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Indonesia can achieve food security through crop loss mitigation and risk reduction: anticipating the second wave of Indonesian agricultural involution due to impact of natural hazards and climate extremes

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Indonesia has been experiencing a high agricultural loss due to natural hazards in agricultural sectors. However, there is barely adequate ex-ante risk management policy available to guide risk reduction in the sector. Inability to reduce risk will affect the country's food security. This research examines the impact of disasters and climate hazards on Indonesian agricultural and food crops. The findings firmly conclude that natural catastrophes have already caused a great deal of loss in agricultural sectors in particular food crops. Loss accumulation over the last decade has caused significant leakage of central government funds, and reduced agricultural production. We argue that the government's existing policy in expanding crop fields and agricultural areas needs to be complemented by strategic measures in reduction of loss and damage .

Impact of Natural Hazards on Agriculture

Clifford Geertz (1963) argued that Indonesian's reluctance to adopt technological change during 1950s had eventually led to stagnation in production prior to the 1960s. This phenomenon was known as 'agricultural involution' or it is defined as the first 'agricultural involution' era. Some of the challenges were attributed to lack of flood control and poor infrastructure including transportation. Today, we noted an emerging 'agricultural involution' in Indonesia which is closely associated with the increased risks in agricultural crops contributed by natural catastrophe.

During the first decade of the 21st century, Indonesia has been seriously experiencing loss and damage in agricultural crops. Based on BNPB-DIBI's disaster database (March 2012), our calculation suggests the following facts:

- gross crops' damage and loss (*or* harvest failure) is about 3.44 million ha of general food crops' loss occurred during 1970-2010, as a result of more than 7,500 events.
- Overall, the average crop damage probability was 455 ha (rice field equivalent) per any natural hazard.
- Floods have a damage probability event of 298 ha/flood event.
- While drought has higher damage probability at the rate of 11.182 ha/drought event).
- Earthquake-tsunamis dominated the probability with 138 km damage/event – This implies the effect of infrastructure damage on food prices too.

Despite inaccuracy of the BNPB-DIBI's data system due to insensitivity of data collection and inconsistency in disaggregating the agricultural crop loss, there is enough clues to suggest that natural catastrophes have been creating serious problems for agricultural sustainability.

Agricultural Statistics of the Ministry of Agriculture (2009 and 2011) suggest an increase in crop loss and damage in Indonesia due to drought and floods during 2003-2008. The data disaggregates two types of risks: the total affected of crop lands and the total loss of crop lands (total failure).

- The total accumulation of rice area affected by floods in the period 2003-2008 equals 15% of the 2008 total area under cultivation (or about 1.8 out of 12 million ha).
- During the same period, drought has affected 17% of the 12 million ha of rice field. Floods and drought combined have affected 32% of the total cultivated areas. While the total rice loss (termed locally as *puso*, or absolute quantity of harvest failure) caused by floods during 2003-2008 was about 564,000 ha and by drought about 424,000 ha. The total loss from both hazards was about 1 million ha. The monetary losses equal US$ 618 million (calculated at US$ 280/mt).
- If the total loss of maize is included, the total monetary loss during the same period can be more US$ 725 million. This equals US$ 125 million loss per year.

It is important to note that the loss is highly concentrated in certain provinces therefore it creates significant shocks in very specific regions of local farmers and consumers. The annual growth rate of flooded rice field was on average 5% during 2003-2008. This is obviously far above the annual rate of rice field expansion promoted by central governments during past decades. We actually discount the risk from plague (pest attacks) which actually shares high loss probability too.

Early government investment in irrigation system rehabilitation and expansion combined with a 'green revolution' policy at the national scale in the 1970s in Indonesia was considered a necessary decision. It also complemented by the land expansion strategy (See Figure 1) which overall has helped Indonesia to avoid the trap of agricultural involution. However, the government officials were seriously challenged by series of droughts and pest attacks that caused severe harvest loss during the 1970s and in 1982-1983 (Simatupang and Timmer 2008). They briefly note the condition of irrigation systems prior to 2006 based on reports from the Ministry of Public Works. Data shows serious damage in canals, dams and reservoirs in the period. Of the total 6.7 million ha irrigated by canals, 1.5 million ha (or 19%) reported damage (severe damage 5% and some damage 17.4). Of the total 273k of dam-related irrigation, 5.1% (or 14k) experience severe damage. Some of the damage may be attributed to the biophysical condition surrounding both the canals and dams.

Hierarchy of Risk in Agriculture

There is adequate evidence to conclude that Indonesian agricultural production is highly inefficient due to failure to mitigate losses associated with multiple risks (Table 1, Hierarchy of Loss).

Table 1. Hierarchy of Loss in Indonesian Agriculture

Type of agricultural loss	Causation of loss	Likelihood of occurrence	Mitigation option
Productivity loss	Lack of plot management measures incl. labor inputs	Every planting season, extensive	Training, basic management, incentives for crop specific farmers
Harvesting loss	Inefficiency in harvesting	Every planting season, extensive	Technological and logistical option
Post-harvesting loss	Inefficiency	Every planting season, extensive	Technological option; infrastructure development
Cyclones and floods	Exposure of agricultural ports to extreme rainfalls	La-Nina events, extensive	Flood management measures
Drought hazard	Exposure of agricultural ports	El-Nino events, extensive	Water management, drought resistance seeds
Geological hazard	Vulnerability of irrigation infrastructure	Area specific, intensive	Seismic Codes of dams and irrigation systems
Pest attacks/ Plagues	Local environmental change, lack of bio-security measures	Area specific, intensive	Pest management and bio-security measures
Combination of losses	Lack of multi-loss mitigation measures	Worst scenario can happen	Multi-loss reduction scenarios

Source: Lassa 2012

The first is the loss associated with natural catastrophes (cyclones and floods, drought hazard (See Table 1), geological hazard). The second is the loss associated with the internal human activities during the processes of production, harvesting and dealing with post harvesting problems. The third is loss due to the lack of a resilient irrigation infrastructure to cope with biophysical and geophysical problems. The rest of the losses relate to risk associated with pest attacks/plagues and/or combinations with other types of the risks.

Agricultural Land expansion in hazard prone areas?

Selection of new agricultural areas should be carefully made. Recent trends in losses may indicate that government's drive to create new rice field may have ignored the risks embedded in the newly expanded areas, such as flood prone areas. The question is whether the expansion of agriculture is taking place in hazard-prone areas. Or is there ecological change taking place that modifies losses? In order to answer these questions, one needs to assess at high data resolution to see the correlation between loss data and disaster risk assessment.

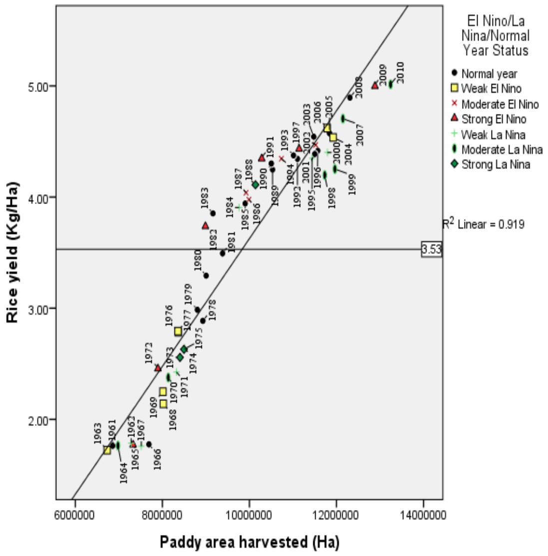
Our research also found that government's promotion of field expansion to boost production was countered by high annual loss rates during. For instance, the rice field expansion rate in 2008 was reported to be 1.3%. Unfortunately, evidence suggests that there was a rice loss equivalent to -1.6% of total rice field in 2008. Therefore, the net balance was actually -0.3%.

The government's mission to expand the rice land turns out to be less effective when the government were unaware of and unable to mitigate crop loss. Similar trends may have occurred in other crops at lower rates, especially in the case of maize. This phenomenon begs the question whether the government should strategically plan for a systematic prevention of crop loss without expanding the rice and maize areas of cultivation? Or should the government creatively increase the level of production efficiency through combining both expansion and loss prevention?

The next question is whether expanding the agricultural area and raising rice yields are the only ways to increase production, given the fact that the yield growth may have its limit. Land expansion may not always be the best alternative but it should be complemented by proper and systematic reduction of risk in agriculture.

Therefore, there is an urgent need to mitigate losses in the agricultural sectors. The expansion of agriculture area may be taking place in hazard-prone areas. But the reverse can actually be true: the aggressive expansion of agricultural crop land in the places like Gorontalo – as often portrayed as positive achievement by the media – may have laid new source of risks: the higher incidence of floods in the low lying areas in the city of Gorontalo as exemplified by new stories of floods in the city (during 2010-2012) due to changing landscape or large conversion from forest to crop land.

Figure 1. Indonesian rice and maize yields & areas cultivated 1960-2010



Source: Ministry of Agriculture 1980-2009.

Climate Change and Agricultural Loss

Climate change may have also adversely affected agricultural crops such as rice. Naylor Rosamond and colleagues (at Stanford University) predicts that for every 1°C change in May-August SSTAs (sea surface temperature anomalies), Indonesia rice production varies on average by 1.4 million tons. Research at the International Rice Research Institute in the Philippines suggests that for every 1°C increase in the minimum temperature, rice yields decrease by 10% (Naylor et. al. 2007).

Agricultural crop losses will persist if the "business as usual" scenario takes place. Global climatic change has certainly impacted local climate patterns and their impact on agriculture is clearly suggested by previous studies. It is very likely that Indonesia will continue to experience high levels of loss and damage in food crops. Therefore, hazard mitigation and adaptation strategies are needed for all agricultural crops.

Policy Options and Recommendation

Some early list of required investments needed for loss prevention in response to drought and El-Nino include adaptation to climatic change suggests **drought resistance seeds**, **water harvesting diversification, crop diversification, and people centered climate early warning intractably linked with early climate response systems that can be operationalized at local levels and adoption of agricultural catastrophe insurance**.

In regards to drought, local adaptation to climate change (e.g. different forms of public action and community action such as communal rainwater management) combined with drought resistant seeds might be the best (justified) options.

Flood management and water management in agricultural fields should be continuously integrated and sustained. In addition, it has become clear that earthquakes and tsunami mitigation in the agricultural infrastructure should also be considered. While these suggestions are technically feasible and necessary, they remain challenging at institutional levels.

Most of the losses are still largely uninsured. This suggests the importance of risk transfer mechanisms such as agricultural insurance. The challenge is to find ways of making such a policy a reality in the future in both the local and the national context.

The emerging 'agricultural involution' - as an outcome of ignorance in dealing with multiple stressors in agricultural crops – suggests that Indonesia may hardly achieve stable food production. This challenges the long standing food 'self-sufficiency' policy. In theory, one of the keys to achieving food 'self-sufficiency' in the broader sense could be loss prevention. Data suggests that land expansion for agriculture is always held back by losses, by as much as 1%.

Further policy questions

A question for future research concerns the kind of institutional scenarios required for Indonesia to be able to safeguard its agricultural infrastructure and agricultural crops from the impact of the natural hazards and climate change that are embedded in the nation's biophysical and geophysical systems. Indonesia is likely to experience agricultural Involution in the 21st century, not because it fails to adopt the required technology but because there is a lack of loss mitigation and adaptation policy and planning relating to both natural catastrophes and to climate risks.

Further Reading

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