LINKING CLIMATE CHANGE ADAPTATION OPTIONS FOR RICE PRODUCTION AND SUSTAINABLE DEVELOPMENT IN INDONESIA

(*Keterkaitan Opsi-opsi Adapatasi Perubahan Iklim untuk Produksi Beras Nasional dan Pembanguan Berkelanjutan di Indonesia*)

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ABSTRACT

Climate change is expected to significantly influence Indonesian rice production as this phenomenon will exacerbate extreme climate events such as El Nino and La Nina which have caused serious loss in rice production. This paper is attempted to propose plausible climate change adaptations for rice production by examining the formal documents on climate change studies in Indonesia and rice development strategies and to investigate their linkage with the Sustainable Development in Indonesia. The result shows that climate change adaptations will support Indonesian rice development strategies through options of "change cropping pattern/modified planting season" which has not been addressed by the development strategies. The proposed adaptations which are directed through two major programs for increasing rice production called as Extensification and Intensification, have also already addressed the four pillars of Indonesian sustainable development, namely: pro-job, pro-poor, pro-growth and pro-environment.

Key words: adaptation, climate change, development, rice production, sustainable

INTRODUCTION

Indonesian rice production is strongly influenced by climate extreme events associated with ENSO, which could cause flood and drought (Boer and Subbiah 2005; D'Arrigoa and Wilson 2008; Naylor et al. 2002; Naylor et al. 2001). Data from Ministry of Agriculture 2007 showed that about 546,487 hectares and 1,036,641 hectares of rice field area were inundated by flood in 2004 and exposed to drought in 2003. These two years were considered as El Nino and La Nina, respectively. These climate anomalies can also hinder the advantage of implementing a new farming technology (Ditlin 2007)

Understanding these consequences of extreme climates to Indonesian rice production, adaptation to climate change must be put as priority in order to secure Indonesian rice production. This action is important because climate change is believed to exacerbate extreme climate events such as ENSO (DFID 2005; PEACE 2007; Hansen et al. 2006). Recorded data on disaster in Indonesia reported that number of natural hazards occurred in Indonesia from 1907 to 2007 categorized as global hazards were about 345 events, of which about 60% were climate-related hazards (Boer and Perdinan 2008). The authors also stressed that these extreme events, flood and drought were more frequent after 1980s.

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Indonesian government through Ministry of Environment already paid a high attention on developing adaptation strategies to climate change by officially documenting National Action Plan to Cope With Climate Change (SME 2007). This dynamic document offers a foundation to develop further strategy to mainstream climate change adaptation into national development planning. As the real action, Indonesian government through State Ministry of National Development Planning had also developed a document of National Development Planning Response to Climate Change in 2007 (SMNDP 2007). In addition to these documents, country report on Status of Climate Variability and Climate Change, and Their Implications was also already published (GOI 2007).

Furthermore, in relation to rice production, Indonesian government already projects Indonesian demand for rice from 2010 to 2025 and strategies to meet the demand, which is documented in Prospek dan Arah Pengembangan Agribisnis Padi – *Prospect and Direction for Rice Agribusiness Development* (Deptan 2005). Therefore, investigating the linkage between climate change adaptation strategies proposed by the previous three documents and sustainable development plan for Indonesian rice production documented in the last document is an interesting issue to be discussed. The result of this investigation is important in order to propose appropriate adaptation options for sustaining domestic rice production in Indonesia.

Presentation of this paper is divided into there sections. The first section is to clarify the existence of climate change in Indonesia and synthesize previous study on climate change in the country. The next section is to discuss about the possible adaptation strategies and their link with the Indonesian rice production strategies. The last part is addressed to discuss the linkage between proposed adaptations and sustainable development in Indonesia so that implementation of the proposed adaptations will benefit to support Indonesian sustainable development goals.

Climate Change Studies in Indonesia

Recently, research on climate risks and climate change is growing significantly in Indonesia. Many government and non-government agencies in the country focused their research on issues related to climate models, impact studies, mitigation and adaptation (

Figure 1). Terminology for each issue mentioned here is described as follow:

- climate model: assessment of the existence of climate change
- impact studies: identification of the impacts of climate change
- mitigation: reduction of atmospheric carbon
- adaptation: adaptation strategies to climate change

However, there is no specific research directly addressed to develop appropriate adaptation strategies to climate change for rice production in Indonesia. Previous research related to this issue is mostly addressed to utilize climate information to alleviate the negative impacts of the extreme climate event (ADPC 2003; Boer 2004; Elsa 2006). Therefore, we clarified agencies focused on adaptations based on their role and research project on utilizing climate information.

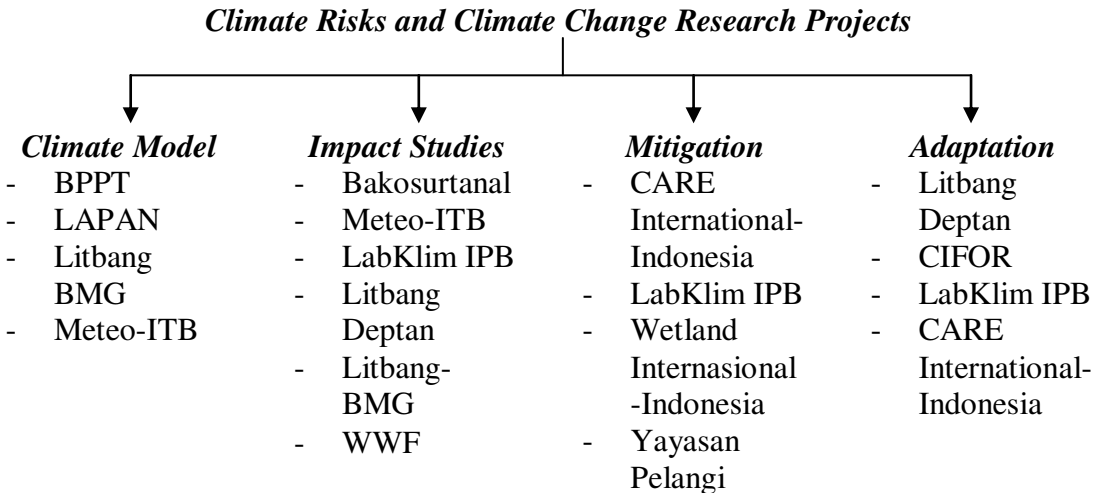

Figure 1. Indonesian agencies focused on Climate Risks and Change Research Projects
Source: Redrawn from (Boer and Kartikasari 2007)

Technically, institutions focused on climate research in Indonesia have used climate and impact models intensively. Spatial methods dealing with Geographic Information System (GIS), Remote Sensing (RS) and statistical models have also been utilized. Interestingly, the climate research has also moved towards to use participatory approach and economic valuation models to study climate risks and climate change (Table 1). These findings provide a glimpse about Indonesian current capacity to assess the impact of future changing climate on certain sector such as crop production and water resources from which early action to alleviate the possible negative impacts can be devised.

As for more specific research projects on climate risks and crop production, it can be synthesized that generally previous works were dealing with climate variability and the use of climate forecast information for agricultural sector (APN 2003). The Indonesian climate research has also moved into practice through the implementation of Climate Field School program (ADPC 2003). Under this program farmers were trained to use climate information appropriately. Another research project was attempted to develop a linkage among Indonesian local scientist, policy makers and community to ultimately utilize climate information (APN 2007). These findings clearly reveal that climate studies in Indonesia have moved from theoritical framework to the application and dissemination of utilising the climate information through capacity building (Table 2). Thus, it is expected that lesson learnt from these works would benefit to propose potential adaptation strategies to climate change for securing rice production and investigate Indonesian current capacity to implement the options. Furthermore, in order to ensure the implementation of adaptations nationally, the adaptation options should also support the Indonesian rice development strategy. Detail information about each research is presented in Appendix 1.

Table 1. Techniques analysis, model and approach used for studying climate risks and climate change in Indonesia

Tool, Model, Teknique Analysis	ITB	IPB	BKLIM	BMG	LAPAN	BPPT
- Impacts Model (crop simulation, hydrology simulation and etc.)	Yes	Yes	Yes	No	Yes	No
- GIS and Remote Sensing	Yes	Yes	Yes	Yes	Yes	Yes
- Statistical Model for Climate Forecast Application	Yes	Yes	Yes	Yes	Yes	Yes
- Dynamical Model for Climate Forecast Application	Yes	No	No	Yes	Yes	Yes
- Statistical downscaling technique of GCM to analyze climate change	No	Yes	No	Yes	Yes	Yes
- Climate Data Generador	No	Yes	Yes	No	Yes	No
- Participatory Approach	No	Yes	Yes	No	No	No
- Economic and Valuation Model	Yes	Yes	Yes	No	No	No

Note:
BKLIM : Balitklimat, BPPT : UPT Hujan Buatan BPPT, BMG : Litbang BMG, LAPAN : Natural Resources and Environmental Monitoring -LAPAN Pekayon and Climatology Application and Environment and Climate Modelling -LAPAN Bandung. Source: Adapted from Boer and Kartikasari (2007)

Table 2. Synthesis of Climate Research on Crop Production as well as Relevant Climate Change Studies in Indonesia

Authors/ Research Project	Classification of the Research Project				
	Tools/Models (TM_S)	Risk (R)	Management (M)	Capacity Building (CB)	Policy (P)
(APN 2003)	√	√	√		
(AIACC 2003)	√	√			
(ADPC 2003)			√	√	
(Boer 2004)			√		
(Mardawilis 2004)	√	√	√		
(Aser 2004)		√	√		
(Leemhuis 2005)	√	√			
(Elsa 2006)	√	√	√		
(LAPAN 2006)	√	√			
(APN 2007)				√	
(Boer 2007)	√	√			
(LAPAN 2008)	√	√			

Climate Change Adaptations and Indonesian Rice Development Strategies

As has been discussed above, climate change will significantly influence rice production in Indonesia. Understanding the possible negative impacts of climate change, Indonesian government has already highlighted some key aspects of how to design plausible adaptation strategies to climate change in Indonesia so that they can be mainstreamed into national policy. The Indonesian government through ministry of environment provides guidance that adaptations to climate change should be performed through the following ways:

1. Integrate the climate change adaptation agenda into national development plans such as Medium and Long Term Development Plans;
2. Review and adjust the existing initiatives or programs, so they will be resilient to climate change;
3. Institutionalize the use of climate information in order to have capability to manage climate risk;
4. Encourage local autonomy to integrate consideration of climate risk into local development plans;
5. Strengthen the information and knowledge to reduce present and future climate risk
6. Ensure the availability of domestic resources and funding for adaptation activity and maximize the use, probably with the international support;
7. Choose no regret option, which is conducting adaptation action with or without climate change so the benefit receive could be used to reduce the vulnerability to climate change, but also could be used for national development benefit;
8. Encourage a national dialog to accelerate implementation process of adaptation agenda to climate change in Indonesia (SME 2007).

This guideline implicitly emphasizes that climate change adaptations should be integrated with national policy and institutionalized so that the implementation can be sustained. The adaptations should benefit to support programs of agricultural development which are formulated to 1) increase food security; 2) develop agro business; 3) increase farmer welfare. As a consequence, the adaptations should be directed to increase not only production but also farmers' income and agribusiness development (Figure).

Having these expectations in mind, short and long term adaptation strategies are needed to avoid the negative impacts of climate change on rice production. GOI (2007) proposed that the short plan of adaptations can be directed through options such as cropping calendar, efficiency of water use, rainfed rice development, pest and diseases control, and searching for breeding new variety tolerated to high temperature. On the other hand, the long-term program can be taken by developing early warning system to flood and drought and integrated management of water uses. Detail plans are presented in Table 3.

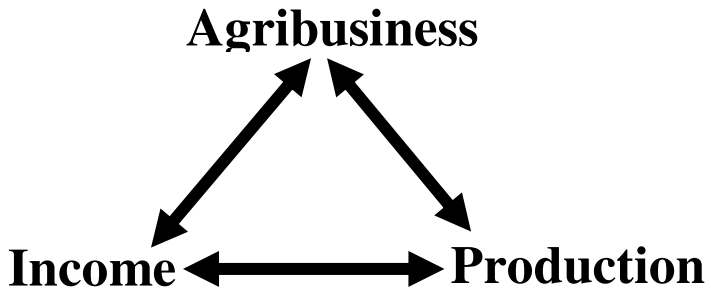

Figure 2. Three major goals of the rice production development in Indonesia

Table 3. Climate Change Adaptation Options for Agricultural Sector

Problems /Impacts	Proposed General Adaptation Program	
	Short term	**Long Term**
Drought • Limit of irrigation water • Reduce of the planting areas • Lost of crops yield • Felt of harvesting • Reduce of farmers income	• Water conservation • Water harvesting • Controlled groundwater exploitation • Efficient of water uses • Prioritize of water uses • Introducing crops tolerance varieties to drought • Introducing the early mature crops varieties • Crops calendar • Rainfed rice development • Farmers' capacity in understanding drought behaviour	• Early warning system to drought hazard • Integrated irrigation water management for food crops
Flood/standing water • Physical damages of crops growth • Lost of crops yield • Felt of harvesting • Reduce of farmers income	• Flood mitigation • Drainage improvement • Raise bed system • Introducing crops tolerance to deep water • Crops calendar	• Early warning system to flood hazard • Integrated drainage water management for farming system
Increase of humidity during La-Niña • Pest and diseases outbreaks	• Crops environment improvement • Pest and diseases control • Introducing the crops tolerance varieties to pest and diseases • Jointly planting time	• Integrated crops pest and diseases control
Increase of temperature • Increase of transpiration and respiration • Crops early mature with low yield	• Breeding of tolerance crops varieties to high temperature	

Source: (GOI 2007)

Furthermore, if we look at closely to the proposed adaptations, they are highly coherence with the rice development strategies proposed by Indonesian Government to meet the projected demand for rice in the future. Deptan (2005) projected that the demand for rice in Indonesia in 2025 will be about 41.5 million tons which equals to paddy production of about 65.85 million tons. To meet this projected demand, Indonesian government planned programs to increase paddy production through intensification and extensification strategies. The intensification is programmed by improving rice varieties, which are resilient to drought condition, and farming technology (PTT) in order to increase rice productivity of about 1-1.5% annually. The extensification is programmed to expand rice planting areas in outside of Java, particularly in Sumatera and Kalimantan, and other land types such as rain-fed, dry land and tidal swamp areas (Table 4).

Table 4. Strategy to increase paddy production on four agro-ecosystems

Agro-ecosystems	Expanded Areas	Quality and Yield	Proposed Activities
Irrigated paddy field	**	***	• Increase the planting intensity through pump programs, improvement the irrigation channels, and implementation of superior variety. • Narrow the yield discrepancy through dissemination and technology for specific location. • Improve the yield quality to support the agribusiness.
Rainfed paddy field	**	**	• Increase the planting intensity and yield stability through implementation of superior variety which resilient to pest and diseases as well as drought.
Dry land areas	***	*	• Increase the planting intensity and yield stability through introduction of new superior variety and Improved Agricultural System model called as PTT.
Tidal swamp areas	***	*	• Attempt to cultivate rice in this area regarded the problem on water management, soil fertility, water quality, contamination of iron, organic acids and aluminium, even though, water is always available.

Note: Number of stars indicated the priority (Source: Modified from (Deptan 2005))

Specifically for the intensification, Indonesian government has developed short, medium and medium plan. In 2009, programs are mainly addressed to improve the implementation of improved agricultural farming model and adoption of the new farming technology. For the medium term (2015) the programs are expanded to assemble superior variety supported by seed system and to enhance the effectiveness and efficiency of land, water, crop and organism management supported by basic research and technology. Moreover, the long term program (2025) is directed to improve the cultivation of rice farming in the four agro-ecosystem, irrigated paddy field, rain-fed paddy field, dry land areas and tidal swamp areas (Table). In addition to this, rehabilitation of degraded land, as a result of erosion, tidal land and lowland swamp, and land conservation are also programmed. Therefore, it seems many strategies of climate change adaptations are principally similar with the Indonesian rice development strategies.

However, it is important to note that the proposed climate change adaptations have significant contribution by adding some strategies to cope with the possible changing climate in the future such as cropping calendar and early warning system to drought and floods. These strategies will benefit to better utilize future climate information for rice farming practices in the future. The high correlation between the climate change adaptations and rice farming strategies also provides a great opportunity to easily mainstream the climate change options into national policy of rice production in Indonesia.

Table 5. Intensification programs for increasing rice production in Indonesia

Shortterm plan (2009)
1. Improvement of technology for specific location, improved agricultural system model (PTT) or prescription farming, in particular the use of new superior variety (higher productivity about 5-10% than IR64) which can adapt to a specific environment 2. Acceleration of adoption the technology by improving the dissemination system of the technology (development of pakar system, test kit, website information system and others)
Mediumterm plan (2015)
1. Assembly the superior variety (VUB, VUTB, VUH, VUHTB) supported by well seed system 2. Enhancement of the effectiveness and efficiency of land, water, crop and organism management supported by basic research and technology 3. Development of network system for research and application focussed on paddy commodity 4. Dissemination and promotion of results of research on paddy using information technology
Longterm plan (2025)
1. Irrigated paddy field: improvement of the intensification quality (PMI) in relation to the approach of PTT, application of new superior variety (VUS, VUH and VUTB), appropriate use of fertilisers, and the implementation of cultivated technique for specific location. 2. Rainfed paddy field: improving technology of PTT in particular cropping pattern, controlling interfered plants, VUB and management of nutrients for specific location, and the utilisation of organic compounds. 3. Dry land areas: implementation of PTT with consideration on aspects of land conservation, cropping pattern, and management of nutrients and VUB for specific location. 4. Tidal swamp areas: implementation of PTT and introduction of paddy variety for a specific location, micro water management, land conservation, and management of nutrients for specific location

(Source: Translated from (Deptan 2005))

Linking Climate Change Adaptations for Rice Production and Indonesian Sustainable Development

Implementation of climate change adaptations should be able to promote country's sustainable development. In Indonesia, the government through Ministry of Environment has already established four pillars of sustainable development, namely economic growth (*pro-growth*), poverty alleviation (*pro-poor*), employment opportunities (*pro-job*), and environmental protection (*pro-environment*) (SME 2007). Considering these pillars, country's capacity to implement the proposed climate change adaptations is a crucial to be investigated so that implementation of the options will not impede one the pillars. Climate change adaptations for rice production should be able to offer a new job opportunity, to alleviate poverty, to increase economic growth and to promote sustainable environment.

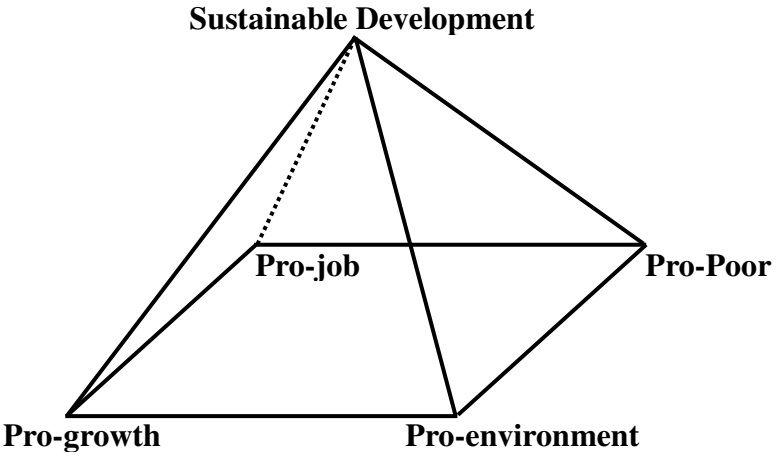

Figure 3. The Four Pilars of Sustainable Development in Indonesia

Moreover, to clarify about the proposed adaptations that we discussed in previous section, we developed a matrix to investigate the correlation between the rice development strategies and climate change adaptations. This investigation will benefit to present country's capacity to implement the adaptations and the possibility to mainstream the climate change adaptations into national policy for strengthening rice production in Indonesia. The correlation matrix was developed by examining future strategies proposed for rice development and climate change adaptations in relation to climate research which already conducted in Indonesia.

The correlation matrix shows two main programs for increasing rice production through intensification and extensification programs have been addressed well by both rice development and climate change adaptation strategies. It can be seen as well that the adaptations to some extent support the rice development strategies by proposing a program called as "Change Cropping pattern/Modified Planting Season", as this program has not been addressed by the rice development strategy. As for increasing farmers' capacity, the two strategies are supporting each other as they stressed equally the important aspects of the capacity building to increase farmers' knowledge on using new farming systems or technologies including the use of climate information. In the context of economic programs, both rice development strategies and climate change adaptations do not propose any incentive system such as insurance to secure farmers' income when experiencing negative consequences of climate exposures (Table 5).

The matrix also shows that current capacity of Indonesia to implement climate change adaptation strategies is likely to be adequate. This indication can be seen by considering the adaptation options to some extent already captured by Indonesian rice development strategies and climate studies in Indonesia have attempted to deal with similar issue proposed by the adaptation strategies.

Table 6. Matrix of programs for rice strategy and climate change adaptation and climate research in Indonesia

	Focussed Programs	Rice Development Strategies			Climate Change Adaptation						Climate Research
					Country Report		RAN-MAPI				
		09	15	25	15	30	09	12	25	50	
Extensification-Intensification	**A. Intensification**										
	• New Variety		√	√	√				√	√	TM
	• Technology Invention	√		√			√			√	TM
	• Farming System/ Management	√	√	√	√		√		√	√	TM/R/M
	• Water Management		√	√	√	√	√	√		√	TM/R/M
	• Planting Index	√	√	√		√					TM/R
	B. Pest and Diseases Control				√	√					TM/M
	C. Change Cropping pattern/ Modified Planting Season				√			√	√		TM
	D. Creating new rice field areas	√	√	√	√						TM/R/M
	E. Infrastructure/Irrigation*	√	√	√	√	√	√				TM/M
Capacity	**F. Capacity Building/ Awareness Increasing**	√	√	√	√		√	√			CB
	G. Community/Research/ H. Institutional Network		√				√	√	√		CB
	I. Drought and Flood Map						√				TM/R
	J. Dissemination Information/ Early Warning System	√	√					√			TM/CB
Economic	**K. Alternative Activities**				√						TM/R/M
	L. Farmers' income								√	√	TM/R/M
	M. Incentive System										
	• Credit scheme programs*	√	√	√							TM/R
	A.Insurance										TM/R/M
Policy	**16. Land Conversion Policy**				√						TM/M
	17. Conservation Program				√						TM/M
	18. Institutional Development/ Empowerment						√	√			TM

Note: * Strategy proposed by (Swastika et al. 2007); Country Report (GOI 2007) and RAN-MAPI (SME 2007); ** Please see Table B-2 for explanation of each abbreviation in the column of climate research; Values in the headings is respected to the final year of implementing the programs

Furthermore, the developed matrix reveals that climate change adaptations for rice production have strongly linkage with the pillars of Indonesian sustainable development. The Intensification and Extensification programs listed in Table have been emphasized equally to increase the farmers' income and create job opportunity (pro-job). This conclusion was taken by considering the proposed programs are more focused on labour intensive than capital intensive (Figure 4) considering there are no specific programs that proposed the use of machinery intensively. The capacity building programs

also clarify clearly that the programs are labour intensive which is suitable with the Indonesian condition whose population is relatively high. This means the proposed programs already directed to increase economic growth (pro-growth) and to alleviate poverty (pro-poor) particularly in rural regions. The last pillar, pro-environment, is already considered as well by the programs as the conservation programs are proposed. In sum, the developed matrix has shown that the proposed adaptations have considered well the four pillars of Indonesian sustainable development and are believed to benefit for economic growth of the rural livelihoods.

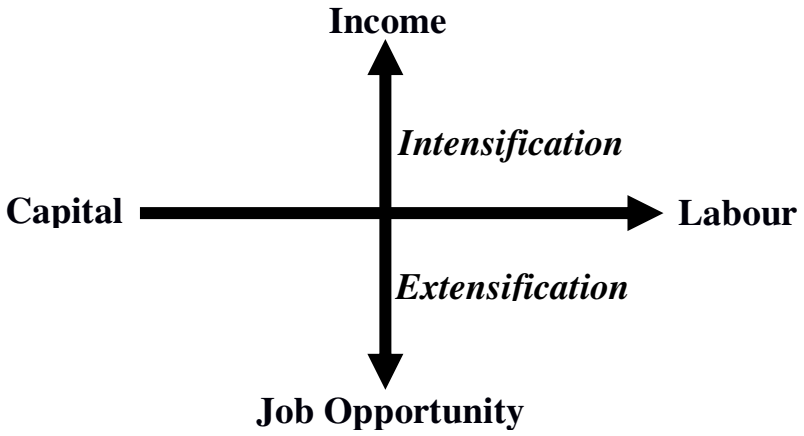

Figure 4. Classification of the main programs for increasing rice production in Indonesia using quadrant diagram

CONCLUSION AND RECOMMENDATION

Climate change is expected to significantly influence Indonesian rice production as this phenomenon will exacerbate extreme climate events such as ENSO which have caused serious rice production losses. To minimize the risk of climate change impacts, Indonesian government had proposed a set of climate change adaptation options. In the context of climate change adaptations for rice production, the adaptations are directed not only to increase rice production but also to increase farmers' income and agribusiness development.

In many parts, the climate change adaptations are similar to the rice development strategies to meet the future projected demand of rice in Indonesia. Additionally, the adaptations support the rice development strategies through options of "change cropping pattern/modified planting season" which has not been addressed well by the development strategies. Furthermore, in relation to sustainable development, the proposed adaptations, which are mainly to support the two major programs for increasing rice production, called as Extensification and Intensification, also already consider the four pillars of Indonesian sustainable development: pro-job, pro-poor, pro-growth and pro-environment.

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Appendix 1. Summary of Climate Research in Indonesia

Authors/ Research Project	Summary of the research project
(APN 2003)	- Exploring options for supporting farmers in decision-making on the choice of cropping strategies based on climate forecast - Changing rice to soybean or maize when the El Nino occurs
(AIACC 2003)	- Assessing current and future rainfall in Indonesia and found that under changing climate, rainfall in Indonesia might increase or decrease depends on the region - Clarifying a watershed system taken as a case study of Citarum watershed is very vulnerable to current climate and future climate change - Assessment the impact of land use change and climate change on river flow at citarum upper catchments result in vulnerable map of water deficit and water surplus
(ADPC 2003)	- use of climate (forecast) information for improving farm management system through climate field school (CFS) program develop institutional framework to disseminate the climate forecast information to support farming activities
(Boer 2004)	- Use of ENSO and IOD indicator for potato management practices
(Mardawilis 2004)	- Application of Crop Simulation Model for Developing Palawija Cultivation Technique - Identifying the Impact of SOI to rainfall variability - Optimal Planting Date of Maize and Peanut - Recommendation of Cultivation Technique
(Aser 2004)	- Crop vulnerability to drought and flood - Alternative strategy of rice cultivation in vulnerable area to drought/flood
(Leemhuis 2005)	- Impact of climate variability to water resource management - in general, the scenario simulations of hydrological models show a great potential to critical water resource situations in space and time - regional impact on rice production
(Elsa 2006)	- Analysis of extreme climate impact to rice, maize and soybean production - Land allocation strategy to anticipate extreme climate event - economic valuation of climate information for farming system (gross margin in normal condition, drought, flood)
(LAPAN 2006)	- changing pattern of rainfall in Indonesia as a response to change in CO_2 concentration of the atmosphere varied among location of the project - assessment of suitable statistical downscaling technique among the three options (MARS, PCR, and ANN) to gather data for a specific location in Indonesia
(APN 2007)	- strengthening the capacity of local scientist in Indonesia to conduct research and identify problem related to climate issues - enhancing the policy, science and community networking through scientific discourse (training workshop) for building capacity of the local scientist among Indonesian regions.
(Boer 2007)	- Clarifying Indonesian past climate condition (1900-2000) especially on rainfall - Projecting future climate condition of 2001-2100 using GCM CSIRO - Identification of climate change problems on agriculture, forestry and health in Indonesia
(LAPAN 2008)	- Daily monitoring: cloud cover, rainfall, fire danger rating system, hot spot, potential area to flood, sea level temperature - Fire danger rating system, hot spot, NDVI, flood prediction, food insecurity - Mapping of paddy growth and development