS et al, 2002b).

The effect of the crisis and of rice imports on rice farmers is not uncontroversial and much work has gone into challenging the protectionist arguments. For example, Indonesia imports milled rice and hence imports impact on *beras* (medium quality rice) but much less so on *gabah* (un-husked rice). So while the retail price for urban *beras* rose by 207% over the

[4] The retail price of rise rose significantly more than the overall cost of living.
[5] This despite the smuggling in of an estimate 600,000 to 700,000 tons of rice per year (USDA, 2004).

July 1997 to September 1998 period the average price that farmers in Java received for dry un-husked rice rose by 133% from 530 Rupiah/Kg to 1,236 Rp/Kg. The rural *beras* price also rose significantly more than the *gabah* price and convergence took nearly a year. The movement of *beras* and *gabah* prices in urban and rural areas in relation to imports and domestic production indicates that the latter, and not imports, has been the primary factor driving changes in the farm gate price of *gabah* in Java (BAPPENAS et al, 2001).

With regard to exposure to a thin and unstable world rice market, available evidence indicates that with the rise in the number of rice exporters (Vietnam, India) world rice price volatility has declined. For example, Indonesian rice imports surged during the 1997/98 El-Nino drought but Thai 25% broken rice rose by only 3% (BAPPENAS et al, 2002a).

Finally, rice farmers get about 28% of household income from rice and the benefits/costs to them of higher/lower prices are limited (Molyneaux and Rosner, 2004). Data presented in BAPPENAS et al (2001) also show that despite significant rice imports and a rise in the fertilizer price real net farmer income in terms of rice has been more or less constant in 1994, 1995, 1996 and 1998/99 (BAPPENAS et al, 2001).

The topic of rice price protection continues to be of interest and in this study we use a multi-market model to provide *ex-ante* information on the effects of tariff changes on cropping patterns, producer and consumer prices, household income and calorie intake and other variables related to rice policy. An assessment of the impact of the policy changes on the desired objectives is important from the point of view of helping to shape the policy debate on the reform alternatives. What happens to cropping patterns also relates to the question of crop diversification[6] which high rice prices are expected to discourage but which is important from the point of the distortionary effect of rice sector protection on agricultural and economy wide transformation.[7] With the gradual transformation of food demand patterns this is likely to become a more pressing issue in the future (San et al., 1998).

2. MODELLING AGRICULTURAL POLICY REFORM[8]

2.1 Introduction

For a number of reasons it is important to be able to provide an *ex-ante* analysis of proposed agricultural policy changes in developing countries. Many governments intervene directly in agricultural product, in particular food, markets through taxation and subsidization. Key objectives are to redistribute income, generate public revenues, correct market failures and provide incentives to producers (Braverman, Ahn and Hammer (1983)). An assessment of the impact of the policy changes on the desired objectives is important from the point of view of helping to shape the policy debate on the reform alternatives. In this paper we apply one tool, i.e. a multi-market model,[9] that has been used to analyze *ex ante* the impact of agricultural policy reforms.[10]

Multi-market models fall short of the complexity of CGEs but do include direct and indirect effects in a small number of markets. In that sense they are an improvement over single market partial equilibrium analysis. They typically consist of a producer and consumer core and allow for the analysis of the impact of price and non-price policies on production,

[6] The issue of diversification from rice to other key staple food items is the focus of Sayaka et al (2007) using the multi-market model already applied in this paper.
[7] The price of rice is important not only for crop choice but also for its impact on the real wage (see for example BAPPENAS et al. (2002b) and Timmer (2006) for a detailed discussion).
[8] This section is an abridged version of section 3 in Siam and Croppenstedt (2007).
[9] Multi-market models are sometimes referred to as "limited general equilibrium" (for example in Quizón and Binswanger (1986)) or "multi-market partial equilibrium" (as in Arulpragasam and Conway, 2003)) models.
[10] A more detailed discussion of the various tools to analyse policy change can be found in World Bank (2003).

factor use, prices (for non-tradables), incomes, consumption, government revenues and expenditures and balance of trade (Sadoulet and de Janvry, 1995)). The analysis focuses on those markets which are assumed to be strongly interlinked, either on the demand or the supply side. Prices in those markets included in the analysis are endogenous. The bias in estimating welfare changes as a result of policy reforms is diminished, but remains. It follows that multi-market models will generate reliable results when the reforms being analysed affect commodities or factors for which the set of close substitutes and complements are well defined (Arulpragasam and Conway, 2003)).

Multi-market models have proven particularly popular for work on agriculture sector analysis. In the 1980s the World Bank developed multi-market models for Senegal, South Korea and Cyprus to analyse how the impact of changes in price policies would affect production, demand, income, trade and government revenues (Lundberg and Rich, 2002)). Braverman, Ahn and Hammer (1983) and Braverman and Hammer (1986) extended the single market surplus method to include income distribution and some general equilibrium considerations. Their analyses cover the agricultural sector and includes an exogenous urban sector. This is important as urban consumption may have an important impact on government revenue/deficits. Moreover staple food price changes are important for the urban poor. They note the trade-off between complete information on the consequences of policy and the need for simplicity in operational work.

More recently multi-market models have been used for agricultural sector Poverty and Social Impact Analysis (PSIA).[11] For example Murembya (1998) uses a multi-market model along the lines of Braverman and Hammer (1986) to study the impact of loosening agricultural price controls on agricultural production in the smallholder sector, the government budget deficit and on household welfare in Malawi. Dorosh et al., (1995) addresses the question of whether open market sales of yellow maize food aid is an effective means of poverty alleviation in Maputo and whether such a policy has any negative effects on the rural poor. Minot and Goletti (1998) use a spatial multi-market analysis which focuses on market liberalization of the rice sector in Vietnam.[12] Their model is innovative in the sense that it allows for differences in impacts across regions. Building on their work (and also using the Viet Nam Agricultural Spatial-Equilibrium Model) Goletti and Rich (1998a) study alternative policy options for agricultural diversification in Viet Nam and Goletti and Rich (1998b) use the Madagascar multi-market spatial-equilibrium model to analyse agricultural policy options for poverty reduction. Srinivasan and Jha (2001) analyze the effect of liberalizing food grain trade on domestic price stability using a multi-market model. In their model the direction of trade is determined endogenously.

Lundberg and Rich (2002) built a multi-market model to look at agricultural reforms in Madagascar. This was meant to be a generic model that could be adapted to policy analysis in a number of African countries. On the product side this model includes fine and coarse grains, roots and tubers, cash crops, livestock, other food products and non-agricultural production. On the input side fertilizer, feed and land were included. Labor was not included as the authors surmised that this input was more appropriately studied through the use of a CGE model. Stifel and Randrianarisoa (2004) built on Lundberg and Rich (2002) to analyze the impact of agricultural reforms, such as tariff changes, but also going beyond price changes by looking at infrastructure improvements and yield increases, in Madagascar. The model

[11] For detailed information on PSIA see the so dedicated World Bank website [www.worldbank.org/psia]. For a detailed overview of analyses on agricultural market reforms on poverty and welfare see Lundberg (2005).
[12] See also Minot and Goletti (2000).

used in this paper derives from the work of Lundberg and Rich (2002) and Stifel and Randrianarisoa (2004).[13]

3. THE MODEL[14]

3.1 Product Categories

The product categories are: 1) food items, 2) maize for animal-feed, and 3) agricultural inputs. More specifically, these items include:

Rice: Indonesia is one of the world's leading rice producers, with paddy production in 2003 of more than 50 million tonnes and a cultivated area of more than 11.5 million ha. Rice occupies about 61% of the total area planted – mainly in the irrigated lowland systems. In 2003 the import tariff was 430 Rupiah/kg, equivalent to a 30% ad-valorem rate.

Maize: In Indonesia, maize is the second most important cereal crop after rice, in terms of the proportion area planted to maize relative to the total area for all food crops. It's grown mainly in dry-land areas (89%), with low soil fertility and erratic rainfall, and is often exposed to drought conditions. Maize is grown in less developed or remote areas. It is an important staple food for the Madurese and in East Java. South and North Sulawesi people also consume a high proportion of maize. The main production areas of maize are West, Central and East Java, Lampung, Bali, Nusa Tenggara, South Sulawesi and Kalimantan. We include maize twice, once for human consumption and once for animal feed. The total use is around 28.5% of the total consumption with demand on the increase. We include maize as animal feed as our livestock variable covers poultry.

Soybean: is a major food crop consumed as sprout or more often in processed form as tofu (soybean curd), tempe (fermented soybean), kecap (soy sauce) and tauco (salty-fermented soybean). Soybeans, together with groundnuts, are an important source of protein in the traditional diet of Indonesians. The area harvested has fallen over the 1998-2002 period from 1,094 to 547 thousand hectare.

Table 2: Proportion of overall rice, maize and soybean output by region

Region	Rice	Maize	Soybean
Sumatra	24 %	23 %	18 %
Java	54 %	56 %	61 %
Bali, East Timor and Nusa Tenggara	6 %	8 %	12 %
Kalimantan	5%	1 %	2%
Sulawesi	11 %	13 %	7 %

Source: FAO (1998)

[13] We are grateful to Mattias Lundberg and David Stifel for making their GAMS code available to us. Making use of their model and adapting it to Indonesia has proven immensely helpful and time saving.

[14] When preparing the model we benefited from the active participation of Henny Reinhardt and Tanti Novianti, Department of Economics, Faculty of Economics and Management, Bogor Agricultural University; Leo Mualdy Christoffel and Yudha Hadian Nur, Ministry of Trade; Noor Avianto and Jarot Indarto, BAPPENAS; Erika Speelman and William Henderson, UNESCAP-CAPSA, and; Roosgandha, Helena J. Purba, Erna Maria Lokollo, Saktyanu K. Dermoredjo, Sri Nuryanti, Tri Bastuti Purwantini, Budiman Hutabarat, Reni Kustiari and Sri Wahyuni, ICASEPS, participants in two "Multi-Market Learning Workshop" held at the Indonesian Centre for Agriculture and Social Economic Policy Studies (ICASEPS), Bogor, between the 19-23 June, 2006 and 19-26 November 2006.

Cassava: is the third most important crop in Indonesia which is widely eaten and used as a staple food during times of hardship. However, it is considered inferior to rice. Both maize and cassava (cassava and *gaplek* – dried cassava) are often consumed as staple food, particularly in Java (Gunawan, 1997).[15]

Banana: is one of the main horticultural commodities in Indonesia.

Wheat: Indonesia does not produce wheat. Although wheat consumption is small relative to rice and other staples produced, wheat is a substitute for rice and is an important source of calories. Total consumption in 2003 was about 3.8 million tons.

Livestock (poultry): the country has a large poultry industry. Production is mainly aimed at the domestic market, although some export can be regionally important, e.g. from Sumatra. Eighty percent of the poultry in Indonesia is produced by three large commercial companies, which are vertically integrated poultry production systems of substantial capacity. Seventy percent of total poultry production in Indonesia is carried out in Java.[16] Our modelling of livestock supply is therefore unrealistic but, since output only depends on output price and animal feed prices, still accurate with regard to output response to price changes.

Three agricultural inputs are modelled explicitly:

Urea and **Phosphorous and Potassium**: The dominant fertilizers produced and used in Indonesia. The dominant fertilizers produced and used are urea, TSP (triple superphosphate), AS (ammonium sulphate) and KCl (Potassium chloride) (FAO (2005)).[17] There are six fertilizer producing companies, five of which are government owned while the sixth is a joint venture that produces for export. The supply, distribution and price of fertilizer is regulated by the government which gives priority to domestic fertilizer requirements.[18] Urea is produced from indigenous raw materials and domestic production typically exceeds consumption. Exports fluctuated between 1 and 2.3 million tons between 1998 - 2003. For a brief period between December 1st 1998 and 2001 fertilizer prices were left to the market but subsequently decrees were issued to regulate prices. Fertilizer price subsidies were phased out in 1998 because they placed a heavy burden on government finances and lead to inefficiency in fertilizer application at the farm level. The government re-introduced subsidies for 2003-05 for urea, SP-36, AS and NPK fertilizers but only for use on food crops and smallholder plantations. However control of fertilizer use proved difficult and applications to cash crops are more profitable. A further serious issue with regard to fertilizer consumption are the distributional problems.

Land: Land is included as a variable but is not incorporated into the model as a traded commodity.

3.2 Households

Production and consumption patterns are distinguished among nine broad types of household groups: urban-rich, urban-middle, urban-bottom, Java-top, Java-middle, Java-bottom, off Java-top, off-Java-middle, off-Java-bottom . Where top, middle and bottom refer to the top 20%, the middle 50% and the bottom 30% of households on the basis of per-capita income. Only Java and off-Java households are involved in production activities.

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[15] Cassava, maize, soybean, as well as groundnut and sweet potato are the most important secondary crops after rice. In particular cassava, maize and sweet potatoes are consumed by rural people mostly as seasonal substitutes to rice (Gunawan, 1997).

[16] FAO, EMPRESS, *Transboundary Animal Diseases Bulletin*, n. 25, January-June 2004.

[17] More recently TSP has been replaced by SP-36 (superphosphate).

[18] However, illegal exports are known to have occurred when export prices were particularly attractive.

3.3 Structure of the model

The multi-market model is an adaptation of Stifel and Randrianarisoa (2004) and consists of six blocks of equations: prices, supply input demand, consumption, income and equilibrium conditions. Unlike Stifel and Randrianarisoa (2004) we do not include seasonality and an aggregate for all other food products as well as non-food commodities in the model. Below we detail the different sets of equations, present the data used and explain which are their sources.

Prices: Consumer prices (PC) are higher than producer prices (PP) due to the domestic marketing margin (MARG) which can proxy, for example transportation costs due to infrastructure improvements:

$$PC_{c,h,r} = PP_{c,h,r} \bullet (1 + MARG_{c,r}) \qquad (1)$$

where the subscripts c, h, and r refer to commodity, household type and region, respectively.

The border price (PM) of the importable products (*im*) rice, soybean and wheat are linked to the world price by the exchange rate (*er*), import tariffs (*tm*), and the international marketing margin (RMARG).

$$PM_{im} = \overline{PW}_{im} \bullet er \bullet (1 + RMARG_{im}) \bullet (1 + tm_{im}) \qquad (2)$$

Although no exportable items are included the relevant price equations are already defined. Specifically, the border price (PX) of the exportable products (*ix*) are linked to the world price by the exchange rate (*er*), import tariffs (*tm*), and the international marketing margin (RMARG).

$$PX_{ix} = \frac{\overline{PW_{ix}} \bullet er}{(1 + RMARG_{ix}) \bullet (1 + te_{ix})} \qquad (3)$$

Consumer prices for the importable items are related to the border price by the commodity specific border-to-market marketing margin:

$$PC_{im,'urban'} = PM_{im} \bullet (1 + IMARG_{im}) \qquad (4)$$

where IMARG is the border-to-market marketing margin, specific to commodities.

Consumer prices for the exportable items are related to the border price by the commodity specific market-to-border marketing margin:

$$PC_{im,'urban'} = \frac{PX_{ix} \bullet (1 + MARG_{ix})}{(1 + IMARG_{ix}} \qquad (5)$$

where IMARG is the market-to-border marketing margin, specific to commodities.

Rural consumer prices differ from urban consumer prices by an internal marketing margin (INTMARG) that reflects transportation and marketing costs.

$$PC_{c,'urban'} = PC_{c,'rural'} \bullet (1 + INTMARG_c) \qquad (6)$$

The internal marketing margin is positive for products which are primarily exported from rural to urban areas. Products that are assumed not to move from rural to urban or vice-versa have a zero INTMARG).

This particular set-up allows one to distinguish between farm-rural market (MARG), rural market to urban market (INTMARG) and urban-border (IMARG).

We assume that households in the different income groups face the same prices in rural and urban locations. We include a price index for each household group to reflect changes in prices weighted by their shares of consumption:

$$PINDEX_h = \sum_i \left(w_{h,r,i} \bullet \left(\frac{PC^1_{h,r,i}}{PC^0_{h,r,i}} \right) \right) \qquad (7)$$

where w is the budget share for each commodity. The superscript on the PC terms refers to periods 0 and 1 (not the seasons) and denote starting prices and end of simulation prices. Since we do not include all consumption items on which households spend money the weights in the PINDEX must be multiplied by the actual weight of the consumption commodities included in the model.[19]

Supply: Rural household's supply of rice, maize, soybean, cassava and bananas are determined by a) the total amount of land available to each household; b) the share of that land allocated to the specific crops and, c) the associated yield for the crops. The share of land (SH) allocated to a particular crop by household group h is a function of all crop prices:

$$\log(SH_{h,f}) = \alpha^s + \sum_f \beta^s \bullet \log(PP_{h,f}) \qquad (8)$$

where *f* refers to farmed commodities. The sum of the shares may or may not be restricted to sum to 1. If not restricted to 1 the assumption is that land is endogenously determined even though land is not explicitly traded. If shares add up to more than one following a simulation then extensification is practiced. The realism of this assumption will depend on the particular setting. The land substitution and expansion elasticities will reflect how easy it is to switch between crops and/or to bring new land into production.

Yields (YLD) for crops *f* by household groups *h* are a function of output and input prices as well as land. The log-log equations are based on an underlying translog profit function.

$$\log(YLD_{h,f}) = \alpha^y + \sum_f \beta^y \bullet \log(PP_{h,f}) + \sum_{in} \gamma^y \bullet \log(PC_{h,in}) \qquad (9)$$

where the coefficients represent the price elasticities.

The total household supply to the market is then determined as the product of the initial area under cultivation, the share of land devoted to the crop, and the yield. Adjustments are made for losses and use of the output for seed (*loss*), and for any related conversion factors (*conv*).

$$HSCR_{h,f} = AREA \bullet SH_{h,f} \bullet YLD_{h,f} \left(1 - loss_f\right) \bullet \left(1 - conv_f\right) \qquad (10)$$

The total supply of each of the commodities is the sum of household supply:

[19] The share of the consumption bundle included in this model in total expenditure is estimated as 40 %.

$$SCR_f = \sum_h HSCR_{h,f} \qquad (11)$$

Household livestock supply is modelled as a function of livestock prices and input prices of animal feed products, i.e. berseem and maize.

$$HSLVSTK_h = \alpha_h^{lvstk} + \beta^{lvstk} \bullet \log\left(PP_{h,lvstk}\right) + \gamma^{lvstk} \bullet \log\left(PC_{h,af}\right) \qquad (12)$$

where the subscript *af* refers to animal feed products. Total livestock supply is given by:

$$SL = \sum_h HSLVSTK_h \qquad (13)$$

Input Demand: Household *h*'s demand for input – maize for animal feed, urea and P&K - (HDIN) is a function of output prices (PP) and input prices (PC).

$$\log\left(HDIN_{h,in}\right) = \alpha^{in} + \sum_f \beta^{in} \bullet \log\left(PP_{h,f}\right) + \sum_{in} \gamma^{in} \bullet \log\left(PC_{h,in}\right) \qquad (14)$$

where the subscript *in* refers to urea, P&K and maize for animal feed. Total demand for the inputs is given by:

$$DIN_{in} = \sum_h HDIN_h \qquad (15)$$

Consumption Block: Demand for the consumption items (HC) by the household groups in urban and rural locations is modelled as:

$$\log\left(HC_{h,i}\right) = \alpha_{h,i}^d + \sum_f \beta_{h,i}^d \bullet \log\left(PC_{h,i}\right) + \gamma_{h,i}^d \log\left(YH_h\right) \qquad (16)$$

where the *i* refer to commodities households purchase, i.e. rice, maize, wheat, soybean, cassava and bananas. YH is household income (defined below), PC are consumer prices, P is the stone geometric price index defined as:

$$\log\left(P_{h,r,i}\right) = \sum_i w \bullet \log\left(PC_{h,i}\right) \qquad (17)$$

Total demand is:

$$TCON_i = \sum_h HC_{h,i} \qquad (18)$$

Income Block: Agricultural income (YHAG) for rural households is the sum of crop revenue minus input costs:

$$YHAG_h = \sum_f \left(PP_{h,f} \bullet SCR_{h,f}\right) + PP_{h,lvstk} \bullet \quad HSLVSTK_h - \left(PC_{h,in} \bullet DIN_{h,in}\right) \qquad (19)$$

And total household income (YH) is the sum of agricultural income and the exogenously determined non-agricultural income. The latter component is adjusted by a price index:

$$YH_h = YHAG_h + \overline{YHNAG}_h \bullet PINDEX_h \qquad (20)$$

and the price index is as defined in equation (7).

Equilibrium Conditions: All commodity markets clear, i.e. the sum of quantity supplied (domestic production plus net imports) is equal to the amount demanded for human and animal consumption.

$$SCR_f + M_f + STOCK\Delta_f = CONS_f + \overline{FEED}_f \qquad (21)$$

$$LVSTK + M_{livstk} = DIN_{livstk} \qquad (22)$$

$$SDIN_{in} + M_{in} = DIN_{in} \qquad (23)$$

where M equals imports and CONS and FEED denote human and animal consumption respectively. For products not traded imports are fixed at zero. Feed for maize is endogenous but other feed products are treated as exogenous.

Rice, wheat and soybean are treated as importable commodities. Net imports of maize and cassava are also non-negligible but only amount to about 13 and 4% of production respectively while imports of bananas and livestock are negligible. Hence prices for maize, cassava, bananas and livestock are assumed to be determined by domestic supply and demand and imports are allowed to fluctuate within a set range around the baseline level.

3.4. Data requirements

Three types of data are needed to calibrate the model to a baseline solution. These are:

Levels: production, consumption, income, and input levels must be defined for all commodities and household groups. Aggregate levels are typically taken from *Statistik Indonesia* (for land and production) or FAOSTAT (for consumption) for 2003. Household level data are either from SUSENAS for consumption data or the 1999 PATANAS survey for production data.

Prices: consumer, producer, user, and border prices must be defined for all commodities. They also define the marketing margins. Producer and consumer prices are taken from *Indonesia Statistik* (CBS), except for bananas, wheat, poultry and cassava for which they are derived from the PATANAS data set.

Parameters: these are the demand and supply elasticities, all of which are best guesses.[20] We give a short overview of the elasticities used: Land-share elasticities – equation 8: own price elasticities are 0.3 while cross-price elasticities with respect to all crops and cassava and banana and are -0.05 while all the rest are -0.1. Crop yield elasticities – equation 9: The own-price elasticities are 0.3 for rice, maize and cassava and 0.2 for soybean and bananas. The crop yield elasticities with respect to input prices are

[20] These best guesses are based on the experience and knowledge of the two first named authors, i.e. Bambang Sayaka and Sumaryanto. We also acknowledge the considerable effort made by Wayan I. Rusastra to document available estimates of supply and demand side parameters. More detail is available from André Croppenstedt at andre.croppenstedt@fao.org.

-0.11 for all commodities and all inputs except for bananas for which the elasticity is assumed to be -0.04. Livestock output supply elasticity – equation 12: The own-price elasticity is 0.6 and the elasticity of livestock supply with regard to the price of animal feed (maize) is -0.5. Input demand elasticities – equation 14: The own-price elasticity for fertilizer (both types) is -0.1 and for animal feed it is -0.2. The price elasticity of fertilizer (nitrogen and P&K) with regard to the price of the crops to which they are applied is 0.05. The elasticity of animal feed with respect to the price of livestock is 0.5. Consumer demand elasticities – equation 16: The own price demand elasticity is -0.3 for rice, maize and soybean. For cassava, banana and wheat it is -0.15, -0.1 and -0.12, respectively. For livestock it is -0.5. The cross-price elasticities are positive and between 0.05 and 0.2 for rice and maize, rice and wheat, maize and soybean, maize and wheat. They are negative and between -0.01 and -0.12 for all other combinations of commodities. The cross-price elasticities for banana with all crops except for cassava are zero and for the latter -0.01. The elasticities of demand with respect to income are 0.2 for rice, soybean and banana; -0.1 for maize and cassava; 0.1 for wheat and 0.3 for livestock.

3.5. Baseline Scenario[21]

The baseline solution corresponds to aggregate data for 2003. Rice (milled) output is 31.8 million tons while for maize, soybean, cassava, banana and livestock (poultry) output are 10.1, 0.5, 12,7, 3.9 and 1.2 million metric tons, respectively. 54% of rice production and 62% of maize production originates in Java. Banana and livestock production are 70% and 71% from off-Java. With regard to consumption we note that for rice this is fairly evenly distributed among Urban, Java and off-Java areas. Maize is predominantly consumed in rural areas and 3.3 million tons of maize are used for animal feed. Soybean consumption is concentrated in Urban and Java areas while about half of cassava output and 46% of the wholly-imported wheat is consumed in off-Java. Imports of rice, maize, soybean, cassava and wheat are 0.8, 1.3, 1.2, 0.8 and 3.9 million tons and the self-sufficiency ratios for rice, maize, soybean, cassava and banana are 0.98, 0.88, 0.31, 0.94 and 1, respectively. Crop diversification – a diversification index closer to 1 indicates greater specialization (see note iii at the bottom of table 3 for more detail) - in the baseline is relatively less in Java and in particular so for the middle and bottom income groups. Caloric intake is lower for top urban than for middle and bottom urban groups and is lower in urban than in rural areas. This is in line with findings for urban households reported in Skoufias (2001) also using SUSENAS. For rural households this may reflect our focus on a sub-set of commodities.

4. POLICY SIMULATION RESULTS

4.1 A drop in the rice tariff from 30 to 0%

A zero rice tariff leads to a sharp fall in producer and consumer rice prices (with the average fall in the CPI[22] – for the commodities included - being 6%) and results in a 2% drop in rice production. Maize and cassava output rise modestly by just over 1% while soybean production rises by 6%. Rice consumption increases by 1.8% while wheat consumption falls by 2.8%. There is also a drop in soybean consumption of 0.8%. These supply and demand

[21] The baseline data set is calibrated using interlinked excel sheets that may be useful to others [even if considerable adaptation will inevitably be required] in simplifying this kind of exercise. The excel file for the Indonesia multi-market baseline is available from André Croppenstedt at andre.croppenstedt@fao.org.

[22] We recall that the CPI weights are adjusted for the fact that the commodities account for only a subset of the entire consumption basket.

changes are also reflected in changes in imports with rice imports increasing to just under 2 million tons, up from 0.8 million tons. Maize, soybean and wheat imports fall by 9, 4, and 3%, respectively.

Self-sufficiency ratios are not much affected; although rice self-sufficiency falls from 98 to 94%. Crop diversification increases relatively strongly in all regions for all households but the effect is stronger in Java and stronger for the middle and bottom groups. The results show that farmers, in response to producer price changes switch land from rice (-5.8%) and maize (-1.7%) to soybean (4.9%) and cassava (3.8%) production (we note that final supply figures depend also on the endogenously modelled yield changes).

The income effects are modest for urban households as well as for the top income group in rural areas. Rural farm households of the middle and bottom group see a loss in income of between 1.4 and 2.9%, the drop being more pronounced in Java than in off-Java. Calorie intake increases in all cases although the rise is small. The improved calorie intake results from the greater demand for rice, maize, cassava and livestock. We note that the change in the value of the original consumption bundle when evaluated at new versus old prices indicates that all households could afford the original bundle at the new prices and by this measure are significantly better off.

4.1.1 Sensitivity Analysis

The results are found to be only moderately sensitive to a doubling/halving of demand side elasticities. Doubling the bounds on imports for maize, cassava, banana and livestock also has only a marginal effect on the results. The results are sensitive to a doubling/halving of supply side parameters, in particular crop elasticities and input demand elasticities with respect to output price as well as input prices.

4.2 A drop in the rice tariff from 30 to 15%

The results are similar to the previous simulation in that the directions of change are the same. We note that the move to a 15% tariff is of interest as this figure is the upper end of the range (0-14%) for the optimal tariff considered reasonable by Warr (Warr, 2005). The size of the changes are dampened with the effect of a reduction of the tariff apparently being non-linear in this sense. For example the change in rice output is -2 and -1.2% for the 30% to 0% and the 30% to 15% scenarios respectively. For soybean output the respective change is 6 and 2.6%. On the consumption side rice increases by 1.8% due to the 30% drop in tariff and by 1% due to the 15% drop in tariff. The fall in consumption for wheat is -2.8 and -1.3% respectively.

Self-sufficiency ratios and crop diversification are only marginally affected. Household income changes are nearly neutral for urban and Java-top and modest for the other groups with the largest impact being a -1.5% drop for Java-bottom. The change in the value of the original bundle when measured in old versus new prices is as in the previous scenario but only half as large.

4.3 A rise in the rice tariff from 30 to 50%

The simulation of a significant rise in tariffs results in a rise in rice output (1.4%) and a fall in the output of maize (-1%), soybean (-2.9%) and cassava (-0.9%) with banana output nearly unchanged. Rice consumption falls (-1.1%) while the demand for wheat increases by 1.6%. Demand for maize, soybean and bananas rises modestly while that for cassava drops slightly. These changes imply that imports for rice fall to zero (a very small amount of exports is projected) while maize imports increase by 10%.

Rice self sufficiency rises to 100% while the ratio for the other crops are not much affected. Crop diversification declines in all areas for all households. The increase of 15% in rice prices and of 7% in maize prices means that urban households (as well as Java top) see a slight fall in income while otherwise rural households see incomes rise – more so in Java than in off-Java. The overall CPI change is estimated as about 4%. The rise in prices means that in terms of their ability to purchase the original consumption bundle at the new prices all households are considerably worse off.

5. CONCLUSIONS

In this study we use a multi-market model to assess the impact of hypothetical rice tariff changes on cropping patterns, producer and consumer prices, household income, caloric intake and other variables related to rice policy. Such a model can generate substantial detail with regard to supply and demand changes in the rice market as well as those for other, closely related commodities. It is not able to capture wider impacts, say of wage and labor changes, as would be the case with a CGE model. Information on welfare changes based on household income and expenditure should therefore be treated as data specific to the model and valid for comparisons across scenarios but not valid for comparisons outside the model.

The results for a reduction in the rice tariff from 30 to 0% lead to a significant reduction in rice prices which impact on rice supply (-2.1%) and demand (+1.8%) but also on other commodities, in particular soybean supply (+6%) and wheat demand (-2.8%). Rice imports increase strongly from 0.8 to 2 million tons. Rural households except for the Java-top income group, see incomes fall and the fall is more pronounced for middle and bottom income groups in Java. However in terms of purchasing power (as measured by a household's ability to purchase the original basket at old versus new prices) all households gain very significantly. The effect of a 30 to 15% reduction in the rice tariff is similar but more moderate. The effects for supply and demand changes are not quite proportional (to the 30-0% change in tariff rates).

An increase in the tariff from 30 to 50% eliminates rice imports completely, reduces soybean output (-2.9%) and stimulates wheat demand (1.6%). Rural households, except for Java-top income group, see incomes rise but the effect is relatively modest (0.27 to 1.71%) but stronger for middle and bottom income groups in Java. In terms of purchasing power households are all significantly worse off and caloric intake falls, if modestly.

The results indicate that a reduction in rice tariffs increases crop diversification. The effect is very small for the 30-15% reduction but relatively strong for the 30-0% reduction. The effects are stronger for Java and in particular for Java-middle and Java-bottom income groups, i.e. those areas and income groups which started off least diversified as per the baseline model. This result is of interest because it underlines that rice sector protection has a distortionary effect on agricultural transformation which with the gradual change in food demand patterns is likely to become a more pressing issue in the future (San et al , 1998).

It is clear that the higher retail rice price resulting from a 30% ad-valorem tariff rate imposes significant cost on the 90% of Indonesian households, including most of the very poor households, who are net rice buyers. The implied income gains from tariff reduction appear relatively modest but do accrue to middle and poorer households especially in Java.

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Table 3: Baseline solution and results for the 3 policy reform scenarios

Variable	Baseline Import Tariff = 30%	Import Tariff = 0%	Import Tariff = 15%	Import Tariff = 50%
Domestic Production (tons)				
Rice				
Java	17,164,849	16,822,225	16,955,315	17,402,188
Off-Java	14,604,366	14,312,852	14,426,088	14,806,301
Total	31,769,216	31,135,077	31,381,404	32,208,489
Maize				
Java	6,303,024	6,376,597	6,361,051	6,237,860
Off-Java	3,816,679	3,861,229	3,851,816	3,777,220
Total	10,119,702	10,237,826	10,212,867	10,015,080
Soybean				
Java	386,391	409,688	395,974	375,272
Off-Java	145,209	153,965	148,811	141,031
Total	531,600	563,652	544,784	516,303
Cassava				
Java	6,713,139	6,793,133	6,765,525	6,652,844
Off-Java	6,026,671	6,098,484	6,073,700	5,972,541
Total	12,739,810	12,891,617	12,839,225	12,625,384
Banana				
Java	1,163,735	1,162,117	1,162,699	1,165,264
Off-Java	2,716,985	2,713,207	2,714,566	2,720,553
Total	3,880,720	3,875,324	3,877,265	3,885,817
Livestock				
Java	352,354	361,335	355,151	349,094
Off-Java	850,926	872,614	857,680	843,053
Total	1,203,281	1,233,949	1,212,831	1,192,147

Consumption (tons)				
Rice				
Urban	11,629,867	11,852,348	11,754,217	11,493,474
Java	9,587,526	9,754,694	9,682,970	9,483,779
Off-Java	9,803,837	9,985,752	9,906,457	9,691,716
Total	31,021,230	31,592,794	31,343,644	30,668,969
Maize				
Urban	839,105	842,612	837,481	840,370
Java	4,201,447	4,223,053	4,195,156	4,205,468
Off-Java	3,115,688	3,129,552	3,110,003	3,119,929
Total	8,156,240	8,195,217	8,142,639	8,165,766
Soybean				
Urban	807,443	801,485	805,452	810,191
Java	715,149	708,715	712,876	718,229
Off-Java	199,988	198,397	199,448	200,729
Total	1,722,580	1,708,597	1,717,776	1,729,149
Cassava				
Urban	3,733,294	3,753,671	3,739,663	3,724,939
Java	2,967,900	2,987,255	2,974,391	2,959,473
Off-Java	6,487,416	6,524,691	6,499,171	6,471,972
Total	13,188,610	13,265,617	13,213,225	13,156,384
Banana				
Urban	1,635,409	1,634,021	1,634,312	1,637,085
Java	497,021	495,583	496,232	498,104
Off-Java	1,748,514	1,745,920	1,746,921	1,750,867
Total	3,880,944	3,875,524	3,877,465	3,886,057
Wheat				
Urban	1,096,497	1,066,031	1,081,915	1,113,892
Java	969,043	941,232	955,768	984,916
Off-Java	1,734,350	1,685,584	1,711,059	1,762,172
Total	3,799,890	3,692,847	3,748,741	3,860,979
Livestock				
Urban	423,827	434,964	427,254	419,782
Java	302,202	309,354	304,310	299,735
Off-Java	474,171	486,231	477,868	469,830
Total	1,200,200	1,230,549	1,209,431	1,189,347

Input Demand (tons)				
Maize - Animal Feed				
Java	1,030,376	1,017,140	1,025,764	1,036,407
Off-Java	2,269,624	2,240,469	2,259,464	2,282,907
Total	3,300,000	3,257,610	3,285,228	3,319,314
Urea				
Java	2,640,810	2,640,810	2,640,810	2,640,810
Off-Java	1,374,190	1,374,190	1,374,190	1,374,190
Total	4,015,000	4,015,000	4,015,000	4,015,000
P&K				
Java	659,140	659,140	659,140	659,140
Off-Java	359,860	359,860	359,860	359,860
Total	1,019,000	1,019,000	1,019,000	1,019,000

Net Imports (tons)				
Rice	781,814	1,987,517	1,492,040	-9,721
Maize	1,336,538	1,215,000	1,215,000	1,470,000
Soybean	1,190,980	1,144,945	1,172,992	1,212,846
Cassava	818,800	744,000	744,000	901,000
Banana	224	200	200	240
Wheat	3,896,350	3,789,307	3,845,201	3,957,439
Livestock	-3,081	-3,400	-3,400	-2,800
Maize - Animal Feed	0	0	0	0
Fertilizer - Urea	0	0	0	0
Fertilizer - P&K	0	0	0	0

Urban Consumer Prices (Rupiah/ton)				
Rice	3,174,480	2,441,908	2,808,194	3,662,862
Maize	2,295,150	1,962,711	2,180,783	2,443,628
Soybean	5,308,270	5,308,270	5,308,270	5,308,270
Cassava	1,028,764	1,070,197	1,055,768	998,285
Banana	2,983,948	2,664,034	2,841,269	3,167,354
Wheat	3,248,982	3,248,982	3,248,982	3,248,982
Livestock	13,661,010	12,504,637	13,264,979	14,172,327

Rural Cosumer Prices Java (Rupiah/ton)				
Rice	2,769,569	2,130,438	2,450,003	3,195,657
Maize	2,002,399	1,712,363	1,902,620	2,131,939
Soybean	4,631,190	4,631,190	4,631,190	4,631,190
Cassava	897,543	933,692	921,103	870,952
Banana	2,603,340	2,324,231	2,478,859	2,763,352
Wheat	3,035,297	3,035,297	3,035,297	3,035,297
Livestock	13,153,293	12,039,897	12,771,981	13,645,607

Rural Consumer Prices Off-Java (Rupiah/ton)				
Rice	2,940,422	2,261,863	2,601,143	3,392,795
Maize	2,125,926	1,817,998	2,019,992	2,263,457
Soybean	4,915,065	4,915,065	4,915,065	4,915,065
Cassava	952,912	991,291	977,926	924,681
Banana	2,763,939	2,467,612	**2,631,779**	2,933,822
Wheat	3,188,402	3,188,402	3,188,402	3,188,402
Livestock	13,260,542	12,138,067	12,876,120	13,756,870

Rural Producer Prices Java (Rupiah/ton)				
Rice	1,408,876	1,083,751	1,246,314	1,625,627
Maize	1,319,799	1,128,634	1,254,034	1,405,180
Soybean	3,049,042	3,049,042	3,049,042	3,049,042
Cassava	551,486	573,697	565,962	535,147
Banana	2,429,168	2,168,733	2,313,016	2,578,475
Wheat	..	..	..	..
Livestock	12,579,660	11,514,821	12,214,978	13,050,504
Maize - Animal Feed	1,319,799	1,128,634	1,254,034	1,405,180
Fertilizer - Urea	649,351	497,628	580,922	741,512
Fertilizer - P&K	931,818	714,096	833,623	1,064,069

Rural Producer Prices Off-Java (Rupiah/ton)				
Rice	1,495,789	1,150,607	1,323,198	1,725,911
Maize	1,401,217	1,198,259	1,331,395	1,491,865
Soybean	3,235,937	3,235,937	3,235,937	3,235,937
Cassava	585,507	609,088	600,876	568,160
Banana	2,579,023	2,302,521	2,455,705	2,737,540
Wheat	..	..	..	..
Livestock	12,682,232	11,608,710	12,314,576	13,156,915
Maize - Animal Feed	1,401,217	1,198,259	1,331,395	1,491,865
Fertilizer - Urea	837,872	642,100	749,577	956,789
Fertilizer - P&K	1,242,839	952,445	1,111,868	1,419,232
CPI				
Urban Top	100	93.8	96.9	104.4
Urban Middle	100	94.6	97.3	103.9
Urban Bottom	100	93.3	96.7	104.7
Java Top	100	93.8	97.0	104.3
Java Middle	100	94.3	97.2	104.0
Java Bottom	100	94.0	97.2	104.0
Off-Java	100	93.6	96.9	104.5
Off-Java Middle	100	95.3	97.8	103.3
Off-Java Bottom	100	94.1	97.2	104.0
Self-Sufficiency Ratio (%)[i]				
Rice	98	94	95	100
Maize	88	89	89	87
Soybean	31	33	32	30
Cassava	94	95	95	93
Banana	100	100	100	100
Crop Diversification Index[iii]				
Java Top	0.42	0.39	0.40	0.44
Java Middle	0.48	0.43	0.45	0.51
Java Bottom	0.54	0.48	0.51	0.58
Off-Java Top	0.42	0.39	0.41	0.44
Off-Java Middle	0.37	0.34	0.35	0.39
Off-Java Bottom	0.46	0.42	0.44	0.49
Change in Household Income (%)				
Urban Top	0.0	-0.4	-0.1	-0.1
Urban Middle	0.0	-0.5	-0.1	-0.2
Urban Bottom	0.0	-0.4	-0.1	-0.1
Java Top	0.0	0.1	0.2	-0.4
Java Middle	0.0	-2.6	-1.1	1.1
Java Bottom	0.0	-2.9	-1.5	1.7
Off-Java Top	0.0	-1.0	-0.4	0.3
Off-Java Middle	0.0	-1.9	-0.8	0.8
Off-Java Bottom	0.0	-1.4	-0.8	0.7

Caloric Intake (Kcal/capita)				
Urban Top	1,308	1,326	1,318	1,297
Urban Middle	1,564	1,585	1,575	1,552
Urban Bottom	1,367	1,386	1,377	1,356
Java Top	1,746	1,770	1,758	1,733
Java Middle	2,078	2,099	2,088	2,066
Java Bottom	2,453	2,476	2,462	2,442
Off-Java Top	1,900	1,925	1,913	1,885
Off-Java Middle	2,688	2,716	2,701	2,673
Off-Java Bottom	2,557	2,583	2,568	2,544
Change in value of original consumption bundle when valued at new versus old prices (%)[ii]				
Urban Top	0.0	-16.4	-8.0	10.6
Urban Middle	0.0	-14.7	-7.0	9.4
Urban Bottom	0.0	-17.7	-8.6	11.4
Java Top	0.0	-16.3	-7.8	10.4
Java Middle	0.0	-15.3	-7.2	9.6
Java Bottom	0.0	-15.9	-7.2	9.6
Off-Java Top	0.0	-16.8	-8.1	10.8
Off-Java Middle	0.0	-12.8	-5.9	7.9
Off-Java Bottom	0.0	-15.8	-7.2	9.7
Land Shares (%)				
Rice				
Java	0.3251	0.3065	0.3154	0.3367
Off-Java	0.3548	0.3343	0.3441	0.3676
Total	0.6799	0.6408	0.6595	0.7043
Maize				
Java	0.1113	0.1094	0.1110	0.1115
Off-Java	0.0875	0.0860	0.0873	0.0878
Total	0.1988	0.1954	0.1983	0.1993
Soybean				
Java	0.0221	0.0231	0.0225	0.0216
Off-Java	0.0091	0.0095	0.0092	0.0089
Total	0.0312	0.0326	0.0317	0.0305
Cassava				
Java	0.0237	0.0246	0.0241	0.0232
Off-Java	0.0499	0.0519	0.0509	0.0488
Total	0.0736	0.0765	0.0750	0.0720
Banana				
Java	0.0079	0.0079	0.0079	0.0081
Off-Java	0.0084	0.0084	0.0084	0.0085
Total	0.0163	0.0163	0.0163	0.0166

[i] Refers to domestic production out of total availability, i.e. domestic production plus net imports.

[ii] Calculated as: (value of original bundle at new prices minus value of original bundle at original prices)/value of original bundle at original prices. The bundle includes the food commodities covered in the model, i.e. rice, maize, soybean, what, livestock, cassava and bananas.

[iii] Various methods are available to calculate the diversification index. Here we used the Herphindal Index, defined as: $H = \sum_{i=1}^{n} p_i^2$ where p_i is the proportion of area under crop i. So $p_i = \frac{A_i \rightarrow \textbf{ area under crop } i}{\sum_{i=1}^{n} A \rightarrow \textbf{ total area}}$

The H index takes value from 0 to one, we have one in case of perfect specialization and zero in case of perfect diversification.

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