Report No. 44434-ID

Adapting to Climate Change:

The Case of Rice in Indonesia

A Study under the Rice Policy Dialogue AAA (P108646)
July 2008

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Printed in July 2008

Cover photograph of Homer Simpson from street art on a Jakarta expressway

Acknowledgments

This report is a product of the World Bank's Rural Development, Natural Resources and Environment (EASRE) Sector Unit of the East Asia and Pacific Region.

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This study was prepared as a follow-up to the Bank's earlier study (Issues in Indonesian Rice Policy, February 2007) on the request of the Deputy Minister, Agriculture, Coordinating Ministry of Economic Affairs. It is based on extensive stakeholder consultations and desk reviews of existing literature.

The team expresses its sincere gratitude to all the key informants from the following agencies: Ministry of Agriculture, specifically, the Directorate-General of Food Crops (Directorate of Plant Protection), Directorate-General for Land and Water Management, Center for Agriculture and Socio-Economic Research (CASER), Research Center for Agro-Climate and Hydrology (Bogor), Indonesian Rice Research Institute (Sukamandi), Central Research Institute for Food Crops (Bogor), Research Center for Land Resources (Bogor), the Meteorological and Geophysics Agency (BMG), Ministry of Public Works (Directorate of Irrigation), Bappenas (Directorate Water Resources), IRRI-Indonesia, UNDP, and CIFOR.

This study benefited from the comments of the peer reviewer Erick Fernandes (Land Adviser, ARD) as well as feedback from the presentation of the draft results at a national workshop on commodity prices organized by IPB and the World Bank in Jakarta on June 10, 2008. Dr. Bayu Krishnamurthi, Deputy Minister for Agriculture, Coordinating Ministry for Economic Affairs was the inspiration behind this study and his insights and suggestions have been extremely valuable in shaping this work.

The study was carried out under the overall guidance of Rahul Raturi (Sector Manager, EASRE) and Sonia Hammam (Sector Manager, Sustainable Development Department, Indonesia).

Executive Summary

Background: There is increasing interest in climate change issues in Indonesia particularly in the lead-up to the COP13 meeting in Bali in December 2007 when there was renewed focus on Indonesia as the third largest emitter of GHG in the world due to deforestation, peatland degradation, and forest fires. In Indonesia, the agriculture sector[1] employs the largest share, 45 percent, of Indonesia's labor and contributes the second largest share, 17.5 percent, of GDP. Poverty is a largely rural phenomenon. In 2002, 61 percent of the poor earned their livelihood in the agricultural sector while 63 percent of Indonesia's poor population resided in rural areas. In Indonesia, the agriculture sector is the main source of methane emissions as it accounts for 59 percent of total national emissions. Seventy percent of the emissions from the agriculture sector are generated by rice cultivation. Methane emission in agriculture is mainly due to inefficient practices such as over-irrigation, misuse of fertilizer, and poor livestock feeding practices (PEACE, 2007). According to Las et al (2006), 8.5 million hectares of paddy land and tidal swamp farming in Indonesia contribute significantly to agriculture GHG emissions.

Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These range from technological options such as drought/flood-resistant varieties, to behavior change at the individual level,such as reducing water use.Cross-cutting responses include poverty reduction and economic reforms, improving the information base, strengthening planning and coordination, promoting participation and consultation, improving disaster preparedness, investing in technology development and dissemination, and establishing effective financial safety nets and insurance systems.

Climate Change and Rice in Indonesia: The important impacts of climate change on agricultural production and productivity in Indonesia are compounded by increasing urbanization that has resulted in loss of valuable agricultural lands, increased pressure on scarce water resources, and reduced labor availability.

Between 1970 and 1994 Indonesia enjoyed steadily increasing rice yields, relatively stable real rice prices at near the world price, progressive reduction in poverty and progressive growth of the non rural economy. However, successive El Niño induced droughts in 1991, 1994 and particularly 1997 illustrated the fact that dry years in the main rice growing areas of Java were becoming more frequent. Drought and climate change are not the only influences on crop production, however. Adaptation to drought also involves factors which control productivity and thus the ability to increase water use efficiency

As noted by Naylor et.al. (2007) agricultural production in Indonesia is strongly influenced by both the Austral-Asian Monsoon and the Indo Pacific El Nino Southern Oscillation (ENSO) dynamics . The balance of influence from sea temperatures in the Indian and Pacific Oceans has different effects on western and southern Indonesia compared to eastern and northern Indonesia. Three different long term climatic patterns have been identified for "Western" (North Sumatra, western Kalimantan) , "Central" (Java, NTB,NTT, southern Kalimantan and Sulawesi) and "Eastern" (northern Sulawesi, Maluku, Halmahera) Indonesia (Aldrian and Susanto, 2003). The ability to successfully predict not only the inter annual climate variability of each region of Indonesia but also the long term influence on the basic climate of global warming and CO2 changes is key to developing a rational food security program.

Short Term Influences on Crop Production

Chief among the short term influences on climate and crop production in Indonesia is the El Nino Southern Oscillation Index (SOI) which measures changes in sea surface temperatures in the Pacific as they relate to periodic dry periods in Indonesia and elsewhere.

The literature reveals that declines in area harvested in El Nino years are apparently compensated for by increases in yield on the area actually planted, possibly due to greater solar radiation in (irrigated) areas. When non- El

1 Agriculture is defined here to encompass forestry and fisheries, consistent with GOI statistical conventions.

Nino years of production decline (compared to the previous year) were investigated, the area harvested and yield declined simultaneously.

The loss of production, (measured as the percentage deviation from a five year moving average) in eight El Nino years between 1965 and 1997, averaged 4 percent. This loss compared to an average loss of 6 percent (12 percent in 1967) for the non El Nino years (Yokoyama, 2003). Furthermore the loss in El Nino years was mostly a single year phenomenon and was compensated by production gains in the following year. Production variability during 1963-1998 was greatest for maize (13.5%) due mainly to changes in area harvested and least for rice (3.5%) , probably because of the impact of irrigation on rice yield. For particular regions the losses may be higher. Thus Naylor et.al.(2007) predict an average loss for East Java/Bali, an area with a very short monsoon, of 18% in January - April, with a probability of 12%. Different crops are also more sensitive than rice, according to the proportion irrigated.

The 1997-8 El Nino event was predicted well in advance. The information, however, was not made available to farmers. Prior to 1997 the Indonesian Metereologiocal and Geophysical Agency (BMG) did not issue information on the forecasted rainfall in terms of monthly distribution, duration and intensity. There was no institutional mechanism to distribute information. These two problems have now been addressed by both improved climate forecasting models and the use of innovative Climate Field Schools that trains the Provincial Bureaus of BMG as well as farmers in rainfall forecasting using the improved models to improve farming activities. Another part of the adaptation process to climate change is the need to address existing constraints in the efficiency of input use by farmers.

Fertilizer Subsidies and the Impact on Food Security: One of the legacies of the Green Revolution has been an excess application of both nitrogen and phosphorus. The Long-Term Fertility Experiment (LTFE) at the Indonesian Center for Rice Research (ICRR), Sukamandi, West Java was initiated in 1995 to assess the long-term changes in soil nutrient supply, nutrient balance, nutrient use efficiency, yields, and overall sustainability of a double rice cropping system. The results show that yield responses to improved balance of fertilizers especially potassium ranged from 11 percent to 35 percent. With about half of Indonesian soils is classified as low-medium potassium status, the opportunity for productivity gains is significant.

The challenge of improving the basic fertilizer balance by using more potassium and possibly micronutrient fertilizer is not unique to Indonesia but is repeated across the region and has obvious impacts on the need for rice imports. The stagnation in rice yields and the consequent increase in rice imports in Indonesia, Malaysia, and the Philippines are clearly related to poor nutrient balance, particularly the low fertilizer K application rates averaging less than 10 kg P_2O_5/ha in these countries.

The Government is keenly aware of the rising fertilizer subsidies and the negative environmental externalities of excessive urea use. Subsidies on compound fertilizers (NPK) have been increased by 450,000 tons in 2008 as part of the strategy for expanding NPK use.While imports of potassium chloride (46% K) have increased in recent years the current level of imports (1.3 million tons or 598,000 tons K equivalent) are far below even the incremental needs for expanded production.

The Way Forward: Future rice food security in Indonesia will depend on the rate at which investment in research and outreach can improve yields beyond the 1990-2000 average rate of about 0.47% per annum. An overhaul of the research system is essential especially given the chronic underfunding of agricultural research in Indonesia. While setting up a national broad-based research consortium for climate change is laudable, it will be ineffective with the current limited funding. Similarly, the outreach program to farmers on using climate-related information to make farm management decisions has seen remarkable progress but this is again in danger of petering out if not supported by adequate local government and central government funding. In essence, policymakers need to take a view of research funding based on its economic rate of return to the nation and not its direct annual financial cost. Technologies like the Bayer Direct Rice Seeder offer a lot of promise for improving productivity and at the same time saving water and labor use. But technology dissemination and awareness-raising of farmers is key. A well-functioning research and outreach process is vital to achieving the rates of gain in yield now being seen in Vietnam.

Price Stabilization and the Role of Bulog: Domestic developments over the last three months highlight the need for a more rational and less political decision making process if Bulog is to perform its rice stabilization role more effectively. *Ad hoc* policy decisions on the scope of the RASKIN (food-for-poor) program are being made without proper planning and adequate input from Bulog on the feasibility of it being able to source the supplies needed. As a *Perum*, Bulog is mandated to pursue "commercial" endeavors, but admonished to "not lose money" on these ventures. In the short run, this is an unrealistic policy in general and this stricture is precluding ambitious domestic procurement efforts from getting of the ground. With a lapse of over two months, this year's effort has not yet got off the ground as Bulog reports it is still lacking 1) a credit guarantee, 2) a loss guarantee, 3) a legal instrument that allows rice purchased above the HPP to be used in the Raskin program, and 4) a decree specifying that the quality purchased commercially will be higher than that secured under the HPP.(Slayton, 2008) Because of these delays, the prospects for major purchases at relatively attractive prices are much diminished likely necessitating larger (and more expensive) imports than otherwise would have been the case. In order for Bulog to perform its role more effectively, three actions need to be undertaken. Firstly, the President should appoint the head of Bulog as the special rice policy coordinator, upgrading Bulog's role from implementer of decisions made by others to a key player at both the design and policy levels; second, Bulog should be given standing authority to import at least 500,000 metric tons of rice annually without any prior approval or restrictions on the timing of those arrivals, and third, Ministry of Finance must provide standing credit guarantees to cover Bulog losses that might result from its commercial buying efforts on behalf of the government. The volume to be purchased and the maximum expenditures would be subject to approval by the Economic Coordinating Minister.

Conclusion: The productivity challenge to climate change adaptation in rice in Indonesia lies in finding means of both applying advances from research in varieties, fertilizer, water, pest management etc and improving farmers' ability to cope with and predict changing season length and available rainfall or irrigation water. The results from this study demonstrate that sources of increased productivity are available but have not been applied, either because of a failure in investment in research outreach and extension services or because of inappropriate subsidy policies. Of equal importance is the fact that a lack of a market-oriented rice policy as well as misplaced fertilizer subsidy policies can negate the gains of improved productivity. These problems are exacerbated by ever declining areas of the most fertile and productive lands due to land conversion and an inadequate appreciation of the role of climate prediction in improving farmers' ability to adapt to climate change and possibly lower prices under lower subsidy policy regimes in the future.

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Introduction

1.1 Understanding climate change

The issue of climate change relates to variations in climate which can be attributed directly or indirectly to human activity that increases the concentration of greenhouse gases (GHGs) in the global atmosphere. Such human-induced change occurs in addition to natural climate variability observed over comparable time periods (IPCC, 2001).

There is increasing interest in climate change issues in Indonesia particularly in the lead-up to the COP13 meeting in Bali in December 2007 when there was renewed focus on Indonesia as the third largest emitter of GHG in the world due to deforestation, peatland degradation, and forest fires. (See Table 1.1)

Table 1.1 GHG emissions summary (MtCO2e)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Energy	5752	3720	275	303	1527	1051
Agriculture	442	1171	141	598	118	442
Forestry	(403)	(47)	2563	1372	54	(40)
Waste	213	174	35	43	46	124
Total	6005	5017	3014	2316	1745	1577

Source: PEACE 2007. Indonesia and Climate Change: Current Status and Policies

In Indonesia, the agriculture sector[2] employs the largest share, 45 percent, of Indonesia's labor and contributes the second largest share, 17.5 percent, of GDP. Poverty is a largely rural phenomenon. In 2002, 61 percent of the poor earned their livelihood in the agricultural sector while 63 percent of Indonesia's poor population resided in rural areas. In Indonesia, the agriculture sector is the main source of methane emissions as it accounts for 59 percent of total national emissions. Seventy percent of the emissions from the agriculture sector are generated by rice cultivation. Methane emission in agriculture is mainly due to inefficient practices such as over-irrigation, misuse of fertilizer, and poor livestock feeding practices (PEACE, 2007). According to Las et al (2006), 8.5 million hectares of paddy land and tidal swamp farming in Indonesia contribute significantly to agriculture GHG emissions. A

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1.2 Climate Change Effects on Agriculture

Climate change will result in temperature increases, changes in precipitation patterns, and changes in the hydrological cycle in terms of a prolonged dry season and a shorter but more intense wet season, and changes in soil moisture which will have an impact on agricultural productivity. While the magnitude or direction of impact for individual countries or regions remains uncertain, climate change is expected to affect crop yields and agricultural production. The impacts could be biophysical, ecological and economic.

Climate change can influence agriculture in a number of ways[3]. One can roughly group the drivers into six categories.

- **Temperature** as it affects plants, animals, pests, and water supplies. For example, temperature alterations directly affect crop growth rates, livestock performance and appetite, pest incidence and water supplies in soil and reservoirs among other influences.

- **Precipitation** as it alters the water directly available to crops, the drought stress crops are placed under, the supply of forage for animals, animal production conditions, irrigation water supplies, aquaculture production conditions, and river flows supporting barge transport among other items.

- **Changes in atmospheric CO2** as it influences the growth of plants by altering the basic fuel for photosynthesis as well as the water that plants need as they grow along with the growth rates of weeds.

- **Extreme events** as they influence production conditions, destroy trees or crops, drown livestock, alter water supplies; influence waterborne transport and ports; and damage aquaculture facilities

- **Sea level rise** as it influences the suitability of ports, waterborne transport, inundates producing lands and alters aquaculture production conditions.

- **Climate change motivated greenhouse gas net emissions reduction efforts** as they would influence the desirability of production processes and the costs of inputs plus add new opportunities.

Agricultural sensitivity to climate change has been reviewed in many IPCC documents. The effects on plants, land and water/irrigation are summarized below:

- **Plants** -- Climate change alters

  » Crop and forage growth -- climatic change can diminish crop growth in some places but also can increase crop/forage growth in places where productivity is cold limited by extending the growing season or removing frost risk. Extreme events can also damage crops, trees or forage availability.
  » Crop and forage water needs -- higher temperatures can increase plant and tree respiration needs and raise water demand.

- **Soils and land supply**-- the vast majority of agricultural production is tightly tied to the soil as a source of nutrients, stored water, etc. Climate change can alter soil characteristics including :
  » Soil fertility -- increased temperature generally stimulates the rate of microbial decomposition in the soil which in turn diminishes organic matter content along with nutrient and moisture holding capacity.
  » Soil moisture supply -- temperature, precipitation and organic content affect soil moisture supply. Increases in temperature lead to diminished soil moisture supply and thus increased precipitation would need to occur in order to replace diminished moisture supplies.

3 The following two sections draw from McCarl (2007).

» Land loss and non-agricultural competition for land—sea level rise can inundate land and severe climate change can lead to serious degradation making land largely unsuitable for agricultural use. Climate change may also alter demand for land such as housing or actions to designate protected areas for species protection or migration.

- **Irrigation Water Supply** -- irrigation water is a key input to many productive agricultural lands. Climate change can alter the amount of water available for irrigation by increasing losses from water bodies, reducing runoff or increasing nonagricultural competition.
  » Availability and Evaporation loss -- precipitation is ultimately the source of much of the irrigation water (not always so for groundwater). However, higher temperatures can lead to greater evaporation losses which diminishes water supply so climate has a major affect on irrigation water and water availability.
  » Run-off --irrigation waters drawn from surface and groundwater sources largely originating from rainfall which in turn is either used by native plants and trees, infiltrates and or runs off into water bodies. Changes in precipitation and climate regimes influence the composition of landscape vegetation which can alter runoff amounts and seasonal patterns.
  » Non-agricultural competition -- water is used by industries, households and cities for cooling, manufacturing, and landscape maintenance.

  » Changing temperature and precipitation regimes can expand nonagricultural water demand which typically has a higher use value than agriculture and thus has the potential to diminish agricultural supplies.

In Indonesia, the doubling of CO_2 concentration in the atmosphere could be positive or negative. It may be an advantage as it will support the photosynthesis process. Solar radiation will have positive impacts while the rise
in temperature will likely have negative impacts on agricultural productivity. Changes in rainfall patterns will have either a positive or negative effect depending on geographical location. (Amin, 2004)

While additional rainfall can augment water supply for irrigation, it could also accelerate soil erosion with impacts being more serious in upland areas where farmers will suffer from deteriorating soils quality and abrupt changes in water supplies due to soil erosion and new precipitation patterns (PEACE, 2007).

1.3 Study Rationale and Organization:

A report entitled **"Issues in Indonesian Rice Policy"** was prepared by the Bank on the request of the Government of Indonesia (Ministry of Trade, Coordinating Ministry of Economic Affairs) in Februray 2007. The objective of the study was to evaluate the extent to which current rice policy is consistent with the food security and poverty reduction objectives of the government and, where appropriate, to propose adjustments to current policy to meet these objectives. The aim was to produce a quick synthesis of existing knowledge based on existing reports/data as an input to the government in thinking through its immediate policy options. The report was judged to be useful to the Government and provided a guiding framework for rice policy issues. The Govt. has since requested that the Bank continue to provide technical assistance and analytic work on additional specific topics relating to rice policy through FY08.

Given the uncertainty over the data, the potential threat to food security associated with a shortfall in the availability of rice due to climate change, coupled with the broader need to revitalize agriculture, the Government felt the need for a specific study on rice policy in Indonesia that would build on the report produced earlier and propose longer-term solutions consistent with the Government's objectives.

The key Ministries that are involved are the Coordinating Ministry for Economic Affairs (EKUIN) and the Ministry of Agriculture. EKUIN's request was that the proposed study provide an assessment of the adaptation issues surrounding climate change and rice production in Indonesia and the options for policy interventions. The study does not include any original modeling research but instead relies on a detailed review of the relevant literature, discussions with key informants in the public and private sectors in Indonesia, and a separately commissioned study on Bulog to arrive at conclusions and recommendations as to how Indonesian rice agriculture needs to adapt to, inter alia, climate change challenges in order to ensure its food security needs.

The audience for this study is primarily the Government of Indonesia. It is intended to provide an overview of the issues in adaptation in agriculture, including an assessment of the current measures undertaken by the Government. Rice agriculture is used as the lens to identify potential agronomic, policy and trade measures that need to be taken into account in order to meet future food security needs. The rationale for the focus on rice is simple. Rice is the single most important commodity in Indonesia. Almost all of Indonesia's 220 million people consume rice, and for most it is the staple food. Rice is also an important part of the rural economy. Although only 38 percent of all rural households actually grow rice, many more are connected to the rice economy through services, labor and trade. Getting rice policy right is therefore essential for food security and for income and employment growth in rural areas.

The study is organized as follows: the introductory chapter is followed by a chapter that discusses the key elements of adaptation in a general agricultural context. This is followed by a review of the literature on climate change in Indonesia and the implications for improving rice productivity in the context of concomitant changes in land use. Chapter 4 focuses on two key issues for economic/policy options as part of the adaptation agenda. The first relates to the important role of Bulog, (logistics agency) and the second pertains to the current structure of the fertilizer subsidies. The final chapter presents conclusions and recommendations.

Chapter II
What is Adaptation ?

2.1 Background

Adaptation is a process through which societies make themselves better able to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These range from technological options such as increased sea defenses or flood-proof houses on stilts, to behavior change at the individual level,such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Cross-cutting responses include poverty reduction and economic reforms, improving the information base, strengthening planning and coordination, promoting participation and consultation, improving disaster preparedness, investing in technology development and dissemination, and establishing effective financial safety nets and insurance systems.

Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on climate change but also on the type of development path that is pursued. Adaptation to climate change is a multi-dimensional process, integrating components such as awareness raising, priority setting, sound planning, capacity building, research and technology development and transfer, and resource mobilization. Addressing climate risks and taking adaptive action will require both individual and collective action, involving firms, communities and governments. As highlighted in the Stern review, development itself is a key to adaptation in developing countries (East Asia Environment Monitor, 2007). At the centre of efforts to address climate change on the international stage is the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC provides the basis for concerted international action to mitigate climate change and to adapt to its impacts. The Convention refers to adaptation in several of its articles although this is essentially focused on adaptation in a more narrow sense than is used in this study.

2.2 Basic Forms of Climate Change Adaptation[4]

In the face of the above climate change drivers and agriculture productivity affects there are a number of different types of mitigating actions that could be pursued. Actions to mitigate or facilitate adaptation to climate change can be undertaken by:

- Agriculture operators like farmers, foresters and fishers
- Industry actors like input suppliers, and processors.
- Public entities like the government, international research organizations, universities
- International donors

The fundamental actors in terms of adapting agricultural production are the persons producing the sectoral outputs who manage the land, trees, boats, aquaculture facilities and capital resources with which production occurs. These individuals can choose to make changes in their management regime and activity mix, adopting alternative practices or enterprises which through their use make adaptations to changing climatic conditions. Some of the fundamental forms of adaptation are:

- **Crop, forage, and tree species/varieties** -- one can choose in the face of climate change to adapt by altering the mix of crop, forage grasses or trees species employed for example growing crops, grasses or trees which are more heat tolerant. More generally this involves replacing some proportion of the crop, forage and tree species populating the land with alternative species that perform more suitably in the face of the altered climatic regime. Typically this involves adopting practices from areas that have historically exhibited comparable climates. Adaptation can also involve adoption of alternative varieties of the same crops or trees that are more suitable in the face of the altered climate due to for example lower water needs, increased resistance to pests and diseases etc.

- **Livestock and fish species/breeds** -- one can choose in the face of climate change to adapt by altering the mix of livestock, aquaculture fish species or target fish species. More generally this involves replacing some proportion of current species or breeds raised with alternative species or breeds that perform more suitably in the face of the altered climatic regime or in a fisheries context seeking alternative species that have potentially migrated into the fishing grounds. In aquaculture and domestic animal raising this involves adopting livestock/fish species from areas that have historically exhibited comparable climates. Adaptation can also involve adoption of alternative varieties/breeds of the same livestock or fish that are more suitable in the face of the altered climate due to for example more tolerance to heat, or a resistance to newly prevalent pests and diseases etc.

- **Crop and tree management** -- one can also change the management of the items being grown. In the case of crops one can plant or harvest earlier so as to adjust to altered soil warm-up rates, soil moisture conditions, earlier maturity dates, altered water availability regimes. Trees and can be managed with increased inputs, altered rotation ages, thinning to mitigate fire risk, replanting, or altered pest management among other possibilities. Producers may also use seasonal climate forecasting to reduce production risk.

- **Livestock and aquaculture fish management** -- one may alter the way livestock and fish are managed, altering aquaculture facility characteristics, changing stocking rates, altering degree of confinement, improving rangeland forages, providing shade/ water among many other possibilities.

- **Moisture management/irrigation** -- climate change can increase crop water needs, decrease water availability, decrease soil moisture holding capacity and/or increased flooding/water logging. Adaptation may occur in the form of provision of irrigation water including investing in facilities, changing drainage management regimes, altering tillage practices to conserve water, altering time of planting/harvesting to better match water availability, changing species to more drought tolerant plants/trees etc.

4 This section and the following section are extracted from McCarl, 2007.

- **Pest and disease management** -- Climate change is likely to exacerbate pest, disease and weed management problems Adaptation can occur through wider use of integrated pest and pathogen management or preventative veterinary care, development and use of varieties and species resistant to pests and diseases, maintaining or improving quarantine capabilities, outbreak monitoring programs; prescribed burning and adjusting harvesting schedules.

- **Land use or enterprise choice change** - - climate change may alter the suitability of land or a region to such an extent that certain enterprises are no longer sustainable and that it may be desirable to adapt by changing the land use from crops to pasture or trees, trees to grazing land. On a fisheries side it may be desirable to abandon aquaculture or discontinue pursuing certain fish species in some regions. In either case one would use the associated land, capital and labor resources in other productive enterprises within or outside of the sector. Many of these adjustment possibilities would proceed without need for direct capital investment but many would require some mix of capital and research investments. Almost al would require information and technology dissemination.

2.3 Industry level Private adaptation

Adaptation need not only occur at the producer level but also can occur at the industry level by parties like the following

- **Input supply firms** – such firms could facilitate adaptation by developing new practices, capital equipment, crop, tree, livestock or fish varieties, pest treatment methods/chemicals, chemical additives etc. which would be made available to producers.(Examples such as the direct seeding technology innovation from Bayer Crop Science is discussed in the following chapter).
- **Processing Firms** -- adaptation by such firms would involve altering processing equipment to conform with new product mixes or products of different qualities along with the potential migration of processing facilities to other regions to accommodate shifts in locus of production.
- **Market trading firms** -- firms could move commodities domestically or internationally to accommodate changes in locations of production, and suitability of transportation facilities. Most of these adjustments would be undertaken by profit profit-seeking firms and would not require public investments other than possibly incubator investments or research investments coupled with appropriate technology licensing arrangements to allow firms to pursue various adaptation possibilities.

2.4 Public facilitation of private adaptation

Governments, international organizations, and NGOs have roles to play in adaptation.
This is where a lot of the public oriented investment exposure would occur. The types of adaptation actions that can be pursued are:

- **Research** -- public investment can be placed into research to provide adaptation strategies that could be adopted by the producers as discussed under the individual producer section above. This investment would be in the form of finding of direct government research organizations, international research organizations such as the Consultative Group for International Research, universities or research oriented NGOs.

- **Extension and training** -- traditionally substantial funding has gone into rural training and extension programs. Funding would need to go into those programs to disseminate adaptation options by providing information and training on practices that could be adopted by producers.

- **Transitional assistance** -- climate change may stimulate location changes and migration. There may be an investment role for support of such, creating job opportunities, supporting incomes, developing new infrastructure/institutions, relocating industry, providing temporary food aid, improving market functions and developing insurance.

- **Trade policy** -- governments may need to revise trade policies to adapt to new climate change conditions providing freer access to international markets to allow imports and exports to mitigate lost production and deal with surpluses.

- **Infrastructure development** -- public investment may be needed to adapt to climate change conditions including development of new transport and municipal infrastructure, development of new lands, protect or improvements of existing lands, construction of irrigation/water control structures, protection of coastal resources, and incubation of new industries among other possibilities.

Chapter III

Options for Improving Rice Productivity

3.1 Impacts of urbanization on landuse and agricultural productivity

The important impacts of climate change on agricultural production and productivity are compounded by increasing urbanization that has resulted in loss of valuable agricultural lands, increased pressure on scarce water resources, and reduced labor availability.

As noted by Agus(2006), paddy cultivation in Java has a wide range of benefits to society apart from its value in food production terms These multifunctional roles include flood mitigation, erosion reduction, water resource conservation, organic waste disposal, heat mitigation, and rural amenity. As an example the 156,000 ha of paddy in the Citarum watershed ,analyzed using replacement cost methodology, amounted to about 51% of the value of rice produced or approximately $92.67 million per annum. Nevertheless, paddy land loss nationwide has been dramatic, with about 42% of irrigated paddy fields allocated to existing or future non agricultural use.

Current net conversion rates of paddy to non agricultural use nationwide exceed 140,000 ha per annum, of which 107,000 ha is lost from the most valuable lands on Java.. For each hectare lost on Java, 2.2ha has to be developed elsewhere in Indonesia to compensate for differences in productivity. (Table 3.1)

Table 3.1 Conversion, addition and net balance of paddy fields in Indonesia 1999-2002

	[illegible]	[illegible]	[illegible]
Java(ha)	167,150	18,024	-107,482
Outer Islands (ha)	396,009	121,278	-274,732
Indonesia (ha)	563,159	139,302	-423,857
Indonesia (ha/yr)	187,720	46,434	-141,286

Source: Agus and Pakpahan, 2006

Indonesia is an archipelago composed of 13,667 islands with a total land area of 192 million ha of this, 15.9% is agricultural land and 78.8% is forest and scrub. Only 23% of Java and Bali is forested, less than the minimum level recommended by professional foresters of 30%. This situation implies that any opportunity to convert forest to agricultural land in Java and Bali will be very costly. At the same time, the growth of the industrial sector and urban centers in Java has increased the demand for land. (Pakpahan 1990)

The accelerated conversion of paddy fields to non-agricultural uses has far-reaching implications for the future performance of the agricultural sector in Indonesia (Anwar and Pakpahan 1990).Even though Java has only about 7% of the total land area of Indonesia, it has 60% of the human population. Java is also the most important island for food production, and provides more than 60% of Indonesia's annual production of such crops as corn, cassava, soybean, peanut and other commodities.(Central Bureau of Statistics data 2003). This high level of production in Java is made possible by the island's fertile volcanic soils, highly skilled farmers and well developed infrastructure. (Table 3.2)

Table 3.2 Sources of Rice Production Growth, Indonesia 1981-2000 (%)

Java				
Land size	-0.32	-0.15	-0.42	-1.04
Cropping intensity	1.89	0.86	0.88	2.78
Yield	2.80	2.29	1.37	-1.29
Total	**4.37**	**3.30**	**1.83**	**0.45**
Outside Java				
Land size	0.74	2.56	1.46	-4.04
Cropping intensity	2.23	0.34	1.32	5.47
Yield	2.66	1.75	0.38	-0.27
Total	**5.63**	**4.65**	**3.16**	**1.16**
Indonesia				
Land size	0.22	1.40	0.70	-2.83
Cropping intensity	1.94	0.30	0.88	4.41
Yield	2.66	1.93	0.79	-0.83
Total	**4.82**	**3.63**	**2.37**	**0.75**

Source: Mc Culloch and Timmer 2006

The Ministry of Agriculture has classified land in Indonesia into eight classes of land capability. According to this classification, land resources that are suitable for food crop production are limited to classes I to IV. Out of 134 million hectares of land (land capability class I-VI), only about 22.4 million ha are suitable for food crops. Almost a quarter of that land is in Java, and has already been developed for paddy rice and upland farming. In Kalimantan, however, only about 3% of the land is suitable for food crops, while in Sumatera, Sulawesi and Papua the figures are 21%, 34.8%, and 4.4%, respectively. Indonesia's Basic Agrarian Law (Undang-Undang Pokok Agraria-UUPA), promulgated in 1960, clearly states that land has both social and functional values, and is therefore not a commodity that can be traded for profit. Neverheless, debate is ongoing about the continued validity of the law

The Government is considering a "Law on Permanent Food Crops Land" (CASER 2007). similar to the California Conservation Act (1965) which seeks to preserve a maximum of the limited supply of agricultural land, discourage premature conversion, protect the public value of agricultural land and provide a fair property tax to those owners willing to commit to restricted land use (Firman1997). Nevertheless the enforcement of the law seems unlikely. Indonesia has already had experience of weak enforcement under Presidential Decree 53/1989 which made it clear that industrial estate development should not take place in preservation and conservation areas and should not reduce the area of prime agricultural land. In reality it could not be enforced because the Decree lacked the necessary implementing regulations.

Indonesia's 1999 legislation regarding regional autonomy stipulates that the central government will deal only with fiscal and monetary affairs, international affairs, justice, religious affairs and national economic planning and administration. District *(Kabupaten)* and city *(Kota)* governments are authorized to implement programs in agriculture, education, health, public works, environment and land use, cooperatives and labor. Accordingly, the land-use development permits should now be granted by the mayor *(Walikota)* for municipalities *(Kota)* and by a head of district *(Bupati)* for *Kabupaten*. However, in 2001 the central government issued Presidential Decree 10/2001 which prohibits local and provincial government to issue any regulation pertaining to land-use development.

In practice, land development is controlled by the Kabupaten administrations, with supervision by the National Land Agency (BPN) which manages land records, processes titles and administers land development. In practice, however, only four Kabupaten, seriously respect the national land use plan (Yogyakarta and surrounding areas, Denpasar, Sragen and Pontianak). Most issue permits to developers, with no compulsion on the developers to complete development within a particular time frame and land may lie idle for long periods after the permit is issued. In the interim, the land cannot be accessed by any other developer, the price for the land paid by the developer to the former owners (usually small farmers on areas of less than 0.5ha) can be set by the developer without regulation. Even so, examples exist of farmers destroying infrastructure so that their land can be regarded as "non-functional irrigation" in regard to the requirement of spatial plans which specify that functioning irrigations systems cannot be converted to other uses.

The prevailing mechanism of land transfers has, however, given developers excessive authority, while land-owners have no options regarding who they sell their land to. Even if there are certain mechanisms for negotiating the selling price, in most cases land-owners are in weak position. For example, 20 out of 23 (87%) of land acquisition cases in Surabaya during 1992 and 1993 were forced sales, without the consent of the land owners (Suyanto,1996, p. 47). In many cases of land acquisition in large cities, the land-owners are not satisfied with the compensation *(ganti rugi)* paid by the developers, as it is far below the prevailing land prices. Moreover, compensation is offered only for the lost assets, such as land, buildings, utilities, as well as plants growing on the land. However, this does not include loss of income and other disadvantages experienced by land-owners resulting from unfair land transfer practices.(Firman 2004)

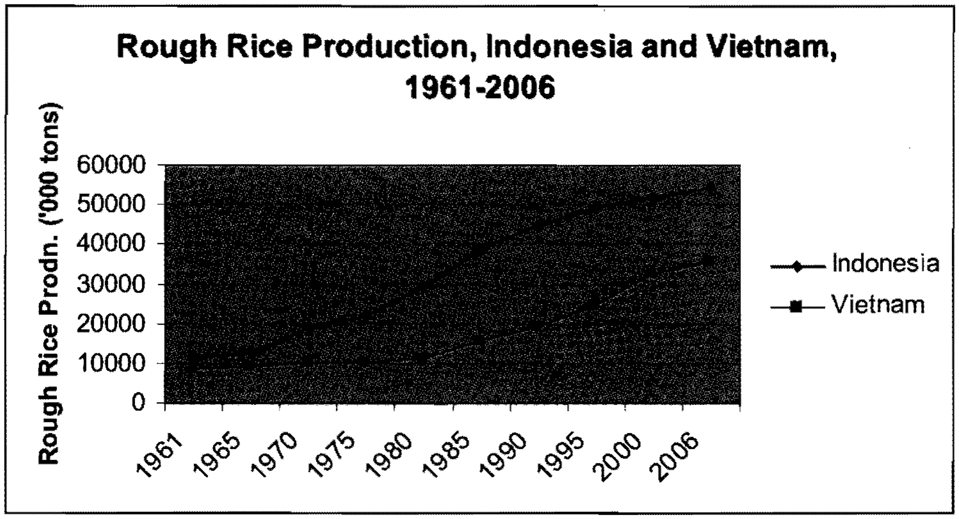
In contrast when the developed land is sold to new users, the price is set by the market. Developers and local governments have powers to persuade and if necessary, threaten small owners. The tendency is to issue too many land development permits on the strength of foreign capital investment, particularly in West Java which result in excessive conversion but also an excess of idle land which creates a shortage of potential sites for development leading to more requests for permits. Few sanctions against development plan violations are imposed. The enforcement of the land use plan *(Rencana Tata Ruang)* has been so weak that the impression has been created that the plan's contents are negotiable (Firman, 1996). Local government budgets with targets based on fees from permits have been a feature of past administrations at the district level. Agricultural land has thus been "commoditized" (Firman 2004), resulting in a net loss of some 480,000 ha of paddy land between 1981 and 1999. Average increases in productivity over this period of about 1.5% per annum have compensated for the loss so far but as noted below (Figure 1,2), Indonesia has reached a temporary limit in terms of the rate at which losses can be compensated for by increased productivity.

In summary land conversion is a part of the normal socioeconomic development process, but in Java it has tended to be dominated by speculation, particularly around major centers. The key issues of land development in Indonesia include poorly coordinated urban land management, an inflexible land regulatory framework, inappropriate land taxation, lack of secure land tenure, and the lack of urban land data and information.

3.2 Agricultural Productivity – History and Evolution

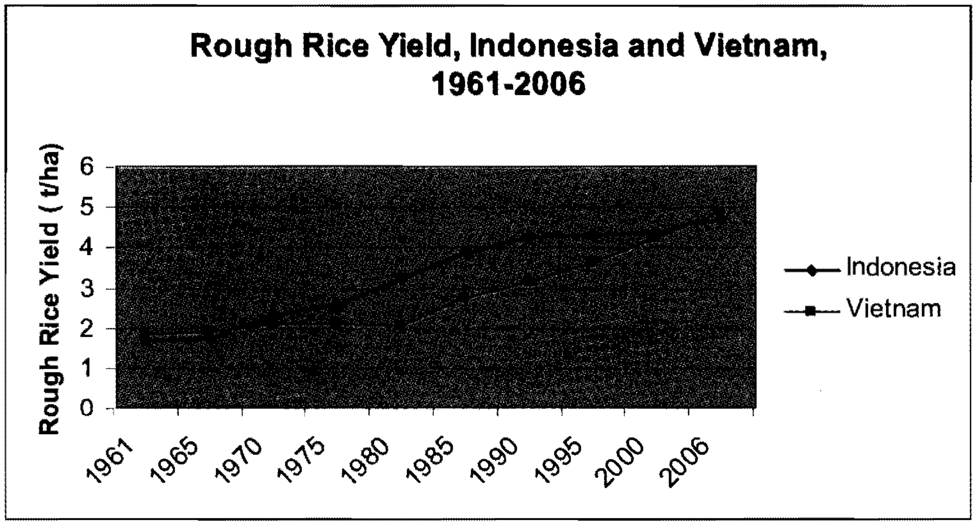
Between 1970 and 1994 Indonesia enjoyed steadily increasing rice yields, relatively stable real rice prices at near the world price, progressive reduction in poverty and progressive growth of the non rural economy (Timmer 2004a, Figure 1)). However, successive El Nino induced droughts in 1991, 1994 and particularly 1997 illustrated the fact that dry years in the main rice growing areas of Java were becoming more frequent. Drought and climate change are not the only influences on crop production, however. Adaptation to drought also involves factors which control productivity and thus the ability to increase water use efficiency.

Figure 1. Indonesian and Vietnamese Rough Rice Production 1961-2006



Source IRRI Rice Statistics 2006

Figure 2. Indonesian Rough Rice Yields 1961-2006



After early rapid gains in yields per unit area due to irrigation, integrated pest management, better seed and increased major nutrient (mainly Nitrogen and Phosphorus) application, increases in productivity in Indonesia have become more difficult to achieve and national average yields and production have been largely stagnant from 1990-2006 (IRRI 2006 Rice statistics).

The situation is in marked contrast to that of Vietnam, where adoption of a "second generation" of green revolution technologies, already available and awaiting adoption, has markedly boosted yields to make Vietnam the most important exporter after Thailand. Vietnam's impressive rates of gain in productivity demonstrate that there is still scope for improvement using known technologies.

Productivity gains in Indonesia, by contrast, have not been assisted by unanticipated effects of the policy of rice price stability. The policy included measures to maintain profitability of rice through subsidy in the face of a decline in the real price of rice from $1000/ton in 1975 to $200/ton in 2004. The long term impacts are potentially less positive and include isolation of the nation from potential development as an exporter, an addiction to subsidy by farmers and a decline in the incentive to raise productivity and to diversify and modernize agriculture, a trend which has been seen elsewhere in Asia (Timmer 2004 b,1993).

(Wassmann and Dobermann (2006) have suggested four means of improving yields whilst adapting to climate change

- Increases in the efficiency of nitrogen fertilizer use
- Increases in efficiency of water management
- Improvements to the efficiency of rice plant metabolism, specifically the development of C4[5] metabolism rice which is tropically adapted
- Utilizing crop residues for carbon sequestration

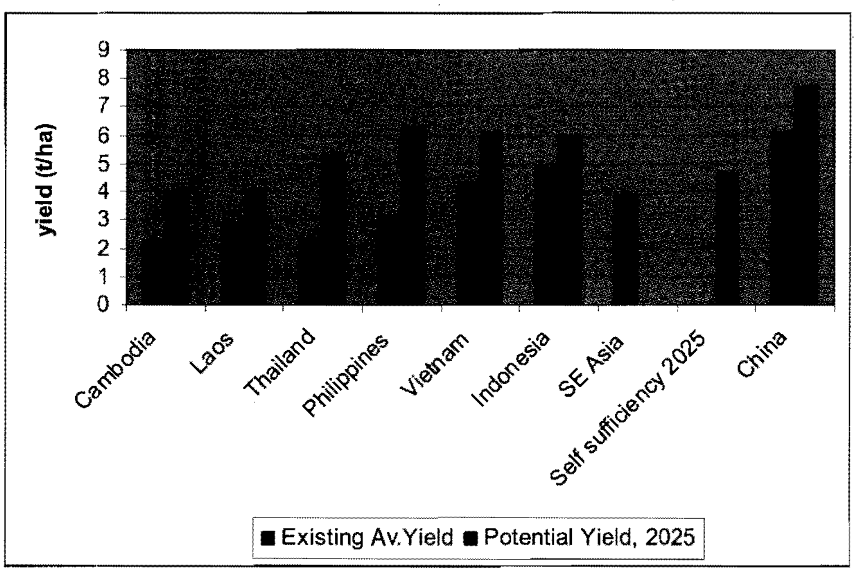
Of these measures, the first two apply to Indonesia immediately, whilst the latter two apply in the longer term if investment by they global community occurs and subject to validation with more modeling. The third point is also relevant given advances in plant breeding with conventional C3 lines, but much of the work already done has not been sufficiently adopted.

3.3 Scope for Yield Improvements in SE Asia – Theory and Practice

There is substantial scope to increase current rice yields. Mutert and Fairhurst (2005) noted that in 2002 farmers in SE. Asia had an average rice yield of 3.4 m.t./ha, a requirement for self sufficiency by 2025 of 4.5t/ha and thus a yield difference of about 25%. Hossain and Narcisso(2003) came to similar conclusions. Analysis of the yield gap by country (yields achievable on farm now compared to those achievable on farm in future with full application of existing technology), however, shows a gap of about 15-50%.(Fig 3)

The area under the most productive and fertile irrigated rice lands, located in areas of high population density, is expected to decrease due to the effects of rapid urbanization and industrialization. Thus, productivity in rice systems must increase from the current average of 3.4 t/ha to at least 4.5 t/ha if food security and export potential of SE Asia are to be maintained (Mutert and Fairhurst 2002). To maintain regional self-sufficiency in rice, the irrigated and rainfed rice systems must achieve yields of 6 t/ha and 3 t/ha, over the next two decades.

Figure 3. Asia- Average and Potential Rice Yields by Country



Sources: Mutert and Fairhurst 2002; IRRI Rice Statistics 2006; FAO data

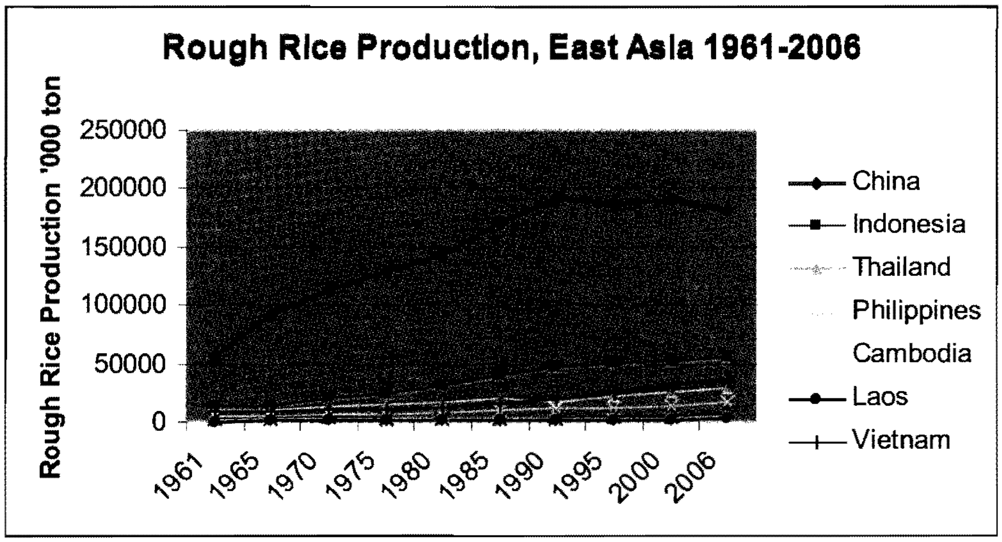
5 Photosynthesis in plants occurs through two systems. In C3 systems the first product of carbon dioxide fixation is a 3 carbon chain compound In C4 plants it is a 4 carbon chain compound .C4 plants like sugarcane are more efficient because they separate photosynthesis during daylight from respiration at night and thus are able to store more of the products of photosynthesis during daylight hours.

Major constraints to improving productivity include low soil fertility, pest and disease damage, competition from weeds, drought in rainfed systems, flooding, soil acidity, poor infrastructure, land fragmentation, and land losses due to urbanization, poor availability and high cost of inputs, low and fluctuating rice prices, land degradation due to salinization, and poor extension services. If the demand for food is to be met in the face of climate change, rice production will need to become more efficient in the use of increasingly scarce natural resources. Better crop, nutrient, pest, and water management practices, along with the use of germplasm with a higher yield potential, are required in order for rice production to be profitable for producers and to supply sufficient affordable staple food for consumers.

China continues to be the world's biggest rice producer, growing one-third of Asia's total on 29 million ha (Fig 4)). India produces nearly a quarter on 43 million ha. Other top rice-producing countries in Asia include Indonesia, Bangladesh, Vietnam, Thailand, Myanmar, the Philippines, and Japan. Average yields in these countries range from 2.6 t ha^{-1} to 6.5 t ha^{-1} (IFC 2006)

Thailand has maintained its position as the world's major rice trader, exporting an average of 8 million tons of rice annually (Fig. 5). Vietnam and India export a total of 7 million tons. A positive trade balance for rice has been maintained by Asia, Australia and the United States. Latin America, Africa, and Europe, however, continue to be

Figure 4. Rice Production 1961-2006



Source: IRRI Rice Statistics 2006

net importers of rice. Price spikes such as those experienced in 2008 are a direct result of low stocks (Fig 5). Utilization of stocks commenced in 2002, on the basis that they are expensive to maintain and can be easily replenished if agriculture is productive. As noted in Fig 4, above, however, production has been stagnating.

Figure 5. World Rice Stocks (million tons) 2002-07

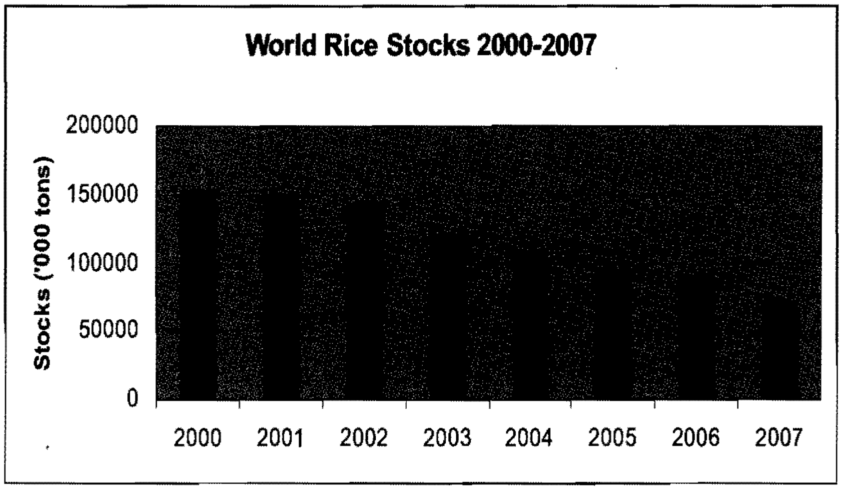
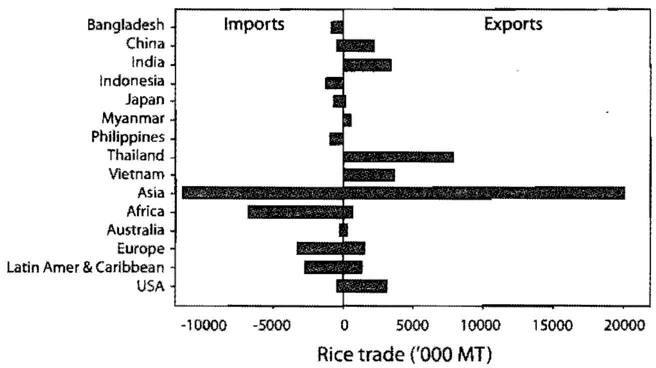


Figure 6. Global rice trade. Data are the average of five years in 2000 to 2004 (FAO 2006).



Low and unstable rice yields compared to those seen in research trials in the main production areas of Java, are not only a result of drought. They are also the result *of a long period of soil nutrient depletion under unbalanced fertilizer regimes* during the green revolution period and losses due to insect pest infestation. A part of the adaptation process to climate change is the need to address existing constraints in the efficiency of input use by farmers. A second challenge is to make the required inputs available by changes in import and subsidy policy on fertilizer.

3.4 The Impact of Climate Change in Indonesia - Short and Long Term Issues

As noted by Naylor et.al. (2007) agricultural production in Indonesia is strongly influenced by both the Austral-Asian Monsoon and the Indo Pacific El Nino Southern Oscillation (ENSO) dynamics . The balance of influence from sea temperatures in the Indian and Pacific Oceans has different effects on western and southern Indonesia compared to eastern and northern Indonesia. Three different long term climatic patterns have been identified for "Western" (North Sumatra, western Kalimantan) ,"Central" (Java, NTB,NTT, southern Kalimantan and Sulawesi) and "Eastern" (northern Sulawesi, Maluku, Halmahera) Indonesia (Aldrian and Susanto, 2003). The ability to successfully predict not only the inter annual climate variability of each region of Indonesia but also the long term influence on the basic climate of global warming and CO2 changes is key to developing a rational food security program.

Short Term Influences on Crop Production

Chief among the short term influences on climate and crop production in Indonesia is the El Nino Southern Oscillation Index (SOI) which measures changes in sea surface temperatures in the Pacific as they relate to periodic dry periods in Indonesia and elsewhere. A clear definition of what constitutes an El Nino year is missing, however, Yokoyama (2003) has used a definition based on a year when the SOI was lower than the standard deviation (-7.28) and the decline in the index compared to the previous year was more than 2.0.

El Niño: the phenomenon

El Niño (Spanish for Christ Child) is the name given by Peruvian fisherfolk to the warming of the surface waters of the Pacific Ocean that tends to occur around Christmas. A natural event that recurs in more or less regular cycles (on average every four to five years), El Niño affects the Pacific from Peru to Indonesia. The local warming of the world's largest ocean also has repercussions for global atmospheric circulation of winds and waters.

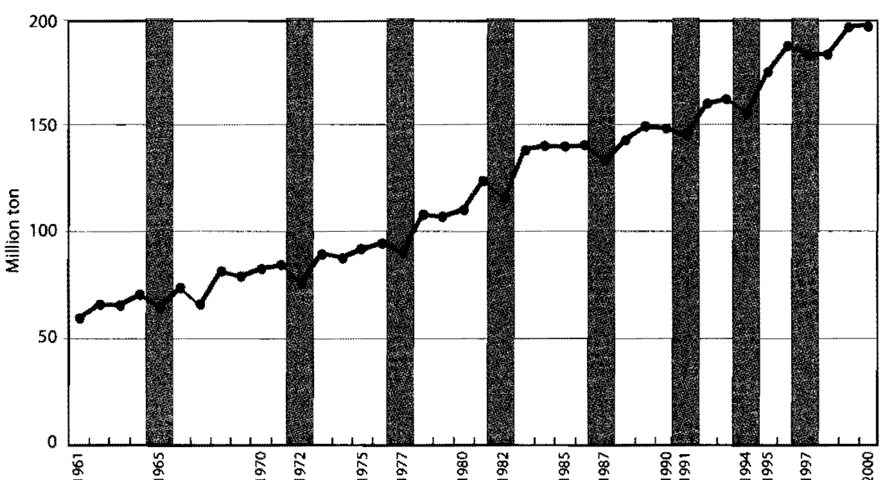
Although some of its effects may be beneficial, the phenomenon is better known for the havoc it can wreak: harvests can be lost, fishery yields reduced and oceanic ecosystems endangered, threatening food security in many regions. The disturbance can produce droughts in southern Africa, parts of India, Indonesia, Australia and certain regions of the Americas, floods in Kenya, Argentina and the United States, erratic monsoons in South Asia and extremely high temperatures in Japan and some regions of Canada.

Although the warming of the waters may last from 12 months to five years, a time lag between the phenomenon itself and many of its most important climatic consequences means that repercussions are long term. The intense El Niño of 1982/83 brought devastation to more than 15 countries.

Source: FAO News Highlights 14 October 1997

On this basis, El Nino events have increased in frequency consistently over the last 40 years, occurring once in the 1960s, twice in the 1970s- 80s and three times in the 1990s (Yokoyama, 2003) The impact of El Nino on rice production has been shown by Yokoyama to be related to area harvested rather than yield. The trend was different, however, for the two main periods of rice production expansion (1961-1980) and rice production stagnation (1980-present). Irawan (2002a) found that 58% of the 1454 wetland rice producing kecamatens suffered area losses averaging 6.9% per kecamaten. Some 52% of dryland rice producing kecamatens suffered area losses averaging 19%.

Figure 7. Changes in Cereal Production compared to El Nino occurrence, Asia Pacific, 1961-2000. (data of Shigeko Yokoyama)



Note:
$lny = -43.12 + 0.031x - 0.080D$
(R^2 + 0.98, significant at 1% lev
y : The total cereal production (metric ton)
x : Years
D : El Nino dummy
Data source: FAOSTAT

Yokoyama (2003) used a dummy variable to simulate an El Nino effect. The dummy variable was statistically significant for area harvested in both periods, significant for its impact on total production in the first period but not significant for yield in either period. Declines in area harvested in El Nino years are apparently compensated for by increases in yield on the area actually planted, possibly due to greater solar radiation in (irrigated) areas. When non- El Nino years of production decline (compared to the previous year) were investigated, he found that the area harvested and yield declined simultaneously.

Yield loss is not inevitable. Irawan(2002a) notes that in the El Nino years 1982-3 the government 's Special Intensification Program resulted in yield increases of 3-7% in wetland rice, dryland rice and maize. In cassava, groundnut and sweet potato the increases were 1-2%. The program involved:

- Farmer group formation for food crop management
- Application high yield variety seed , fertilizer and pesticides

Nevertheless, in 1997 yields and area harvested both decreased because the simultaneous onset of the economic crisis which made the necessary input subsidies prohibitive. Rice yields therefore decreased by almost 4% , wetland area harvested by about 4% and rice production by some 1.2 million tons . Most of the harvested area loss occurred in the dry season of 1997-8. (Irawan, 2002a). Palawija crops such as soybean suffered declines as high as 15% nationally (Table 3.3).

The loss of production, (measured as the percentage deviation from a five year moving average) in eight El Nino years between 1965 and 1997, averaged 4 percent. This loss compared to an average loss of 6 percent (12 percent in 1967) for the non El Nino years (Yokoyama, 2003). Furthermore the loss in El Nino years was mostly a single year phenomenon and was compensated by production gains in the following year. Production variability during 1963-1998 was greatest for maize (13.5%) due mainly to changes in area harvested and least for rice (3.5%) , probably because of the impact of irrigation on rice yield. For particular regions the losses may be higher. Thus Naylor et.al.(2007) predict an average loss for East Java/Bali, an area with a very short monsoon, of 18% in January –April, with a probability of 12%. Different crops are also more sensitive than rice, according to the proportion irrigated (Table 3.3).

Table 3.3 ENSO Sensitivity by Crop In Indonesia 1963-1998

Crop	Production (1)	Area Harvested (Ha)	Yield
Maize	0.61*	0.61**	0.2
Sweet Potato	0.48*	0.46**	0.05
Soybean	0.41*	0.43**	-0.02
Groundnut	0.34*	0.52**	-0.25
Rice	0.23	0.50**	-0.17
Cassava	0.16	0.05	0.16

1 Correlation between percentage deviation from 5 year moving average and SOI monthly average (Jun-Sep)
Significance **P<0.01, *P<0.05
Source: Irawan (2002a)

The conclusion from experience of El Nino events must therefore be that whilst El Nino has a potential impact on rice area, it is not as severe as in maize, and is compensated for by increases in yield within the El Nino year and in the following year. The variations in production in non El Nino years are actually more worrying as they involved both yield and area harvested. Factors affecting productivity other than climate are thus of concern for rice production in Indonesia.

Farmer response differs depending on whether the climatic event can be predicted before planting or not. Thus Irawan (2002a) notes that where the event can be predicted before planting the strategies used are

- Crop diversification and water rationing
- Use of drought tolerant (principally shorter season) varieties
- Postponing planting

Where the event occurs after planting, the alternatives are more drastic

- Replant with alternative crops or drought tolerant varieties
- Thinning, use of pesticides to reduce damage to remaining plants
- Premature harvest (leading to reduced yield and quality)

Of these options, premature harvest was the most common response, with 17.6% of wet season and 11.1% of dry season crops harvested early. Early harvest was particularly noticeable in maize, groundnut and soybean.

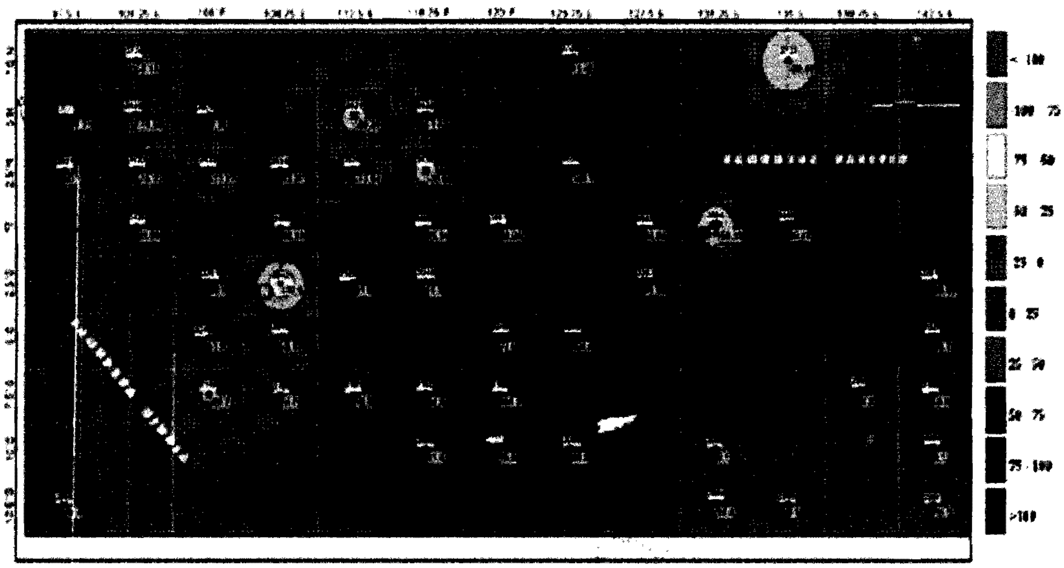
Irawan (2002a) analyzed the impact of the 1997 El Nino event to determine a vulnerability index by kecamatan for Java. He found that kecamatans with similar altitude and rainfall could have widely differing vulnerability because of factors such as lack of input kiosks, transport infrastructure social and cultural characteristics of households which determine adaptability, including relative poverty. Areas of lower farm size and higher crop intensity were also more vulnerable. The statistically significant factors affecting area loss included altitude (>500 meters more vulnerable to lower rainfall), percentage of crop area as technical or traditional irrigation , irrigated area (<0.5ha more vulnerable) , crop intensity , average rainfall in preceding 5 years and the ratio of households to cars (a measure of poverty and transport infrastructure).

Prediction of Climate Abnormalities

The 1997-8 El Nino event was predicted well in advance . The information, however, was not made available to farmers (Irawan 2002a). Prior to 1997 the Indonesian Metereologiocal and Geophysical Agency (BMG) did not issue information on the forecasted rainfall in terms of monthly distribution, duration and intensity. There was no institutional mechanism to distribute information. These two problems have now been addressed by both improved climate forecasting models and the use of farmer field schools and training of Provincial Bureau of Meteorology staff in rainfall forecasting using the improved models (Irawan 2002a).

In order to predict when El Nino years might occur, Ratag (2007b) used an iterative approach to match observed rainfall distribution with the balance of climatic influences from various sources in order to predict inter annual rainfall variability in the near term . For rainfall in Indonesia, it is common to find the presence of annual oscillations associated with monsoon, 2-5 year oscillation associated with ENSO, ~3 year oscillation associated with Indian Ocean Dipole Mode and a semi-annual oscillation (SAO) associated with the movement of the inter-tropical convergence zone (ITCZ) which passes the sites twice a year. Ratag has developed time-series forecasting based on "wavelet transformation" (wavelet transformation removes the "noise in a timeseries from the real changes). The method first forecasts all the basic periodic signals constituting the rainfall time-series and then combines the resulting forecasts. The forecasting of these individual signals was performed using a simpler time-series forecasting technique (ARIMA, or the neural network based technique). His forecasting of individual climate events has reached a prediction accuracy of 90% in terms of location and amounts. A sample of the outputs from the work is given below (Fig. 8) showing that future climate will be dominated by generally higher but more intense rainfall, particularly in eastern Indonesia.

Figure 8. Average change in precipitation pattern (1900-2000) Sept-Oct-Nov(mm/100 yrs) (Ratag 2007 in DFID 2007)



To determine future changes in the influence of various phenomena (ENSO, Indian Ocean Dipole effect, ITCZ effects etc) under climate change on rainfall, Ratag uses changes in the amplitude of signals from these sources. The changes in the amplitudes of the basic signals associated with the phenomena become a good indicator of the changes in the phenomena themselves over time

Using this methodology, Ratag (2007a) has mapped the areas where the wet and dry seasons are changing in date of onset. (Figure 9) For example, since 1930 the wet season has shifted forward by about 60 days in West Sumatra, Jambi, Jayapura and Merauke. It has moved backward by 30 days in Banten and Jakarta but remained constant in Ujung Kulon, Ujung Pandang, Madiun, Malang, Kediri, Pacitan, Gresik Tuban and Blitar.

The term Dasarian refers to a 10 day period of the month (Dasarian 1= days 1-10 , Dasarian 2= days 11-20 and Dasarian 3= days 21-30/31)

Figure 9. Wet Season Anomaly From 1990-2003 Compared to 1961-1990 Period (Ratag, 2007)

No change detected
shift forward 1-2 dasarian
shift forward 3-4 dasarian
shift forward 5-6 dasarian
shift backward 1-2 dasarian
shift forward 3-4 dasarian
shift forward 5-6 dasarian

The approach of Ratag (2007a, b) seems well suited to prediction of inter annual climate variability and the change in the impact of all influences. Ratag is using the approach to develop Kabupaten level field school training of farmers by trained trainers in Kabupaten meteorology offices using current rainfall patterns. However, it has not been shown that the use of historical data in his approach can reliably predict future climate in the medium term.

Potential Long Term Effects of Climate on Crop Production

It is generally recognized (eg. Naylor et.al 2007) that the Global Climate Models (GCMs) based on changes in carbon dioxide and temperature regimes, (even the 3 dimensional models when used in groups of up to 20), are not sufficiently accurate to simulate the annual variation in precipitation for a particular region with its unique geographic features which influence wind, humidity, temperature etc. These CGMs simulate the large scale ($200*200km^2$) atmospheric circulation leading to the general tropical monsoon pattern quite well, but the regional ($50*50km^2$) hydrogeological cycle is often poorly reproduced (additional information section, Naylor et.al.2007,).

The response of researchers such as Naylor et.al.(2006) and Ratag(2007) has been to develop empirical sub models which match observed precipitation to various measures of climate. Naylor et.al compared observed precipitation with simulations from 3 downscaling sub models (which used specific humidity in response to warming, specific humidity and sea level pressure, and specific humidity plus upper and lower atmosphere zonal winds). The upper and lower zonal winds change direction with the onset of the monsoon and thus predict monsoon onset quite well. Specific humidity and pressure predict atmospheric moistening and thus precipitation .

Naylor et.al. (2007) used their approach to investigate future trends in climate by using the outputs of their EDMs to modify and improve the CGM combinations. They show that the probability of a 30 day delay in monsoon onset is currently about 9% for East Java/Bali and 18% for West/Central Java. The predicted impact by 2050 on rice production during January-April for East Java/Bali of such a delay is about 11% and for West/Central Java about 6.5%. This corresponds to a production decline of about 580,000 tons in West/Central Java and 540,000 tons in East Java/Bali respectively. Declines of this magnitude are similar to the impact of a bad El Nino year such as 1997. As bad as such losses seem, the potential for productivity increases(e.g. section 3.5.1 below) could still compensate for them.

Nevertheless, the approach used by Naylor et.al.(2007) has a weakness in that only one of the CGM combinations used by them has realistic ENSO variability. They assume constant rainfall variability patterns over time and use empirical ENSO variability for 1950-2000 to predict longer term trends in precipitation. Thus they do not appear to answer the question of whether long term changes in the basic climate due to global warming will affect the ENSO phenomenon.

Both modeling approaches (Naylor et.al 2007 and Ratag ,2005) give good matches between model data and observed inter annual variation in precipitation based on historical data, particularly for Java and Bali where some 60% of Indonesia's rice is produced (Amien et.al.1999). However, some caution is needed when interpreting predictions of future climate. The changes in the probability of a delay in the date of monsoon onset predicted by Naylor et.al., for example, are relatively small. The authors do not predict that delays in monsoon onset and declines in yield are 100% likely in every year by 2050. The actual changes in yields predicted are also small relative to potential annual gains from applying research effectively between now and 2050, reducing land conversion and increasing farmers' ability to predict and adapt to climate variation.

3.5 Agronomic causes of low rice yields

There was a substantial increase in the productivity of lowland rice in Indonesia between 1960 and 1990. The development of the planted area and yields of lowland rice since the beginning of the intensification programs in the early 1960s are presented in Table 3.4.

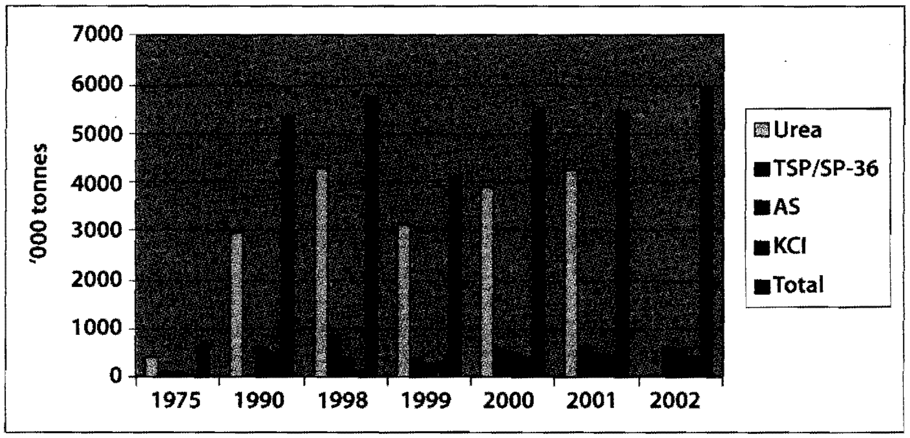
Table 3.4 Development of planted area, production, and yield of lowland rice in Indonesia

1960	6567	14302	2.18
1975	8532	23443	2.75
1990	10502	45179	4.3
1998	10681	46291	4.33
1999	11963	50870	4.25
2000	11794	51900	4.41
2001	11500	50461	4.39
2002	11521	51490	4.47

Source: Indonesian Fertilizer Producers Association (IFPA), 2004 and FAO (2005)

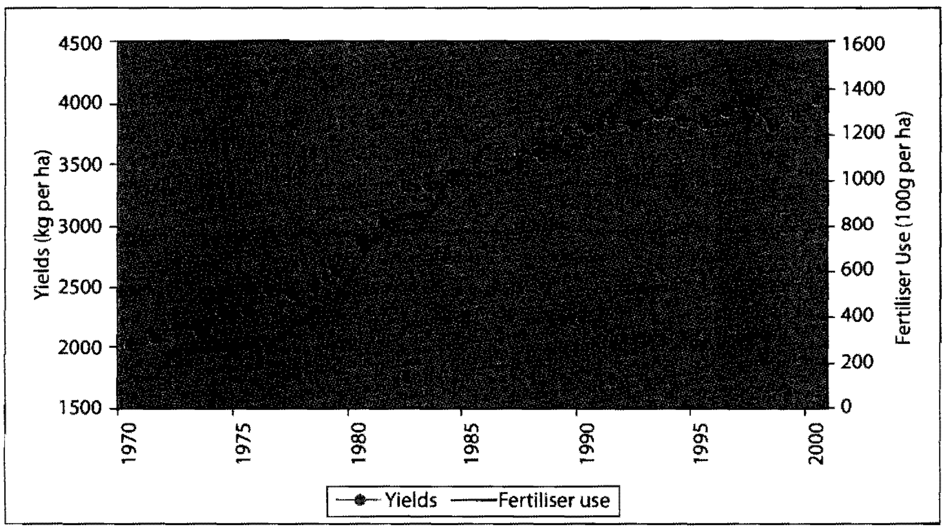
Development of the planted area, and the average yield went hand in hand with fertilizer use to increase production of lowland rice, although fertilizer inputs were dominated by urea (Fig.8) These large increases were due to consistent government support of increased national food production by means of a good supply of agricultural inputs (i.e. fertilizers, pesticides), capital and guaranteed prices, accompanied by extension efforts to encourage the implementation of improved technologies. Between 1975 and 2002 fertilizer consumption increased more than nine-fold (Figure 8), from 635 to 5 931 thousand tons, an average increase of 49.6 percent per year (Indonesian Fertilizer Producers Association, 2004). However, during the 1990s yields began to stagnate whilst fertilizer consumption kept increasing (Figure 10; World Bank 2004, Indonesian Fertilizer Producers Assoc. quoted by FAO 2006)

Figure 10. Development of Fertilizer Consumption in Indonesia 1975-2002



Between 1990 and 2002, the rice area increased only slightly, from 10.5 to 11.5 million ha. The yield increased by a total of four percent, an average increase of just 0.3 percent per year. *This small increase in rice yields coincided with static use of fertilizer materials other than urea.* Urea use still increased at an average annual rate of 0.9 percent. (Figure 11; World Bank 2002) and is now excessive, with farmers on Java using up to 600kg/ha compared to recommended rates of 150 kg/ha (MOA pers com) to enhance crop appearance before contracted sales.(see for example data in Appedix 2 b) . However, several authors also comment on the fact that urea use, particularly on Java is excessive, particularly on small farms(see Pakpahan, 1990, Squires and Tabor 1997, Makarim, 2000, FAO 2005)

Figure 11. Fertilizer Use and Cereal Yields in Agriculture in Indonesia, 1970-2000



The decreases in fertilizer consumption for fertilizers other than urea were due, among others, to the following factors (IFPA, 2004, quoted by FAO 2005):

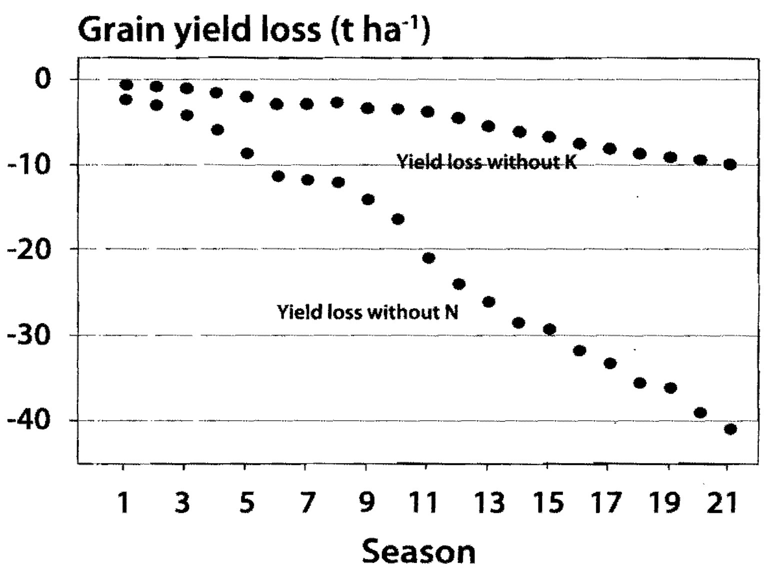
1. Removal of fertilizer subsidies i.e. for potassium chloride in October 1991, TSP/SP-36 in October 1994 and urea in December 1998. (since reinstated in 2003 for all fertilizer used on food crops and smallholder plantations). The subsidy on phosphorus as TSP/SP-36 was replaced with a subsidy on double superphosphate, a sound move given the requirement for sulfur and the excess use of phosphorus in some areas
2. A policy to reduce phosphorus fertilization on Java Island due to the accumulation of residual phosphorus.
3. A reduction in the extension services.
4. The low purchasing power of farmers.

One of the legacies of the Green Revolution has been an excess application of both nitrogen and phosphorus. However, comparison of soils from sites sampled in 1970 and 2006 (Darmawan,et.al.2006) has shown that potassium decreased markedly in areas which were supplied with standard fertilizer mixtures (nitrogen plus phosphorus) , whereas phosphorus content of the soils approximately doubled.

The Long-Term Fertility Experiment (LTFE) at the Indonesian Center for Rice Research (ICRR), Sukamandi, West Java (an area supplied with reservoir water band previously fertilized with potassium before the long term trial) was initiated in 1995 to assess the long-term changes in soil nutrient supply, nutrient balance, nutrient use efficiency, yields, and overall sustainability of a double rice cropping system.

Results for 21 cropping seasons (or 10.5 years of intensive cropping) indicate that with *balanced fertilization* of N, P, and K grain yield averaged 5.5 t ha^{-1} in the dry season and 6.5 t ha^{-1} in the wet season. The accumulated loss in grain yield without application of fertilizer N was 40 t ha^{-1} across the 21 cropping seasons (Figure 11). This corresponded to an average grain yield loss of 2 t ha^{-1} in each season if fertilizer N was not used. Thus, the use of fertilizer N *at correct rates* with appropriate amounts of fertilizer P and K ensured an average additional grain yield of 2 t ha^{-1} in each season.

Figure 12. Loss in rice grain yield after 21 crops (1995 to 2005) when nitrogen and potassium fertilizers are not applied. Long Term Fertility Experiment, Sukamandi Experiment Station, Indonesia



Farmers in West Java often believe the supply of K in the soil is sufficient for high rice yields and hence there is no need to apply fertilizer K to their rice fields. However, results of the LTFE show that the total loss in yield without application of fertilizer K was 10 t ha^{-1} across the 21 seasons (Figure 11). For the first eleven seasons, there was a slow decline in yield (0.3 t ha^{-1} per crop) without K fertilization. But then from the 12th season onwards the yield loss increased by 0.6 t ha^{-1} per crop. The results indicate that with continuous cropping, K becomes depleted in the soil, and thus it should be replenished for the attainment of high yields. With fertilizer K application, there was an average increase in grain yield of 0.5 t ha^{-1} per season.

Data from research by MOA at Malang in East Java (MOA staff pers comm.) show that retention of straw would greatly assist the potassium balance, by providing about 18 kg/ha of potassium. However, few small farmers are able to retain straw given the feeding requirements of their ruminant animals.

At Jakenan Experiment Station, Central Java, work by Boling et.al.(2004a) on rainfed lowland rice areas, which comprise about 30% of the total rice area of the province, has demonstrated the interactive effects of plant nutrition, drought and pest incidence over a four years (1997-2000). Average yield reduction due to nitrogen omission was 42%, to K omission 33-36% and to P omission 3-4 %. On sandy soils of upper slopes, responses to potassium on farmers' fields were up to 85%.

Estimated yield loss from pests in the dry season (March-June) was 56-59% in both well watered and well fertilized treatments. In only one out of six seasons, rainfed yields were 20-23% lower than well watered controls. Thus the supply of an adequate nutrient balance and pest control were at least as important as drought in limiting yields in Central Java.

Responses to potassium fertilizer such as these are common in rainfed lowland areas, comprising most of the rice area of Java, but are the exception in the areas supplied with water from reservoirs, which account for about 11% of total rice area in Java . Overall, about 49% of Indonesia's soils are considered to have low to medium potassium status according to soil test (FAO, 2005), (Table 3.5) although the same authors state that fertilizer recommendations are well out of date. If the responses seen in Central Java and on the Long Term Fertility Experiment at Sukamandi are typical, much more of Java's rice may be responsive to potassium for high yields.

Table 3.5. Soil potassium (K) status of lowland rice solls in the early 2000s

Java	473	1.172	2.008	3.653
Sumatera	247	1.176	856	2.279
Bali & Lombok[1]	0	0	214	214
Kalimantan[2]	66	261	138	465
Sulawesi	89	197	610	896
Indonesia	*875*	*2.806*	*1.818*	*7.507*
Percent of total	12	37	51	100
Excluding Java	402	1.634	3.826	3.854

[1] Does not include the whole West and East Nusa Tenggara Provinces.
[2] Does not include West, Central and East Kalimantan Provinces.

Source: FAO(2005)

Changes in fertilizer balance can improve rice nitrogen use efficiency by 30-40% (Wassmann and Dobermann, 2006) and thus reduce the need for urea at a time of high fossil fuel prices.. Rice accounts for nearly 20% of global N fertilizer consumption. The soils of most Indonesian rice production areas , particularly those with a long cultivation history, have been shown by several authors (Mamaril et al 1994, Wihardjaka, et.al. 1999) to be deficient in nitrogen and potassium and to a lesser extent phosphorus, whereas the dominant fertilizer inputs in Indonesia are Urea, triple superphosphate, and ammonium sulfate (FAO 2005). Indonesia is a net exporter of urea, an importer of the raw materials for phosphorus fertilizer and an importer of the finished fertilizer for Potassium Chloride

Makarim (2000) has used a modeling approach to estimate the potential yields of rice in various districts of Java with optimal management compared to existing practice. In most cases the predicted yields are above 6t/ha. The simulation (Annex 2) clearly illustrates the problem of excess urea application and lack of potassium use.(Note that "ZA" refers to sulfate of ammonia.)

Apart from potassium, the response to micronutrients such as zinc, copper and boron has scarcely been investigated (Makarim (2000), FAO 2005). The necessary studies are constrained by the fact that Indonesia has only one central laboratory capable of such analyses at Bogor. The laboratory at Ujung Pandang is in need of total rehabilitation, although its staff are well trained and capable. Laboratories in Medan and Lampung are either small but efficient although lacking critical equipment (Medan) or in need of rehabilitation and expansion (Lampung) (author's note).

The challenge of improving the basic fertilizer balance by using more potassium and possibly micronutrient fertilizer is not unique to Indonesia but is repeated across the region and has obvious impacts on the need for rice imports.(Wassman and Dobermann 2006)

Syers et.al(2001) have estimated the annual deficit of Potassium fertilizer (KCl equivalent) in Asia at 11 Mt/annum. The estimated the deficit in Indonesia at 1.2Mt/annum or 41 kg/ha of rice area. One consequence of unbalanced fertilizer use in the region is the extent to which the K reserves in soils are being depleted. It is estimated that at least 1 M t of K is mined each year from SE Asia's rice soils. However, when combined with improved N management techniques (i.e., more precise timing and splitting of N fertilizer, use of a leaf color chart), increased applications of K resulted in average yield increases across several Asian trials of about 0.5t/ha.

Long term fertility trials demonstrated as long ago as 1993 that over 9 sites in five countries in SE Asia, distinct responses were possible to rates of K as low as 38 kg/ha . However, at such rates, dilution in extra yield still leaves soil K balance strongly negative. Thus whilst Indonesia has made a good start by increasing the subsidy on NPK fertilizer (Ponska 15:15:15 $N:P_2O_5:K_2O$) by 500,000 tons in 2008, the initiative may not be enough to ensure rice food security. Use in the tree crop industries plus the relatively high requirements of grain production will probably demand further adjustment of the balance in subsidies in the short term. In the long term, however, Indonesia also needs to invest in productivity improvement as an alternative to reliance on subsidy (see Section IV below).

Table 3.6 Growth Rates of Rice Yield, Fertilizer Consumption and Rice Trade in Asia

Cambodia	0.7	2.5	22.6	3.4	0	946	472	-474
Indonesia	4.0	0	4.6	-5.4	-1.0	4,915	13,784	+8,869
Laos	4.4	2.0	26.5	15.8	10.4	157	167	+10
Malaysia	1.6	0.5	3.7	4.7	6.5	3,150	4,409	+1,259
Myanmar	2.5	0.9	12.2	11.7	-2.3	0	0	0
Philippines	3.4	-0.4	0.3	1.8	2.1	1,044	5,898	+4,854
Thailand	0.5	1.5	6.2	4.7	9.6	0	2	+2
Vietnam	2.2	2.1	15.1	16.4	37.2	2.272	28	-2,244

Better Crops International
Vol. 15. Special Supplement. May 2002

The stagnation in rice yields and the consequent increase in rice imports in Indonesia, Malaysia, and the Philippines are clearly related to poor nutrient balance, particularly the low fertilizer K application rates averaging less than 10 kg P_2O_5/ha in these countries (Table 3.6 above).

The challenge in rice systems in SE Asia is to achieve regional food security and increase farm incomes using site-specific integrated crop management techniques. This will require much greater investments in research and extension for actions such as Site Specific Nutrient management (Annex 1) over the next two decades and a greatly expanded availability of materials such as potassium chloride and micronutrients.

3.6 Government and Private Sector Measures

The Central Ministry of Agriculture has established a research consortium for adaptation and mitigation to climate change as well as the development of technology innovations, action research, outreach, and supporting improved agricultural infrastructure. Yet the annual budget is only 2 billion Rupiah ($200,000). A considerably greater investment in outreach will be needed if Indonesia is to make best use of its research investments.

Climate field schools (Box 1) and the Direct Rice Seeder discussed below are interesting innovations that need to be disseminated through greater investments and outreach activities.

Box. 1 Climate Field Schools (CFS) in Indonesia

The objectives of the CFS are: (i) to increase farmers' knowledge on climate and the ability to anticipate its phenomena such as extreme events for their farming activities based on past experiences and current knowledge; (ii) to assist farmers in observing climate variables and using it to support their farming activities, and (iii) to increase farmers' ability to translate climate forecast information into management decisions. The Directorate-General of Food Crops in the Ministry of Agriculture started the implementation of the CFS (which is run like any other Farmer Field School) as a pilot in Indramayu district in 2002/2003. Transferring knowledge of climate to farmers takes time and the involvement of well-trained intermediaries is critical. BMG and IPB are collaborating with MOA in carrying out the training activities under the CFS. As a first step, agricultural extension specialists (PL1) are trained in climatology and applications of climate information. The PL1s are at the district/sub-district level. Based on the knowledge gained from this training, the PL1 along with the trainers develop CFS modules. The modules are then tested through a gaming/simulation process with extension workers who will become field facilitators (PL2) – at the village/farmer group level. An initial evaluation of the initial CFS yielded positive results.About 70 percent of farmers considered that their knowledge and understanding on weather/climate, the ability to use observed climatic data and climate forecast information to support their farming activities, and their awareness on the importance of working in a group have increased significantly. The CFS are now no longer restricted to rice but also include maize, soybean, horticulture. Availability of good technical staff and trainers is a constraint as is the availability of national and local government budgets to support the CFS activities. Climate data information that used to be very global (and hence less useful) has now expanded, thanks to the work of BMG, to over 220 climate types that has allowed technical advice to farmers to be more specific. As of 2007, MOA has expanded the CFS has been expanded to 230 CFS in 19 provinces (150 districts) across the country. A major impact evaluation study is planned in 2008 with the assistance of the Asian Disaster Preparedness Center, Bangkok.

Source: Boer (2006); pers. Comm.

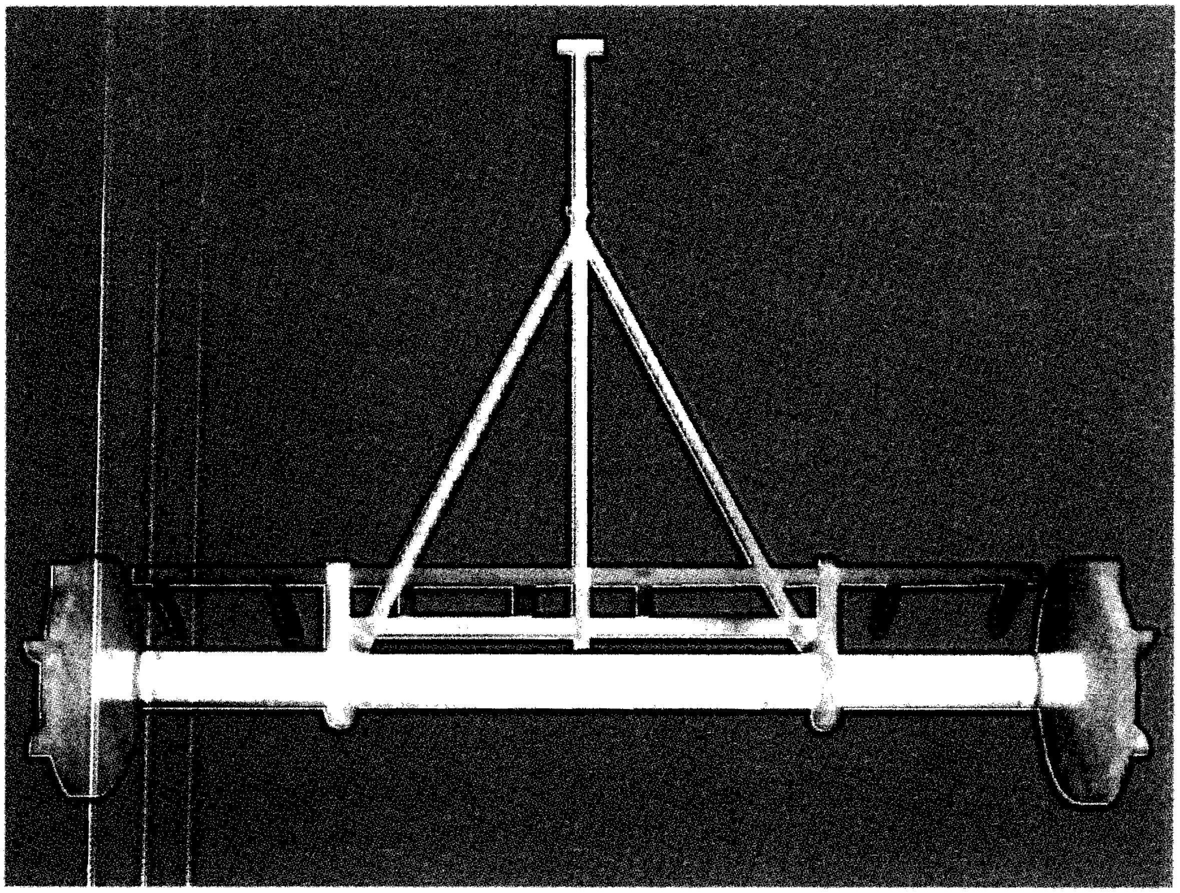
An interesting innovation developed by Bayer Crop Science Indonesia is the improved direct rice seeder (DSR) (Jowett, 2008, pers.comm) that adapts to both water scarcity as well as labor scarcity.

Traditionally, farmers have favored the transplanting (TPR) method over the Direct Seeded Rice (DSR) production method commonly used in other SEA countries. The DSR planting method was introduced by the Indonesian Government in 1994/1995 and is currently being practiced in South Sulawesi. However uptake in other areas has been limited due to difficulties associated with production methods, risk of crop failure in the early stages of planting, and perceived impression of lower productivity due to a lower seeding rate. Direct seeded rice culture method provides Indonesia with improved production sustainability offering the opportunity to increase production output to reach the target of self sufficiency in rice production. "Baytani" is a new and improved DSR seeder (Figure 13) that helps address some of the issues associated with DSR rice production in Indonesia.

Benefits from pilot projects include:

- Water saving of approx 10 Megalitre/ha/season (20%)
- Reduces labor requirements from average of 30 people/ha to 2/ha, during planting, a significant benefit where labor shortages occur
- Time reduction in sowing practices from 4 days to 4 hours to plant a hectare of rice
- Potential yield production increase of >10%
- Enables farmers to use Seed treatment products to fight pests & diseases (eg: TungroVirus)
- Potential to reduce the amount of seed used at sowing

Figure 13. The "Baytani" – improved DSR

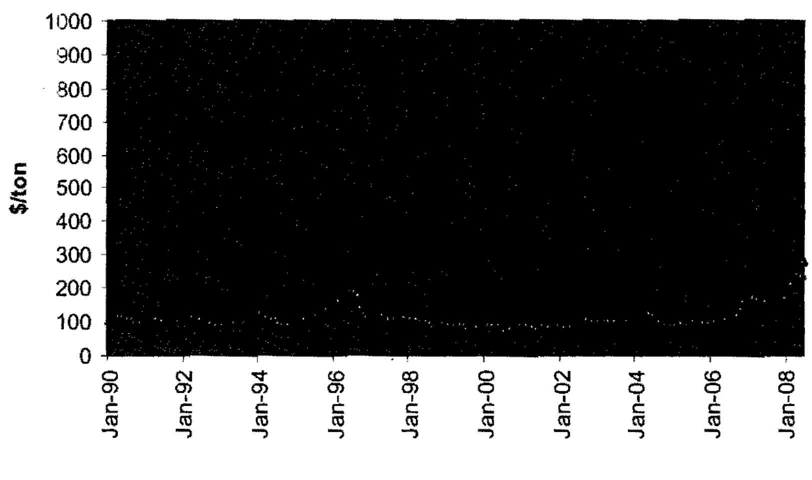


Chapter IV
Adaptation in Economic Policies - Fertilizer Policies and Bulog

4.1 Background

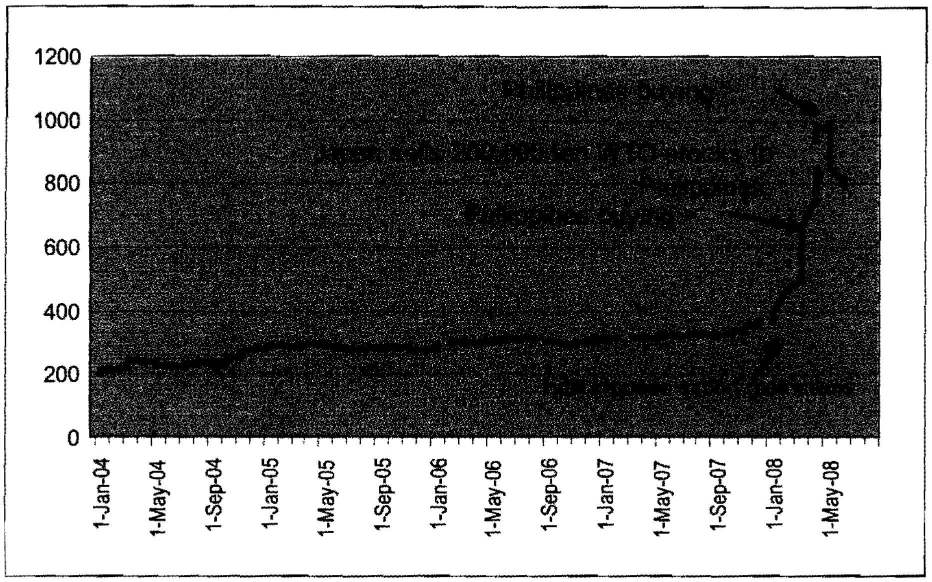
In the last six months world rice prices have risen by more than at any other time since 1990. (figure 14) and Indonesia now finds its domestic price well below international levels. There is considerable anxiety among policy makers that the Indonesian rice economy is once again vulnerable to these external conditions. The issue is what role Bulog should be playing to help maintain stability in the Indonesian rice economy as well as guarantee that the poor have access to rice. The role of fertilizer policies will also take on increasing importance in view both of its potential impacts on productivity gains as well as its impacts on GHG emissions.

Figure 14. Rice price increase outstripped increase in other cereal prices



Source: L. Christiansen Luc Christiaensen, World Bank. Presentation at the "Managing Vulnerability in East Asia" workshop, Bangkok, June 25-26, 2008

Figure 15. Rice Price (100B) 2004-08US $/mt



4.2 Fertilizer Production and Distribution

Fertilizer production is controlled by six state run and subsidized (by way of reduced costs of gas for urea manufacture) fertilizer plants. These plants are assigned responsibility for supply of urea to provinces or areas close to each plant. The distribution of other fertilizers (Ammonium Sulfate, Superphosphate and Ponska (NPK)) is the sole responsibility of PT Petrokimia Gresik. Prices are regulated to a highest retail price at farm level, valid for all regions of Indonesia. Priority is given to domestic supply rather than export, although illegal export sales do occur at times of high prices and lower port security (FAO 2005).

Apart from potassium, the response to micronutrients such as zinc, copper and boron has scarcely been investigated (FAO 2005). The necessary studies are constrained by the fact that Indonesia has only one central laboratory capable of such analyses at Bogor. The laboratory at Ujung Pandang is in need of total rehabilitation, although its staff are well trained and capable. Laboratories in Medan and Lampung are either small but efficient although lacking critical equipment (Medan) or in need of rehabilitation and expansion (Lampung).

Table 4.1. Indonesian Production of Fertilizers Compared to Capacity

[illegible]	[illegible]				
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ammonia	4.353	4.200	4.395	3.687	4.032
Percent of capacity	95	91	96	79	82
Urea	6.156	5.971	6.333	5.333	6.006
Percent of capacity	96	86	91	76	80
TSP/SP-36	643	854	520	654	595
Percent of capacity	64	85	52	65	60
AS	284	457	491	448	420
Percent of capacity	44	70	76	69	65
Ponska	0	0	30	56	66
Percent of capacity			10	19	22

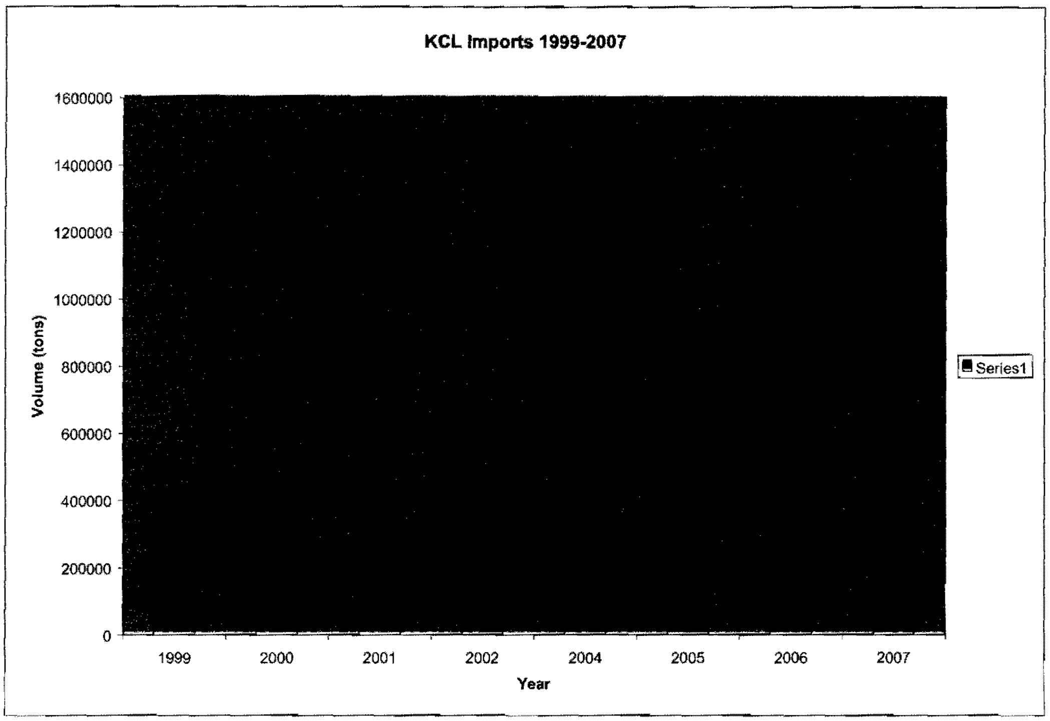
Source: IFPA, 2004.

The government's policy is to give priority to domestic fertilizer requirements rather than to exports. The government limits the quantities of fertilizer that may be exported by the producers in order to safeguard domestic supply. However, if export prices are attractive and port security is not strict, illegal exports of fertilizer reserved for domestic supply may occur. This jeopardizes the allocation of fertilizer to the country's farmers (IFPA, 2004 quoted by FAO 2005). Such impacts could be seen from the short supply of fertilizer that have frequently occurred during the peaks of the lowland rice planting seasons between 2002 and 2004. Among the food crops, the total costs for lowland rice, which uses the highest amount of mineral fertilizer, ranged between Rp110 000 (15.7 percent of total cost) in Kalimantan and Rp503 000 (31.7 percent of total cost) in Java. The higher proportion of the cost of fertilizer in relation to total cost in Java reflects the more intensive rice cultivation in Java. The second crop that used high fertilizer application rates was maize and the crops that used the least fertilizer were groundnut and cassava. (FAO 2005).

4.3 Expanding the Availability of Potassium Fertilizers

The dominant fertilizers produced and used in Indonesia are urea, TSP (triple superphosphate, 46 percent P_2O_5), AS (ammonium sulphate, 21 percent N and 24 percent S) and KCl (potassium chloride, 60 percent K_2O). More recently Indonesia replaced TSP with SP-36 (superphosphate, 36 percent P_2O_5) and produced the compound fertilizer Ponska (15 percent N, 15 percent P_2O_5 and 15 percent K_2O). The government is considering a reduction in fertilizer P content by using single superphosphate. There are six fertilizer-producing companies in Indonesia. Five of the six companies are government-owned and one is a joint venture with governments of other Asian countries. This joint venture produces urea and ammonia for export. Indonesia owns 60 percent of the shares, Singapore, Malaysia, Philippines and Thailand 40 percent. All six companies produce urea. Only one plant produces also AS, TSP, SP-36, and Ponska. The total production capacity of the six factories is more than 6.5 million tons/year. Between 1998 and 2002, the capacities of all the companies were expanded and reached 7.55 million tons per year (Table 4.1).Urea is produced from indigenous raw materials and Indonesia is a net exporter of urea. Indonesia is a net importer of the other fertilizers because of a lack of domestic sources of raw materials for AS, TSP or SP-36. Potassium chloride is imported as a finished fertilizer, mainly for blending. The importation of fertilizer and fertilizer materials is handled by state trading companies, which sell the materials to the factories.

Figure 16. Imports of Potassium Chloride, Indonesia 1999-2007



The imports of potassium chloride (46% K) are shown in Figure 16 and while they have increased in recent years the current level of imports (1.3 million tons or 598,000 tons K equivalent) are far below even the incremental needs for expanded production of about 1.2 Mt Potassium Chloride,discussed above, let alone current base production. Production capacity for Ponska (15:15:15 NPK) is being enhanced by a new factory in east Java which will bring installed capacity to 450,000t/annum. An increase of 450,000 tons in allowances for NPK subsidy payments has been made as part of the strategy of expanding NPK use.

Overall, shortage of imports of potassium chloride and excess use of nitrogen (urea and ammonium sulfate) appear to be a major constraint to adoption at farm level of a better balanced fertilizer regime and better use efficiency of water and nitrogen. To address this constraint, Government might consider redirecting subsidy payments on urea production to potassium imports, possibly using a carbon fund initiative to assist in financing the imports or a subsidy on their use. In the medium term, the parastatal companies controlling fertilizer manufacture and distribution need to be freed up to trade in all forms of fertilizer according to market demand in their coverage area. Greater competition among suppliers across Indonesia would also help, in place of regulated pricing.

4.4 Bulog – A Brief History

Between the late 1960s and the mid-1990s, BULOG defended a floor price and a ceiling price through a combination of the following four policy instruments:

1. monopoly control over international trade in rice;
2. access to an unlimited line of credit (at heavily subsidized interest rates in the early years and at commercial rates with a Bank Indonesia guarantee in the later years);
3. procurement of as much rice as necessary by DOLOGs to lift the price in rural markets to the policy-determined floor price; and,
4. extensive logistical facilities, including a nation-wide complex of warehouses, which permitted seasonal storage of substantial quantities of rice (including the one million tons for the "iron stock" that was considered essential for Indonesia's food security).

These rice stocks, accumulated through domestic procurement in defense of the floor price and, when these supplies were inadequate, through imports, were then used to defend a ceiling price in urban markets. In the early years, the ceiling price was explicit and announced publicly; in the later years, it was informal, providing local DOLOG officials more flexibility in maintaining stability of rice prices.[6]

This was a heavily interventionist approach to formation of rice prices in Indonesia, and thus to the country's food security. Still, few observers doubted the need for such intervention in the late 1960s and through the period of instability in the world rice market in the 1970s. An econometric assessment of the 25-year period from 1970 to 1995 concluded that *BULOG's stabilization efforts paid very high dividends in fostering faster economic growth during Repelita I and II [the first two five-year plans, from 1969 to 1979], apart from the additional benefits provided by enhanced political stability*. But even this positive assessment concluded that benefits from this market intervention were diminishing as rice became a much smaller proportion of the value added in the economy and as a share of consumers' budgets. By the mid-1990s there was clearly a need to design a much more market-oriented price policy.[7]

This need for reform of the approach to food security was driven by two forces. First, the price stabilization program was very expensive in budgetary terms, because heavy subsidies had to be provided to BULOG to maintain large stocks, subsidize exports when surpluses accumulated, and subsidize imports when domestic supplies were short. By the late 1980s internal accounts suggested that the costs of BULOG's rice price stabilization activities were greater than the benefits from faster economic growth.[8] The increased corruption in the agency in the mid-1990s further called in question the use of public funds to support the price stabilization role.
Second, successful stabilization of rice prices enhanced the profitability of growing rice and biased farmer decision making toward its cultivation. This bias was desirable in the 1970s and early 1980s, as new rice technology and extensive investment in rural infrastructure, especially irrigation, meant farmers had to learn how to manage a radically new way of growing rice. In addition, Indonesia was exposed to a very thin and unstable world rice market in the 1970s and additional domestic rice production enhanced its food security. But as early as the 1980s, the bias toward rice production was causing serious difficulties in diversifying Indonesia's agriculture toward higher- value crop and livestock systems.[9]

A long-run decline in the price of rice in world markets, and significantly greater stability in world prices, sharply lowered the opportunity cost of rice to the Indonesian economy, and the risks from relying on imports for a small share of domestic consumption. In 1998, for example, the country was able to import over 6 million metric tons of rice in the wake of the worst drought in recent history-caused by a historically severe *el Nino* weather pattern-with very little impact on the world rice market. With Indonesian rice imports returning to the "normal" levels of earlier years after 1998, world prices continued their long-term decline.[10] Indeed, the decline through 2003 was so severe that even the increase in world prices during 2006 only brought them back to their 10-year downward trend. In the face of these long-run opportunity costs of growing rice, farmers needed to diversify out of rice to have better income-earning prospects in the future. Somewhat paradoxically, the smallest Indonesian farmers need to get out of rice growing to ensure their food security, and this remains true even if the current price environment in world markets lasts for several years.

Alternatives to the high-cost and inefficient approach to rice price policy in the 1980s and early 1990s-and to the country's food security-were already under discussion in the mid-1990s. Although various analysts had differing priorities for reform, the core ideas were similar. Indonesia should rely much more heavily on rice imports for its food security, including taking the lead in forming a free trade zone for rice in East and Southeast Asia (possibly to include Bangladesh and India as well). Substantial investments in rural infrastructure to improve efficiency of rice marketing would be needed so that traders and farmers would buy and store nearly all of the harvest.

6 The details of this story are contained in C. Peter Timmer, "Food Security in an Era of Decentralization: Historical Lessons and Policy Implications for Indonesia." This paper was part of the output from the Food Policy Support Activity (FPSA) and is available at the project website: www.macrofoodpolicy.com.

7 See C. Peter Timmer, "Does BULOG Stabilize Rice Prices? Should It Try?" *Bulletin of Indonesian Economic Studies*, vol. 32, no. 2 (August 1996), pp. 45-74.

8 See the above article as well as Scott R. Pearson, "Financing Rice Price Stabilization in Indonesia," *Indonesian Food Journal*, Vol. 7, no. 4 (1993), pp. 83-96.

9 See C. Peter Timmer, "Crop Diversification in Rice-Based Agricultural Economies: Conceptual and Policy Issues" in Ray A. Goldberg, ed., *Research in Domestic and International Agribusiness Management, vol. 8*. (Greenwich, CT: JAI Press, 1988), pp. 95-163.

10 See David Dawe, "The Future of the World Rice Market and Policy Options to Counteract Price Instability in Indonesia," FPSA Working Paper No. 3, and David Dawe, "The Changing Structure of the World Rice Market, 1950-2000," IRRI Los Banos, 2002.

Continued development of rural capital markets would also be needed to ensure that the financial liquidity traditionally provided by BULOG procurement in defense of the floor price would be available from the formal banking system at reasonable rates to farmers and traders.[11]

Greater variability in seasonal prices would be permitted so that these farmers and traders could earn adequate returns on their investments. Such variability would not be a problem for most consumers because rice has declined to a small and manageable share of their budget expenditures. In case of large increases in rice prices in world markets (which would be much less likely with a large Asian free trade zone) or localized shortages, subsidies to poor consumers could be targeted through special logistical efforts.[12] Variable tariffs on rice imports were also discussed as a mechanism for stabilizing rice prices in Indonesia without the need for a costly logistical agency.

These discussions about improving the efficiency of the rice economy were put on hold during the financial crisis (and there is a further pause in the face of the current world price environment), but there is substantial merit to the market-oriented rice economy seen at the end of this transition. It remains a highly desirable goal, both for its effect on efficiency in the agricultural sector and the sustainability of the country's food security. But there are also substantial political barriers in the way of this outcome.

One worrisome element in the current policy debate has been the small degree of understanding about (i) how the previous rice price policy was designed and implemented as the core component of the country's approach to food security, (ii) what its true costs were, (iii) how fast they were rising because of corruption and loss of focus at BULOG, and (iv) what the implications might be for price stabilization if BULOG, already converted into a commercially-oriented state enterprise, is again given monopoly control over rice imports. Thus the political discussions were being conducted in a near vacuum of institutional memory and experience with earlier policy design and implementation.

That vacuum was released in early December, 2006, in a series of press briefings and seminars that were presented on the topic of "the future of food policy in Indonesia."[13] In the short run, the press and academic commentators began to accept the economic rationale for immediate imports to stabilize rice prices on behalf of the welfare of the poor. On December 22 the government announced it would import 520,000 tons of rice to cover "the shortage of BULOG's stock until harvest time in March next year" (*Tempointeractive*, December 22, 2006). The nature of the food security debate changed.

Unfortunately, no significant policy or institutional changes were made during this window of opportunity. Imports of rice continue to be determined by political forces with little understanding of the mechanics of food security at the level of national rice markets. One fortuitous outcome has been that Indonesia has so far been spared the worst manifestations of the current world rice crisis, and the excellent La Nina-driven rice crop expected in 2008 has minimized the need for imports to supplement Bulog domestic procurement efforts.

but to do so it is essential to understand the historical pathway that brought Bulog to its current status. It is clear from the public debate that few people in Indonesia remember this history or understand Bulog's earlier [or current] mission. It is useful to review how Indonesia got to where it is.

4.5 The recent debate over food security

There is an ongoing debate about what role Bulog should be playing to help maintain stability in the Indonesian rice economy as well as guarantee that affordable access to the poor.

11 See C. Peter Timmer, "Building Efficiency in Agricultural Marketing: The Long-run Role of BULOG in the Indonesian Food Economy," *Journal of International Development*, vol. 9, no. 1 (1997), pp. 133-45.

12 BULOG had already experimented with such a program during the drought in 1991-the pilot activity was called "Special Market Operations," OPK. This also became the name of a similar program used during the financial crisis to target cheap rice to poor consumers, still with BULOG as the implementing agency, a program that has evolved into the poorly targeted and expensive RASKIN program of rice distribution to the poor.

13 The paper by C. Peter Timmer, "The Future of Food Policy in Indonesia," is available on the CGD website. The interview in the *Jakarta Post*, headlined as "Banning rice imports 'not the right option,' appeared on December 5.

There are three broad approaches. First, Bulog could continue its recent evolution into a private sector trading company, able when contracted by the government to carry out public-sector tasks such as distributing rice to the poor. At the other extreme, Bulog could be returned to its earlier mission during the Suharto years as a public agency charged with stabilizing rice prices, with trade rules, operating budget and inventory financing adequate for the task. Finally, a "middle road" option, reflective of the current status, would mean that Bulog continues to operate in the grey area between a public and private institution, called upon by public officials to carry out tasks for which it no longer has management or logistical capacity, access to public finance, or even legal status to undertake rice operations. In the current political environment, it seems almost inevitable that this third option will be followed. Much of the following sections discuss how to improve the probability that Bulog can carry out successfully the missions now being asked of it by public officials.

In late 2006, a remarkable debate took place in Indonesia over the nature of food security, the role of rice prices in the country's higher poverty levels, and whether the ban on imports, in place since January, 2004, had contributed to the sharp rice in domestic rice prices. The debate was ignited by the earlier report on rice policy from the World Bank that linked the sharp increase in poverty levels between February 2005 and February 2006 to the 30 percent real increase in rice prices during that period. The Bank report argued that the removal of fuel subsidies in late 2004 had been more than compensated for by the unconditional cash transfers to the poor, so the culprit was higher rice prices. Because world prices for rice had been stable in rupiah terms over that period, the cause of the sharply higher rice prices was the import ban on rice.

The Minister of Agriculture promised a massive increase in the rice harvest due to start in February, 2007, so there was still no need to import rice (beyond the 210,000 tons imported as an "emergency measure" to replenish BULOG's stocks beginning in October, 2006, a decision that had intensified the food security debate).

Lost in the recent debates has been any clear recognition that food security is primarily an economic issue, one on which a substantial analytical and empirical literature exists, for Indonesia and in general.[14] The universal conclusion from this literature is that only good economic policies can ensure food security on a sustainable basis for both the country as a whole and the millions of households individually. From this economic perspective, the food security "time bomb" in Indonesia's future-referred to in an article in the *Jakarta Post* on May 4, 2002--is not potential reliance on rice imports. Instead, *the time bomb is poverty and the failure to restructure Indonesia's economy in a way that stimulates rapid growth of productivity in both rural and urban areas, leading to higher incomes.*

Indonesia's rice economy is undergoing a painful transition. It started as a sector heavily regulated by a centralized Ministry of Agriculture and stabilized by a well-financed food logistics agency (BULOG). It needs to become an open, market-oriented sector which depends on farmer, trader, and consumer decision making to allocate resources efficiently. The transition has stalled, however, and Indonesia does not have a market-oriented rice economy.

The key question at this juncture is how to complete the transition to such a rice economy given the challenges of adapting to climate change while recognizing the constraints on policy initiatives that face the government. These constraints are mostly political, although the lack of new rice technology certainly narrows the degrees of freedom for policy makers. But policy makers seem to think that rice farmers need higher prices to stimulate production, and hence to improve Indonesia's food security. This perception is based on a faulty understanding of Indonesia's earlier success in stimulating rice production and improving the country's food security, as well as a lack of understanding about the current profitability of rice farming for the larger growers with net surpluses to sell. Thus it is worth reviewing briefly how rice prices were set during the New Order government, when they were stabilized and maintained on the long-run trend in world market prices, until the financial crisis. It is also necessary to explain why the policies that achieved these desirable outcomes are no longer appropriate or even feasible.

14 This general literature is reviewed in C. Peter Timmer, "The Macro Dimensions of Food Security: Economic Growth, Equitable Distribution, and Food Price Stability," Food Policy, vol. 25, no. 4 (August 2000), pp. 283-295, in "Food Security and Economic Growth: An Asian Perspective." [Heinz W. Arndt Memorial Lecture, Canberra, Australia, November 22, 2004] Asian-Pacific Economic Literature, Vol. 19, no. 1 (May 2005), pp. 1-17, and in the Indonesian context in C. Peter Timmer, "The Meaning of Food Self-Sufficiency," Indonesian Food Journal, vol. 5, no. 10, 1994, pp. 33-43.

4.6 Current Status

But this good fortune is at an end. A recent report (Slayton, 2008) on the Indonesian rice situation indicates that the country will need between 1.75 and 2.0 million tons of imports before the end of 2008 to maintain adequate stock levels, stable rice prices, and the mandated deliveries of rice to the poor.

What next? The proposed decision to import rice to stabilize rice prices is clearly an attempt by the economic realists in the government to wrest control of food security issues from the politically charged agricultural lobby. But nothing has actually been done yet to clarify rice trade mechanisms beyond the one-off deal in December 2006. The import ban is still technically in place, and BULOG's stocks-and ability to sustain market operations on behalf of stabilizing rice prices-are still hostage to unique decisions by the President and the Cabinet. Even in the short run, Indonesia has still not come up with a coherent strategy for food security.

In the longer run, the links between pro-poor growth and food security remain weak in political terms while still strong in economic terms. The political appeal of the new strategy for dealing with poverty-direct fiscal transfers to the poor-is obvious. These transfers have immediate and visible impact on the recipients, and the political "pitch" for the programs makes it sound as though the government is actively committed to poverty reduction. Thus although democracy has probably increased the size and influence of the political coalition concerned

about poverty, it has sharply *undermined* the coalition supporting economic growth as the main mechanism for dealing with it. In the current political rhetoric, poverty reduction is no longer linked to economic growth, and food security remains almost entirely a political issue.

In fact, BULOG seems to have built a political coalition similar to the one supporting Food Stamps in the U.S. Congress-support comes from conservative rural legislators eager to have additional markets for the food that is produced in surplus by their farm constituents, and from urban liberals who have many poor people who use food stamps as a major source of their income. Similarly, BULOG has assembled support for its rice procurement program (to help rice farmers), which supplies the rice for the RASKIN program that delivers subsidized rice to the poor. No parliamentarians have been willing to take on both dimensions of the rice program simultaneously, and so the huge budget subsidies that accrue to BULOG to run these programs, and the corruption that accompanies them, go unchallenged. BULOG's budget in 2005 was Rp 4.7 trillion.

In the long run, the only way to sustain food security is through pro-poor economic growth. No country has been able to generate such growth decade after decade without reasonably open engagement in the world economy. Rice has lost much of its significance to the Indonesian macro economy, but the poor still rely on stable access to rice in rural and urban markets. Keeping those markets stable and accessible will be far easier and cheaper if Indonesia's rice economy also participates openly in world markets.

4.7 The Evolution of Rice Price Stabilization Approaches[15]

One can characterize three different approaches that have been taken towards price stabilization in Indonesia:

Up until 1998: Government purchases – government trade

As noted above, prior to the crisis, Bulog was responsible for both making government purchases to support domestic prices, as well as managing imports to ensure that domestic supply kept domestic prices stable. Bulog had an explicit mandate to stabilize prices and, because it could finance both purchases and imports, was able to do this reasonably effectively for 20 years.

1999-2004: Government purchases – private sector trade

In 1999, Bulog's import monopoly was removed and Bulog began a process of evolution towards becoming a

15 The indented material is from Issues in Indonesian Rice Policy, World Bank, 2007.

Perum.[16] As part of the commercialization of Bulog, its mandate for price stabilization was removed. However, prices remained stable because the private sector was allowed to import.

2004-now: Government purchases – ad hoc trade/Operasi Pasar (OP)
Since January 2004, the import ban has removed the role of the private sector in stabilizing the upward movement of prices. Its place has been taken by ad hoc administrative decisions to import, as well as OP.

This characterization suggests that it has been the removal of the effective price ceiling provided by trade-initially government trade, and subsequently private sector trade-that may be responsible for much of the current price instability. A key policy problem facing the government therefore is how to re-introduce trade-based instruments of price stabilization in the most effective manner.

4.8 Recent events and issues

Commodities are hot. Oil is now routinely over $100 a barrel, wheat on the Minneapolis futures exchange hit $25 a bushel in late February, and traders with hundreds of billions of dollars to invest are looking for opportunities that might outperform a sinking stock market and a bond market that is spooked waiting for the next shoe to drop on the sub-prime mortgage fiasco.

What does that have to do with rice policy in Indonesia? Everything, as it turns out. Rice is the world's most important commodity (even more important than oil in value of production and role in providing food calories to billions of consumers). Politicians in rice consuming countries-all of Asia and increasingly important parts of Africa, the Middle East, and Latin America-know that their survival depends on providing reliable access to rice supplies at affordable prices. To fail is to lose political credibility. Even dictators can be thrown out in a rice crisis.

Rice has long been caught in the tension between its role as an economic commodity-produced, traded and consumed as the main calorie source of half the world's population-and its role as a political commodity-for precisely the same reasons. Much speculation has linked the historical despotism of Asian societies-and their long experience with national governance--to their need to have a reliable and effective control mechanism over the irrigation systems needed to grow rice for dense and potentially restless populations. As Asia emerges into democracy, the power of rice to drive politics is not lost on any of the competitors for political power. For example, it kept the LDP in power in Japan for over half a century.

All politics is local, as Tip O'Neil once famously observed. That creates a terrible tension in Asia, as all countries need to provision rice for their citizens from either domestic farmers or the world market. The tension is especially acute for large countries, such as China, India and Indonesia, where world market supplies are inevitably a small fraction of total consumption needs. How far can the world market be trusted? How much should domestic farmers be paid as the source of "food security?" What happens to the poor in this debate?

More than almost any other country, Indonesia has struggled with these issues over the past half century, often in a surprisingly open and empirically-driven debate. But since the fall of President Suharto in 1998 and the emergence of a vigorous democracy since then, the debate has turned shrill and almost devoid of empirical and historical evidence. A new special issue of the *Bulletin of Indonesian Economic Studies*[17] (hereafter referred to as "Special Issue") attempts to re-energize the debate over Indonesian rice policy by presenting a series of rigorously empirical analyses of the key policy issues facing Indonesian leaders over rice production, marketing and international trade, consumption, and pricing- both with respect to levels and stability.

World commodity markets, including those that deal in rice, are on a tear. The underlying causes are subject to much debate, but rapid demand growth in China and India, politically mandated growth in bio-fuels in the

16 Bulog eventually became a BUMN in January 2003 based on Peraturan Pemerintah RI No. 7/2003.
17 *Rice Policy in Indonesia: A Special Issue [Bulletin of Indonesian Economic Studies, Volume 44, Issue 1], editors Neil McCulloch and Peter Timmer.* The discussion here extracts from the introductory essay to the Special Issue.

United States and the European Union, and the drop in value of the US dollar, are certainly a big part of the story. The drive to find profitable opportunities for hundreds of billions of dollars in loosely regulated investment funds that are sloshing around the world's financial system no doubt contributes to short-run volatility.

Virtually none of these short-run factors really matter to Indonesia's farmers and consumers, but they matter a lot to policy makers trying to decide how best to provide food security to the country. Relying on the world market looks increasingly risky, but cutting off trade has been enormously costly to the poor in the past and almost certainly will be equally so in the future. Balancing those tensions is the key to rice policy in Indonesia, and to the future role of Bulog.

The current phase of rice policy, starting in 2004, has been marked by the imposition of a rice import ban which removed price stabilization mechanisms available through trade (either through BULOG or private trade). As a result, during each of the "hungry" seasons prior to the main harvest in March/April, prices rose sharply as stocks began to run low. Although prices typically fall once the main harvest is underway, since 2005, they have immediately started to rise again once the main harvest is in. Rice prices have ratcheted up over the last four years. In January, 2008, the domestic price of rice (IR-III in Jakarta markets) stood 90 percent above the level of January, 2004 and 60 percent above the world price (Vietnamese 25% brokens, FOB Saigon). Of course, given events in world markets since February, these prices now seem low—Indonesian domestic rice prices are currently about half of their equivalent in world markets.

During the 2006-2008 period, the government attempted to dampen price increases through *ad hoc* imports and public distribution of subsidized rice by BULOG, as well as increases in the RASKIN program ("rice for the poor"). During 2007, the government also appeared to move back towards stabilizing prices by giving greater autonomy to BULOG. Meanwhile, the government's desire to boost production and revitalize rice production gave rise to large increases in input and credit subsidies and some experimentation with hybrid seed.

The price increases of recent years were naturally very contentious. Net consumers of rice, who constitute 80 percent of the population, have been understandably unhappy with increases in the price of the staple food. Such increases hit poor rice consumers particularly hard, since a large share of their expenditure goes on this one commodity. But at the same time a large share of the Indonesian population maintains close links with agriculture. Although the structural transformation of the economy over the last few decades means that there are now more non-agricultural households than agricultural ones, it is still the case that 40 percent of employment is in the agricultural sector and it is the occupation of the household head for three-quarters of rural households below the poverty line. Thus the government has to strike a delicate balance between the interests of consumers in both urban and rural areas, and the interests of the millions of small-scale rice producers spread throughout the country.

Unfortunately, the politically sensitive nature of the topic sometimes obfuscates the facts on which good policy should be based. Those in favor of lower rice prices and rice trade liberalization are accused of betraying Indonesian farmers and acting in the interests of foreign farm lobbies, whilst those in favor of higher rice prices and greater protection are accused of narrow vested interests. Interestingly, both groups claim to be on the side of the poor.

4.9 How much rice does Indonesia "need" to import?

The base assumption in many of the recent debates about rice policy is that, in a "normal" year, Indonesia does not need to import rice. Thus, when prices rise, there is a desire to determine whether the increase in prices is due to a genuine reduction in supply, or some alleged manipulation of the rice market by traders. As a result, much of the debate about Indonesian rice policy has focused on levels of production and consumption, on the grounds that imports are justified only if anticipated consumption is higher than estimated production. However, as Rosner and McCulloch show in their paper in the Special Issue, Indonesian rice production and consumption data are inaccurate. Given the weaknesses in the estimates of production and consumption, attempts to reconcile these figures in order to calculate an estimate of surplus or deficit must rely on a range of assumptions.

Rosner and McCulloch review studies which have employed different combinations of assumptions and show that the range of resulting estimates of surplus/deficit is very wide indeed –so wide, in fact, that one cannot, using currently available data, provide an accurate estimate even of whether there is a surplus or a deficit. This is a remarkable and important finding, since the estimation of surplus or deficit is precisely the basis on which the government currently determines the scale of official imports.

If production and consumption data cannot be relied on to determine the quantity of rice imports "needed" the implication is that either the government should allow private traders to import independently when they see prices rising, or that the government itself should use price as a trigger for determining when imports of rice may be needed.

4.10 Implications for Indonesian rice policy

The evidence presented in the Special Issue suggests that several changes should be considered to Indonesia's rice policy. Several are important for the future role of Bulog.

i. Rice price stabilization should be automatic and based on prices
One of the key lessons is that thousands of private sector traders respond faster to price changes, than do government bureaucracies. As a result they were able to stabilize prices in Bangladesh during a major flood more quickly and much more cheaply than the government would have done. However, the key difference is not between private and public sector, but between automatic and non-automatic systems for stabilization. Indonesia's system for price stabilization during the New Order, in which BULOG was given the autonomy to manage imports, was also relatively successful. By contrast, the experience of 2006 and 2007, in which parliamentary approval was required for individual rice import shipments, led to substantial delays and much larger price increases than might have otherwise been necessary. Moreover, Rosner and McCulloch's paper highlights the importance of using price rather than quantity as the trigger for imports. Again this is achieved automatically with private sector trade, but can also be achieved administratively if a government agency is given the mandate to stabilize prices and the access to imports and resources necessary to do so.

ii. Indonesia should engage more fully in the world rice market (despite the recent turmoil)
As discussed in the previous section, there are important productivity gains to be had if the right changes were to be made in input use policies It makes sense for Indonesia to both seek increases in productivity and to engage more fully in the world rice market to secure its supplies of rice. Current policies, which take a wary approach to integration in the world rice market, would appear to be based on concerns about the size and volatility of the world rice market derived from the experience of the 1970s. Even the current world rice crisis does not undermine the importance of trade-to both exporting and importing countries-in stabilizing their domestic rice economies.

iii. The government should review the effectiveness of its public procurement and distribution systems
The government, through BULOG, is still responsible for procuring around 4 percent of rice harvest each year. This rice is then distributed at subsidized prices primarily through the rice-for-the-poor RASKIN program. Recent increases in the prices of several commodities have given rise to indications that the government may be considering a larger role for BULOG in the management of key commodities in order to stabilize prices. But there is already strong evidence for inefficiency and poor targeting in the RASKIN program.[18] Public procurement and distribution programs can be a useful component of a social security system – but the government should weigh the costs of a greater role for public procurement and distribution with those of alternative mechanisms for achieving the same objective.

18 A February, 2008 report from SMERU on the effectiveness of the RASKIN program offered the following conclusions: "The findings suggests that, in general, the Raskin program indicates relatively low effectiveness, that many problems emerge in the distribution of the rice from the primary distribution point to the beneficiaries, and that the issues faced are actually similar each year. The low effectiveness of the program is indicated by the lack of program socialization and transparency; inaccurate targeting, amount, and frequency of rice received by beneficiaries, as well as price of rice; high cost of program management, ineffective monitoring and evaluation; and ineffective complaint mechanism."

Chapter V
Conclusions and Recommendations

The productivity challenge to climate change adaptation in rice in Indonesia lies in finding means of both applying advances from research in varieties, fertilizer, water, pest management etc and improving farmers' ability to cope with and predict changing season length and available rainfall or irrigation water. This study seeks to demonstrate that sources of increased productivity are available but have not been applied, either because of a failure in investment in research outreach and extension services or because of inappropriate subsidy policies. Of equal importance is the fact that a lack of a market-oriented rice policy (as discussed in the previous chapter) as well as misplaced fertilizer subsidy policies can negate the gains of improved productivity. These problems are exacerbated by ever declining areas of the most fertile and productive lands due to land conversion and an inadequate appreciation of the role of climate prediction in improving farmers' ability to adapt tc climate change and possibly lower prices under lower subsidy policy regimes in the future.

Land use policy changes

The scale of extensification required to compensate for loss of high yielding lands, is however, alarming (Agus 2006). At existing yield assumptions and rates of conversion, an extensification rate in excess of 200,000 ha per year would be required It is doubtful that sufficient land of adequate quality is available outside Java. Instead there must be intensive efforts to both increase yields on Java and to adhere to land policy regulating land use planning and land development permits. The land permit and planning system needs several changes. In the past, urban spatial planning in Indonesia neglected the public as stakeholders and was dominated by initiatives of both central and local government. The main problem is that the Legislation of Spatial Planning *(Undang-Undang Tata Ruang)*, i.e., Law 24/1992, has not been followed with the appropriate regulations concerning implementation procedures. In addition, land-owners need to be 'share holders' in the projects being carried out by developers on their lands. This is the essence of a partnership between the private sector, the community and government in urban land-use development, where existing land owners share in the profits of development. Urban spatial plans should be made accessible and available to the public. The Local Development Planning Board *('Bappeda')* of the provincial administrative level (Province) and of the district and municipal levels should be the institution that undertakes such coordination. However, most local development planning boards face a serious shortage of qualified personnel. Permits should be granted primarily with reference to urban spatial plans (RUTR) and only with a realistic development plan. The procedures for granting of permits (general permits, locational permits and building permits) needs reform. A time limit should be enforced on development, with authority to cancel the permit where the developer does not meet the time limit. Higher land taxes (current rates are 0.1% per annum) on abandoned and undeveloped land would also discourage speculation. Fortunately the Government moved to limit any one developer to an area of 400ha in any province and 4000 ha in the nation as a whole, with a system of annual renewal, in 1999(Firman 2004), however, more reform of land tax, volume of permits and general speculation is needed to limit the loss of agricultural land.

Research and outreach

Future rice food security in Indonesia will depend on the rate at which investment in research and outreach can improve yields beyond the 1990-2000 average rate of about 0.47% per annum. An improvement to 0.61% on Java and 1.2% elsewhere (Oad,2001) would allow Indonesia to obtain a positive rice balance by 2020. Such an increase would allow Indonesia to obtain yields of 6.38 t/ha on Java (base rate 5.48 t/ha) and 4.95t/ha off Java (base rate 4.8 t/ha). However, these increases will not allow rebuilding of stocks without imports and without stocks, the market will remain volatile. An overhaul of the research system is essential especially given the chronic underfunding of agricultural research in Indonesia. While setting up a national broad-based research consortium for climate change is laudable (Chapter 3), it will be ineffective with the current limited funding. Similarly, the outreach program to farmers on using climate-related information to make farm management decisions has seen remarkable progress but this is again in danger of petering out if not supported by adequate local government and central government funding. In essence, policymakers need to take a view of research funding based on its economic rate of return to the nation and not its direct annual financial cost. Research funds derived from partnerships with the private sector and from industry levies must be returned directly to the Indonesian Agency for Agricultural Research and Development (IAARD), according to Law 2007/35. Technologies like the Bayer Direct Rice Seeder offer a lot of promise for improving productivity and at the same time saving water and labor use. But technology dissemination and awareness-raising of farmers is key. A well-functioning research and outreach process is vital to achieving the rates of gain in yield now being seen in Vietnam

Production support and price stabilization policies.

One of the legacies of the Green Revolution has been an excess application of both nitrogen and phosphorus that has resulted in severe environmental externalities notably increased eutrophication and increased emissions of NO2. The pattern of imbalanced fertilizer use is repeated across the region and demonstrates that for 1980-99, growth rates of rice imports were lowest in countries where imports of potassium fertilizer were greatest Vietnam, notably has led the region in the adoption of balanced nutrition of rice.

Research from Indonesia's leading institutes indicate that there is significant potential for improving productivity of existing soils by reducing urea application and increasing application of potassium fertilizer. Overall, however, shortage of imports of potassium chloride and excess use of nitrogen (urea and ammonium sulfate) appear to be a major constraint to adoption at farm level of a better balanced fertilizer regime and better use efficiency of water and nitrogen. To address this constraint, Government might consider redirecting subsidy payments on urea production to potassium imports, possibly using a carbon fund initiative to assist in financing the imports or a subsidy on their use.

Improving fertilizer management will not only improve yield by its productivity impact. It will have direct impacts on GHG emissions and thus climate change mitigation. In terms of GHG equivalents the amount of N applied to rice represents 100 million tons of CO_2 equivalents, with approximately one half embedded in fossil fuels used in manufacturing processes and the remainder as N_2O emissions arising from the fact that N fertilizer use efficiency is commonly only about 50%.

In the long-term the government would need to move toward the parastatals giving way to a fully privatized free market input supply systems with no subsidies (except perhaps freight for disadvantaged regions) and with open competition for business.

Bulog – The Way Forward

Domestic developments over the last three months highlight the need for a more rational and less political decision making process if Bulog is to perform its rice stabilization role more effectively. *Ad hoc* policy decisions on the scope of the RASKIN program are being made without proper planning and adequate input from Bulog on the feasibility of it being able to source the supplies needed. After the peak of the main harvest on Java was passed and Bulog's opportunities for local purchases were diminishing, the government initially considered increasing the quantum of rice being distributed to the poor by nearly one-third or over 1 million tons without a concomitant decision to authorize imports. Ultimately the increase was scaled back to 560,000 tons, but no arrangements were made either to facilitate large-scale commercial buying by Bulog in the local market or to authorize imports.

As a *Perum*, Bulog is mandated to pursue "commercial" endeavors, but admonished to "not lose money" on these ventures. In the short run, this is an unrealistic policy in general and this stricture is precluding ambitious domestic procurement efforts from getting of the ground. Last year Bulog bought less than 25,000 tons of domestic rice commercially and was able to dispose of it during market operations while covering its costs. This year, though, it is being asked to buy very large tonnages commercially to supply its expanded RASKIN needs – which have nearly doubled. Initially, the target was set at 0.5 million tons, but has subsequently been increased to 1.5 million tons. As this involves selling the rice at below the HPB (cost price), this cannot be done without financial guarantees, and these have not been forthcoming from the Ministry of Finance. With a lapse of over two months, this year's effort has not yet got off the ground as Bulog reports it is still lacking 1) a credit guarantee, 2) a loss guarantee, 3) a legal instrument that allows rice purchased above the HPP to be used in the Raskin program, and 4) a decree specifying that the quality purchased commercially will be higher than that secured under the HPP.(Slayton, 2008) Because of these delays, the prospects for major purchases at relatively attractive prices are much diminished likely necessitating larger (and more expensive) imports than otherwise would have been the case.

Key recommendations would include the following:

i. The President should appoint the head of Bulog as the special rice policy coordinator, upgrading Bulog's role from implementer of decisions made by others to a key player at both the design and policy levels.
ii. Bulog should be given standing authority to import at least 500,000 metric tons of rice annually without any prior approval or restrictions on the timing of those arrivals.
iii. Ministry of Finance must provide standing credit guarantees to cover Bulog losses that might result from its commercial buying efforts on behalf of the government. The procurement price for these purchases would be Rp 600/kg over the average price paid for these purchases. The volume to be purchased and the maximum expenditures would be subject to approval by the Economic Coordinating Minister.

Annex 1

Site Specific Nutrient Management Implementation

Site Specific Nutrient Management (SSNM) for Improvement of Farm Level Fertilizer Decision making

Existing fertilizer recommendations for rice often advise fixed rates and timings of N, P, and K for vast areas of rice production. For example, the Ministry of Agriculture has produced a manual providing recommended does of N, P and K fertilizers for every Kabupaten Such recommendations assume the need of a rice crop for nutrients is constant in Indonesia , however, the recommendations are necessarily broadly based and may not optimize inputs or maximize yield across years and over large areas. Requirements can be strongly influenced by crop-growing conditions, crop and soil management, and climate - which can vary greatly among fields, villages, seasons, and years.

Researchers at the International Rice Research Institute (IRRI) developed the SSNM approach (see Annex1) in the mid 1990s and evaluated it from 1997 to 2000 on about 200 irrigated rice farms at eight sites in Asia. (IFC 2006) Since 2001, the on-farm evaluation and promotion of SSNM have markedly increased. In 2003 to 2005, SSNM was evaluated and promoted with farmers at about 20 locations in tropical and subtropical Asia (IRRI 2006), each representing an area of intensive rice farming.

On-farm research conducted by IRRI and the National Agriculture Research and Extension Stations (NARES) on 118 farms in four SE Asia countries has shown that the improved techniques of site-specific nutrient management (SSNM) can contribute to productivity increases of 10 to 15 percent, with an average increase in net farm income of about US$50/ha/crop or US$100/ha/yr in double cropped systems. Yield and income gains were much larger, however, in well-managed farms (Dobermann et al., 2002).

Successful implementation of SSNM, however, requires complementary and comprehensive crop management techniques, including pest and disease management, and the use of high quality seed. The research showed that the impact of SSNM on yield and profitability were much greater where farmers achieved high standards of general crop care.

Site-specific nutrient management (SSNM provides an approach for 'feeding' rice with nutrients as and when needed (IFC 2006, IRRI, 2006) by filling the deficit between the nutrient needs of a high yielding crop and the nutrient supply from naturally occurring indigenous sources, including soil, crop residues, manures, and irrigation water. The SSNM approach does not specifically aim to either reduce or increase fertilizer use. Instead, it aims to apply nutrients at optimal rates and times in order to achieve high rice yield and high efficiency of nutrient use by the rice, leading to high cash value of the harvest per unit of fertilizer invested.

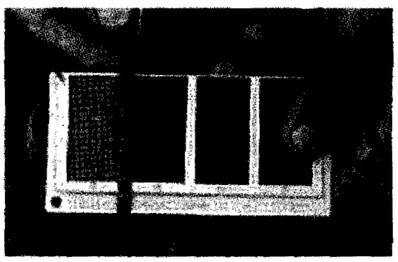
The demand of rice for N is strongly related to growth stage. In order to achieve high yield, rice plants require sufficient N at early and mid-tillering stages (branching) to achieve an adequate number of panicles (grain bunches), at panicle initiation stage to increase spikelet (flower) number per panicle, and during the ripening phase to enhance grain filling. The supply of N from soil and organic sources is seldom adequate for high yield, and supplemental N is typically essential for higher profit from rice fields. The SSNM approach enables farmers to apply fertilizer N in several doses to ensure the supply of sufficient N is synchronized with the crop need for N.

A key ingredient for managing N to meet crop need is a method for rapidly assessing leaf N content, which is closely related to photosynthetic rate and biomass production and is a sensitive indicator of the N demand during the growing season. Leaf color charts (LCC), are an inexpensive and simple tool for monitoring the relative greenness of a rice leaf as an indicator of the leaf N status (Balasubramanian et al., 1999; Witt et al., 2005). The LCC is typically a plastic, ruler-shaped strip containing four or more panels that range in color from yellowish green to dark green.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	**20**	**40**	**60**		
4	15	25	40	60	
5	0	20	30	40	60
6	0	0	25	35	45
7	0	0	0	30	40
8	0	0	0	0	35

Table 1: Guidelines for the application of fertilizer P2O5 according to yield target and P-limited yield in P omission plots (Witt et al., 2002).

SSNM provides two complementary and equally effective options for improved N management using the LCC. In the 'real-time' N management option, farmers monitor the rice leaf color regularly (e.g. once a week) and apply fertilizer N whenever the leaves become more yellowish-green than the critical threshold value indicated on the LCC. In the 'fixed-time/adjustable dose' option, the time for N fertilization is pre-set at critical growth stages, and farmers adjust the dose of N upward or downward based on the leaf color.



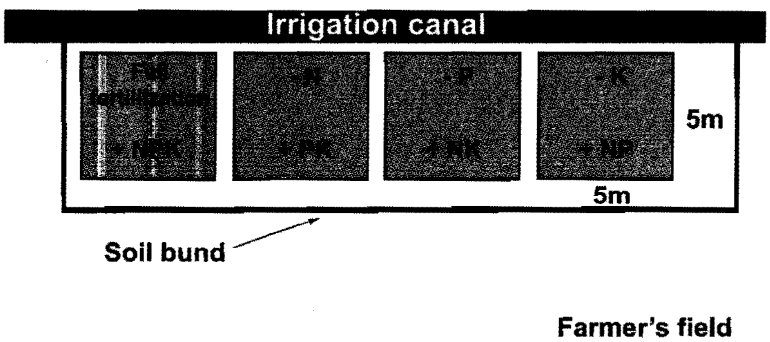
The leaf color chart (LCC) for efficient N management in rice. © IRRI 2005.

The real-time and fixed-time/adjustable-dose options for N management are typically comparable in terms of grain yield and profit when implemented according to the guidelines of SSSM. The selection of an option for using the LCC can be based on farmer preferences and location-specific factors. The fixed-time/adjustable-dose option, for example, is less time-consuming and is preferred by farmers with gainful non-rice activities and insufficient time for weekly visits to their rice fields. The real-time option is generally preferred when farmers lack sufficient understanding of the critical stages for optimal timing of fertilizer N. The effective management of N with both approaches, however, requires sufficient application of P, K, and micronutrients to overcome limitations of other nutrients.

Low (< 1 t/ha)	3	45	75	105		
	4	30	60	90	120	
	5	0	45	75	105	135
	6	0	0	60	90	120
	7	0	0	0	75	105
	8	0	0	0	0	90
Medium (2–3 t/ha)	3	30	60	90		
	4	0	35	65	95	
	5	0	20	50	80	110
	6	0	0	35	65	95
	7	0	0	0	50	80
	8	0	0	0	0	65
High (4–5 t/ha)	3	30	60	90		
	4	0	30	60	90	
	5	0	0	30	60	90
	6	0	0	10	35	70
	7	0	0	0	25	55
	8	0	0	0	0	40

Table 2. Guidelines for the application of fertilizer K_2O according to yield target and K-limited yield in K omission plots (Witt *et al.*, 2002).

The SSNM approach advocates sufficient use of fertilizer P and K to overcome P and K deficiencies, to avoid the mining of soil P and K and to allow best N management. Fertilizer P and K requirements are obtained from an estimate of attainable yield target and either the P- or K-limited yield. The yield target must be realistically attainable by farmers. It can be estimated from the grain yield in a fully fertilized plot with no nutrient limitations and good management (for example, the NPK plot or NPK plus micronutrient plot). P- and K-limited yields are determined by the nutrient omission plot technique.



Schematic layout of omission plot at farmers' field.

With the nutrient omission plot technique, one plot of rice is grown with abundant fertilizer supplements (NPK plot or NPK plus micronutrient plot)and the yield thus achieved is used to calculate the full demand of rice for P and K. The attained yield can also serve as a yield target. Rice is simultaneously grown in two other plots, one without added P fertilizer and the other without added K. The rice yield in the plot without fertilizer P provides an estimate of P-limited yield, and the rice yield in the plot without fertilizer K provides an estimate of K limited yield. The yields are then compared with P and K requirements for a particular yield (see tables above) to estimate optimal rate fertilizer P_2O_5 and K_2O rates, which overcome P and K deficiencies and include sufficient P and K to prevent depletion of soil fertility arising from their long-term removal with grain and straw.

Annex 2

Examples of Results of Prescription Farming in West Java using PADI300.CSM Simulation Model (Makarim 2000)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Garut	Selawi	Cigawir	240	190	125	0	175	35	79	0	6072	P, K Def. & Fe Tox.
		Cinunuk	130	210	100	0	162	3	74	0	6195	Low K
			440	270	70	0	162	3	74	0	6195	
			360	200	72	0	162	3	74	0	6195	
Sumedang	Darmaraya	Cibogo	180	110	70	0	103	40	78	0	6530	P, K Def. & Fe Tox.
			180	110	90	0	103	40	78	0	6530	
			120	120	60	0	103	40	78	0	6530	
	Sumedang Utara	Marga mukti	200	75	50	0	103	63	69	0	5659	P Def.
Cianjur	Cilaku	Sirnagalih	200	100	100	0	115	39	30	0	6552	P Def., Low K, potential, Fe Tox
	Bojong Picung	Cibarengkok	380	150	38	0	175	0	59	0	6072	Good
			150	150	60	0	175	0	59	0	6072	
			430	280	140	0	175	0	59	0	6072	
			200	300	0	0	175	0	59	0	6072	
	Ciranjang	Mekar Galih	200	100	100	0	175	14	79	0	6072	K Def, Fe & Mn Tox.
Subang	Pagaden	Sumur Gintung	300	300	0	0	199	74	54	0	5279	P def
			250	100	50	0	199	74	54	0	5279	
			200	100	0	0	199	74	54	0	5279	
			300	150	0	0	199	74	54	0	5279	
	Binong	Nangerang	200	50	50	0	175	30	94	0	5648	Fe & Mn Tox.

Annex 1 Examples of Results of Prescription Farming in West Java using PADI300.CSM Simulation Model (Makarim 2000)

Glossary

Adaptation: actions by individuals or systems to avoid, withstand or take advantage of current and projected climate variability, changes and impacts. Adaptation decreases a system's vulnerability or increases its resilience to impacts.

Adaptive capacity: a system's inherent ability to adapt to climate change impacts.

Mitigation: actions to reduce greenhouse gas emissions by sources and/or enhance carbon removal by sinks.

Resilience: the ability of a system to withstand negative impacts without losing its basic functions.

Vulnerability: the potential for a system to be harmed by climate change, considering the impacts of climate change on the system as well as its capacity to adapt.

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