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RISK IN MALAYSIAN AGRICULTURE: THE NEED FOR A STRATEGIC APPROACH AND A POLICY REFOCUS

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The agricultural sector is exposed to a variety of risks that occur with high frequency. These risks include climate and weather, natural catastrophes, pests and diseases, which combine to cause highly variable production outcomes. The broad objective of this study is to examine these agricultural risk factors and the policies in place for countering them. The approach adopted here includes an in-depth review of literature, government policy documents and Emergency Disasters Databases (EM-DAT) data on disaster occurrences. Inferential statistics were employed in data analysis. Risk management in agriculture ranges from informal practices such as the avoidance of highly risky crops and crop and income-source diversification to formal measures such as crop insurance, a minimum-support price system and a futures market. Statistics show the prevalence of weather-related hazards of cyclone, floods, landslides, earthquake and tsunami. As to the impact of such hazards on human health, statistics for 1980–2010 show that deaths caused by epidemics amounted to 43.4% of all deaths arising from natural disasters. Epidemics accounted for the highest number of deaths against 5.8% the lowest arising from mass movement (dry). Government policy documents show that efforts have been made to manage hazards, such as the construction of the Stormwater Management and Road Tunnel (SMART), the tsunami-recovery plan and the December 2006 flood-recovery plan, among others. Analysis shows, however, that not every economic sector has a specific policy for addressing the effect of global warming on its productivity. The nation urgently needs to strengthen its ability to predict the effects of climate variability and subsequent weather hazards. This study recommends the establishment of a coordination-and-planning committee at the national level to address issues related to climate variability and climate change and to identify and mobilise the national capacity to strengthen research-and-development activities in line with national priorities and needs.

Keywords: risk, agriculture, climate change, strategy, policy

BACKGROUND INFORMATION

Malaysia, a middle-income country, has transformed itself since the 1970s from a producer of raw materials into an emerging multi-sector economy. After achieving independence, Malaysia faced a need to develop and diversify its economy given its rapidly growing population. The country abandoned reliance on the export of primary natural resources and agricultural products and established itself as a rapidly industrialising country with a diversified export base. By the beginning of the 21st century, Malaysia had become one of the fastest-growing economies in Southeast Asia and the third-richest state (after Brunei and Singapore) in the Association of Southeast Asian Nations (ASEAN).

Agriculture has been identified as the economy's third engine of growth. "During the Ninth Plan period, the agriculture sector will be revitalised to become the third engine of growth. The emphasis will be on new agriculture which will involve large scale commercial farming, the wider application of modern technology, production of high quality and value-added products, unlocking the potential in biotechnology, increased convergence with information and communications technology (ICT), and the participation of entrepreneurial farmers and skilled workforce. The function of agricultural services will also be streamlined to enhance service delivery and efficiency" (Economic Planning Unit, 2006: 81).

Agriculture contributes approximately 10% of Malaysia's GDP, and at least one-third of the country's population depends on the sector for its livelihood, with some 14% employed on farms and plantations. Climate change will affect the sector in terms of production, it will also have a socioeconomic impact on the people who are employed in the sector and the nation as a whole (Mustafa, 2007). From the perspective of land use, approximately 39.2% of the total arable land, (approximately 5.18 million ha) is planted with tree crops, such as rubber, oil palm, cocoa, coconut and fruits and vegetables. Agriculture is greatly affected by extreme climate change, which is known to have a particularly important effect on crop development. Change in climatic factors, such as the amount of rainfall, sunshine hours and temperature, results in a year-to-year variability of crop production, physical damage, loss of harvest, drop in productivity and vigour as well as other problems. In addition, high temperatures and reduced rainfall dry the soil, lessening the amount of water available for irrigation and decreasing crop growth in non-irrigated regions (Siwar et al., 2009). Climate change is a major potential threat to food security and agriculture for the country. Because climate change is a continuous and long-term process, its impact will be felt for many years.

Agriculture, which predominantly employs the poor, is a fragile and risk-prone sector. Risk means susceptibility to an unforeseen major or minor hazardous event (Sinha and Lipton, 1999; Anderson, 1999). Agriculture is subject to risks that are often unpredictable and outside human control. Examples of such risks include weather, commodity-price fluctuations, changes in consumer demand and outbreaks of pests and diseases. Such disasters could have harmful effects on the economy and the social organisation and psychology of the people affected. Floods in Johor (2006–2007) displaced 110,000 people, damaging an estimated Ringgit Malaysia (RM) 0.35 billion worth of infrastructure and causing RM2.4 billion in economic losses. An estimated RM84 million worth of agricultural produce was damaged or lost, affecting 7,000 farmers. Approximately 9% of the Malaysian land area (2.97 million ha) is in flood plains, and 3.5 million people have become victims of flooding. Estimating the cost of flood damage is difficult; however, a conservative figure of RM100 million has been estimated as the average loss by flood damage per year (Mustafa, 2007; Siwar et al., 2009).

In general, Malaysia has not experienced frequent climate-related disasters (i.e., floods and droughts that had a significant socio-economic impact on the nation), although lately some minor climate-related disasters have been recorded. Landslides due to excessive rainfall and strong winds occur in hilly regions and at the coast, the latter causing minimal damage (Mustafa, 2007).

Because disaster management and climate-change management share many concerns, a unified approach to disaster and climate-change management should be mainstreamed into national policies, programmes and plans. Although the country is institutionally capable of managing disasters, much room for improvement remains. The existing mechanism for stakeholder consultation is insufficient and requires enhancement because both the government and the community are responsible for dealing with issues pertaining to disasters. In addition, current sectoral approaches need to be changed, with reference to the Hyogo Framework Action, which emphasises mainstreaming disaster management into planning (Ministry of Sciences, Technology and Innovation, 2007).

OBJECTIVES OF THE STUDY

The broad objective of the study is an in-depth analysis of the relation between risk in agriculture and the existing policy framework in Malaysia. The specific objectives of the study include:

1. Ascertaining a risk profile for Malaysia;
2. Identifying the sources of risk in agriculture;
3. Examining the policy environment and analysing the existing framework to understand capacity and possible shortcomings; and
4. Identifying new directions for meeting existing challenges.

METHODOLOGY

Study Area

Malaysia is located in Southeast Asia, and its land is divided between the Peninsular Malaysia and the northern part of Borneo (corresponding to one-third to the country). Malaysia shares land borders with Brunei (381 km), Indonesia (1,782 km), Thailand (506 km), and Singapore, and, across the South China Sea, a maritime border with Vietnam (United Nation Development Programme, 2009). Of its total land area of approximately 329,847 km^2, 63.6% is tropical forest, much of the forest located on a central mountain range. Coastal plains dominate the Borneo states, while Borneo's interior is mountainous. Malaysia's lowest point is in the Indian Ocean (0 m), while its highest point is Gunung Kinabalu (4,100 m). The nation has a total coastline of 4,675 km, of which 2,068 km is in Peninsular Malaysia and 2,607 km in East Malaysia.

According to UNdata, the population of Malaysia is 26.6 million, and the population density is 80.6 people per sq km (UNdata, 2009). The annual population growth between 2005 and 2010 was approximately 1.7%. As for Malaysia's age structure, in 2008, 29.8% of Malaysia's population was under 15 years of age; 45.5% was between 15 and 60 years of age; and 15.7% was 60 years and older. Approximately 69.6% of the Malaysian population is concentrate in the urban areas. According to the Economic Planning Unit (2008), Malaysia's multiethnic and multicultural population comprise Malays (50.4%), Chinese (23.7%), Indians (7.1%), indigenous peoples (11%) and others (7.8%). In 2002, 5.1% of households were living below the poverty line. In 2008, the adult literacy rate was 92%.

The general features of the Malaysian climate are a uniform temperature, high humidity and copious rainfall. Seasonal variations in climate are marked by rainfall patterns: the northeastern monsoon dominates from November to March, bringing moisture and rain, and between June and September, the southwestern monsoon winds prevail. The seasonal variation of rainfall in Peninsular Malaysia is of three main types depending on the area: the eastern coastal states, the southwest coastal area and the rest of the peninsular. The three areas correspond in having June and July as the driest months, while differences occur in the wet months. October and November register high rainfall for all areas, as do April and May, with the exception of the eastern coastal states. The highly variable geography of the states located in Borneo (Sarawak and Sabah) makes establishing a seasonal rainfall pattern difficult. More than 3,550 mm of rainfall a year is recorded in the lowlands. As for temperature distribution, although the annual variation of the daily mean temperature may be small (approximately 2°C to 3°C), the diurnal variation may be as large as 12°C. The mean temperature in the lowlands ranges between 26°C and 28°C (Malaysian Meteorological Department, 2009).

Study Approach

The approach draws primarily upon existing data, policy documents, research results and other country models. The study followed a three-pronged process of examining existing capabilities at the national, state and local levels of government. To conduct the synthesis, the study reviewed historical weather data, pilot and research-based studies on risk in agriculture, policy documents and the regulatory framework for mainstreaming risk in agriculture.

In 2010, the Regional Climate Change Adaptation Knowledge Platform published its study *Impacts, vulnerability and adaptation to climate change: Lao PDR, Vietnam, Philippines, Indonesia, Thailand, Cambodia, Myanmar and Malaysia* (Satya, 2010). The study aimed to provide information on the status of vulnerability at the national and regional level in the countries of the Association of Southeast Asian Nations (ASEAN), which are among the most vulnerable to the impacts of climate change. The study adopted the desktop approach, and although the result was far-reaching, it had the limitations of a large level of aggregation. This study adopts a similar approach. However, this study avoids a large level of aggregation by focusing specifically on agriculture because it is regarded as the sector most vulnerable to climate change and other natural disasters.

RESULTS AND DISCUSSION

Malaysia Risk Profile

The risk profile of Malaysia has shown some negative consequences on both the people and the economy as a whole. Malaysian agriculture is prone to different types of risk. A risk-profile analysis of mortality and economic loss for three weather-related hazards (tropical cyclones, floods and landslides) is shown in Table 1. In addition, new insights have been gained into other hazards, such as earthquakes, tsunami and drought.

Table 1: Human exposure: Modelled number present in the hazard zones that are subject to potential losses

Hazard type	Population exposed	Country rating (out of)
Cyclone	–	– (89)
Drought	–	– (184)
Flood	25,419	63 (162)
Landslide	5,012	32 (162)
Earthquake	17,161	96 (153)
Tsunami	11,649	41 (76)

Source: PreventionWeb, 2009.

The economic cost in terms of GDP is further highlighted in Table 2. This table presents a picture in terms of exposure to Gross Domestic Product (GDP) loss as a result of the various types of risk identified. The table highlights the threat posed by landslides and earthquakes in the country. The values seem small; however, they can translate into a sizeable portion of the GDP, if quantified in real monetary terms.

Table 2: Economic exposure: Modelled amount of GDP present in the hazard zones that is subject to potential loss

Hazard type	GDP exposed (billions-US$)	Country ranking (out of)
Cyclone	–	– (89)
Flood	0.11	51 (162)
Landslide	0.23	20 (162)
Earthquake	0.57	84 (153)
Tsunami	0.04	37 (76)

Source: PreventionWeb, 2009.

As to the impact of such hazards on human health, statistics for 1980–2010 show that deaths caused by epidemics amounted to 43.4% of all disaster-related deaths: the highest against 5.8%, the lowest arising from mass movement (dry). The values reported for the other hazard types are shown in Figure 1. The statistics presented indicate that the threat of these hazards to the environment is a cause for concern.

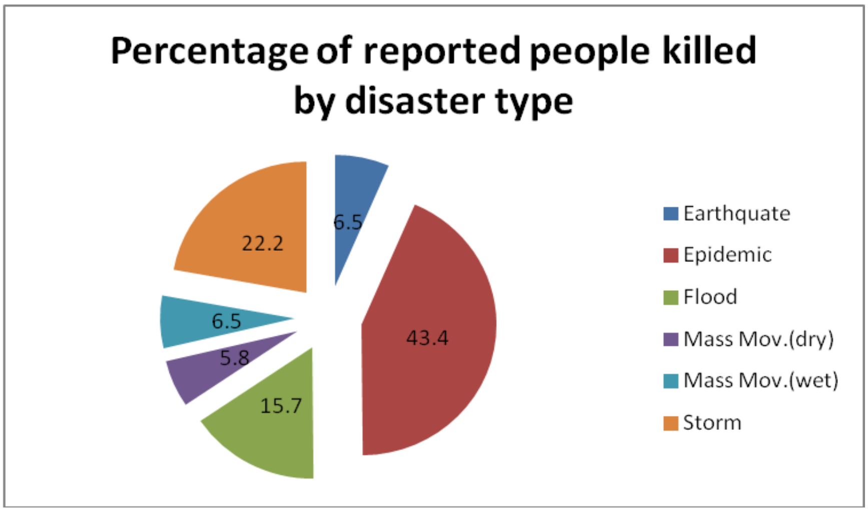

Figure 1: Statistics by disaster type: Percentage of people reported killed by disaster type

RISK IN AGRICULTURE

Overview

The enterprise of agriculture is subject to a great many uncertainties. Agricultural risk is associated with negative outcomes that stem from imperfectly predictable biological, climatic, and price variables. These variables, as identified by Jain and Parshad (2006), include natural adversities (for example, pests and diseases) and climatic factors not within the control of the farmers. They also include adverse changes in both input and output prices. To set the stage for the discussion on how to deal with risk in agriculture, classifying the different sources of risk that affect agriculture is essential.

Types of Risk

Production risk

Agriculture is often characterised by a high variability of production outcomes or production risk. Unlike most other entrepreneurs, farmers are not able to predict with certainty the amount of output that the production process will yield due to external factors such as weather, pests, and diseases. Farmers can also be hindered by adverse events during harvesting or threshing that may result in production losses (Jaffer, Siegel and Andrews, 2008).

Price or market risk

Input- and output-price volatility is an important source of market risk in agriculture. Prices of agricultural commodities are extremely volatile. Output-price variability originates from endogenous and exogenous market shocks. Segmented agricultural markets will be influenced mainly by local supply-and-demand conditions, while more globally integrated markets will be significantly affected by international production dynamics. In local markets, price risk is sometimes mitigated by the natural-hedge effect, in which an increase (decrease) in annual production tends to decrease (increase) output price, although not necessarily farmers' revenues. In integrated markets, a reduction in prices is generally not correlated with local supply conditions, and, therefore, price shocks may affect producers in a more significant way (Agwe and Fissha, 2009). Another type of market risk arises in the process of delivering production to the marketplace. The inability to deliver perishable products to the right market at the right time can impair the efforts of producers. The lack of infrastructure and well-developed markets makes this issue of timely delivery a significant source of risk.

Financial and credit risk

The ways businesses finance their activities is a major concern for many economic enterprises. In this respect, agriculture also has peculiarities. Many agricultural production cycles stretch over long periods of time, and farmers must anticipate expenses that they will only be able to recuperate once the product is marketed. This time lag leads to potential cash-flow problems that a lack of access to insurance services and credit and the high cost of borrowing exacerbate. These problems can be classified as financial risk (Antón and Kimura, 2011).

Institutional risk

Another important source of uncertainty for farmers is institutional risk, generated by unexpected changes in regulations that influence farmers' activities. Changes in regulations, financial services, level of price- or income-support payments and subsidies can significantly alter the profitability of farming (Jaffer, Siegel and Andrews, 2008). This potential for variation in profitability is particularly true for import/export regimes and dedicated support schemes. It is also important in the case of sanitary and phytosanitary regulations that can restrict the activity of producers and impose costs on producers (Melyukhina, 2011).

Technology risk

Like most other entrepreneurs, farmers are responsible for all the consequences of their activities. Adoption of new technologies in modernising agriculture, such as the introduction of genetically modified crops, causes an increase in producer-liability risk (Anton, Kimura and Martini, 2011; Kimura and Anton, 2011).

Personal risk

Finally, agricultural households, like the households of any other economic entrepreneurs, are exposed to personal risks affecting the life and well-being of the people who are employed on the farm. Agricultural households are also exposed to asset risks from floods, cyclones and droughts and possible damage or theft of production equipment and other farming assets (Satya, 2010).

Risk Management in Agriculture

In discussions on how to design appropriate risk-management policies, understanding the strategies and mechanisms used by producers to deal with risk and distinguishing between informal and formal risk-management mechanisms and ex ante and ex post strategies are useful. As highlighted in the 2000/2001 World Development Report (World Bank, 2001), informal strategies are identified as "arrangements that involve individuals or households or such groups as communities or villages," while formal arrangements are "market-based activities and publicly provided mechanisms." The ex ante or ex post classification focuses on the point in time at which the reaction to risk takes place: prior to the occurrence of the harmful event (ex ante) or after the event has occurred (ex post). Among the ex ante reactions, highlighting the differences between on-farm strategies and risk-sharing strategies can also be useful.

Informal mechanisms

The diversification of income sources and the choice of agricultural production strategy characterise ex ante informal strategies. One strategy producers can employ is simply to avoid risk. In many cases, extreme poverty makes people risk averse, so much so that they often avoid activities that entail risk but that could also bring greater income (Jain and Parshad, 2006; Agwe and Fissha, 2009). This inability to manage risk and accumulate and retain wealth is sometimes referred to as "the poverty trap."

Once farmers have decided to engage in farming, the farmers' production strategy is an important means of mitigating the risk of crop failure. Traditional cropping systems in many places rely on crop diversification and mixed farming. Crop diversification and intercropping systems are means to reduce the risk of crop failure due to adverse weather events, crop pests or insect attacks. Studies present evidence that households whose consumption levels are close to subsistence (and are, therefore, highly vulnerable to income shocks) devote a larger share of land to safer, traditional varieties of rice and other cereals than to riskier, high-yielding varieties. Studies also present evidence that near-subsistence households spatially diversify their plots to reduce the impact of weather shocks that vary by location (Jain and Parshad, 2006).

Apart from altering agricultural production strategies, households also smooth income by diversifying income sources, thus minimising the effect of a negative shock to any one of these sources. According to the study conducted by Ryan and Spencer (2001) for the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), most rural households in villages of semi-arid India surveyed generate income from at least two different sources: typically crop income and some livestock or dairy income. Off-farm seasonal labour and the trade and sale of handicrafts are also common income sources.

Buffer-stock accumulation of crops or liquid assets and the use of credit present obvious means for households to smooth consumption. Studies also show that currency and crop inventories function as buffers or precautionary savings. Crop-sharing arrangements in land renting and labour hiring can also provide an effective way of sharing risks between individuals, thus reducing producer risk exposure. Other risk sharing mechanisms, such as community-level risk pooling, occur in specific communities or extended households where members of the group transfer resources amongst themselves to rebalance marginal utilities (World Bank, 2005). These types of arrangements are effective for counterbalancing the consequences of events that affect some members of the community; however, these arrangements do not work well in cases of covariate income shocks.

Ex post informal income-smoothing mechanisms are typically the sale of assets, such as land or livestock, or reallocation of labour resources to off-farm labour activities, deferred or low key family functions, reduced consumption patterns and migration. Some studies report that southern Indian farmers are able to quickly shift from 100% on-farm labour activities to largely off-farm activities, if the monsoon rains are expected to be poor (Jain and Parshad, 2006).

Studies in India and elsewhere reported considerable efficiency losses associated with risk mitigation, typically due to lack of specialisation. In other words, farmers trade-off income variability for profitability. The need to smooth consumption not only against idiosyncratic shocks but also against correlated shocks comes at a serious cost in terms of production efficiency and reduced profits, thus lowering the household's overall level of consumption. A major consideration for innovation would be to shift correlated risk from rural households. An obvious solution is for rural households to engage in risk-sharing with households or institutions from areas largely uncorrelated with the local risk conditions. Examples of such extra-regional risk-sharing systems are found in the literature, for example, through credits and transfers with distant relatives, migration and marriages, or ethnic networks (Jaffer, Siegel and Andrews, 2008).

Although some degree of risk-sharing and, thus, of insurance against weather exists, none of the systems are so widespread that they cover all households, nor are they even close to providing a fully efficient insurance mechanism. Most households are, therefore, still left with no insurance against correlated risks, the main source of which is weather.

Formal mechanisms

Formal risk-management mechanisms can be classified as publicly provided or market based (Table 3). Government action plays an important role in agricultural risk management, both ex ante and ex post. Ex ante education and services provided by agricultural extension help familiarise producers with the consequences of risk and help them adopt strategies to deal with risk. The supply of quality agricultural inputs is another institutional strategy. Governments also reduce the impacts of risk by developing relevant infrastructure and adopting social schemes and cash transfers to relieve the aftershocks that have occurred. As mentioned earlier, production and market risks probably have the largest impact on agricultural producers. Various market-based risk-management solutions have been developed to address these sources of risk.

Production/weather risk management

Insurance is another formal mechanism used in many countries to share production risks. However, insurance is not as efficient in managing production risk as derivative markets are for price risks. Price risk is highly spatially correlated, as illustrated in Figure 2. Futures and options are appropriate instruments to deal with spatially correlated risks. In contrast, insurance is an appropriate risk-management solution for independent risks. Agricultural production risks typically lack sufficient spatial correlation to be effectively hedged using only exchange-traded futures or options instruments. At the same time, agricultural production risks are generally not perfectly spatially independent and, therefore, insurance markets do not work at their best. Experts refer to these risks as "in-between" risks. According to economists, "good or bad

Table 3: Risk management strategies in agriculture

		Informal Mechanisms	Formal Mechanism: Market based	Formal Mechanism
Ex-Ante Strategies	On-farm	• Avoiding exposure to risk • Crop diversification and inter-cropping • Plot diversification • Mixed farming • Diversification of income source • Buffer stock accumulation of crops or liquid assets • Adoption of advanced cropping techniques (fertilisation, irrigation, resistant varieties) • Agricultural		• Agricultural extension • Supply of quality seeds, inputs, etc • Pest management systems • Infrastructures (roads, dams, irrigation systems)
	Sharing risk with others	• Crop sharing • Sharing of agricultural equipment, irrigation sources, etc • Informal risk pool	• Contract marketing futures • Contracts • Insurance	
Ex-Post Strategies	Coping with shocks	• Reduced consumption patterns • Deferred / low key social and family functions • Sale of assets • Migration • Reallocation of labor • Mutual aid	• Credit	• Social assistance (calamity relief, food for-work, etc) • Rescheduling loans • Agricultural insurance • Relaxations in grain procurement procedures • Supply of fodder • Cash transfer

weather may have similar effects on all farmers in adjoining areas" and, consequently, "the law of large numbers, on which premium and indemnity calculations are based, breaks down." In fact, positive spatial correlation in losses limits the risk reduction that can be obtained by pooling risks from different geographical areas (World Bank, 2005; Jain and Parshad, 2006). This limited risk reduction increases the variance in indemnities paid by insurers. In general, the more the losses are positively correlated, the less efficient traditional insurance is as a risk-transfer mechanism.

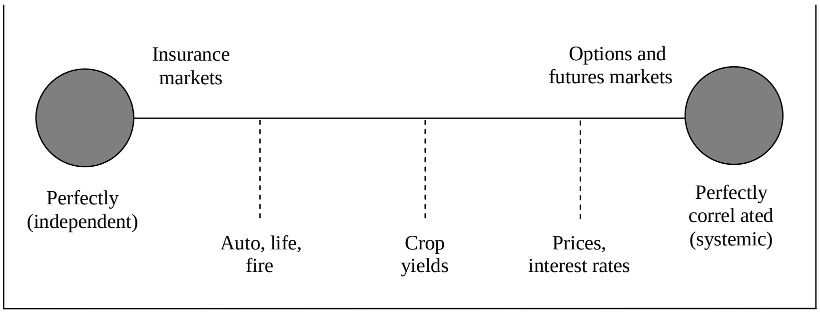

Figure 2: Independent versus correlated risk
Source: Managing agricultural production risk – Innovations in developing countries, World Bank (2005).

Lack of statistical independence is not the only problem with insurance in agriculture. Another set of problems is related to asymmetric information, a situation that exists when the insured have more knowledge about their own risk profile than does the insurer. Asymmetric information causes two problems: adverse selection and moral hazard. In the case of adverse selection, farmers have better knowledge than the insurer about the probability distribution of losses. Thus, the farmers find themselves in the privileged situation of being able to discern whether the insurance premium accurately reflects the risk they face. Consequently, only farmers who bear greater risks will purchase the coverage, generating an imbalance between indemnities paid and premiums collected. Moral hazard is another problem that lies within the incentive structure of the relationship between the insurer and the insured. After entering the contract, the farmer's incentives to take proper care of the crop diminish, while the insurer has limited effective means to monitor the eventual hazardous behaviour of the farmer. This behaviour might also result in greater losses for the insurer (World Bank, 2005).

Agricultural insurance is often characterised by high administrative costs. These costs are high, in part, due to the risk-classification and monitoring systems that must be put in place to address asymmetric-information problems. Other costs are associated with acquiring the data needed to establish accurate premium rates and conducting claims adjustment. However, the Indian area-yield insurance programme is designed in such a way that the administrative costs are minimal due to the involvement of multiple agencies and credit link.

Price risk management

One way producers have traditionally managed price variability is by entering into preharvest agreements that set a specific price for future delivery. These arrangements are known as forward contracts and allow producers to lock in a certain price, thus reducing risk but also foregoing the possibility of benefiting from positive price deviations. In specific markets, and for specific products, these types of arrangements have evolved into futures contracts, traded on regulated exchanges based on specific trading rules and for specific standardised products. This practice reduces some of the risks associated with forward contracting (for example, default). A further evolution in hedging opportunities for farmers has been the development of price options that represent a price guarantee that allows producers to benefit from a floor price but also from the possibility of taking advantage of positive price changes. With price options, agents pay a premium to purchase a contract that gives them the right (but not the obligation) to sell futures contracts at a specified price. Futures and options contracts can be effective price-risk management tools. Such contracts are also important price-discovery devices and market-trend indicators (Jaffer, Siegel and Andrews, 2008; Agwe and Fissha, 2009).

Recent policy changes are more permissive of futures markets. However, globally, the principal benefits of futures markets are indirect: from price discovery and helping to manage price risk. Commodities traded in world markets are also subject to price variability. The problem of matching supply to demand requires coordinated actions amongst producers. Such coordination can arise from the dissemination of market information and price-discovery mechanisms. Price-support mechanisms have been limited to some regions only. In most cases, farmers face a serious price risk because of the immediate need to dispose of stocks for want of storage and to repay loans.

Climate Variability and Change

Climate risk

Since the Third Malaysia Plan (1976–1980), environmental concerns are progressively being emphasised in development plans (Hezri and Mohd. Nordin, 2006). Many ministries formulated policies that have taken into account environmental concerns specific to sectoral context. Climate-related policies in Malaysia include the National Policy on the Environment, the National Forest Policy, the Biodiversity Policy, the National Energy Policy, the National

Transport Policy (Land) and the Third National Agricultural Policy, among others. Although sectoral in nature, these policies also contribute indirectly to addressing climate change. However, none of these policies clearly acknowledges the existence of climate change (Muthusamy, 2007). Furthermore, the various policies need to be harmonised so that win-win options could be formulated through inter-agency collaboration and coordination for climate-change mitigation and adaptation measures. The reviews of the Ninth Malaysian Plan (2006–2010), the currently ongoing development plans, and several national policies contain programmes that directly or indirectly contribute to managing issues of climate-change adaptation and mitigation (Pereira and Tan, 2008).

Climate change is a cross-sectoral issue, involving more than environmental concerns. However, climate change also affects economic growth and human well-being. As previously stated, while past and existing national policies have indirectly addressed climate-change concerns in the context of sustainable development, the need to formulate a specific climate-change policy is increasingly recognised. In view of this need, the Ministry of Natural Resources and Environment of Malaysia, in collaboration with the Institute for Environment and Development (LESTARI) at the National University of Malaysia, had conducted the policy study on climate change. The aim of the study was to develop a national climate policy and strategy on climate change, while fostering sustainable development in Malaysia to meet the needs of the country and respond to United Nations Framework Convention on Climate Change, UNFCCC (Tan et al., 2009). In addition, the study aimed to guide national activities and strengthen inter-agency collaboration in addressing climate change. This effort could be further consolidated under the framework of sustainable development, an effort that is spearheaded by the Economic Planning Unit.

Challenges in climate variability

However, making use of climate-forecast technology and information to benefit society faces formidable challenges. Some of the major barriers identified by the *Report of the working group on risk management in agriculture for India's eleventh five-year plan (2007–2012*) are the following:

1. Most of the climate-information products and tools that scientists have developed for risk management are not fully utilised. This underutilisation occurs partly because we are still developing the institutional, economic and cultural frameworks within which decisions are made in any society. Further, decision makers frequently do not actively seek new technology and information sources or initiate contacts with experts who could be helpful in making better-informed decisions.

2. While most climate-information products are generated by advanced global-climate research centres, the need and demand for these products lies within local at-risk communities.
3. The uncertainties associated with climate change and the related long-term socio-economic scenarios, some of which extend over the next 100 years and beyond, do not lend urgency to efforts and make mainstreaming climate-change adaptation options into the immediate development-planning process difficult.
4. The financial and managerial constraints on developing appropriate means to spread, share and master climate-related and other risks in agriculture seriously undermine the benefits of technological breakthroughs in climate forecasting. Like all knowledge-intensive processes, the use of climate information requires national and local institutions with the capacity to interpret and effectively disseminate probabilistic climate information and to match such information to local needs. Recent experience in Malaysia in using climate information to anticipate and manage agricultural risk provides useful insights. Agriculture is the socio-economic sector most exposed to the risk associated with climate variability and change, and its centrality should be recognised in efforts to mitigate and adapt to their effects. Climate-change mitigation and adaptation measures should, therefore, be integrated into the country's five-year plans and poverty-reduction strategies.

Drought risk

From an economic perspective, agricultural drought may be viewed as an exogenous, supply side shock, one widely recognised as resulting directly in sharp reductions in agricultural production and employment, apart from other losses associated with declines in rural income. In addition, meteorological drought may result in hydrological conditions that have a direct impact on non-agricultural production, including hydroelectric power generation and the drinking-water supply. Droughts have caused severe disasters in Malaysia. In 1991, drought in Malacca caused the drying up of the Durian Tunggal Dam reservoir and resulted in prolonged water rationing in most parts of the state. Among many past droughts, the most significant was the 1997–1998 El Nino-related drought, which had an extensive impact on the environment and society across the nation. Extensive wild forest fires due to the prolonged dry conditions threatened many parts of the country, including the states of Selangor, Sarawak and Sabah. The local situation combined with similar occurrences in a neighbouring country produced a persistent haze that threatened the health of every citizen (Mustafa, 2007).

Sabah was perhaps the state most affected by the 1998 drought. All the state's divisions experienced extremely large rainfall deficits (some as great as 90% of the long-term mean) for a period ranging from 4 to 9 months, affecting more than 2,797 km^2 and 170,000 people. Approximately 1580 km^2 was engulfed by wild fires, of which more than 100 km^2 were agricultural lands. More than 7,200 farmers were affected, with an estimated loss of approximately RM87 million. A number of districts had to ration water to ease the situation. In few villages, their hill padi crops were totally wiped out prompting the authority to send in food supply to the affected areas. A similar situation was experienced in the northeastern part of Sarawak, around Miri. The prolonged extremely dry spells resulted in rampant wild fires that destroyed a sizable area of agricultural crops (Mustafa, 2007). During the particularly dry period of the 1997–1998 El Nino-related drought, almost the whole of Sabah experienced a rainfall deficit of 75% compared to the long-term mean (for a period of between 4 to 9 months), and in some areas the deficit was as large as 90%. In Miri, Sarawak, one rainfall station recorded more than 100 days with zero precipitation, the longest drought ever recorded (Ahmad Husaini, 2007). Changes in climate will cause more droughts in dry years (i.e., 2028, 2029, 2034, 2042 and 2044). More extreme hydrological conditions may be expected, including floods and droughts (Salmah and Ahmad Jamalluddin, 2007).

Floods and cyclones

Following the disastrous flood of 1971, which affected many areas in Malaysia, the government has established the Natural Disaster Relief Committee in 1972, assigning the committee the task of coordinating flood-relief operations at the national, state and district levels with the goal of preventing the loss of human life and reducing flood damage. The coordination of relief operations is the responsibility of the Natural Disaster Relief Committee, which is headed by the Deputy Prime Minister of Malaysia, under the purview of the National Security Council of the Prime Minister's Department (Ahmad Husaini, 2007).

Procedure in case of risk: In accordance with official flood-relief operating procedure, when river water at any flood-warning station reaches the alert level, the Department of Irrigation and Drainage (DID) will begin to monitor the flood situation closely. When water reaches the warning level, DID will inform the relevant flood-control centres so that the flood-relief mechanism is activated. At the danger level, considerable areas are flooded and will warrant the evacuation of flood victims. During the flood season, the respective state DID office shall perform flood forecasting using real-time telemetric data (rainfall and river-water levels) and computer models. When the river water at any forecasting point exceeds the critical level, the forecasts shall be transmitted to the Flood Operation Centres and other relevant agencies, such as the National Security Division of the

Prime Minister's Department and the National and State (Police) Control Centre for flood relief/operation (Ahmad Husaini, 2007).

To date, DID has established approximately 335 telemetric rain gauges and 208 telemetric water-level monitoring stations in 40 river basins for real-time flood monitoring. At these stations, three critical flood levels are designated, namely, alert, warning and danger. In addition, 400 river observation points are provided with manual flood gauges, and more than 250 siren stations have been established (Ahmad Husaini, 2007).

REFLECTIONS ON MALAYSIAN RISK-MANAGEMENT POLICY ISSUES

Extensive reviews of government policies and research efforts revealed some degree of political will to cope with environmental risk. Although success has been achieved in some sectors, elsewhere, gaps have been identified in developing and implementing policy. The country faces challenges, including the lack of environmental data needed to adequately monitor environmental policy management and implementation, an insufficient supply of sustainable fuels for transporting people and goods, and the under-optimisation of renewable and fossil-fuel energy. At the regional level, adaptive measures for climate change are needed (Malaysia, 2007).

In regard to governance, to be effective, national policies must be adopted and implemented by the state authorities without amendments. As one study highlights, sound planning can still fail in the absence of enforcement at the operational level. Thus, plans made at the national level need to be implemented effectively at the local level without any political interference. Furthermore, the roles and responsibilities of all stakeholders should be clarified, and the participation of industry players in addressing climate change should be enhanced.

Without doubt, the political commitment to manage hazards exists, as demonstrated by the construction of the SMART Tunnel, the tsunami recovery plan and the December 2006 flood recovery plan, among others. Notwithstanding this commitment, further adaptive measures are necessary and should be given more priority, especially over the next 20 to 30 years. In addition, mitigation measures should be taken into account. Policy options that could be explored may be either regulatory or economic and include instruments such as trading permits, a carbon tax and tax rebates. Thus, the challenge lies in balancing adaptation and mitigation measures.

At present, no separate, specific policy exists for every economic sector that would address the effect of global warming and climate change on the individual sectors and their productivity. The most advantageous approach may be to adhere to best practices to minimise environmental degradation and natural-resources exploitation, as strategised in the objectives of the 9th Malaysia Plan and the National Environmental Policy (Khairulmaini, 2007).

As for water shortages, the information that is needed to forecast water availability should include an improved estimate of regional population growth, land use changes, and likely shifts in water demand as a result of demographic and economic changes. In addition, improved information on the likely range of climatic conditions is an important prerequisite for a better formulation of adaptive and abatement measures (Ministry of Science, Technology and Environment, 2000).

Although it can be said that Malaysia has sufficient water resources to meet population needs, water problems remain, for example, managing water effectively to achieve objectives. In some river basins, water is already short, especially during prolonged droughts, and conversely, the wet season brings excess water and floods. The most challenging issue is to coordinate the activity of various government agencies and the private sector in managing the watershed. The river basin should be a basic planning unit. Now, however, rivers are managed according to political or administrative boundaries, a practice that does not provide an overall engineering solution (Ahmad Husaini, 2007).

The reduction of flood and drought losses must involve a number of government agencies and often the private sector. For example, reservoirs for irrigation, water supply and flood mitigation have conflicting operational rules. For efficiency and success, the development of common objectives and the definition of clear roles for each of the stakeholders and close cooperation and understanding amongst the stakeholders are needed. In addition, the implementation and formulation of flood- and drought-management action plans cannot be made without the cooperation of all stakeholders (Ahmad Husaini, 2007).

The Urban Storm water Management Manual for Malaysia (Manual Saliran Mesra Alam Malaysia, MSMA is only a guideline, and DID has no legal authority to make the procedure outlined in this manual mandatory for local authorities, developers, and contractors. Although, at present, the proposed development programmes have been based on those master plans, a few problems arise during implementation: local authorities lack the technical expertise and financing to maintain the newly constructed drainage systems; developers consider that following manual guidelines will increase a project's cost; contractors are unfamiliar with the work of maintaining erosion controls and sediment traps; and consultants are still weak on the concept of urban storm-sewer design. Without widespread application of the manual guidelines, however, effective flood and drought management for urban areas will continue to lag (Ahmad Husaini, 2007).

The Economic Planning Unit is missing a chapter on sustainable water-resource management. Such a chapter would include a holistic, integrated approach to water-resource management (IWRM and IRBM); an understanding of how economic development, unless properly planned and executed, can exacerbate pollution, floods, forest fires, and extreme climate events subsequent to climate change; and an acknowledgement of how better integrated, managed, monitored and enforcements of infrastructure development can provide not only better returns but also a better-managed environment, including the water supply and flood and pollution abatement in affected areas. The National Water Resources Study (for Peninsular Malaysia) Mac 2000 and the Master Plan for the Development of Water Resources in Peninsular Malaysia (2000–2050) did not take into account a potential change of hydrologic regime and water resources due to climate change (Salmah and Ahmad Jamalluddin, 2007).

The National Hydraulic Research Institute of Malaysia (NHRIM) notes that climate-change projections must be studied further. The projections must be assessed with regard to the impact of climate change on Malaysia's social and economic sectors (i.e., agriculture, forestry, biodiversity, coastal resources, water resources, public health and energy). Expected changes in water availability by 2050 will require a review of current water-resource plans in the various sub-sectors and states of peninsular Malaysia. Further downscaling studies using other General Circulation Models, GCM's (ECHAM5- MPI Germany, MRI-CGCM2.3.2- MRI Japan, CM2.1-GFDL USA, CGCM3.1 Canada) and further research on the future hydrologic regime (rainfall/streamflow characteristics at finer temporal and spatial timescales) are needed (Salmah and Ahmad Jamalluddin, 2007).

In agriculture, the third National Agricultural policy makes no reference to climate change and the need to adapt. Drought- and flood-resistant rice varieties need to be introduced. Crop varieties with improved water-use efficiency suited to production with reduced water inputs need to be generated (Mohd. Yusoff, 2008). Uncertainties remain, such as the magnitude of climate change, the technology available, crop and pest responses, and what the adaptation measures are, and there are a lack of policies and a lack of assessment methods (Mohd. Yusoff, 2008).

As for the socio-economic aspects of climate change, adaptation measures are feasible in the Malaysian context. However, additional efforts are needed to quantify the cost of these measures. Some of these additional efforts include further research and development in improving the science of response prediction and the quantitative bases for estimating impacts and economic costs (Ministry of Science, Technology and Environment, 2000).

More research is needed to refine methods of estimating the socio-economic cost of climate change and to establish a disaster-impact inventory. In addition, economic recovery plans must be developed and incorporated into disaster-management plans. Non-communicable diseases that may result from the effects of climate change, for example, increased stress amongst residents of small homes as a result of rising temperatures, must be studied. The management of energy, water and land resources needs to be planned with a view to balancing supply and demand and with an adequate emphasis on managing consumption. A greater effort should be made to provide more information to policy makers to promote information-based decision making (Ministry of Sciences, Technology and Innovation, 2007).

POLICY DIRECTIONS AND RECOMMENDATIONS

The policy gaps identified can be addressed by refocusing strategy, especially now that government has shown the political will to prioritise risk management. Some recommendations have been proposed, particularly those that will be relevant to the agricultural sector.

Enhance research and development (R&D) efforts and activities are critical in providing the technological support for reducing the effects of El Nino-induced climate change, especially in the agricultural sector. Special attention must be paid to the following research areas:

1. To enhance national predictive capabilities, an interaction between climate change, agricultural production and the relevant preventive and mitigating mechanisms must be established, such as through an expert system and computer modelling.
2. Research should continue on plant breeding and biotechnology for the development of varieties resistant to water stress and related technologies, in view of the possible limitation on water available for agricultural purposes in the future.

3. Research on the development of precision farming technology should be enhanced to ensure an efficient utilisation of resources, especially water in crop production.
4. Future variability in climate will most likely result in different sets of problems with regard to pests and diseases. An effective control method and preventive measures under an entirely different farm environment must be developed. Similarly, the change of farm environments necessitates the development of related technologies for land and water management, crop management and post-harvest management.
5. Emphasis should continue on the development of water-saving technology, including the possibility for greater utilisation of recycled water, in view of the impending shortages in irrigation water.
6. A concerted effort must be made to critically isolate the effect of climate variability on agriculture through a standardised methodology. Such information is an essential part of the predictive and early warning system to be developed.

Improve national prediction capability

A stronger national capability to predict the effects of climate variability and subsequent weather-related hazards is urgently needed. This capability must be extended to include forecasting for agricultural commodities based on the changing climatic environment, such as in the form of a simulation model or expert system. Such capability would not only enable prediction of forthcoming climate variation but possibly its magnitude and duration. This capability would also enable the forecasting of the possible impact of climate variation on agricultural production. Such information, coupled with information on marketing and pricing, would enable agricultural planners and farmers to make decisions about what crops to grow, where and how much, in view of the impending climate change. The prediction would allow the agricultural industry to adjust itself (especially for the annual crops) to reduce its vulnerability to environmental stresses by a specific management strategy.

Accurate predictions should provide time to prepare for the impending climate change. Such early warning mechanisms can contribute towards reducing the risk that farmers face by allowing farmers to adjust their crop types and farm management to such climate change. Specifically, the following measures are suggested:

1. Improve access to technical and financial resources to strengthen the national scientific capability in the relevant departments and institutions and their monitoring and predictive capabilities. A larger pool of scientists, research funds and facilities for research on environmental sciences and other relevant disciplines must be established as part of national capacity-building.
2. Establish a coordination-and-planning committee at the national level specifically to address issues related to climate variability and climate change. The committee could serve as a coordinating body to identify and mobilise national capacity to strengthen R&D activities in line with national priorities and needs. Additionally, the committee could support the existing IRPA (Intensification of Research in Priority Area) panel on environmental science in identifying and allocating R&D funds in relevant critical areas.
3. Ensure greater commitments and support from established international centres in this area of expertise in providing the necessary expert advice and services. In this respect, current regional initiatives by the Global Change System for Analysis, Research and Training (START), the Asia Pacific Network for Global Change Research, and the World Climate Research Programme are welcome. However, the current involvement of Malaysian scientists within these regional initiatives must be strengthened to reflect seriousness in this area of research. This would facilitate the information flow and sharing so that optimal benefits could be derived.
4. Strongly support the proposed Numerical Weather Prediction Centre under the Malaysian Meteorological Services Department to strengthen the national weather prediction capability.

Upgrade water-management capability

The existing water-supply infrastructure and water storage and distribution system, particularly for agricultural purposes, has been fairly efficient. The adoption of various water-conservation strategies is commendable, especially the efforts taken to ensure high irrigation efficiency through the application of various water-saving technologies, including that of water recycling. Nevertheless, the amount of water wasted is still fairly high. Since irrigation water is heavily subsidised, it is inexpensive, as such, people tend to waste it. In this regard, and to ensure that the water supply can be maintained on a long-term basis, the following strategies are proposed:

1. Introduce a new water-pricing policy according to which water's price reflects its scarcity value. This policy would ensure efficient water use, especially that of irrigation water.

2. To increase water availability at a time when no new sources of irrigation water are anticipated, the government must increase the money allocated annually for maintaining and improving the existing infrastructure and minimising water waste during distribution and use. In the past, this type of investment has not received sufficient support.
3. The current activities encouraging farm-level use of recycled water must continue because these activities have been found to be effective in increasing water-use efficiency.

Introduce drought action plan

While drought is not among the largest problems facing the agricultural sector, the development of drought action plans would be helpful in times of severe drought. The development of similar plans, such as the National Haze Action Plan, should be considered. The proposed plan should at least include the following elements:

1. Identification of drought-prone areas.
2. Establishment of drought-monitoring procedures to improve prediction and the degree of preparedness.
3. Establishment of a drought-prevention programme and response strategy.
4. Inclusion of insurance and government-support strategies.
5. Identification of the key players needed to realise the action plan.

Introduce contingency-aid schemes for affected farmers

The following interventions are proposed:

1. A government-sponsored scheme should be introduced to provide aid to affected farmers to protect their livelihood and welfare. This aid could take the form of monetary assistance or farm inputs.
2. Crop insurance should be introduced to farmers, especially in regions vulnerable to El Nino-related damage. Crop insurance would help farmers to withstand the effect on farm production and income of climate abnormality.
3. Based on the prediction that climate change is impending, the government must be able to suggest and implement mitigating measures to be undertaken at the farm level, even to the extent of changing crop types. The alternative crops introduced must be supported in terms of the availability of planting materials, technology, credit facilities and marketing outlets.

Strengthen regional cooperation

The establishment of the ASEAN Haze Action Plan by ASEAN member countries is a testimony to the possibility of a collective effort in combating an environmental disaster at the regional level. The plan was ambitious, comprehensive and covered all aspects of responsibilities and commitments among the member countries. Fairly frequent meetings were held to strengthen and ensure its effectiveness. However, as with other regional collaboration efforts, some areas need further strengthening:

1. Different levels of capability and capacity among the different member countries hinder the implementation or enforcement of decisions or agreements made at the regional level. Hence, continued upgrading is essential, including that of forest-fire fighting capabilities.
2. All barriers to information- and technology-sharing related to climatic change should be abolished. More group efforts and resource pooling must be pursued to step up preventive and mitigation measures.

Improve the regional food-security arrangement

Currently, a rice buffer stock exists under the ASEAN food-security arrangement. Under this programme, member countries are committed to maintain a certain level of rice stock that is to be released into the market when requested by a member country that experiences severe rice shortages and finds difficulty purchasing rice in the normal world rice market. However, the rice still needs to be purchased at current market prices. The last El Nino episode clearly indicated that the El Nino effect was very much regional in nature, affecting almost the whole region, although with different degrees of intensity. The possibility of a much stronger El Nino affecting the whole region and having a greater adverse effect on food production than previously cannot be discounted (Emergency Disasters Databases, EM-DAT, 2009). A review of the ASEAN buffer-stock arrangement that takes into consideration this possibility is essential. The enhanced capacity to predict such a disaster should be helpful in determining the right amount of buffer stock required.

CONCLUSION

Public intervention can facilitate better risk management through risk-reducing sectoral development strategies and programmes with due emphasis on community-based disaster reduction, improved hydrometeorological alert and information systems, pre-event emergency preparedness and recovery planning, the development of financial markets, the promotion of market-based price and yield insurance schemes, and ensuring that the poor are able to benefit from these interventions and from participation in emerging systems. The incidence of risk in agriculture is important to policy makers at national and international levels. Risk-management approaches can be distinguished according to whether they are undertaken before (mitigating) or after (coping) an event. Management approaches may vary depending on whether risk is viewed primarily as an individually experienced phenomenon (idiosyncratic) or a more widely experienced event (systemic). In general, Malaysia has not registered frequent climate-related disasters, although lately, mild climate-related disasters have been observed. These mild disasters include floods and droughts that caused significant socio-economic harm to the nation and landslides due to excessive rainfall and strong winds. They occurred on hillsides in coastal areas and caused minimal damage (Mustafa, 2007). In Malaysia, there are existing national policies regarding the adaptation to and mitigation of climate change. However, specific adaptation measures are necessary to manage sectoral impacts. In the agricultural sector, adaptation measures are vital to ensure the sustainability of agricultural systems.

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