

# CAPTURING THE BENEFIT OF MONSOONAL AND TROPICAL CLIMATE TO ENHANCE NATIONAL FOOD SECURITY

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## ABSTRACT

Although the consumption level is declining with improved economy and living condition, rice remains the staple food in many Asian countries. With annual consumption per capita of more than 100 kg, Indonesia is far higher than Japan, Korea, Taiwan, and Malaysia with around 90 kg but less than the least developed countries in Southeast Asia, Laos and Myanmar that consume around 200 kg. Java the most populous island with about 7% of Indonesian terrestrial territory has long been and is still the national rice basket although its contribution to the national rice production is steadily declining. With population is still growing by 1.30% annually, competition for food, water, and energy will increase. Consequently food prices will rise, more people will go hungry, and migrants will flee the worst-affected regions. Therefore, to cater the national rice demand, alternatives has to be found in outer islands. The geographic position and variable climate of monsoonal and tropical rainfall patterns as well as the availability of large swathes of swampy land offer opportunity to evenly spread planting time and hence rice production throughout the year. However, recent rapid development of tree plantations will make it difficult to implement without political will supported with strong policy and appropriate planning. This paper describes the challenges and opportunities in utilizing climate variability to enhance national food security and improve farmers' welfare.

**Keywords:** Climate variability, climate change, food security

## ABSTRAK

### *Menangkap manfaat iklim monsun dan tropis untuk meningkatkan ketahanan pangan nasional*

Meskipun terjadi penurunan konsumsi beras karena adanya peningkatan ekonomi dan kondisi masyarakat, beras tetap merupakan pangan utama di beberapa negara Asia. Indonesia memiliki tingkat konsumsi beras sekitar 100 kg/kapita/tahun, tertinggi dibandingkan dengan Jepang, Korea, Taiwan, dan Malaysia dengan tingkat konsumsi beras hanya sekitar 90 kg/kapita/tahun, tetapi masih cukup rendah bila dibandingkan dengan Laos dan Myanmar yang bisa mencapai 200 kg/kapita/tahun. Jawa sebagai pulau terpadat di Indonesia merupakan produsen utama beras nasional, walaupun kontribusinya terhadap produksi nasional mengalami penurunan dari tahun ke tahun. Laju pertumbuhan penduduk 1,30% per tahun meningkatkan kompetisi dalam pemenuhan kebutuhan utama seperti makanan, air, dan energi. Akibatnya harga pangan meningkat, makin banyak orang yang kesulitan makanan, dan mendorong orang untuk bermigrasi mencari tempat yang lebih baik. Oleh karena itu, untuk memenuhi kebutuhan beras nasional perlu ditempuh alternatif dari luar Jawa. Posisi geografis dan peubah iklim dari pola curah hujan monsun dan tropis serta ketersediaan lahan gambut yang luas merupakan peluang untuk memproduksi beras sepanjang tahun. Pengembangan perkebunan akhir-akhir ini makin mempersulit implementasi perluasan sawah tanpa dukungan politik dan perencanaan yang matang. Tulisan ini mengulas tantangan dan peluang pemanfaatan keragaman iklim dalam penyediaan beras nasional untuk meningkatkan ketahanan pangan dan pendapatan petani.

**Kata kunci:** Ketahanan pangan, keragaman iklim, perubahan iklim

**T**he increasing population requires more food and discharges more waste. All these need more resources that presently already scarce. Producing food requires energy, land, water, and genetic resources and has to adapt to the vagary of climate (Sun *et al.* 2009; Ludwig and

Asseng 2010). The anxiety of Malthus (1798) seem had been overcome by the green revolution in the 1960s. The miracle seeds require prime lands and large inputs as fertilizers (Ning *et al.* 2009), irrigation (Jalota *et al.* 2009) and other chemicals to protect the crops from pests and diseases

(Qi *et al.* 2009). The crops also cannot be cultivated on marginal ecosystems where most the poor people earn their living. Although green revolution has remarkably increased world food production, distributing the food to the needy requires energy, passion, and political will. This

has left millions of people in the world still suffering from hunger or malnutrition.

Rice is still the national staple food, although in many countries the consumption levels of rice are declining with improved economy and living condition (Marquez *et al.* 2009). Maclean *et al.* (2002) reported that in Indonesia rice consumption per capita is still more than 100 kg annually compared to Japan, Korea, Taiwan, and Malaysia with around or less than 90 kg (Figure 1). In Laos and Myanmar, the least developed in Southeast Asia, the rice consumption per capita is around 200 kg annually. Decreasing rice consumption in Indonesia is probably because of food diversification with unfortunately by more consumption of imported wheat. This paper describes the challenges and opportunities in utilizing climate variability to enhance national food security and improve farmers' welfare.

## ROLE OF JAVA IN NATIONAL RICE PRODUCTION

Amid only about 7% of Indonesian terrestrial territory, Java is the most populous island of Indonesia with present population of 132 millions. The island has also been and is still the national rice basket although its contribution to the national rice production steadily declining. The population is expected to grow by 1.30% annually and is estimated will reach 167 million by 2030. As population grows, competition for food, water, and energy will increase. Food prices will rise, more people will go hungry, and migrants will flee the worst-affected regions. These problems will certainly be exacerbated by the adverse impacts of climate change.

Because of its fertile land and large working force, Java is the center of political, educational and economical activities since colonial era. With largest proportion of suitable lands for agriculture and available working force it benefited from government investment in agricultural infrastructure. With its vicinity to the center of development and well developed transportation system of the outer islands, Sumatra is the second largest rice producer followed by Sulawesi and almost similarly by Kalimantan and Nusa Tenggara. Sumatra, Kalimantan, and later Papua, the three largest islands of Indonesia have vast lands that available

and potentially can be developed for food crop areas to cater national demand. While the islands of Sulawesi, Maluku, and Nusa

Tenggara because of the limited suitable lands can be developed mainly for regional food crop production (Figure 2).

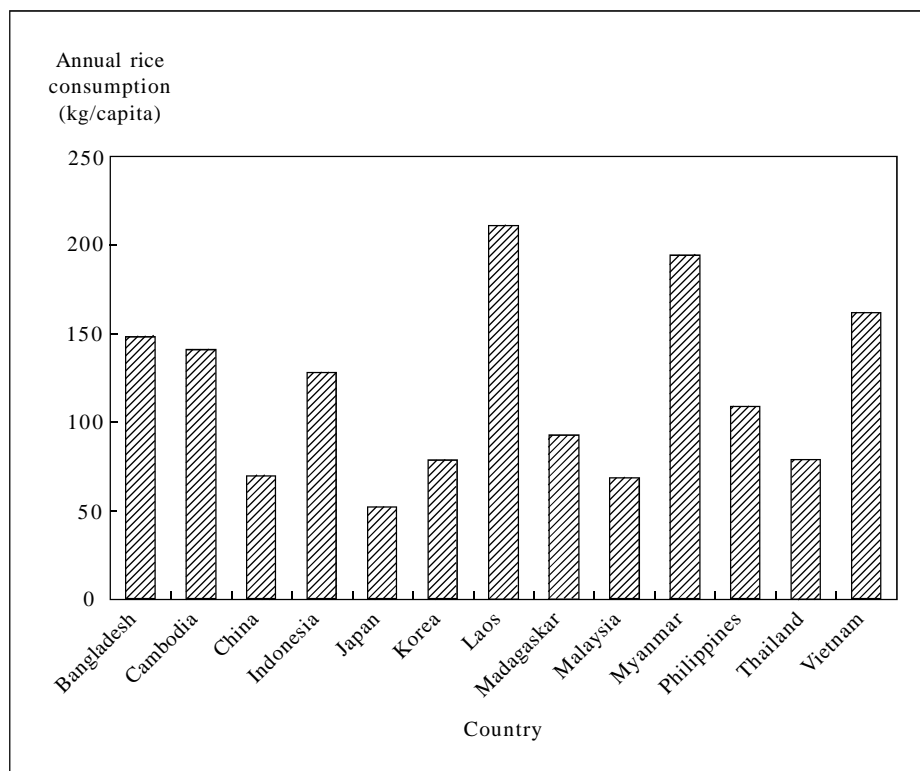


Figure 1. Rice consumption in selected countries with rice as the main diet (Maclean *et al.* 2002).

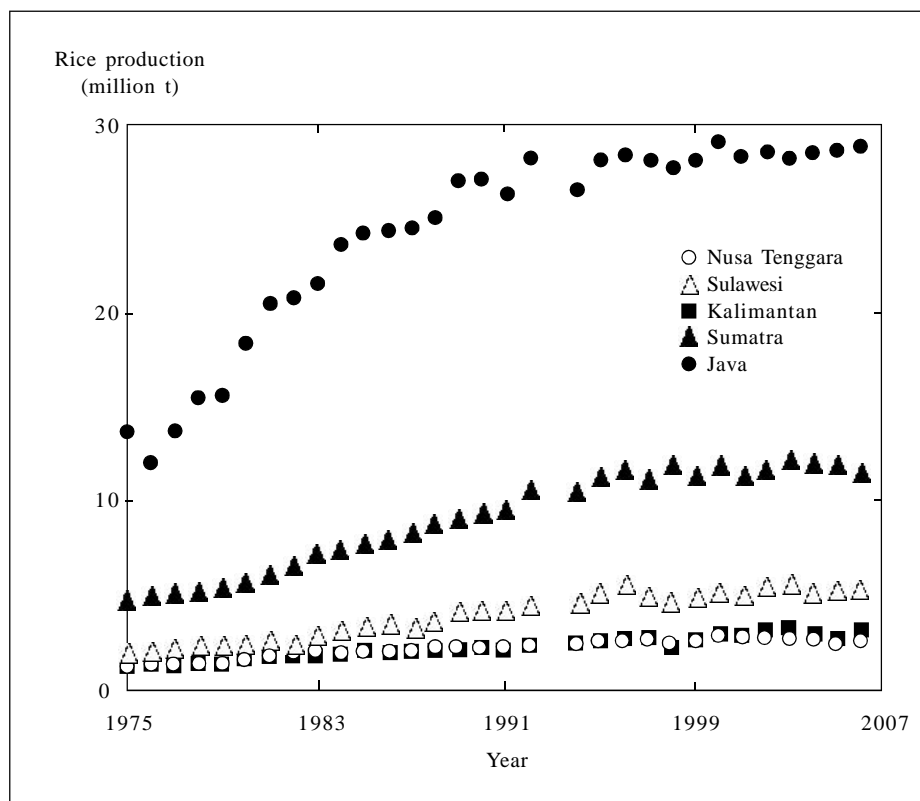


Figure 2. Regional rice production in Indonesia, 1975>1999 (BPS 1975>2007).

The role of Java as national rice basket is threatened because of the increasing tight competition in land and water on the island. The increasing population and growing economy have taken the prime agricultural lands for non-agricultural uses such as residential, industry, and transportation infrastructure. Water demand in other sectors such as domestic, industry or even high valued agricultural crops will deprive water supply to the high requirement of water for rice cultivation. In the last three decades, contribution of Java to national rice production was declining from around 63% to about 53% (Figure 3).

The conversion of bunded rice fields is accelerated by the policy in transportation development. Development of roads instead of rail will certainly speed up housing development along with business multipliers that follow causing more agricultural lands become impermeable that increase run-off. The sprawling phenomenon that happens in many places will certainly taken away productive fertile agricultural lands. If left unchecked, in West Java the transportation infrastructure development along with its multipliers is predicted to take away about 40% of agricultural lands in the year of 2025 (Brinkman 2008). Expanding impermeable lands will reduce the time of water retain on the lands and often trigger flood and in this monsoonal climate resulting of water shortage during dry season.

The immense role of Java as the main national rice supplier is because of beside the demand for its large population it is also due to the availability of suitable fertile lands along with well developed transportation infrastructure. The adoption of modern rice cultivation technology is noticeably in the soaring rice production in Java during the period of 1975–1985. The rice production growth in Java was far higher than that in the other regions (Figure 1). The three variables, market demand, available land and developed infrastructure also make Sumatra the second biggest national rice supplier. Beside the larger available lands compared to Java, well developed transportation system and its vicinity to Java with large market make Sumatra better choice than the other regions.

The leveling off in rice production happened earlier in Java in the period of 1985–1990 (Figure 1). While in Sumatra the

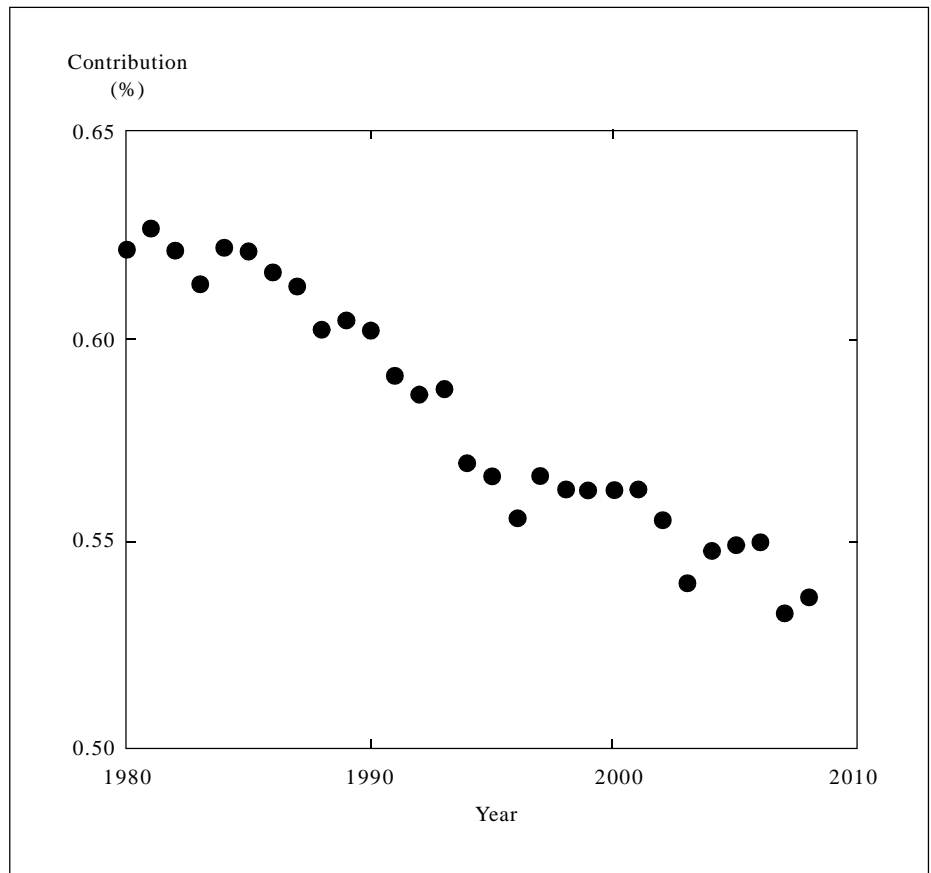


Figure 3. Declining contribution of Java to the national rice production, 1980>2007 (BPS 1980>2007).

leveling off seemed after the year of 1995 and in Kalimantan after the year of 2000. The earlier leveling off in rice production in Java was probably because of limited land and contribution of intensification either by increasing cropping intensity or other technological inputs already limited. The period when leveling off in rice production in each region can be an indicator for future national rice production centers.

However, developing rice production centers in Sumatra is constrained by the farmers' preference in plantation, particularly oil palm and rubber (Figure 4). More development of plantation is probably because of labor shortage for annual crop farming and more promising return in the plantation. Many of the farms designed for food crops and the reserve lands in the transmigration program have been converted to tree plantation. Similar trend is also happening in eastern parts of the country where food crop lands are converted to cacao plantations in Sulawesi and for orange orchards in the tidal swamp areas of Kalimantan.

## ADVERSE EFFECTS OF CLIMATE VARIABILITY AND CLIMATE CHANGE

Climate varies temporally either seasonally, intraseasonally or interannually, and in the long run it is believed that climate is changing driven by increasing atmospheric temperature (Runtunuwu and Kondoh 2008). Interannual characterized with El Nino southern oscillation (ENSO) when instead of normal seasonal variation of wet and dry season in the normal monsoonal climate, a prolong drought during El Nino or wetter than usual during La Nina occur (Zhou *et al.* 2009). Intra-seasonal is a season break wetter than usual in dry season or drier during wet season during 10 days or several weeks. All these will disrupt water supply during the normal cropping rhythm commonly practiced by the farmers that eventually cause reducing yield or even crop failure (Vries *et al.* 2010). In Indonesia amid increasing rice harvested areas trend since

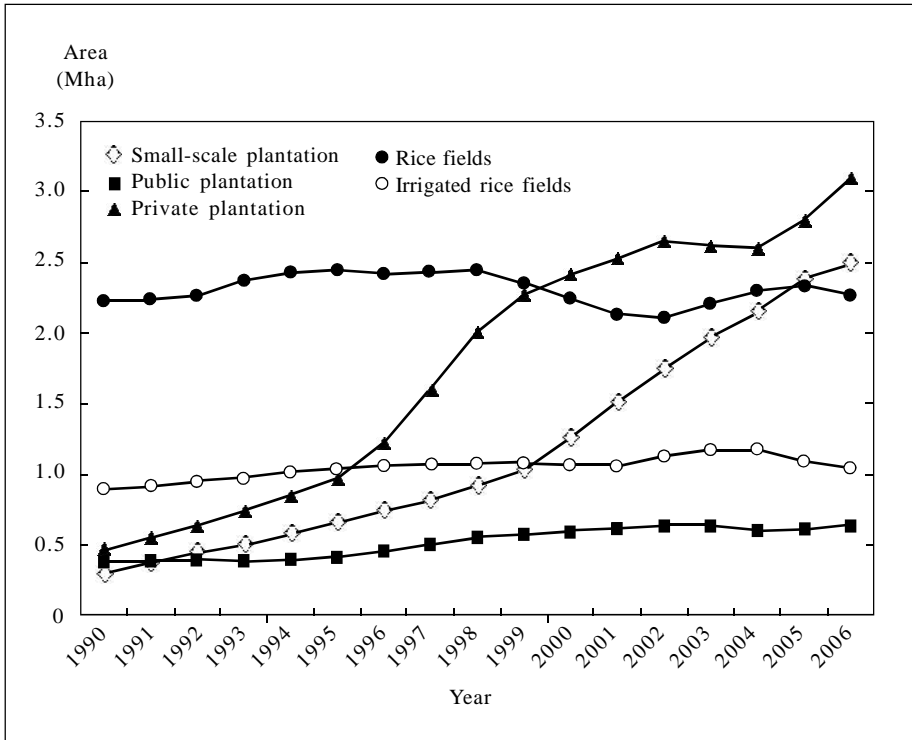


Figure 4. Comparison of rice fields and plantation development in Sumatra, 1990-2006 (BPS 1990>2006; Direktorat Jenderal Perkebunan 1990>2006).

green revolution it significantly decreased by interannual climate anomaly (Figure 5). Higher decreases were observed during strong ENSO that coupled with Indian Ocean Dipole Mode (IODM) positive when cooler temperature occurs in eastern part of Indian Ocean bordering Indonesia (Kug *et al.* 2009).

Climate change will adversely affect agriculture both directly and indirectly (Kang *et al.* 2009). The increasing temperature will shorten generative stage and along with increasing pests and diseases eventually reduce crop yield. Changing rainfall pattern will alter cropping calendar, and delay cropping time. The increasing frequency and intensity of extreme climate events are augmenting the risks of flood and drought that will further reduce crop production. Sea level rise will inundate productive agricultural lands and increase soil salinity that potentially reduces crop productivity (Amien and Runtuwuwu 2008).

Increasing CO<sub>2</sub> in the atmosphere will promote photosynthesis hence speed up growth and the increasing temperature will increase respiration resulted in decreasing yield. Climate change certainly causes increasing temperature, and probably rainfall and solar radiation. Simulating the effects of different climate scenarios on rice yields at two sites in Java, Amien *et*

*al.* (1999) reported that rice yield did not decrease significantly in the first crop at Mojosari in East Java, but significant decrease was observed at Pusakanegara

in West Java during normal year (Figure 6). However except for Godard Institute for Space Studies (GISS) climate scenario at Pusakanegara, the yield significantly decreased during ENSO driven dry year.

The changing rainfall pattern will alter rice cropping timing such like late planting of the first crop (October-December) that push back the timing of the second crop (April-June). These late planting will limit the possibility of the third crop when irrigation facility is not available. Studying the rainfall pattern in Sumatra, Java, Bali, and South Sulawesi, Naylor *et al.* (2007) reported that climate change according to the Fourth Assessment Report (AR4) suite of climate models will increase probability of 30 day delay of monsoon onset. The delay will certainly have significant impact on rice production.

The prospect of decreasing national rice production and increasing demand will exacerbate food shortage. The increasing is caused both by higher consumption of less fortunate and changing diet pattern of the rich that likely to consume more protein rich meat and fish. With still increasing population, more people particularly the poor will occupy the less favorable region that most likely more vulnerable to the adverse impacts of climate change.

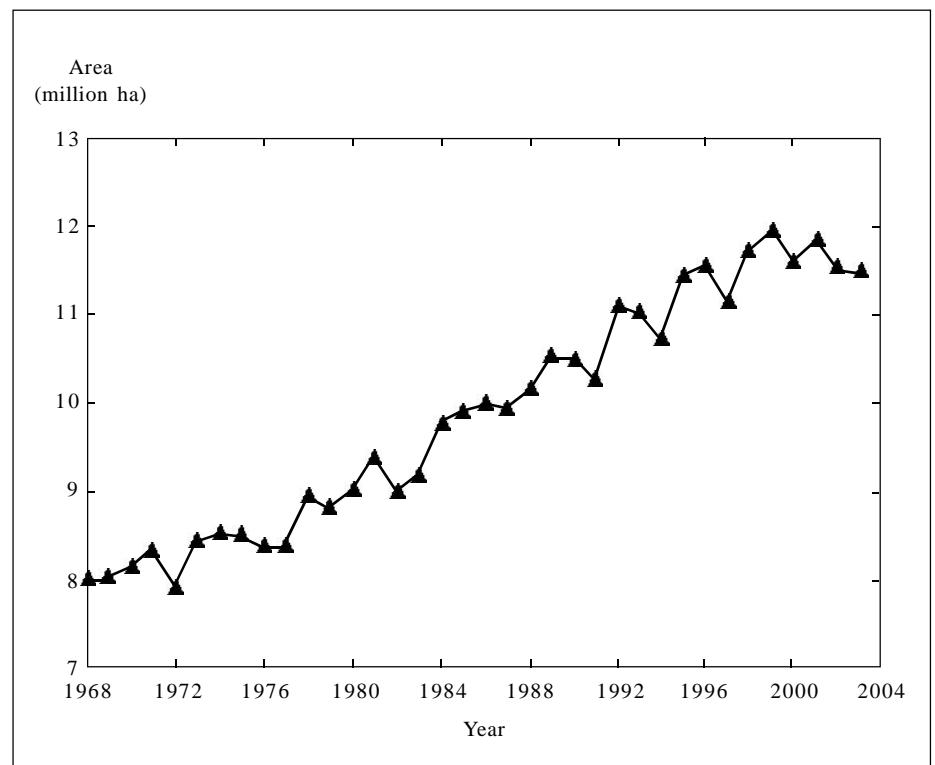


Figure 5. Decreasing rice harvested areas in Indonesia affected by climate variability, 1968>2004 (BPS 1968>2004).

## CLIMATE AND RICE REGIONAL PRODUCTION

Geographical position of Indonesian archipelago bestows the country with three different sources of moisture, the Pacific and Indian Oceans and the seas

surrounding the islands. Those close to the equator have two peaks of almost evenly distributed rainfall commonly called equatorial pattern and those away have distinct seasonal rainfall called monsoonal pattern (Figure 7). The effect of El Nino seems also to be stronger in the monsoonal than tropical rainfall pattern.

The availability of water throughout the year allows the planting season to be well spread within the year. The onset and peak of planting season on the island of Sulawesi are more evenly distributed in the northern compared to the southern parts of the island (Las *et al.* 2009a; Figure 8). The almost evenly distributed planting

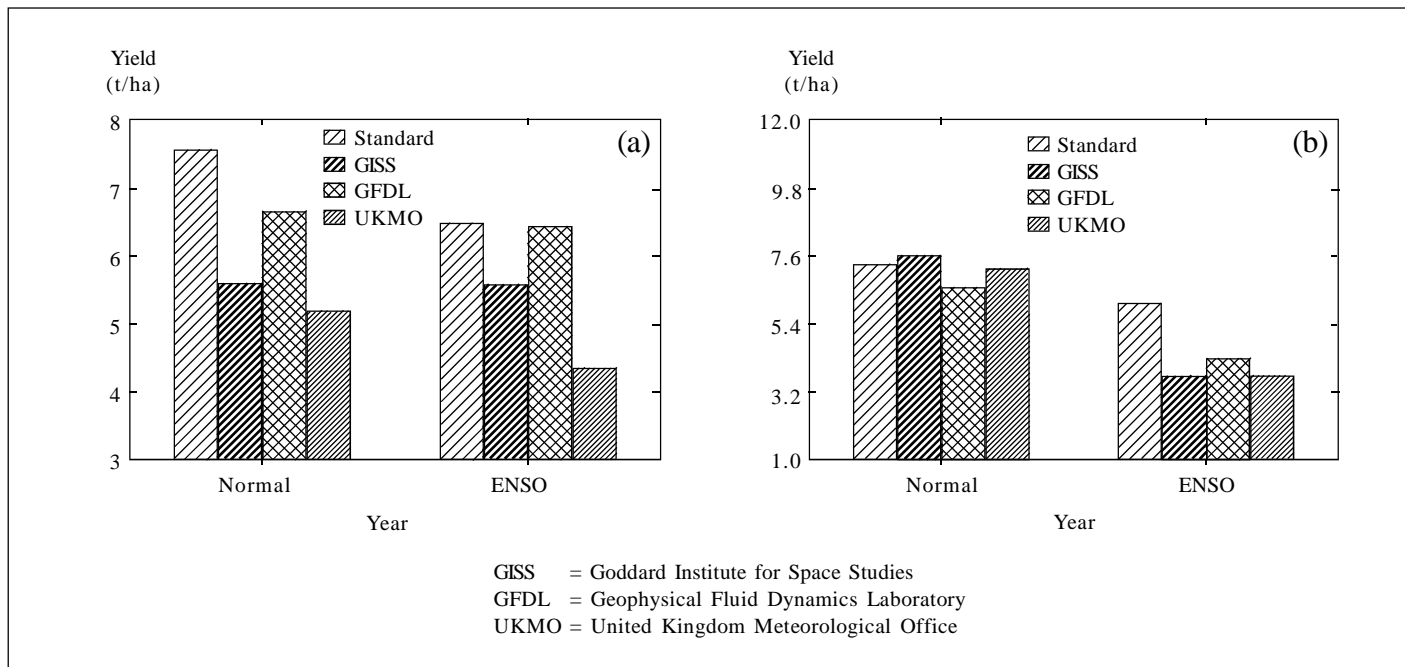


Figure 6. Simulated rice yields as affected by climate change at (a) Pusakanegara, West Java and (b) Mojosari, East Java (Amien *et al.* 1999).

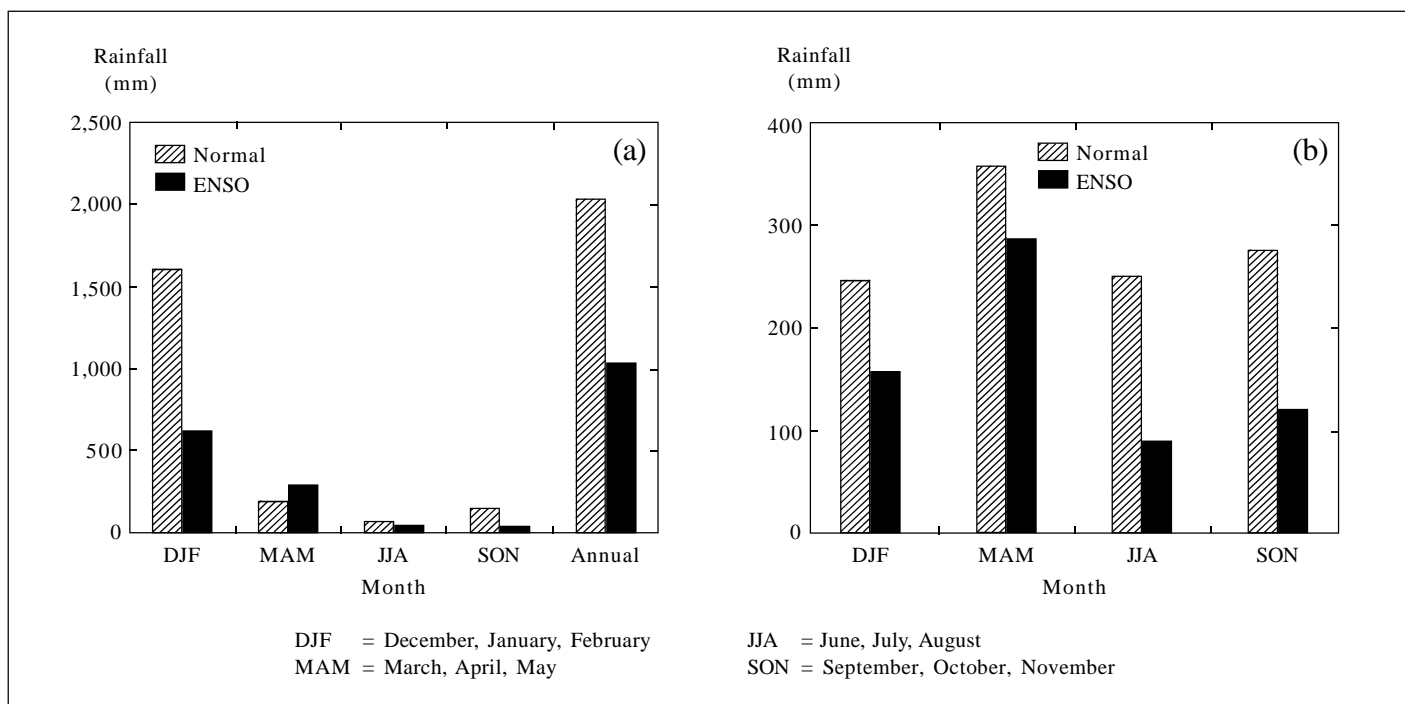


Figure 7. Quarterly rainfall pattern at (a) Pusakanegara, West Java, and (b) Enrekang, South Sulawesi.

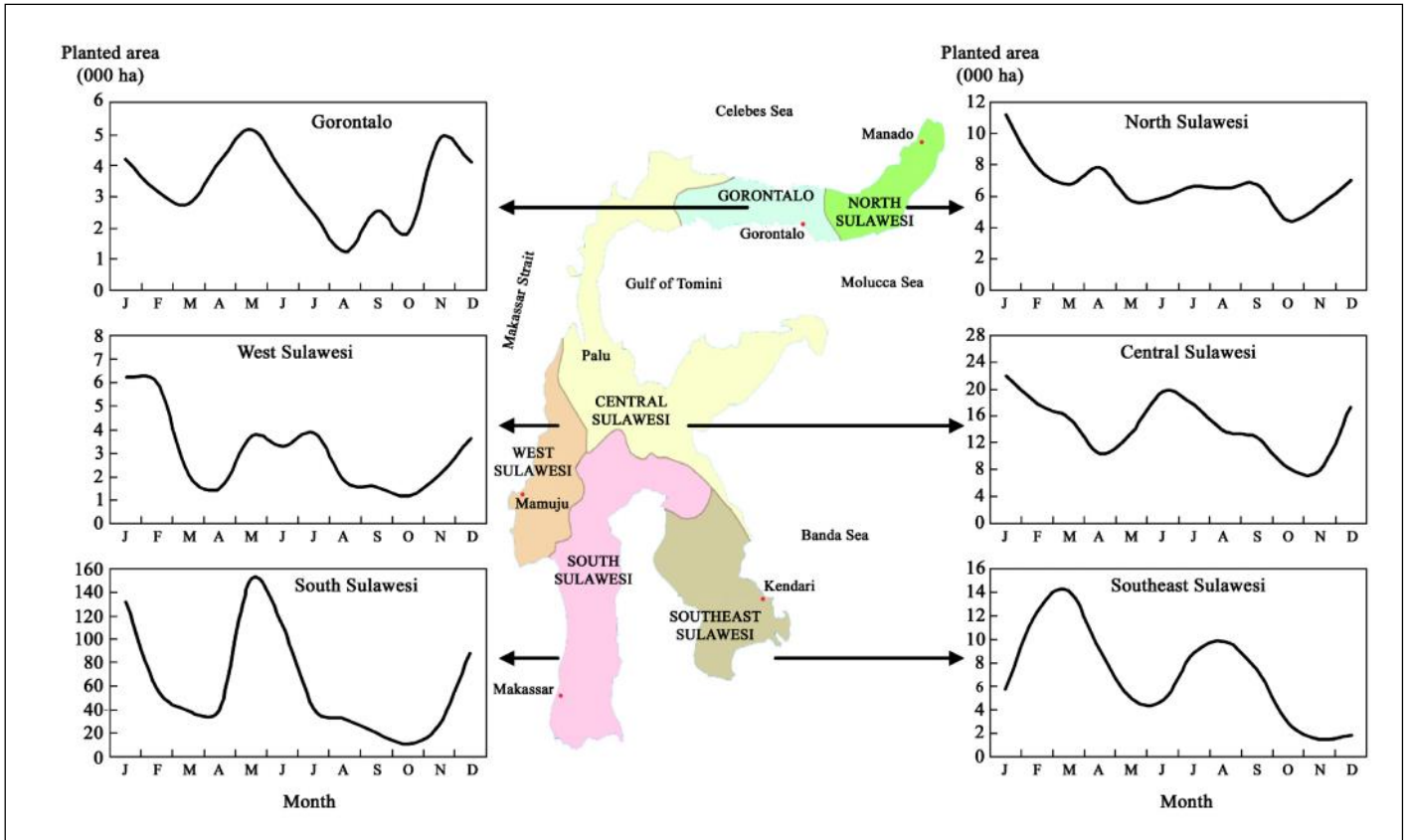


Figure 8. The monthly distribution of rice planting in Sulawesi, 2000>2007 (BPS 2000>2007).

season is also observed in the regions close to equator in Sumatra and Kalimantan with vast swathes of swampy lands. The availability of freshly harvested rice throughout the year benefited both the farmers and consumers with more stable price, fresh product, and less storage cost.

Java, Nusa Tenggara, and southern parts of Sumatra and Sulawesi with distinctly monsoonal pattern have two peaks of planting seasons. But Aceh and West Kalimantan only have one peak season a year from October to February and East Kalimantan from April to August. This is probably because of the weak market pull and somewhat costly transportation cost for export to the other islands. The existence of vast swampy land both in Sumatra (Las *et al.* 2008) and Kalimantan (Las *et al.* 2009b) can be optimized to cater the national rice requirement, particularly during El Nino when harvested rice area declined in many parts of the country.

Besides the water availability, rice production is also determined by the market pull as indicated by rice cropping indices that is higher in Java compared to

that in Sumatra and Kalimantan. The strong effect of market pull was indicated by the trend of seasonal rice harvest that became converge both monsoonal as in West Java, tropical as in West Sumatra, and region with vast swathes of wet lands as South Kalimantan (Figure 9). Monsoonal Java benefited from the availability of irrigation infrastructure showed increasing trend of the third rice cropping. But although West Nusa Tenggara has good irrigation facility, it did not show the trend of third rice probably due to the more attractive option of tobacco cultivation with higher return.

## RICE IMPORT

As one of the world biggest rice consumers, Indonesia has strived to cater national rice self-sufficiency through multifaceted programs. The programs among others are the rice intensification as adoption of modern rice variety, strengthening rice research and maintaining rice reserve. Rice self-sufficiency was attained

in the early 1980s and maintained through early 1990s (Figure 10). However, the rice reserve while maintaining stability during lean year has become counter productive through the marketing mechanism during the good year. The difficulty in marketing the reserve left the government with no other option except distributing rice to public servants and military throughout the country. The problems become more aggravated with unfair trade from rice exporting countries. Coupled with more frequent El Nino more rice was imported in the 1990s. But when energy and food crisis hit the world in 2008, many rice exporting countries withheld their import and making domestic rice cultivation become more attractive. Energized by the launching of national rice development program, Indonesia has maintained rice from 2005 until this year.

Rice was commonly imported during the lean months starting from November or December (Figure 11). Throughout 1995 after El Nino of 1994, rice was imported almost every month and after the strong El Nino of 1997 large quantities of rice were imported commencing August 1997 until

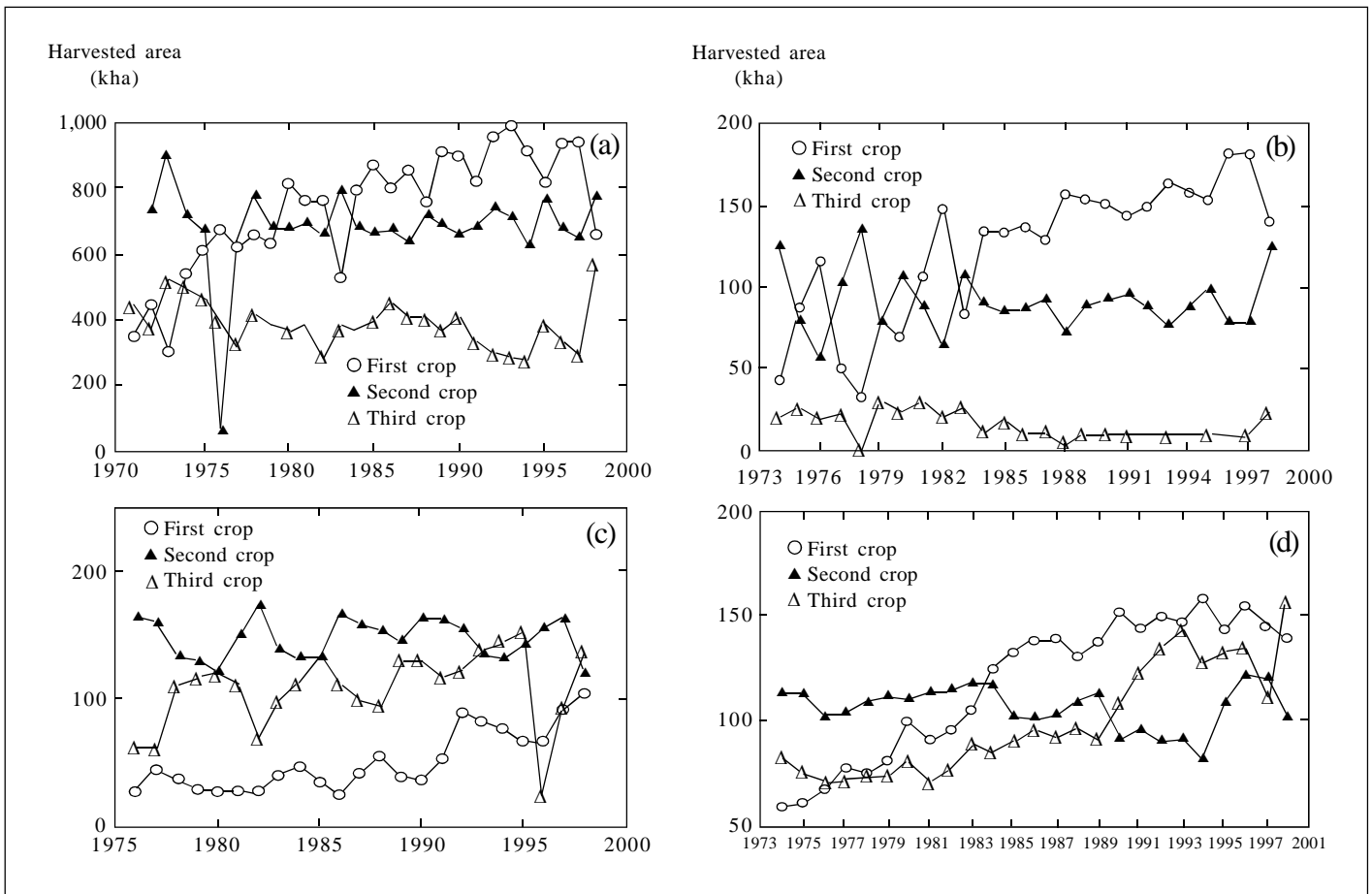


Figure 9. Seasonal rice harvested area in (a) West Java, (b) West Nusa Tenggara, (c) South Kalimantan, and (d) West Sumatra (BPS 1975>1998).

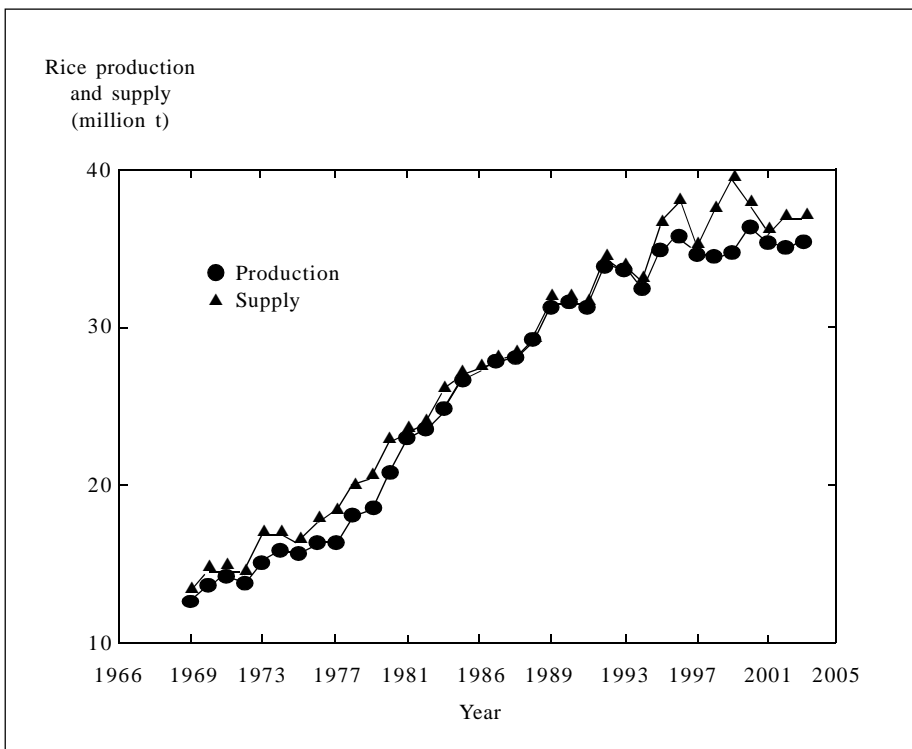


Figure 10. Rice production and supply in Indonesia, 1966>2005 (BPS 1970>2003).

mid 2000. Significant rice was also imported during the weak El Nino of 2002 and positive dipole mode (IODM) of 2003. This indicates that climate is one of the main considerations in rice import. By adjusting planting time in the different regions with different rice planting time in Indonesia, rice can be produced domestically to cater national requirement, by using agrometeorology data (Amien and Runtuuwu 2009). Domestically produced rice can save foreign expenses and provide opportunity for the farmers to improve their wellbeing.

### FUTURE NATIONAL RICE BASKET

The contribution of Java in national rice production is declining by almost 10% in the last three decades and expected to drop further and faster with the increasing population and growing economy. Although protection of productive agri-

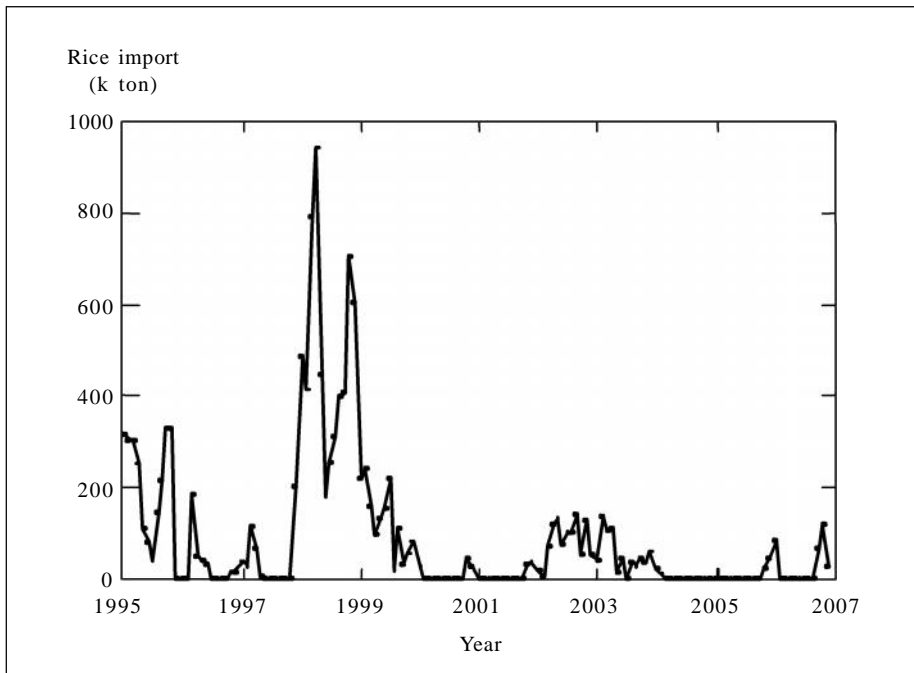


Figure 11. Monthly Indonesian rice import, 1995>2006 (BPS 1995>2007).

cultural land has been enacted recently, banded rice fields still threatened by conversion and competition of water with domestic and industrial uses will make it harder to increase rice cropping intensity. Therefore, new agricultural lands have to be selected for substitute in the big outer islands, Sumatra, Kalimantan, and Papua. Because of the size and consist of many

islands considering production capacity and transportation infrastructure development, Sulawesi, Nusa Tenggara, and Maluku can also be explored but mainly to cater local demand.

The first priority is Sumatra with its vicinity to Java and well developed infrastructure. By also considering the substantial local market, Sumatra can be

envisioned to gradually take over Java as national rice basket. However, the rapid development of oil palm plantation although not significantly converting present rice fields will deprive further development from available lands. For the next 20 years from 2010 to 2030, proper land use planning is necessary to ensure the land availability to secure national food security. Similar planning needs to be considered for rice field development in Kalimantan from 2020 to 2040 and Papua from 2030 to 2050.

## CONCLUSION

In a more equatorial climate and those with large areas of wet lands, the rice production is more evenly distributed during the year than that of the distinctly monsoonal. Spatial and temporal variations of the monsoon in the Indonesian archipelago provide an opportunity in manipulating cropping systems to strengthen food security. Declining contribution of Java as national rice basket has to be anticipated by appropriate planning of food crop development in outer islands. Rapid development of tree plantations will make it difficult to implement without political will supported with strong policy and appropriate planning.

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