
Climate change adaptation provisions for the agricultural sector in Malaysia

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Abstract: Malaysia has been experiencing an unusual harsh mixture of droughts and extreme rainfall events at present. As consequence, significant fall in crop production will be caused in the coming years. Current agriculture adaptation strategies are not significantly enough to cope with this issue. Therefore, this study aims to capture the scenarios in the field of climate change adaptation. The main focus of this study is to chalk out the adaptation efforts that the government and local stakeholders should consider. This study identifies the challenges associated with the implementation of adaptation options for the agricultural sector in response to climate change. Furthermore, this study presents some insight on the possible future strategies for adaptation that legislators may consider in designing and formulating the policy which may ultimately help the agricultural sector of Malaysia to be effective. Such adaptation framework actions and measures are adjudicated to assure cohesive participation of all concerned development bodies including government and non-government organisations along with local communities towards achieving the appropriate climate change response.

Keywords: adaptation; agriculture; impacts; climate change; Malaysia.

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1 Introduction

Climate change is a very complex phenomenon which has a profound impact on virtually every aspect on earth. Therefore, it involves research from multiple dimensions and disciplines. Proper understanding of the impacts of climate change in presence of obstacles associated with the probable actions for vulnerability reduction is a necessary condition for a project to be successful. Researchers and policy makers need to think about these issues separately as the impact of climate change can vary from region to region; between countries even within a country. This is also true for different sector of the economy of a specific country as impact can vary from sector to sector. Agriculture is one of the key economic sectors that are highly vulnerable to the impacts of climate change (Pearson et al., 2011). However, depending on their geographical location and adaptive capacity, the agricultural output of some countries may increase as a result of climate change and decrease for others. Countries where agricultural activities occur close to the limits of heat tolerance and moisture availability, that agriculture is most likely to be negatively affected by climate change (Burton and Lim, 2005). For Malaysia, the impacts are measured as unfavourable.

Every society have distinctive ability to adapt to some extent with the climatic condition but uncertainty related to extreme climate event plays a major role in adaptive capability specially for the community associated with agricultural sector for its strong dependency on weather. Therefore, it is necessary to assess the feasibility of future adaptation plan to choose appropriate adaptation actions for the agricultural sector-based community. A precise awareness of the barriers and limitations to agricultural adaptation can play an important role for the decision maker to choose a suitable adaptation option. For doing this, it is crucial to identify the obstacles on the first hand so that necessary steps can be taken. Many studies have proven that developing nations are more vulnerable to the impacts of climate change but they are facing many constraints to take measures toward reduction of emissions and consequently the impacts of climate change. Therefore, adaptation is becoming a growing concern as a way forward for developing countries, including Malaysia. Moreover, as a developing country, Malaysia has no quantitative loyalty under the Kyoto Protocol at present.

However, expert view suggests that there is no way to get exemption from adverse climate change effects, unless appropriate action is taken place. It is true that research on finding appropriate action and its long term consequences is still in its preliminary states in many developing countries, including Malaysia. Researchers and policymakers are trying to get precise estimated future consequences of climate change impacts with and without adaptation so that effective action can be taken. Toward this aim, some global and country basis study has been conducted in this area of research. For example, a recent study on Nigeria by Bosello et al. (2013) shows that climate change would bring negative impacts in terms of production loss, burden of imported food dependency and thus negative impacts on trade etc. The study found total agricultural production losses will be 4.8% to 7.4% and GDP loss (only for agricultural impacts) is estimated 3% to 4.4% without any initiatives by 2050. Then they consider 'soft' (here they consider shift of planting dates, increased fertilisation, manure management to complement nutrient provision) and 'hard' (expansion of irrigated land through irrigation plants) adaptation measure and estimate the cost; effectiveness of these policies through computable general equilibrium analysis. The results show that a combination of soft and hard measures will be more cost-effective and can offset roughly 90% of climate change damages. Global estimates also show adaptation policy is much more effective for developing countries (Mertz et al., 2009).

Therefore, adaptation can be considered as part of a growing interest for Malaysia. To the best of our knowledge, at present there is very less efforts by the government and non-government organisations as well as by research communities that aim to reconcile the potential barriers of adaptation in Malaysia. However, there is no concrete guideline to climate change adaptation provisions for the agricultural sector visualised the long-term provisions particularly as the issue is concern. Therefore, we have taken this study as a way of option, as least with some substantial related adaptation indicators. Here, we present some suggestions regarding how the existing weak adaptive capacity of Malaysia can be strengthened further. The attention is mainly paid on the agricultural sector. In doing so, our specific objectives are; a) to identify the challenges associated with the implementation of adaptation options and provision for the agricultural sector of Malaysia in response to climate change, and b) to find different remedial actions that are available at present so that an integrated view can be presented for the future policy makers.

2 Climate change challenges for agriculture in Malaysia

Agriculture plays a critical role for Malaysian economy not only for its share of growth but also for its contributions to the nation's food supply. Agriculture provides 12% of the nation's GDP (CIA, 2012). About 16% of the population of Malaysia is employed all the way through some sort of agriculture (CIA, 2012). However, the employment is much more if we consider foreign labour engaged in agricultural work. As we know, the agricultural sector's susceptibility to weather and climatic conditions is apparent. Consequently, intensive investigation is needed to assess the vulnerability of the agricultural sector of Malaysia. According to Kulshreshtha (2011), changes in temperature, rainfall and the concentration of CO₂ in the atmosphere will directly affect

agricultural profitability through crops and livestock productivity. Malaysia could suffer from the changes of climate variable over a hundred year period as predicted in Table 1.

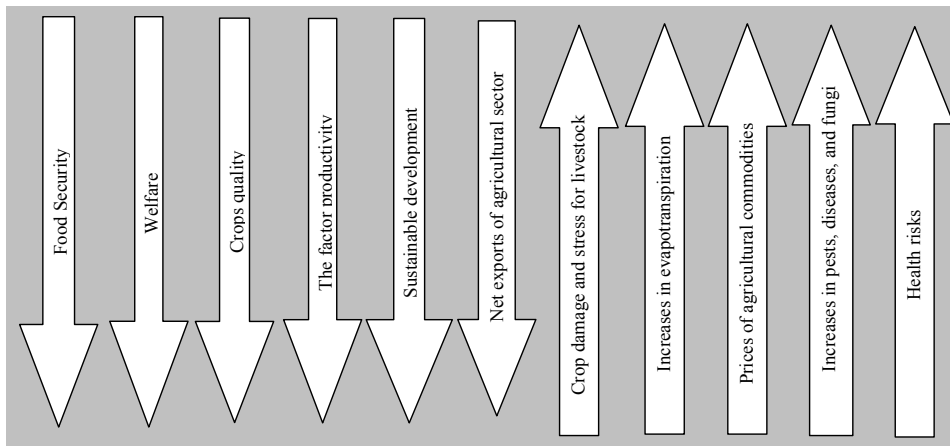
Table 1 Climate variability conditions for Malaysia in the next 100 years

Temperature increase	• 0.7 to 2.6°C
Rainfall changes	• -30% to 30%
Sea level rise	• 15 cm to 95 cm

Source: Adapted from Baharudin (2007) and Chong (2000)

This scenario means noteworthy challenges for Malaysia because increases to global average temperatures beyond 2°C is considered as ‘dangerous’ internationally. According to Al-Amin et al. (2011), for Malaysia, climate change will bring “Loss of land through sea level rise and associated salinization”. Continued climate variability in addition to extreme events, the agriculture sector will be forced to cope beyond the traditional changes prominent through time (OCCIAR, 2011). At this standpoint, from many studies it is evident that the changes of these climate variables will lead to make changes (Al-Amin et al., 2013; Ahmed et al., 2012; Al-Amin and Leal, 2011; Maria et al., 2009).

Figure 1 Factors affecting by climate change



Note: Down arrow shows decreasing factors while up arrow shows increasing factors

From Figure 1, it is clear that for Malaysia, the impacts of climate change are measured as unpleasant. Though there may be some positive impacts from climate change including probable increases in soil moisture; length of the growing season, grow new crop species in a warmer climate, etc. However, these impacts are yet to be verified. Therefore, similar to many other developing countries, climate change negatively affects Malaysia. Accordingly, adaptation should be considered as a major concern for Malaysia. Before we elaborately discuss about the stress related to climate change adaptation in the agriculture sector in Malaysia, we try to give some basic ideas about adaptation strategies for agriculture sector in the next subsection.

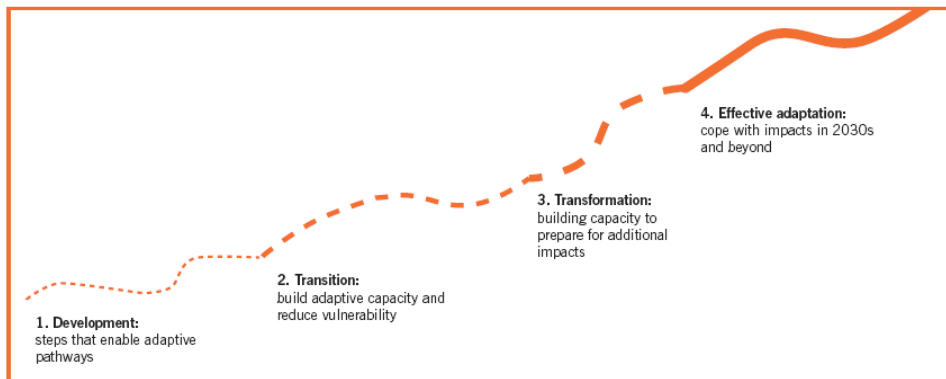
3 Adaptation strategies

All the way through behavioural, resource, and technological adjustments, adaptive capacity refers to the potential ability of a system to successfully respond to climate change (Adger et al., 2007). According to the Inter-Governmental Panel on Climate Change (IPCC), climate change adaptation is the “adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities” (IPCC, 2001). Recently, IIED (2011) also focused an adaptation as a pathway for a way forward in the long-run action plans (Figure 2).

To be more specific, adaptation is the way of adjustments to develop the feasibility of social and economic activities and to trim down their vulnerability to climate change, together with its existing unpredictability and extreme weather events with long term climate change (Smith et al., 2000). There are several strategies that farmers can implement to trim down the risk of climate change impacts from an agronomic perspective. Figure 3 shows some methods that can be applied to make communities live better under a changed climate.

It should be noted that adaptation is a complicated process. Among the available adaptation strategies, which and what level of adaptation will be implemented varies upon individual farmers depending on their capability and willingness to adopt (Crimp et al., 2010; Howden et al., 2007). Pannell et al. (2006) argues that willingness to adopt depends on farmers’ goals, attitudes, values, confidences, and risk perceptions. Also, farmers are willing to adapt a particular strategy on the basis of how much it affects their welfare (Greiner and Gregg, 2011; Pannell et al., 2006; Edwards-Jones, 2006).

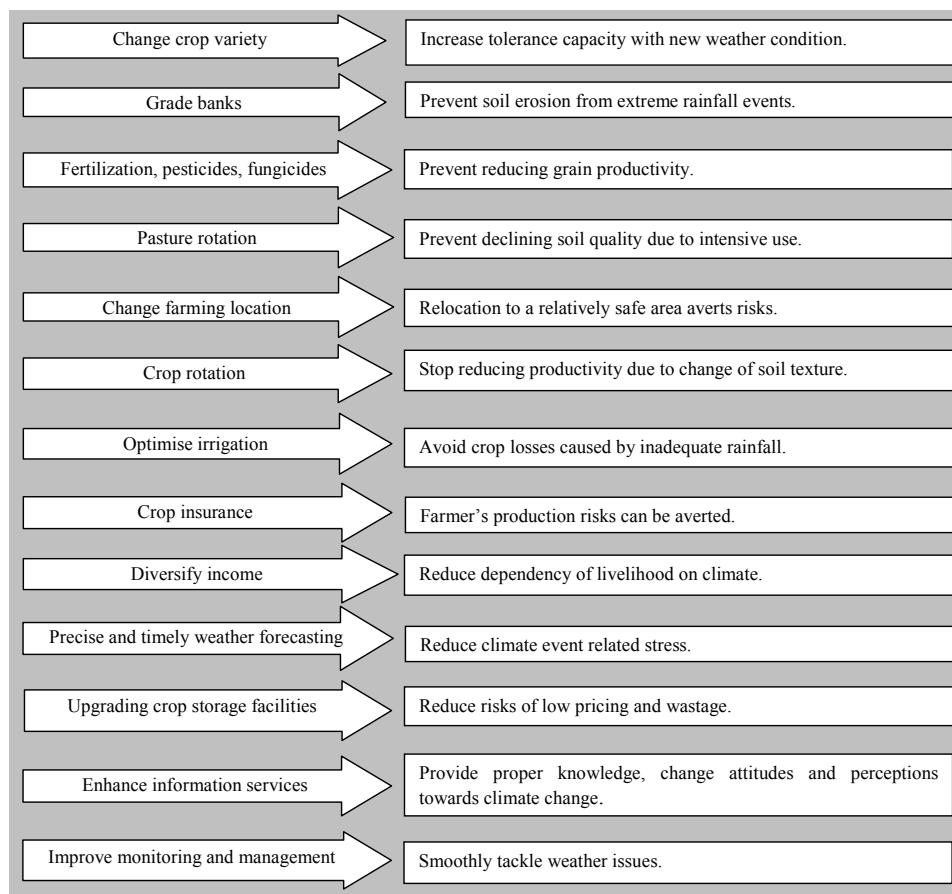
Figure 2 Adaptation as a pathway for a way forward (see online version for colours)



Source: IIED (2011)

Taking into account the financial and non-financial costs and benefits as of the individual farmer’s perceptions, adaptation decisions may vary among farmers as everyone wants to maximise his utility. This is evident from the rural innovation adoption literature that the farmer will adapt only when he feel getting benefited (Greiner and Gregg, 2011; D’Emden et al., 2008; Pannell et al., 2006).

Figure 3 Various adaptation strategies and their benefits



Source: Adapted from Olesen et al. (2011), Howden et al. (2007), Smit and Skinner (2002)

4 Current status and lacking in Malaysia

Presently farmers of Malaysia are conferring little attention in planning for potential climate change impacts on both at individual and community levels. Rigorous analysis on the net impacts of climate change on agriculture is yet to be performed on account of the uncertainty associated with the success of any adaptation action to handle climate change. Generally, farmers cope with weather patterns on a short term basis and sometimes able to adjust to potential risks and weather variability through best management practices, but climate change may pose new unpredictable risks for the future of Malaysia similar to rest of the world. There are substantial limits and barriers to adaptation, including environmental, economic, informational, social, attitudinal and behavioural barriers that are not fully understood (EPA, 2013). Hence, understanding the limits and barriers to adaptation is crucial to support a sustainable and resilient agricultural sector (Stokes and Howden, 2010). An absolute obstacle that leads to adaptation action ineffective as a

response to climate change which cannot be overcome, are known as limits to climate change adaptation (Adger et al., 2007). Barriers to adaptation are obstacles that can be overcome with some efforts, for instance, creative management, or changed thinking (Moser and Ekstrom, 2010).

Every individual sector should have its own policy which may separate from other sector depending on the vulnerability to climate change. However, in Malaysia, “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” (Austin and Baharuddin, 2012). Furthermore, it is necessary to provide better and accurate information of probable climatic variations for designing efficient adaptive measures (Ministry of Science, 2000). But unfortunately in Malaysia, there exists a huge lack of information in this regard. Hence it is apparent that, for Malaysia main obstacles are lack of knowledge of climate change impacts; limited conservation facilities; political willingness etc. Moreover, there is one distinct and important challenge for Malaysia which is the continued uncertainty about how much climate change it will face. The perception is complex to understand. Current adaptation techniques may be practical in future circumstances but it is uncertain under extreme weather conditions. It is also unsure that to what extent adaptation will reduce vulnerability in Malaysian context. But despite the uncertainties, rigorous effort is needed to facilitate decision making based on climate projections. Subsequently, for a range of climate change scenarios, a range of adaptation options and costs should be estimated. Heath and Gifford (2006) discussed on the subject of the continued debate worldwide about what is causing climate change.

5 Future guidelines for developing the effective adaptation strategies and provision for Malaysia

What adaptation policy should be taken and how much to adapt is a vital question for policymakers. At this point, government can set the level of adaption based on the optimum investment criteria. If $MB \geq MC$, (MB , MC represents marginal benefit and marginal cost respectively) for a particular adaptation action, the project will be considered as prospective and the social welfare will get better relative to a standpoint with no climate change. On the other hand it is important to be noted that there must be a sort of hedging associated with climate projection because of the existence of uncertainty and timing of climate outcomes. Thus adapt to what exactly and when to adapt is still difficult to speculate. In Malaysia, climate change is not an issue of concern for many farmers because of the lack of information regarding actual trends/patterns of changing climate variables and their effects as well.

Long-term climate change adaptations opportunities could be devastated by this lack of proper knowledge. Policymakers should take proper initiatives so that farmers could identify the risks on their farms associated with weather and climate events and subsequently implement a variety of anticipatory as well as reactive management strategies to manage climate risks. For Malaysia, there exists a lack of organisational involvement. To fulfil this gap, participation from each level government through notification, harmonisation, and direction in regards to climate change adaptation is necessary. Besides, industries, producers, conservation organisations, social and personal

level of organisations should share experiences to establish a common information source basis. Media can play a large role in overcoming the information gap and make the producers better understood the adaptation methods which can change their perceptions and attitudes towards climate change.

Vulnerability assessment is a vital part of adaption planning processes. Following the definition of vulnerability, it can be expressed scientifically as follows:

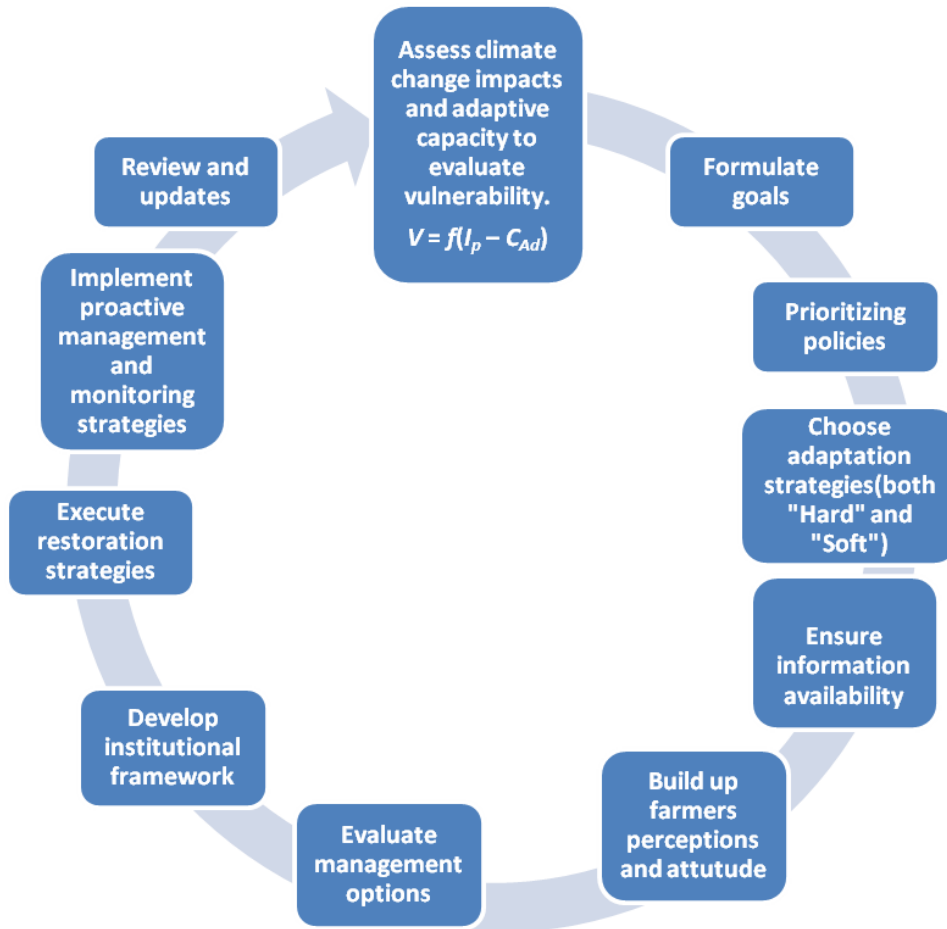
$$V = f(I_p - C_{Ad})$$

where V represents vulnerability, I_p is for potential impact, and C_{Ad} is for adaptive capacity (Adesina and Odekunle, 2011). Vulnerability depends on climate impacts and adaptive capacity. Once this potential impact and adaptive capacity can be traced out for the agricultural sector in Malaysia, the adaptation planning process can be smoothly initiated. To avoid rivalry, government should involve in the adaptation process when the benefactor (i.e., one who is adapting) and beneficiary (i.e., one who is benefitting from the adaptation) of adaptation are different identity (public goods characteristics of adaptation). Government should ensure that the infrastructure, technology supplies and financial supports are evenly available to the farmers. Farm financial management and production practices should modify with climate conditions.

The best adaptive measures can be implemented through employing the farmers in vulnerability assessment and policies supporting to the field of research in adaptation which eventually provides precision of data projection by means of improving data collection and analysis methods. Also, it will help to change the farmers' attitudes towards climate change. Most of them believe it as a slow moving future problem and there is no need to be worried about at present. Government should increase investments in technological developments so that agricultural productivity can be enhanced to ensure food security. Like some other countries, Malaysia may think and consider about precision agriculture (PA) in order to get an environmental friendly agriculture toward facing the challenge of sustainability. PA is a way of transforming the traditional agriculture through proper resource utilisation and management practices that are derived from experiences and intuitions (Mondal and Basu, 2009). In addition, government programmes should support community-based adaptation strategies and government should take initiatives for the integration of climate risk into risk management frameworks. Therefore, if proper and appropriate provision and way forward is taken place; we can visualise the possible environmental friendly agriculture toward facing the challenge in near future. Strategies taken today will bring success for tomorrow in the mission of reducing negative impact and vulnerability.

The idea of this framework comes from the concept of Community-Driven Development (CDD) approach given by the World Bank. In this approach for a particular area, communities as well as local government have decision making power over investment and planning. Therefore, it allows rural people to be aware of addressing their desires and thus can play a vital role in the provision of their basic needs. We do believe that in climate change adaptation planning and implementation process, efficient result can be achieved if local communities are empowered to address suitable adaptation provisions for their particular area. In this case, of course, local government will provide all the necessary information and guidelines to them so that they can understand the climate risks and can take potential actions.

Figure 4 Framework for adaption strategies for agricultural sector of Malaysia (see online version for colours)



Following on the best available information, it is necessary to assess the current and projected climate impacts with the adaptive capacity so that the vulnerability can be figured out as shown in Figure 4. In addition, following the vulnerability assessment [equation (1)], it is needed to identify a target or set of targets, such as the protection of a specific crop production in a particular location. The outcome of vulnerability assessments will assist to decide which crops should be priority conservation targets to ensure future food security. Prioritising the guiding principles among available policies is the next step. Subsequent to that choosing adaptation action with the consideration of different climate scenarios is required. In this framework, we try to combine ‘Hard’ and ‘Soft’ adaptation approaches simultaneously. Malaysia needs both infrastructural development (an example of ‘Hard’ approach) as well as capacity building for policy implementation (an example of ‘Soft’ approach). Once these crucial things have been identified, the various management options among available adaptation specific alternates should be evaluated.

Following this evaluation, it requires to build an institutional framework to assess the methodological practicability of potential solutions and the capability to respond, along with the economic, social and political factor. Implementations of proactive monitoring and management strategies are crucial for a project to be successful. The frequent review and updates of every step is critical to track the status of key indicators. Researchers should examine whether specific adaptation option is viable for producers. Impacts are most felt at the local level and thus should be addressed at the local level. Successful adaptation will build resiliency in the agriculture sector in addition to it will strengthen the capacity needed to force on climate change. However, it is necessary to estimate the impacts and economic cost of these procedures quantitatively through supplementary research and development. In brief, potential solutions are; a) disseminate proper information and guidance, b) develop awareness programmes, c) empower rural communities in decision making, d) precise vulnerability assessment, e) decide priority conservation of crops to ensure food security, f) choose appropriate adaptation options, g) evaluation of management options, and h) build a proper institutional framework to support all of the above.

Table 2 captures the basic information on adaptation metrics using five developing countries. These five developing countries suffer huge financial constraints in balancing the priorities while allocating annual budget. However, due to the 'emergency on the call of climate change' and its adverse impact on development, each of these five countries has provided an especial attention to handle the issue. In planning the adaptation strategies and setting their goals, countries made a careful attention in identifying the problem and solving them with a pragmatic fashion by ensuing a cost effective way. This may also help Malaysia in providing some lessons to make its way forward. Therefore, the discussion that follows talks about the key elements of the five countries outlined.

Malawi is country that suffers financial constraints and the mass people are unaware about the good citizenship life. It is thus policy is considered to make the community aware on the adaptation on climate change through the initiative of private and NGO sectors. The effective campaigning and some degrees of practical implementation have been guiding the country to progress further. Bangladesh suffers with manifolds problems as dealing with huge unaware population with limited resources is always challenging. However with firm initiative, the country has made a remarkable progress by being innovative to the agriculture sector. Country has made the progress both on cultivation process and cultivation culture as well as food habit by superseding its old tradition. However, many scholars also argue that this has challenged on food nutrition value. Rwanda is still on her transition momentum as it is trying to outline the possible best way that the country could adopt. However, the research and innovation in Rwanda is progressing well with help of development partner. The geographical location and pattern for both Tanzania and Nepal are not in an even and comparable position as they have many uncommon features. However, both of the countries are putting effort to use their land more efficiently avoiding the climate adverse sessions. Tanzania is also trying a little transformation to livestock sector. Malaysia is ahead of these five countries in terms of financial liberty, it is thus; once the country may have a comprehensive way of identifying the challenges and possible potential solutions (i.e., a-h), it would able to take more drastic and dynamic plan of action for the way forward if the legislators are convinced. We thus believe that these five causes could be the milestone of step forward.

Table 2 Adaptation action plans in five emerging case studies

<i>Country</i>	<i>Action of adaptation</i>	<i>Goal of adaptation</i>
Malaysia	Identify the challenges associated with the implementation of adaptation options	Possible adaptation measures and solution in the way forward
Malawi	Market linkages, credit facilities, goods and services provided by the private sector	Strengthening maize-based subsistence farming systems
Bangladesh	Breeding and disseminating salt-tolerant varieties of rice	Modifying food production in marginal areas prone to salinity
Rwanda	Research and development, institutional capacity and marketing	Improving smallholder cash cropping, especially coffee
Tanzania	Early warning, land use planning, research, water provision, migration	Protecting pastoral and livestock systems
Nepal	Soil and water management, new seed varieties, local awareness and capacity building	Increasing food production in integrated hill farming systems with mixed cropping

Source: IIED (2011)

6 Conclusions

This study has shown that climate change has many potential negative impacts on the agricultural sector in Malaysia. Particularly, agricultural sector is inherently sensitive to climate variability that would pose significant challenges in future. Malaysia needs to have strong focus on effective agricultural adaptation guidelines at their infancies. Hence, it is required to start practicing climate change adaptation strategies through supplementary research and development. Rigorous research should be conducted in rural agricultural communities as they are in lacking in guided knowledge and climate change is a slow moving long term threat but in the long run the impact is incredibly huge. Government and private sectors need to be working side by side to promote further adoption provision, and adaptation strategies should be viewed as a long term priority. Government can provide financial support for insurance at the beginning stage of implementation of adaptive actions, and private sectors needs to motivate farmers to change their attitudes and perceptions toward climate change. Gradually through providing proper education and information to raise awareness for adaptive management, the local stakeholder will contribute in adaptive management. It has to be noted that there is no single approach to climate change adaptation as appropriate way forward. Therefore, distinctive characteristics on the basis of topography, climatic conditions, and socioeconomic conditions needs to study by research in making climate change adaptation unique to each community. The suggestions as given in this study are efficiently performed, the vulnerability to climate change can be significantly reduced which would enhance socio-economic wellbeing of the communities.

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