

Trade and Protection: the Case of GM Rice Adoption and Acceptance

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Introduction

Rice is the major source of calories consumed by the human population. According to Khush (2001), rice provides 23 percent of the total calorie intake on average, with higher contributions in Asia (between 30 and 76 percent of the calories consumed by humans). Ninety two percent of the world's rice is produced in Asia, with China, India, Indonesia, and Bangladesh being the largest rice producers and consumers of rice. Similarly, most rice is consumed in Asia. Table 1 shows the major rice producers, consumers, and traders over the last four marketing years.

Table 1. Major rice producers, consumers, and traders, 2001-2004 marketing years.

Major rice producers and consumers

Producers	Average Share 2001/02-2004/05	Consumers	Average Share 2001/02-2004/05
China	30.9%	China	32.8%
India	21.6%	India	20.5%
Indonesia	8.7%	Indonesia	8.8%
Bangladesh	6.5%	Bangladesh	6.4%
Vietnam	5.5%	Vietnam	4.4%
Thailand	4.4%	Burma	2.5%

Major rice traders

Exporters	Average Market Share 2001/02-2004/05	Importers	Average Market Share 2001/02-2004/05
Thailand	31.1%	Indonesia	7.1%
India	16.5%	Nigeria	5.8%
Vietnam	14.4%	Philippines	4.9%
United States	12.7%	Saudi Arabia	4.4%
Pakistan	7.1%	EU-25	4.0%
China	5.5%	Iran	3.5%

Source: USDA, FAS, 2005.

Recent advances in science, particularly in the application of biotechnology, are suggested to have the potential to contribute to the improvement in food security and poverty alleviation if their application focuses on addressing the problem of unfavorable agro-systems (Hossain, 2001). GM crops have been developed and commercially used since the mid 1990s in crops such as soybeans, cotton, corn, and canola. As of 2004, seventeen countries cultivate over 87 million hectares of GM crops, with the US being the leading adopter worldwide (James, 2004).

Numerous studies assessing the actual and potential impacts of GM crops have been conducted to date, mainly focusing on the impact of GM crops on production, consumption, trade, allocation of resources, and stakeholders' welfare. Nielsen, Robinson, and Thierfelder (2002) present an interesting survey of empirical studies on GM crops, with a wide variety of technological assumptions, commodities, and regions. Most GM crops being commercially produced generate improvements in production, mainly productivity improvements that lower production costs (first generation GMOs). Thus, most economic studies of GM crops to date have addressed solely the impact on the production side. With regard to method of analysis, most economic studies of GM crops have also utilized general equilibrium models. Partial equilibrium closures limit the ability to assess cross-sectoral effects that productivity gains due to GM adoption would likely generate.

Despite the fact that no GM rice has been released for commercial use yet¹, *ex ante* analyses have been conducted, mainly related to insect, disease, and herbicide resistance, soil salinity and drought tolerance, and nutritional patterns (Anderson, Jackson, and Nielsen, 2004; Huang et al., 2002; Hareau et al., 2004, Annou et al., 2005). Anderson, Jackson and Nielsen (2004) provide an analysis on golden rice adoption and its effect on producers as well as consumers, thus becoming one of the first studies on GM crops to analyze enhanced consumption characteristics. Huang et al. have studied the farm level effects of GM rice in China using the well-received general equilibrium model GTAP. The GTAP database version 5, which represents the situation of the global economy in 1997, was updated to the 2010 baseline period using outside macroeconomic and policy information. It was assumed that the productivity impact of GM rice was factor-biased. Thus, different impacts were assumed for pesticide, seed, and labor use. An import ban on GM rice by the main trading partners was also simulated. Hareau et al. (2004) also analyze the introduction of two specific GM developments, namely drought resistant rice and Bt rice, on rice production and prices. The GTAP model and GTAP database version

¹ According to Huang et al (2002), although several transgenic rice plants in China have already been approved for environmental release, the commercialization of GM rice has not yet been approved due to policy makers' concerns on rice trade and its implications for the commercialization of other GM food crops.

5 were used for this analysis. They disaggregated the GTAP database to account for favorable and less favorable rice environments. Drought resistant rice was assumed to be adopted in less favorable environments where water supply is limited, whereas Bt rice was considered a technology mainly adopted in favorable environments where losses due to insect attacks are more relevant. They assumed GM rice was adopted fully, assuming a positive output shock calculated from estimates of production losses from drought and insect damages in each region. Anderson and Yao (2001) also used the GTAP model and the GTAP database version 4 to simulate the potential impact of China's GM crop adoption, including rice. The database was modified to account for GM and non-GM crops. GM technology was represented by Hicks-neutral technology shifts and an increase in rice yield by 5 percent. Several import bans were also simulated to account for domestic regulations regarding GM crops.

The objective of this study is to assess the potential impact of GM rice adoption in China and Bangladesh on production and consumption patterns among key rice producing and trading regions, as well as the impact of trade policy changes as a result of GM rice production by these two Asian countries. This study differs from previous research on the potential impact of GM rice on the level of regional aggregation, the rates of adoption of GM rice considered, and the structure of intermediate and final demand for rice, which were modified to account for specific substitution between GM and non-GM rice.

Methodology

The analysis is conducted using the GTAP modeling framework. This is a multi-region, multi-sector computable general equilibrium model, with perfect competition and constant returns to scale. The model is fully described in Hertel (1997). The GTAP 6.0 beta version database is used for this analysis (Dimaranan and McDougall, 2005). It contains detailed bilateral trade, transportation and protection data among regions, linked together with country specific input-output tables. This version of the GTAP database corresponds to the global economy in 2001, and divides the world into 87 regions, 57 sectors, and five primary factors of production (land, unskilled labor, skilled labor, capital, and natural resources). For this application, land and natural resources are considered sluggish whereas labor and capital are considered mobile factors of

production. The database is aggregated into 27 regions and 9 production sectors (table 2). The regional aggregation allows us to analyze the impact of GM rice adoption in China and Bangladesh on key domestic rice markets worldwide.

Table 2. Disaggregation of regions and production sectors for this study.

Regions	
U.S.	Taiwan
Mexico	Rest of East Asia
Argentina	Indonesia
Brazil	Malaysia
Uruguay	Philippines
Rest of Western Hemisphere	Vietnam
European Union 15	Bangladesh
Oceania	India
China	Rest of Europe
Rest of South Asia	Middle East
Thailand	North Africa
Japan	Rest of Sub-Saharan Africa
South Korea	Rest of South Africa
	South Africa
Production Sectors	
GM paddy rice	Wheat
Non-GM paddy rice	Other food items
GM milled rice	Manufactures
Non-GM milled rice	Services
	Capital goods

Following the approach taken in previous studies employing GTAP for GM crop analysis², the first step in this study was to modify the GTAP database to create two new commodities, namely, GM paddy rice and GM milled rice. A total of three modifications were conducted to generate three different baseline scenarios based on different rates of adoption of GM rice in China and Bangladesh. China and Bangladesh were selected because the governments in both countries have demonstrated a strong interest in potentially adopting GM rice varieties. The rates of adoption considered are 10 percent, 30 percent, and 50 percent. However, given that the 10 percent and 30 percent adoption rate baselines yield very marginal results on the variables of interest, results are reported

² Some examples are: Anderson and Yao (2001); Anderson and Jackson (2004); Hareau et al (2004); Stone et al (2002); and Huang et al (2002).

only for the 50 percent adoption rate baseline³. Sectoral demand for endowments and other intermediate inputs were split using the same shares. Since only China and Bangladesh are assumed to adopt GM rice, and also given that these countries exported very small amounts of paddy rice during the baseline period mainly as rice seeds, the assumption in this study is that no GM paddy rice is traded internationally. Exports of GM milled rice were allowed, and the shares for splitting the original milled rice export figures were estimated based on the rates of GM rice adoption. Exceptions were made for rice trade flows from China and Bangladesh to the EU, Japan, and South Korea, under the assumption that these regions would ban GM rice imports as soon as they are available in the market. Other small adjustments were made to the database to ensure its balance. The GTAP model was also modified following the approach suggested by Stone et al (2002). The structure of derived demand was modified to introduce two new CES nests called paddy rice and milled rice. According to these changes, substitution between GM and non-GM rice is allowed within each nest based on their relative prices. Figure 1 illustrates the structure of intermediate demand after the modifications were implemented. The structure of final demand by the private household⁴ was also modified to account for specific substitution patterns between GM and non-GM rice. The assumption is that consumers choose between GM and non-GM milled rice based on their preferences, represented by substitution elasticities between GM and non-GM rice, and the relative price of GM and non-GM rice. The final demand for the milled rice composite is then determined based on the CDE functional form used by GTAP. Figure 2 shows the structure of private household demand after the modifications were introduced. The results reported in this study were obtained using GEMPACK economic modeling software (Harrison and Pearson, 1996). Four scenario analyses were conducted to assess the impact relevant productivity and policy changes resulting from GM rice adoption.

³ Results from the other baselines are available from the authors.

⁴ The private household accounts for over 95 percent of total final demand of milled rice; the structure of government demand was not modified.

Definition of Scenarios

Scenario 1: This scenario contemplates increases of 5 percent in the productivity of land and 7.9 percent in the productivity of unskilled labor⁵ devoted to GM rice production in both China and Bangladesh. These estimates are obtained from Huang et al. (2002), and are based on data from field trials conducted in China. These estimates may be conservative as Huang et al. (2005) have reported even higher productivity impacts based on more recent pre-production (commercialization) farm level trials.

Scenario 2: This scenario builds on the previous one, and contemplates the implementation of trade restrictions by the EU, Japan, and South Korea on all rice inflows from China and Bangladesh, given that no segregation and identity preservation policies are in place in these countries. The approach taken in this study is the same as adopted by Huang et al (2002), that is, creating a shift variable against milled rice imports from China and Bangladesh. This variable is shocked to reduce imports to zero. Shocking the import tariff rate for milled rice coming from China to a level that completely eliminates the flows greatly deteriorates the accuracy of the simulation and, therefore, is not used in this case.

Scenario 3: In this scenario, the main assumption is that China implements labeling and segregation regulations. As a result of the adoption, the EU, Japan, and South Korea remove the ban on Chinese rice since regulations now ensure that consumers can clearly identify between GM and non-GM rice imports. Consumers in these regions are assumed to remain reticent to GM rice. Different costs of regulations have been reported for different crops (see Stone et al, 2002). Given that the Bangladeshi rice sector typically does export rice and that their consumers are assumed to be insensitive towards GM rice, no labeling and segregation regulations were assumed for this country. In this scenario, the cost for segregation of GM and non-GM rice in China is accounted for by a 3 percent increase in the cost of rice production. Since in general equilibrium prices are endogenous variables, the increase in price is generated through an increase in the cost of services to the rice production sector. This approach has been suggested by Huang et al (2002) as an appropriate way to account for the cost of labeling and segregation.

⁵ Unskilled labor accounts for approximately 99 percent of the total cost of labor employed by the rice production sector in China and Bangladesh.

Scenario 4: The objective of this scenario is to assess the impact of further reduction of trade distortion in agricultural markets worldwide with and without GM rice adoption. The assumption is that, as a result of multilateral negotiations, agricultural export and import duties would be reduced by 25 percent. According to the GTAP database, agricultural export policies have a net subsidy effect, estimated at approximately USD 3.7 billion, whereas agricultural import policies have a net tax effect estimated at approximately USD 45.9 billion. For rice in particular, the net effect of export policies is almost entirely represented by EU's export subsidies, estimated at approximately USD 46.3 million during the baseline. The net effect of rice import policies is a tax, estimated at approximately USD 3.8 billion. The discussion of results from this scenario focuses on whether or not the differences obtained when assuming GM adoption and no GM adoption are significant.

Results: 50 Percent Adoption Rate Baseline

Scenario 1: Improvement of Land and Labor Productivity in the GM Rice Production Sector

According to the results of this simulation, total rice output in China and Bangladesh is expected to marginally increase by 0.08 percent and 1.56 percent from the baseline as a result of land and labor productivity improvements. The increase in land and labor productivity is expected to decrease the cost of production and, due to the zero profit assumption, lower the output price of GM paddy rice. The price decrease is estimated to be around 3.79 percent for China and 2.58 for Bangladesh. These decreases in price are estimated to induce substitution for conventional paddy rice, and the decrease in output in the latter would also result in a reduction in the price of non-GM paddy rice. Once again, due to the zero profit condition, prices for both GM and non-GM milled rice are expected to marginally decrease as a result of lower paddy input prices.

The expansion in GM rice output in China is estimated to occur mainly at the expense of non-GM rice; skilled labor and capital are estimated to be almost fully transferred from the non-GM rice to the GM rice production sector; land and unskilled labor originally devoted to non-GM rice production would also be drawn into other sectors of the

economy, mainly the other food sector. The expansion in resource usage by the GM milled sector is almost fully based on decreases in use by the non-GM milled sector as shown in table 3. A similar situation is expected to occur in Bangladesh; resources from the non-GM paddy sector are expected to be allocated into GM paddy production as well as into other sectors of the economy (land for production of other food increases by 0.62 percent⁶). Demand for unskilled labor by the GM-paddy sector is expected to marginally decrease as a result of the productivity improvement, showing that the 7.9 percent increase in productivity more than offsets the increase in unskilled labor demand due to increases in sectoral production. Unskilled labor is expected to be drawn into the GM milled sector in Bangladesh from the non-GM milled sector as well as from the non-GM paddy sector. Other factors such as skilled labor and capital are expected to be taken from other sectors of the economy as well.

Rice exports from China and Bangladesh are expected to increase in this scenario. However, the most interesting result is the expected increase in China's exports of milled rice. According to USDA (2004), China ranked 4th in milled rice exports during the baseline period. Both GM and non-GM milled rice exports are expected to increase mainly as a result of a 1.42 percent and 0.51 percent lower export prices of Chinese GM and non-GM milled rice, respectively. The Rest of Western Hemisphere countries and Rest of Sub-Saharan countries are expected to account for most of the increases in China's exports of GM and non-GM milled rice.

Finally, the increase in land and labor productivity due to the adoption of GM rice is expected to increase welfare in both China and Bangladesh. GTAP utilizes equivalent variation as a welfare estimator, and disaggregates it into three components, namely, allocative efficiency effects, term of trade effects, and technological effects. The increases in welfare reported in table 3 are mainly the result of technological changes, with allocative efficiency gains also contributing marginally to the welfare increase. On the other hand, terms of trade are estimated to worsen (lower rice export price) and

⁶ This percentage change has important absolute value, since the aggregate sector called other food accounts for roughly 50 percent of the total value of land in agricultural production in Bangladesh.

therefore marginally decrease welfare. A disaggregation of the regional equivalent variation for this scenario is presented in appendix table 1.

Table 3. Domestic impact of different scenarios for the 50 percent adoption rate baseline.

Output	China			Bangladesh		
	Scenarios			Scenarios		
	1	2	3	1	2	3
Total paddy	0.08%	-0.05%	-1.14%	1.56%	1.55%	2.83%
GM paddy	7.48%	7.41%	6.12%	7.05%	7.04%	8.35%
Non-gm paddy	-7.22%	-7.42%	-8.31%	-3.88%	-3.89%	-2.65%
Total milled	0.01%	-0.25%	-2.21%	1.73%	1.71%	3.17%
GM milled	4.59%	4.56%	2.21%	6.91%	6.90%	8.39%
Non-gm milled	-4.54%	-5.02%	-6.60%	-3.43%	-3.44%	-2.02%
Price						
GM paddy	-3.79%	-3.80%	-0.90%	-2.58%	-2.59%	-1.66%
Non-gm paddy	-1.36%	-1.40%	1.55%	-1.01%	-1.02%	-0.07%
GM milled	-1.42%	-1.43%	-0.34%	-1.53%	-1.53%	-0.87%
Non-gm milled	-0.51%	-0.52%	0.58%	-0.53%	-0.53%	0.14%
Endowment use						
GM paddy						
Land	1.86%	1.81%	0.80%	1.88%	1.87%	2.73%
Unskilled labor	0.13%	0.07%	-1.22%	-0.12%	-0.13%	1.39%
Skilled labor	6.09%	6.02%	4.64%	5.79%	5.78%	7.41%
Capital	6.09%	6.02%	4.65%	5.79%	5.78%	7.40%
Non-GM paddy						
Land	-6.16%	-6.32%	-7.06%	-3.25%	-3.26%	-2.39%
Unskilled labor	-7.64%	-7.85%	-8.80%	-4.35%	-4.36%	-2.84%
Skilled labor	-7.65%	-7.86%	-8.82%	-4.39%	-4.40%	-2.87%
Capital	-7.65%	-7.86%	-8.81%	-4.39%	-4.40%	-2.88%
GM milled						
Unskilled labor	4.64%	4.61%	2.27%	7.09%	7.08%	8.57%
Skilled labor	4.58%	4.55%	2.17%	6.90%	6.88%	8.42%
Capital	4.58%	4.55%	2.20%	6.89%	6.87%	8.37%
Non-GM milled						
Unskilled labor	-4.50%	-4.98%	-6.56%	-3.27%	-3.28%	-1.87%
Skilled labor	-4.55%	-5.03%	-6.65%	-3.44%	-3.46%	-1.99%
Capital	-4.55%	-5.03%	-6.62%	-3.45%	-3.46%	-2.04%
Total Exports						
Total milled rice	3.68%	-8.60%	-0.79%	4.83%	-15.34%	1.51%
GM milled rice	5.70%	5.74%	1.34%	8.45%	8.48%	4.65%
Non-GM milled rice	2.10%	-20.17%	-2.51%	2.40%	-31.34%	-0.59%
Total Imports						
Total milled rice	-5.59%	-5.59%	-2.93%	-4.72%	-4.74%	-1.67%
GM milled rice	5.35%	5.30%	5.93%	6.23%	6.23%	6.81%
Non-GM milled rice	-5.59%	-5.59%	-2.93%	-4.73%	-4.75%	-1.68%
Equivalent variation (USD million)	395.98	392.67	-156.4	102.68	102.65	126.2

The global impact of GM rice adoption in China and Bangladesh, in general, would be marginal. Global paddy rice trade is expected to increase by only 0.09 percent in volume and 0.02 percent in value, whereas milled rice trade is estimated to increase by 0.12 percent in volume and 0.01 percent in value as a result of the changes stipulated in scenario 1. For a more detailed analysis of the most relevant changes in regional rice trade and welfare variables by region, see appendix tables 1 and 4.

As can be seen, regional paddy exports and imports would likely remain roughly unchanged. Paddy import increases by South Korea and Vietnam mean little in absolute terms, given the small volume of paddy rice imported by these countries during the baseline. For large paddy importers such as Brazil, Mexico, and Central American countries (included in Rest of Western Hemisphere), imports are expected to remain roughly unchanged. Regarding imports of milled rice, the percentage changes are also estimated to be small; the largest figures estimated for Argentina, Uruguay, and Thailand mean little in absolute terms given the small volume of milled imports reported for these countries. However, some significant substitution is expected between GM and non-GM milled in most regions except the EU, Japan, and South Korea, where consumers' acceptance of GM rice is assumed to be very low (reflected in this study by the zero substitution elasticity between GM and non-GM rice by the regional household).

Scenario 2: Trade Restrictions by the EU, Japan, and South Korea on non-GM Milled Rice Inflows from China and Bangladesh

The implementation of a total ban by the EU, Japan, and South Korea on rice imports from China and Bangladesh is estimated to generate slight changes in the domestic economies of these two Asian countries. Given that the importance of rice exports for Bangladesh is limited, a ban on its exports by these three regions would have practically no impact on the domestic economy. The 15.34 percent decrease in total milled rice exports means little in absolute terms given the irrelevance of Bangladesh as a rice exporter. More significant changes are expected to occur regarding China's presence in the international rice market. Chinese rice exports are estimated to decrease by 8.6 percent as a result of the ban, and China's share of the global rice market is estimated to drop from an estimated 9.5 percent to 8.6 percent. Domestic demand for milled rice is expected to increase and partially offset the reduction in exports.

Welfare changes are expected to be marginal compared with scenario 1, another indication of the slight impact of the import ban on the Chinese economy. According to the GTAP database, the output value of the paddy and milled rice sectors is estimated to be approximately 1.4 percent of China's GDP. Moreover, rice exports are estimated to account for only 1.3 percent of the total value of paddy and milled production. These figures support the marginal impact expected for this scenario.

Appendix table 2 shows the regional welfare impact of this scenario, and table 5 presents the impact on trade variables for other regions. The most relevant changes are the welfare decreases in EU and Japan as a result of the ban on Chinese rice imports, mainly due to reductions in import policy revenues. Import tariff revenues on rice in Japan are expected to decrease by USD 253 million as a result of the trade policy change, while in the EU revenues are estimated to decrease by approximately USD 63 million.

Scenario 3: China's Adoption of Labeling and Segregation Regulations.

The 3 percent increase in rice production cost in China is expected to generate a decrease in total paddy rice production of approximately 1.15 percent⁷, and a decrease in milled rice output of around 2.21 percent. These results indicate that the costs associated with labeling and segregation of rice more than offset the potential gains. Substitution of GM for non-GM paddy rice is still expected to occur as a result of the productivity gain of land and labor used for GM rice production but to a slightly lesser extent. The price of GM rice, both paddy and milled, is still expected to decrease from the baseline but only slightly, whereas the price for non-GM rice is expected now to increase. The drop in price due to lower output volume registered in the two previous scenarios is offset here by the increase in the cost of services generated to account for labeling and segregation costs.

The net effect on endowments changes slightly from the previous scenarios. Demand for unskilled labor by the GM paddy sector now decreases from the baseline; as shown for the case of Bangladesh in scenario 1, the lower demand for labor due to productivity

⁷ A 1.15 percent reduction in rice production in China represents a significant volume in absolute terms, estimated at 2.6million metric tons.

gains more than offsets the increase in labor demand due to the expansion of production. Resources previously allocated to the non-GM rice production sector are partially relocated into the GM paddy sector, and also into other sectors of the economy such as the other food sector. The same situation is estimated for resources previously devoted to non-GM milled rice.

Regarding rice trade, the removal of the bans against Chinese rice implemented in scenario two by the EU, Japan, and South Korea improves the trade situation of China with respect to that estimated for scenario 2, but the final effect is still a slight decrease in volume of rice trade by this Asian country. The slight increase in export price for Chinese non-GM rice due to the new regulations generates a contraction in exports of this commodity that more than offset the expansion of GM milled exports. Regarding China's rice imports, there would still be a decrease of Chinese rice imports from the baseline but the magnitude is expected to be smaller mainly due to more competitive world prices. China's welfare is expected to decrease by USD 156.4 million from the baseline as a result of the adoption of the regulations regarding labeling and segregation. This implies an estimated USD 540 million loss in welfare from the previous two scenarios.

Similarly for the previous scenarios, the impact of scenario 3 on the global rice market is estimated to be marginal. Total volume of paddy and milled trade is estimated to decrease by 0.13 and 0.09 percent, respectively, whereas the total values of paddy and milled rice exports are estimated to also decrease by 0.09 and 0.08 percent from the baseline, respectively. Appendix table 3 shows the regional welfare effects resulting from this scenario, whereas appendix table 6 presents the impact on trade variables for other regions analyzed in this study. In general, the impact of scenario 3 on other regions is very marginal, as was the case also for the two previous scenarios.

Scenario 4: Reduction of Export and Import Duties on Agricultural Commodities.

Whether or not China and Bangladesh adopt GM rice seems to be roughly irrelevant when assessing the aggregate impact of a 25 percent uniform reduction in export and import tariffs on agricultural commodities. Differences on the impact of agricultural trade policy reduction on the domestic production and consumption with and without GM rice

adoption are expected to be marginal. The total volume of paddy and milled rice trade is estimated to increase by 5.9 and 6.2 percent, respectively, when the reduction in trade barriers is accompanied by adoption of GM rice by China and Bangladesh. When these two countries do not adopt GM rice, trade of paddy and milled rice is still expected to increase but by a smaller amount, estimated at 5.4 and 4.3 percent, respectively. The difference in the aggregate trade figures are marginal, in part, because whereas China's adoption of GM rice contributes to larger export volumes (20.9 percent and 15.0 percent increase in China's exports of rice with and without adoption, respectively), Bangladesh's adoption contributes to a reduction in the volume of trade due to import substitution (-6.0 percent and 2.7 percent change in Bangladeshi rice imports with and without adoption, respectively). The situation for other major rice traders is expected to be roughly the same whether GM rice is adopted or not except for those regions trading mainly with China, e.g., the Sub-Saharan countries. Therefore these results are very interesting because it demonstrates the potential to increase competitiveness as an exporter if the import market does not discriminate against GM rice. In the case of Bangladesh it also shows that GM rice adoption is likely to significantly contribute to an improvement in self-sufficiency and food security. Table 4 shows the changes in rice trade volumes for the major rice traders

Table 4. Major rice traders: changes in volumes of trade with and without GM rice adoption.

Exporters	With GM Adoption	Without GM Adoption	Importers	With GM Adoption	Without GM Adoption
Thailand	8.0%	5.9%	Indonesia	12.2%	11.1%
India	8.7%	7.4%	Sub-Saharan countries	17.9%	7.6%
Vietnam	12.4%	9.8%	Philippines	27.2%	21.0%
U.S.	17.0%	14.7%	Middle East	-1.3%	-0.7%
Pakistan	n.a.	n.a.	South Africa	-3.1%	-0.4%
China	20.9%	15.0%	Bangladesh	-6.0%	2.7%

The reform of agricultural trade policies is expected to yield significant global welfare gains, estimated at USD 8.1 billion with GM rice adoption and USD 7.7 billion without GM rice adoption. When analyzing the decomposition of welfare, it is seen that the difference of approximately USD 400 million between the scenario with and without GM adoption is almost fully explained by the technological gains resulting from GM rice. China is expected to experience a net terms of trade loss experienced as a result of GM

adoption of around USD 100 million, but it is expected to be offset by terms of trade gains in other regions.

Limitations and Suggestions for Further Research

Walmsley, Dimaranan, and McDougall (2000) provide a methodology for updating the GTAP database based on macroeconomic and policy forecasts. This approach was utilized by Huang et al (2004) to create the 2010 baseline to which the different scenarios were compared. Insufficient macroeconomic and policy data were available for this study, and therefore, no database updating was performed. Database updating is being pursued for further analysis in this study.

Following the developments by Stone et al (2002), this study modifies the structure of intermediate and final consumption to better assess the substitution effects between GM and non-GM rice. These modifications require the introduction of elasticities of substitution between GM and non-GM rice. To date, no such estimates are available. The assumption in this study was that regions with negative consumer attitudes towards GM crops would not substitute non-GM for GM rice despite the changes in relative prices (elasticity of zero). On the other hand, in regions where consumer attitudes are believed to be neutral, such as in the U.S., the substitution elasticity was set at 10. For most developing countries, the elasticity of substitution between GM and non-GM rice was set at 5, an intermediate stage between aversion and high substitution. Although sensitivity analysis on these parameters yielded no significant differences, future studies should consider different combinations of elasticity values to obtain a better assessment of the potential substitution effects.

Finally, the issue of technological spillovers⁸ was not simulated in this study. Van Meijl and van Tongeren (1999) developed a module to simulate technology spillovers in the GTAP model. One of their key assumptions was that technical knowledge is embodied in traded commodities. Given the assumption in this study regarding no GM paddy rice

⁸ According to van Meijl and van Tongeren, technology spillovers are said to exist if one market party receives productivity benefits from technologies developed by others, yet there is no monetary compensation for the technology transfer.

trade, technology spillovers are assumed to be irrelevant. Further analysis is expected to include GM rice adoption by other important rice traders. Assuming that the U.S., Uruguay, and Argentina (the main exporters of paddy rice) adopt GM rice, technology spillovers could become an interesting research issue.

Conclusions

In general, the findings of this study suggest relatively small but interesting impacts from GM rice adoption by China and Bangladesh. Across all scenarios, rice production in these nations is expected to vary by less than 3 percent from the baseline. However, the small percentage changes represent significant absolute changes, considering that these two countries rank among the four largest rice producers in the world. The ban on Chinese and Bangladeshi rice by the EU, Japan, and South Korea is estimated to generate a marginal reduction in Chinese rice production, driven by the significant decrease in Chinese milled rice exports; on the other hand, no significant changes in the situation of the Bangladeshi rice sector are expected as a result of the trade ban, mainly because of the insignificance of exports for the Bangladeshi rice sector. The implementation of rice labeling and segregation regulations by China is expected to negatively affect rice output, in this case mainly due to a reduction in domestic demand resulting from the higher production costs. Chinese rice exports are expected to decrease only marginally from the baseline also as a result of the slight increase in China's rice export price. Regardless of the scenario, GM rice production is expected to increase at the expense of non-GM rice in both China and Bangladesh, in some cases up to 8 percent from the baseline. The analysis of a uniform reduction in import and export trade policies on agricultural commodities yields similar results in the aggregate whether or not GM rice adoption is considered. The most significant difference is a larger increase in China's rice exports when GM rice is adopted, with the Sub-Saharan countries benefiting the most from this situation. The global welfare is expected to increase by approximately USD 400 million more as a result of GM rice adoption, most of that difference is explained by increases in productivity.

References

- Anderson, K., and S. Yao. 2001. "China, GMOs and world trade in agricultural and textile products." Presented at fourth annual conference on Global Economic Analysis. Purdue University, West Lafayette, IN.
- Anderson, K., L.A. Jackson, and C.P. Nielsen. 2004. "Genetically modified rice adoption: implications for welfare and poverty alleviation." Discussion paper No. 0413, Centre for International Economic Studies, University of Adelaide.
- Annou, M.M., E.J. Wailes, and F.H. Fuller. 2005. "Innovation dissemination and market impacts of drought-tolerant genetically modified rice." *International Journal of Biotechnology*, vol. 7, No.1/2/3, pp. 113-127.
- Dimaranan, B. and R.A. McDougall, ed. Forthcoming. *Global Trade, Assistance, and Production: The GTAP 6 Data Base*. Center for Global Trade Analysis, Purdue University.
- Hareau, G.G., G.W. Norton, B.F. Mills, and E. Peterson. 2004. "Potential benefits of transgenic rice in Asia: a general equilibrium analysis." Presented at AAEA annual meeting. Denver, CO, 1-4 August.
- Harrison, W.J., and K.R. Pearson. 1996. "Computing solutions for large general equilibrium models using GEMPACK." *Computational Economics*, vol. 9, pp. 83-127.
- Hertel, T.W. 1997. *Global Trade Analysis Modeling and Applications*. New York: Cambridge University Press.
- Hossain, M. 2001. "The challenge to feed the world's poor." In *Rice Biotechnology: Improving Yield, Stress Tolerance, and Grain Quality*. New York: John Wiley & Sons.
- Huang, J., R. Hu, H. van Meijl, and F. van Tongeren. 2002. "Biotechnology boosts to crop productivity in China and its impact on global." Presented at the 5th Annual Conference on Global Economic Analysis. Taipei, Taiwan, 5-6 June.
- Huang, J., R. Hu, S. Rozelle, and C. Pray. 2005. "Insect resistant GM rice in farmers' fields: assessing productivity and health effects in China." *Science*, 308:688-690.
- James, C. 2004. Global status of commercialized biotech/GM crops: 2004. ISAAA Brief No. 32. ISAAA, Ithaca, NY.
- Khush, G. 2001. "Chair's Introduction." In *Rice Biotechnology: Improving Yield, Stress Tolerance, and Grain Quality*. New York: John Wiley & Sons.

- Nielsen, C.P., S. Robinson, and K. Thierfelder. 2002. "Trade in genetically modified food: a survey of empirical studies." TMD Discussion Paper No. 106, International Food Policy research Institute, Washington D.C.
- Stone, S., A. Matysek, and A. Dolling. 2002. "Modelling Possible Impacts of GM Crops on Australian Trade." Productivity Commission Staff Research Paper, Melbourne, October.
- USDA, FAS. 2005. Production, Supply and Distribution Database. At <http://www.fas.usda.gov/psd>.
- Van Meijl, H., and F. van Tongeren. 1999. "Endogenous international technology spillovers and biased technical change in the GTAP model." GTAP technical Paper No. 15, Center for Global Trade Analysis, Purdue University.
- Walmsley, T., B. Dimaranan, and R.A. McDougall. 2000. "A base case scenario for the dynamic GTAP model." GTAP Resource No. 417, Center for Global Trade Analysis, Purdue University.

Appendix Table 1. Welfare decomposition of scenario 1.

	Allocative Efficiency Impact	Technology Impact	Term of Trade Impact	Total
US	-3	0	-11	-16
Mexico	0	0	0	0
Argentina	0	0	-1	-1
Brazil	0	0	-1	-1
Uruguay	0	0	0	0
Rest Western Hemisphere	0	0	0	0
EU	1	0	-5	-4
Oceania	0	0	-1	-1
China	51	360	-12	396
Rest South Asia	0	0	4	4
Thailand	0	0	-2	-2
Japan	3	0	4	7
South Korea	14	0	3	17
Taiwan	0	0	1	1
Rest East Asia	0	0	0	0
Indonesia	0	0	0	0
Malaysia	0	0	1	1
Philippines	0	0	0	0
Vietnam	0	0	0	0
Bangladesh	8	74	15	103
India	1	0	0	1
Rest Europe	1	0	1	1
Middle East	0	0	1	1
North African countries	0	0	0	0
Sub-Saharan countries	1	0	2	3
South African countries	0	0	0	0
South Africa	0	0	0	0
World	77	434	0	510

Appendix Table 2. Welfare decomposition of scenario 2.

	Allocative Efficiency Impact	Technology Impact	Term of Trade Impact	Total
US	-1	0	3	2
Mexico	0	0	1	1
Argentina	0	0	0	0
Brazil	0	0	0	0
Uruguay	0	0	0	0
Rest Western Hemisphere	1	0	1	2
EU	-63	0	-2	-67
Oceania	0	0	-1	0
China	54	360	-19	393
Rest South Asia	0	0	6	6
Thailand	1	0	-2	-1
Japan	-253	0	-18	-269
South Korea	-3	0	3	0
Taiwan	0	0	2	2
Rest East Asia	0	0	1	1
Indonesia	0	0	0	1
Malaysia	0	0	1	1
Philippines	0	0	0	1
Vietnam	0	0	0	0
Bangladesh	8	74	15	103
India	1	0	1	1
Rest Europe	2	0	3	4
Middle East	1	0	1	2
North African countries	0	0	1	1
Sub-Saharan countries	1	0	2	3
South African countries	0	0	0	0
South Africa	0	0	0	0
World	-248	434	0	185

Appendix Table 3. Welfare decomposition of scenario 3.

	Allocative Efficiency Impact	Technology Impact	Term of Trade Impact	Total
US	-4	0	1	-7
Mexico	0	0	0	0
Argentina	0	0	0	0
Brazil	0	0	0	-1
Uruguay	0	0	0	0
Rest Western Hemisphere	0	0	0	-1
EU	4	0	0	-1
Oceania	0	0	0	0
China	70	-179	-57	-156
Rest South Asia	0	0	11	11
Thailand	0	0	-1	-1
Japan	-2	0	10	4
South Korea	-7	0	3	-5
Taiwan	0	0	1	1
Rest East Asia	0	0	0	0
Indonesia	0	0	0	0
Malaysia	0	0	0	0
Philippines	0	0	0	0
Vietnam	0	0	0	0
Bangladesh	14	75	29	126
India	1	0	1	1
Rest Europe	1	0	2	2
Middle East	0	0	0	-1
North African countries	2	0	0	2
Sub-Saharan countries	0	0	0	0
South African countries	0	0	0	0
South Africa	0	0	0	0
World	80	-105	0	-25

Appendix Table 4. Fifty percent baseline, scenario 1: Trade and welfare results for other regions.

Regions	Export Volume		Export Price		Import volume			Import price			
	Paddy	Milled	Paddy	Milled	Paddy	Total milled	non-GM milled	GM milled	Paddy	non-GM milled	GM milled
US	-0.16%	-0.19%	-0.01%	0.00%	0.44%	0.96%	0.07%	13.30%	-0.11%	-0.07%	-1.42%
Mexico	-0.11%	-0.28%	0.00%	0.00%	0.03%	0.31%	0.06%	3.30%	-0.02%	-0.05%	-1.42%
Argentina	0.04%	-0.11%	-0.01%	-0.01%	1.02%	1.69%	0.09%	13.63%	-0.23%	-0.08%	-1.42%
Brazil	-0.13%	-0.24%	0.00%	0.00%	0.03%	0.08%	0.01%	6.50%	-0.01%	-0.01%	-1.42%
Uruguay	-0.03%	-0.10%	-0.01%	0.00%	1.07%	2.22%	0.39%	9.29%	-0.23%	-0.15%	-1.42%
Rest Western Hemisphere	-0.19%	-0.29%	-0.01%	0.00%	0.01%	0.53%	0.05%	4.66%	-0.02%	-0.06%	-1.20%
EU	-0.29%	-0.20%	-0.01%	-0.01%	0.02%	0.07%	0.07%	0.00%	-0.03%	-0.06%	-1.34%
Oceania	-0.23%	-0.14%	-0.01%	0.00%	0.16%	0.17%	0.06%	5.03%	-0.07%	-0.04%	-1.42%
Rest South Asia	-0.18%	-0.31%	-0.01%	0.00%	0.37%	0.16%	0.08%	4.39%	-0.09%	-0.04%	-1.28%
Thailand	0.10%	-0.29%	-0.07%	-0.06%	0.98%	1.72%	0.27%	7.04%	-0.28%	-0.15%	-1.42%
Japan	-0.03%	-0.31%	0.00%	0.00%	0.15%	0.14%	0.16%	0.00%	-0.05%	-0.09%	-1.37%
South Korea	0.19%	0.26%	-0.10%	-0.12%	3.48%	0.21%	0.30%	0.02%	-0.90%	-0.23%	-1.41%
Taiwan	-0.69%	-0.33%	0.00%	0.00%	0.65%	1.23%	0.27%	7.13%	-0.26%	-0.11%	-1.43%
Rest East Asia	-0.44%	-2.28%	-0.02%	-0.01%	-0.03%	0.87%	0.25%	3.72%	0.00%	-0.12%	-1.21%
Indonesia	-0.31%	-0.37%	-0.01%	0.00%	0.23%	0.21%	0.09%	5.96%	-0.05%	-0.04%	-1.22%
Malaysia	-0.56%	-0.21%	-0.03%	-0.01%	0.12%	0.20%	0.05%	5.11%	-0.05%	-0.05%	-1.22%
Philippines	-0.71%	-0.39%	0.00%	0.00%	0.67%	0.08%	0.06%	6.77%	-0.14%	-0.03%	-1.37%
Vietnam	-0.70%	-0.13%	-0.03%	-0.03%	6.24%	1.42%	0.25%	7.02%	-1.24%	-0.12%	-1.42%
India	-0.34%	-0.25%	-0.01%	0.00%	0.94%	1.16%	0.24%	7.40%	-0.19%	-0.09%	-1.42%
Rest Europe	-0.61%	-0.26%	0.00%	0.00%	0.51%	0.39%	0.10%	4.34%	-0.11%	-0.05%	-1.28%
Middle East	-0.83%	-0.11%	0.00%	0.00%	0.01%	0.10%	0.03%	6.21%	-0.03%	-0.02%	-1.24%
North African countries	-0.30%	-0.17%	-0.02%	0.00%	0.17%	0.06%	-0.12%	1.02%	-0.07%	-0.09%	-1.22%
Sub-Saharan countries	-0.31%	-0.30%	-0.01%	-0.01%	0.16%	0.47%	0.05%	5.58%	-0.06%	-0.07%	-1.20%
South African countries	-1.14%	-0.23%	0.00%	0.00%	0.09%	0.17%	0.04%	6.00%	-0.02%	-0.02%	-1.22%
South Africa	-0.05%	-0.09%	-0.01%	0.00%	0.14%	0.10%	0.08%	6.07%	-0.08%	-0.02%	-1.36%

Appendix Table 5. Fifty percent baseline, scenario 2: Trade and welfare results for other regions.

Regions	Export Volume		Export Price		Import volume				Import price			EV (USD million)
	Paddy	Milled	Paddy	Milled	Paddy	Total milled	non-GM milled	GM milled	Paddy	non-GM milled	GM milled	
US	-0.17%	-0.18%	-0.01%	0.00%	0.45%	0.97%	0.08%	13.38%	-0.11%	-0.11%	-1.43%	2.48
Mexico	-0.11%	-0.28%	0.00%	0.00%	0.03%	0.31%	0.06%	3.32%	-0.02%	-0.02%	-1.43%	0.77
Argentina	0.03%	-0.11%	-0.01%	-0.01%	1.05%	1.70%	0.10%	13.72%	-0.24%	-0.24%	-1.43%	-0.42
Brazil	-0.14%	-0.24%	0.00%	0.00%	0.03%	0.08%	0.02%	6.54%	-0.01%	-0.01%	-1.43%	0.13
Uruguay	-0.03%	-0.10%	0.00%	0.00%	1.11%	2.25%	0.40%	9.35%	-0.23%	-0.23%	-1.43%	-0.04
Rest Western Hemisphere	-0.19%	-0.27%	-0.01%	0.00%	0.01%	0.54%	0.06%	4.69%	-0.02%	-0.02%	-1.20%	2.02
EU	-0.29%	-0.14%	0.00%	-0.01%	0.03%	0.04%	0.05%	0.00%	-0.03%	-0.03%	-1.34%	-65.71
Oceania	-0.24%	-0.12%	-0.01%	0.00%	0.17%	0.18%	0.06%	5.06%	-0.07%	-0.07%	-1.42%	-0.27
Rest South Asia	-0.18%	-0.31%	-0.01%	0.00%	0.39%	0.16%	0.08%	4.42%	-0.09%	-0.09%	-1.29%	6.35
Thailand	0.09%	-0.28%	-0.07%	-0.06%	1.03%	1.74%	0.29%	7.08%	-0.29%	-0.29%	-1.43%	-1.22
Japan	-0.03%	-0.28%	-0.01%	-0.01%	0.15%	0.08%	0.09%	0.00%	-0.05%	-0.05%	-1.37%	-265.13
South Korea	0.22%	0.33%	-0.10%	-0.13%	3.58%	0.06%	0.08%	0.02%	-0.93%	-0.93%	-1.42%	-0.06
Taiwan	-0.70%	-0.32%	0.00%	0.00%	0.67%	1.25%	0.28%	7.17%	-0.27%	-0.27%	-1.44%	2.07
Rest East Asia	-0.44%	-2.29%	-0.02%	-0.01%	-0.02%	0.88%	0.26%	3.74%	-0.01%	-0.01%	-1.21%	0.63
Indonesia	-0.31%	-0.33%	-0.01%	0.00%	0.23%	0.21%	0.09%	6.00%	-0.05%	-0.05%	-1.23%	0.56
Malaysia	-0.57%	-0.19%	-0.03%	-0.01%	0.12%	0.20%	0.05%	5.13%	-0.05%	-0.05%	-1.23%	1.06
Philippines	-0.73%	-0.35%	0.00%	0.00%	0.69%	0.08%	0.07%	6.81%	-0.14%	-0.14%	-1.38%	0.66
Vietnam	-0.71%	-0.12%	-0.03%	-0.03%	6.44%	1.43%	0.26%	7.06%	-1.28%	-1.28%	-1.43%	-0.23
India	-0.34%	-0.25%	0.00%	0.00%	0.97%	1.17%	0.25%	7.44%	-0.20%	-0.20%	-1.43%	1.29
Rest Europe	-0.63%	-0.25%	0.00%	0.00%	0.53%	0.40%	0.11%	4.36%	-0.11%	-0.11%	-1.29%	4.35
Middle East	-0.85%	-0.10%	0.00%	0.00%	0.01%	0.10%	0.03%	6.25%	-0.03%	-0.03%	-1.24%	1.65
North African countries	-0.31%	-0.17%	-0.02%	0.00%	0.18%	0.06%	-0.12%	1.02%	-0.07%	-0.07%	-1.22%	0.93
Sub-Saharan countries	-0.32%	-0.28%	-0.01%	-0.01%	0.17%	0.47%	0.05%	5.62%	-0.06%	-0.06%	-1.20%	3.24
South African countries	-1.15%	-0.22%	0.00%	0.00%	0.10%	0.17%	0.04%	6.03%	-0.02%	-0.02%	-1.23%	0.06
South Africa	-0.06%	-0.09%	-0.01%	0.00%	0.15%	0.10%	0.08%	6.10%	-0.09%	-0.09%	-1.37%	0.32

Appendix Table 6. Fifty percent baseline, scenario 3: Trade and welfare results for other regions.

Regions	Export Volume		Export Price		Import volume				Import price			EV (USD million)
	Paddy	Milled	Paddy	Milled	Paddy	Total milled	non-GM milled	GM milled	Paddy	non-GM milled	GM milled	
US	0.14%	0.10%	0.01%	0.00%	-0.44%	0.07%	-0.14%	3.10%	0.10%	0.04%	-0.35%	-7.31
Mexico	0.03%	0.06%	0.00%	0.00%	-0.03%	-0.04%	-0.11%	0.80%	0.01%	0.05%	-0.35%	-0.04
Argentina	0.01%	0.06%	0.00%	0.00%	-1.10%	0.16%	-0.24%	3.17%	0.23%	0.08%	-0.35%	-0.23
Brazil	0.07%	0.09%	0.00%	0.00%	-0.02%	0.00%	-0.02%	1.54%	0.00%	0.01%	-0.35%	-0.56
Uruguay	0.01%	0.05%	0.00%	0.00%	-1.05%	0.12%	-0.41%	2.17%	0.22%	0.16%	-0.35%	0.05
Rest Western Hemisphere	0.15%	0.12%	0.00%	0.00%	-0.06%	-0.04%	-0.17%	1.11%	0.01%	0.06%	-0.29%	-0.82
EU	0.20%	0.16%	0.00%	0.00%	-0.01%	-0.06%	-0.06%	0.00%	0.02%	0.05%	-0.33%	-0.44
Oceania	0.19%	0.06%	0.00%	0.00%	-0.12%	-0.01%	-0.04%	1.20%	0.04%	0.01%	-0.35%	-0.13
Rest South Asia	0.09%	-0.07%	0.00%	0.00%	-0.37%	0.01%	-0.01%	1.06%	0.08%	0.00%	-0.31%	11.27
Thailand	0.56%	-0.08%	-0.02%	-0.01%	-1.50%	0.00%	-0.45%	1.67%	0.28%	0.16%	-0.35%	-0.63
Japan	-0.01%	0.02%	0.00%	0.00%	-0.14%	-0.14%	-0.16%	0.00%	0.04%	0.08%	-0.33%	5.02
South Korea	-0.37%	-0.57%	0.10%	0.12%	-3.61%	-0.23%	-0.32%	-0.02%	0.97%	0.24%	-0.34%	-4.59
Taiwan	0.55%	0.02%	0.00%	0.00%	-0.65%	0.05%	-0.23%	1.82%	0.26%	0.09%	-0.38%	0.61
Rest East Asia	0.42%	-0.74%	0.00%	0.00%	-0.02%	-0.07%	-0.27%	0.88%	0.00%	0.10%	-0.29%	0.28
Indonesia	0.19%	0.09%	0.00%	0.00%	-0.08%	0.01%	-0.02%	1.40%	0.01%	0.01%	-0.30%	0.02
Malaysia	0.57%	0.06%	0.00%	0.00%	-0.16%	-0.03%	-0.07%	1.20%	0.03%	0.01%	-0.30%	-0.23
Philippines	0.52%	0.09%	0.00%	0.00%	-0.67%	-0.01%	-0.02%	1.59%	0.13%	0.00%	-0.33%	-0.03
Vietnam	0.15%	-0.02%	0.01%	0.01%	-6.68%	0.06%	-0.29%	1.74%	1.41%	0.12%	-0.35%	0.08
India	0.21%	-0.03%	0.00%	0.00%	-0.91%	0.04%	-0.21%	1.75%	0.18%	0.08%	-0.35%	1.3
Rest Europe	0.51%	0.08%	0.00%	0.00%	-0.49%	-0.03%	-0.11%	1.03%	0.10%	0.04%	-0.31%	1.82
Middle East	0.56%	0.02%	0.00%	0.00%	0.00%	-0.01%	-0.02%	1.48%	0.00%	0.01%	-0.30%	-0.61
North African countries	0.23%	0.07%	0.02%	0.00%	-0.18%	-0.02%	-0.09%	0.33%	0.06%	0.09%	-0.29%	1.86
Sub-Saharan countries	0.29%	0.07%	-0.01%	0.00%	-0.21%	-0.04%	-0.15%	1.31%	0.04%	0.03%	-0.29%	0.04
South African countries	0.31%	0.04%	0.00%	0.00%	-0.08%	-0.01%	-0.04%	1.42%	0.02%	0.01%	-0.30%	-0.04
South Africa	0.02%	0.01%	0.01%	0.00%	-0.12%	0.01%	0.01%	1.44%	0.07%	0.00%	-0.33%	0.18

Figure 1. Structure of intermediate input demand.

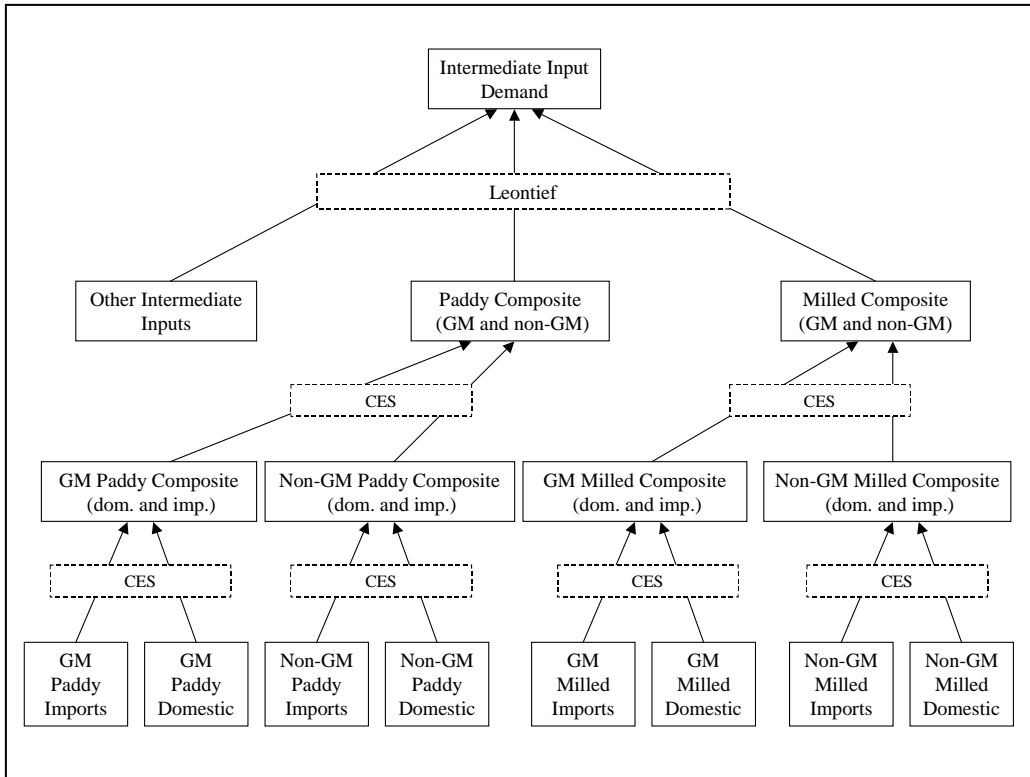


Figure 2. Structure final demand by private household.

