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Till Ludwig "Impact of Hybrid Rice on Food Security. A Spatial Partial Equilibrium Analysis of Global Adoption and Diffusion of Hybrid Rice Varieties"

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Summary

More than half of the global population depends on rice as either production or consumption good. Rice is the staple crop for most consumers in Asia. Around 90% of world rice is produced in Asia. Thus, food security issues in Asia are strongly related to the availability and accessibility of rice. The two main producers of rice, China and India, use mostly irrigation for their rice fields, which results in fairly constant yields each year. However, irrigated rice areas are not the norm in the majority of Asian rice production. Thailand, Myanmar and other rice producing countries use a rain-fed system and are therefore dependent on the climate. At the same time demand for rice is growing as the population especially in Asia is growing. Generally scarce resources for agricultural production and unfavorable conditions will make it hard to meet future demand in rice and threaten future food security.

Accordingly, improved rice technology has been a research topic for decades. Those exist as genetically modified (GM) variants or as hybrid breeds. They show ability to withstand drought, disadvantageous soils and low temperatures. In general the public perception still prevails that GM seeds have a most likely negative impact on human health and on biodiversity. The business model associated with GM seeds is neither promising a quick adoption of GM rice. Hybrid rice on the other hand does not have those disadvantages. A soon adoption on a larger scale in developing countries is on the horizon with according impacts on food security. Hybrid rice technology is a method to increase the productivity of resources needed for rice production. Current developments show not only yield improvements in comparison to existing conventional and hybrid varieties, but also fuel hopes for new abiotic and biotic stress tolerance. The objective of this study is to determine what impact hybrid rice varieties can have on food security.

Assumptions can be made on the basis of current research in which rice producing areas the adoption can be beneficial and to which extent hybrid rice can contribute to regional and global rice supply. The guiding research questions to investigate are if and under which extent hybrid rice can higher yield? What is the price effect? What are the impacts for rice producers and to which rice producers? Special focus needs to be put on the production chain and input costs. What is the impact on the consumers and for consumers from which countries? And eventually, can hybrid rice technology improve food security?

Using the RICEFLOW model, a spatial-equilibrium framework with detailed information about the global rice value chain, the potential for adoption and impacts on food security of new hybrid rice varieties can be estimated. RICEFLOW models the supply chain as well as the production chain for nine different rice commodities. It can disaggregate more than 89 countries and can generate global results on inputs, products, processing, trade and final consumption at a regional and country level. With that it can be used for analyzing trade policies on different levels, impact of new technologies and production chain changes, as well as effects on consumption. In this thesis the RICEFLOW model is modified to fit the research questions. It includes 60 regions and simulates production processes, bilateral trade flows, and consumption patterns of rice commodities, which also include hybrid rice and specific input requirements. A benchmark scenario that included population and expenditure growth first projected the demand of rice and the according production and price changes. The impact scenario incorporated production and output characteristics of the assumed hybrid rice adoption in the seven major hybrid rice producing countries (Bangladesh, China, India, Indonesia, Philippines, USA, and Vietnam). Due to the limited space a detailed discussion of the effects on food security can only be given for a selection of rice consuming countries, i.e. the countries that are most depending on rice as a staple crop.

In comparison to the benchmark scenario it could be shown that hybrid rice induces a 10.8% higher production of rice globally, and even a 12.08% higher production in the major hybrid rice producing countries (see Table 1). The availability of rice is improved and this enhances rice consumption per capita between 0.17% and 7.62% in the countries that are most dependent on rice as a staple crop (see Table 2). It can be assumed that similar positive effects are also perceptible in other countries, which depend on rice. Finally, impacts on retail prices are important. However, due to imprecisions that are inherent to the model, the projection results cannot be taken literally, but as merely indicating trends. They show that the adoption of hybrid rice leads to price drops of rice (see Table 3). The stochastic results took partially into account by introducing yield variability due to uncertainties such as climatic shocks. The stochastic results showed that hybrid rice adoption can improve the food security, and that even in the worst case scenario the rice availability is better with hybrid rice adoption than for the average deterministic scenario without hybrid rice adoption. In conclusion, this study quantified the impact that hybrid rice can have on food security and showed that hybrid rice adoption leads to better food availability and affordability.

Table 1. Comparison of production changes for Long Grain Paddy rice.

Country	Rice production					Hybrid rice difference from benchmark scenario to impact scenario
		Benchmark Scenario		Impact Scenario		
	2009 (1000 t)	2025 (1000 t)	% change from 2009	2025 (1000 t)	% change from 2009	
Bangladesh	47,723	55,094	15.44%	56,443	**18.27%**	2.45%
China	170,705	166,396	**-2.53%**	164,244	-3.79%	-1.27%
India	129,198	139,365	7.87%	165,768	**28.31%**	18.95%
Indonesia	64,399	66,202	2.80%	69,634	**8.13%**	5.18%
Philippines	16,266	17,866	9.84%	20,535	**26.25%**	14.94%
USA	7,551	9,587	26.96%	10,002	**32.46%**	4.33%
Vietnam	38,895	43,196	11.06%	52,154	**34.09%**	20.74%
TOTAL	474,738	530,957	4.84%	538,779	**13.49%**	1.47%
Global	613,517	655,250	6.80%	690,749	**12.59%**	5.42%

Table 2. Comparison of rice consumption changes for Long Grain White rice.

Country	Rice consumption					% change between scenarios
		Benchmark Scenario		Impact Scenario		
	2009 (kg/capita)	2025 (kg/capita)	% change from 2009	2025 (kg/capita)	% change from 2009	
Bangladesh	215.13	208.26	-3.19%	210.02	**-2.37%**	0.85%
Cambodia	234.05	193.77	-17.21%	194.61	**-16.85%**	0.43%
Laos	227.36	180.61	-20.56%	184.22	**-18.97%**	1.99%
Myanmar	228.83	224.25	-2.00%	224.64	**-1.83%**	0.17%
Vietnam	220.36	161.24	-26.83%	173.53	**-21.25%**	7.62%

Table 3. Comparison of nominal retail price percent changes for Long Grain White rice.

Country	Retail price changes for 2025		Hybrid rice difference from benchmark scenario to impact scenario
	Benchmark Scenario	Impact Scenario	
Bangladesh	127.34%	**-6.69%**	-134.03%
Cambodia	3.27%	**1.04%**	-2.23%
Laos	13.06%	**2.42%**	-10.64%
Myanmar	179.79%	**174.89%**	-4.90%
Vietnam	73.34%	**20.04%**	-53.3%