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Climate Change Adaptation Ability among Sabahan Highland Farmers

[1]Hamizah Sahharon, [1,3]Khairuddin Idris, [1,2]Asnarulkhadi Abu Samah, [3]Bahaman Abu Samah and [1]Hayrol Azril Mohamed Shaffril

[1]Institute for Social Science Studies, Universiti Putra Malaysia
[2]Faculty of Human Ecology, Universiti Putra Malaysia
[3]Faculty of Educational Studies, Universiti Putra Malaysia

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Abstract
This study aims to gain more understanding of Sabahan highland farmers' capacity to adapt to the impacts of climate change. This study uses a multi-stage cluster sampling involving 200 highland farmers around Kundasang and Moyog. The data were the analysed using independent t-test, ANOVA, and Pearson correlation. Sabahan highland farmers have a high cognitive awareness towards the changes in their ecosystem, high practices by diversifying their crops, extending their harvest land and also learn other skills related to agriculture and skills impertinent to agriculture to convalesce their household income. However, their structure support was weak as they do not have many livelihood options other than agriculture.
Keywords: climate change, higland farmers, adaptation ability, community development

Introduction

The agricultural sector has long been the backbone of rural development in Malaysia and it is not an overstatement to claim that this sector is the major source of income for rural communities, whom are classified as a marginalized society as compared to the urbanites who benefited most from massive development and have an abundance of employment opportunities (Department of Agriculture Malaysia, 2015). For rural communities, agriculture is no recreational farming, it is their bread and butter. In 2013, 1.43 Million tons of vegetable were harvested, which is equivalent to RM 4.77 Million trade value (Department of Agriculture, 2015). About 57% of vegetables production was dominated by the Eastern region (Pahang, Kelantan, Terengganu), 24% from the Southern region (Melaka, Johor) while the remaining quartiles were produced by the Northern region (Kedah, Perak, Perlis), Central region (Selangor, Negeri Sembilan) and East Malaysia (Sabah, Sarawak, Labuan) with 6%,7% and 6% weightage respectively (Department of Agriculture Malaysia, 2015).

The latest scenario showcases the high demand for vegetable productions, mainly due to the growing numbers of health-conscious consumers, escalating incomes and rapid national population growth. However, up to 2011, Malaysia's vegetable self-sufficiency level was still at 58%, which implies that almost half of the nation's demand were cushioned by imported food supplies. Malaysia's current reliance to imported food scenario has marked the urgency for

policy makers to address the National food supply guarantee by formulating new policies and management strategies for both; the country and the international level. In Malaysia, in order to ensure food security, the government's intervention in formulating policies towards empowering the agricultural industry is evidence (Murdiyarso, 2000, Carvalho, 2006, Siwar, 2009). Moreover, Murdiyarso (2000) claimed that the policy-making process should be balanced by bottom-up approach, in which smallholder farmers' involvement should be dominant. Although in the context of national food production industry the government had launched "Tanaman Kekal Pengeluaran Makanan" (TKPM) under the Ninth Malaysia Plan which was spearheaded by Department of Agriculture (DoA) to enhance food production at mass scale and eventually ensure food sovereignty, there is still a need for bottom-up approach whereby the farmers are empowered to make decisions based on their needs and capabilities.
Despite the government's noble measures in empowering the industry by creating a large-scale food production clusters, which involves investment from private players, the importance of agriculture peasant (smallholders) should not be underestimated. These smallholders are accounted of 1.5 billion rural people living on 380 million farms and they happen to be people who provide food for 238 million hungry urbanites (ETC Group, 2009).The fact that smallholder farmers contributes significantly towards rural-livelihoods, food security, and most probably national economies is provident yet less appreciated by most.

Impact of Climate Change to Agricultural Sector

In year 2050 it is projected that there will be over 9 million mouth to be feed by global agricultural players (de Schutter, 2010). Agricultural sector production rate should be increased by 70% in order to cater the additional 3.5 million world's population in 50 years period (Borlaug, 2007).This projection is causing anxiety to the international community as the currently evident food challenge is further worsened by a variety of emerging issues such as exhaustion of arable land bank, the energy crisis, economic uncertainty and severe climate change (McIntyre, 2009). Climate change is seen as an utmost challenge faced by Agrarian as it may impede farmer's ability to achieve highest possible yields in order to ensure food security (Lobell et al., 2008).
Most significant impacts of climate change to agricultural sectors is global warming as it will affect soil humidity, increase in sea surface levels and glacial melt in the mountains and eventually flooding the fertile lowlands (Sweeney et al., 2008). Murdiyarso (2000) added that agriculture and food production in many regions have experienced serious problems in coping with climate variability due to monsoons, which causes regional climate change like flood and drought. The unpredictable climate change may cause extensive loss of crops and damage every year to farmers.
Studies on the impact of climate change to the agricultural sector has recently drew considerable attention amongst scholars. Based on previous literatures, there are two climatic factors that contribute significantly towards reduction of agricultural yield which are namely, increase in temperature and lowering of precipitation rate. The study findings are based on previous studies conducted on the effects of temperature and precipitation rate on yields for agricultural commodities such as rice, wheat, corn, coconut, rubber and tea (Mathauda et al.

2000, Seo et al. 2005, Basak et al., 2009). Matsui and Horie (1992) in their research in south central and southwestern Japan has concluded that the increase in carbon dioxide resulting from the increase in atmospheric temperature caused a 30% reduction in yield as compared to the initial production potential. This finding is in line with Mathauda et al (2000) in his study nearly a decade later. Based on his research, which adopted the CERES RICE simulation model in Punjab region India, increasing temperature is inversely proportional to yield and the increase in temperature also have negative impacts on the commodities post-harvest quality and attribution such as biomass and straw yield.

In order to further investigate the impact of climate change, scenario faced by developing countries must be taken into account as this phenomenon imposed negative impacts on millions of small-scale farmers which is amongst the poorest economic groups. This group is underprivileged as their capacity to uplift themselves from poverty is limited and agriculture which has long been regarded as the only viable economic activity are getting challenging, and with the onset of climate change may further impose greater pressure on farming and eventually their livelihood. One conclusion is clear - climate change is inevitable and poses a major threat to agriculture productions and Agrarian livelihoods.

Impact of Climate Change to Malaysian Agriculture

According to Intergovernmental Panel on Climate Change (IPCC) fourth assessment report in 2007, the climate change will be significantly affecting tropic and subtropics regions and Malaysia is not spared. This situation is further aggravated with Malaysia's nature as a developing country with low adaptive capacity and proper policy-relevant technical foundations. (Siwar et al. 2009). Although the climate change phenomenon is global in nature involving multiple sectors and various walks of life but agricultural are affected the most. This sector depends heavily on the climate and environmental factors and the situation is further worsen for those cultivating "rainfed commodity" without a comprehensive irrigation system for instance industrial crops (oil palm, rubber).

Climate change affects the agriculture industry in various aspects and it may involve most of agricultural commodities. The most devastating aspect highlighted by academician and policy makers is on the reduction of yield and productivity gains (Chong, 2000). This finding is consistent with the findings enumerated by Mad. Nasir et.al (2009) who found significant impacts of climate change on agricultural productivity and country's food security. This findings was further grounded scientifically by Baharuddin (2007), where in his study concluded that there are two incidents of climate change that would impact agriculture productivity which are precipitation and temperature. In the study he found that the extreme precipitation has caused a negative impact on the yield of palm oil evidence by southern Malaysia 26.3% reduction of crude palm oil production on December 2006. The same scenario encountered by the rubber industry as increasing precipitation rate reduce the intensity of tapping days and latex washout. The granary area on the other hand impacted from temperature rise, reduction up to 10% in yield from 1 degree Celsius temperature increment. Reduction of yield indicates more devastating impact to come among farmers which publically known as the poor and it may eventually add fuel to the poverty flames.

Another noteworthy impact of climate change is potential in downsizing of arable land. As much as 100.000 ha of land planted with oil palm 80,000 ha of rubber cultivated land abandoned as result of sea level rise (Chong, 2000). Apart from the downsizing of agricultural land, Sea level rise also resulted scarcity of available water source for irrigation due to saline water intrusion, thus developing the potential agricultural land is often an impasse (Siwar et.al, 2009).Natural response of ecosystems to changing rain patterns and temperatures have resulted in changes in the type and quantity of weeds and pests. This phenomenon not just pose a problem for cultural practices and increase agricultural input cost but also alleviate possibility of pesticides over usage that eventually will disrupt the stability of ecosystems and causing environmental pollution (Siwar et.al, 2009, Hamdan et al. 2014).

Climate Change in Sabah

The agriculture sector in Sabah have becomes less climate friendly as the atmosphere continues to change. As the temperature rise in Sabah over 40 years since 1960 has been 3°C, the cultivation is unsustainable (Daily Express, 2015). The gap of temperature rise has been widening every year between the maximum and minimum temperatures, in which instability in Climate Change could affect the harvest productivity. Noticeably, Sabah experienced drier soil, which also causes regular harmful smog or haze while the growth of crops are facing much decline in size and productivity. As Daily Express (2015) depicted, Sabah had gone through daily challenges by the worsening climate since the 1990s, however they highlighted that the effort to address the impacts of climate change or temperature rise had plummeted among most residents. The phenomenon not only threatens the environment, ecology and agricultural products, but also affecting the socio-economic aspects of farmers living in the area. Moreover, Sabah is known to be the most vulnerable state to poverty, projected temperature and unpredictable rainfall by 23% in Malaysia (Alam et al., 2012), therefore this study aims to discover the climate change adaptation ability among Sabahan highland farmers in order to overcome and endure the phenomenon.

Methodology

This study is quantitative in nature. An instrument was developed based on reviews of literature and then further improved via series of instrument development meetings. The instrument then was pre-tested at area of Tanah Rata, Cameron Highland. Subsequently, based on the 'if item deleted' analysis, a number of improvement were made and the instrument was presented to community development experts for validation process. The instrument consists of four main sections namely Demographic, Cognitive, Practice and Structure. The options of answers provided for the respondents were closed-ended, open ended (for demographic section) and five-like Likert scale ranging from strongly disagree (1) to strongly agree (5). The data collection process was assisted by a number of trained and experienced enumerators and monitored by the researchers.

The data were analysed using SPSS and descriptive analyses such as frequency, percentage, mean score and standard deviation were used to describe the following results. To establish the level of adaptation capacity, a calculation to determine the range of scores were used:

$$\frac{\text{Maximum mean score (5.00) – minimum mean score (1.00)}}{\text{number of categories (3)}} = 1.33$$

This calculation resulted in a range for low adaptation capacity (mean score between 1.00-2.33), moderate adaptation capacity (2.34- 3.67) and high adaptation capacity (3.68-5.00).

Results and Discussions

Demographic

Table 1 illustrates the demographic data of Sabahan highland farmers. About 51.5% of the Sabahan highland farmers interviewed were females, which shows that despite their homestead rosters the Sabahan women also helped with farming activities. The mean score for the farmers' age was 41.1 years old and approximately 31.5% of them had passed the upper secondary school level while the majority barely passed the lower school level. These statistics indicate that these farmers either took over their family farm after finishing school or continued farming due to limited job scopes within their areas. The majority of them (74.5%) were married and have been full time farmers since they started getting involve in farming activities.

Table 1: Demographic of highland farmers

Factor	Frequency	Percentage/%	Mean score
Gender			
Male	97	48.5	
Female	103	51.5	
Age (years)			41.1
<25	40	20.0	
26-40	55	27.5	
41-50	62	31.0	
>51	43	21.5	
Education achievement			
Never been to school	51	25.5	
Primary school	45	22.5	
Lower secondary school	25	12.5	
Upper secondary school	63	31.5	
Tertiary	15	7.5	
Marital status			
Single	42	21.0	
Married	149	74.5	
Divorced	9	4.5	
Status			
Full time farmers	160	80.0	
Part timer	40	20.0	

The average monthly income from agricultural activities was about rm703.2 per household. This figure shows that most of these highland farmers did not earn much but enough to last a month of food supply and family needs. Although half of them (52.2%) had more than seven family members, with an average income these families barely managed to provide for a big family. Noticeably the Sabahan farmers had been continuing their family of farmer's legacy with an average experience of 18.5 years, they had grown used to their hometown area and have probably never leave the place. They mostly planted vegetables (96%) and usually alternate the types of crop based on season. Overall, most respondents have 18 years' experience in farming activities.

Factor	Frequency	Percentage/%	Mean score
Income per month (from agriculture activities)			RM703.2
<RM750	131	65.5	
>RM751	69	34.5	
Household member			
1-3	39	19.5	
4-6	56	28.0	
>7	105	52.5	
Experience as a farmer (years)			18.5
<5	49	24.5	
6-15	54	27.0	
16-25	38	19.0	
>26	59	29.5	
Main crops			
Fruits	1	0.5	
Paddy	7	3.5	
Vegetables	192	96.0	

Adaptation ability

Climate change have long been affecting the vulnerability of highland farming productivities, thus in this part, results of Sabahan highland farmers' adaptation ability towards the impacts of climate change are discussed. Within Table 2 and Table 3, the farmers' cognitive factors are displayed, this part incorporates their level of sensitivity, their awareness of climate change and its impacts towards their environment and socio-economic routine. Overall, the Sabahan farmers had a high cognitive level (M=3.70).

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Table 2: Cognitive factor of highland farmers

Level	Frequency	Percentage	Mean score
			3.70
Low	5	2.5	
Moderate	92	46.0	
High	103	51.5	

Noticeably, the Sabahan highland farmers are highly aware of the changing climate that occurs around them. Some farms near the Kundasang areas were damaged by landslides, which was why Sabah highland farmers had a high cognitive awareness. They highly agreed that the changing climate in highland areas were getting unpredictable (M=4.69), especially the rain season (M=4.69), the high temperature (M=4.28) compared to six years ago and how unpredictable climate changes have reduced harvest productivities due to changing soil properties based on temperature and increased number of insects and rodents in their plantation. Perhaps as a result of few rain falls in their highland areas, the Sabahan highland farmers suffer less landslide occurrences. As opposed to the claims made by Daily Express (2015), most of the Sabahan highland farmers interviewed had a high level of cognitive awareness, and thus comes their readiness for early practice to overcome the problems that may arise any time.

Table 3: Cognitive statement of highland farmers

Statement	Mean score
Highland climate changes are getting unpredictable	4.69
The rain fall is unpredictable	4.69
The temperature in your area is getting hot	4.28
The productivity of my harvest is decreasing	4.20
The unpredictable climate change have caused an increase in the number of insects and rodents in my farm	4.05
The growth of my harvest has reduced in size	3.98
I have a hard time farming at my farm	3.76
The unpredictable climate change have caused an increase in the types of insects and rodents in my farm	3.65
This area is frequently raining	3.26
Occurrences of land slide/fall is very frequent in this area	2.97
I had to use more fertilizer to double my crops	2.78
I had to use more pesticides to address pest problems in my farm	2.13

Practices

Within Table 4 and Table 5, the farmers' adaptation to practices are displayed, this part incorporates their willingness to change socially and also economically in order to overcome problems that may arise from the impacts of climate change. Overall, the Sabahan highland farmers had a high level of adaptation practices (M=3.68).

Table 4: Highland farmers' practices mean score

Level	Frequency	Percentage	Mean score
			3.68
Low	13	6.5	
Moderate	70	35.0	
High	117	58.5	

The Sabahan highland farmers seemed to have a high level of adaptation practices as an early preparation for any possibilities that their harvest does not yield fruition. Their number one practice would be to diversify the types of crop they plant in their farm (M=4.51), the second would be to extend their farming land in order to harvest more crops (M=4.17) and the third would be learning new skills that are either related to agricultural activities (M=4.01) or skills impertinent to agriculture (M=3.89) as a form of extra income generating endeavour. Although these farmers were practically interested in learning new skills, the lack of structure support from related agencies may hinder their chance of expanding their skills to another level. Plus, their current educational background and existing skills were insufficient for them to get a new job.

Table 5: Highland farmers' practices statement

Statement	Mean score
I can diversify my crops	4.51
I would like to extend my farming land to harvest more crops	4.17
I love to learn new skills related to agricultural activities (e.g. floriculture, fertigation, landscape)	4.01
I love learning new skills that are not related to agriculture (e.g. entrepreneurial, vocational)	3.89
I encourage my wife/my children to work outside my field of employment in order to help improve our household income	3.34
I have no problem in learning how to use the latest agricultural technology	3.33
If I want, I can get another job other than being a farmer with my educational background and skills	2.54

Structure

Within Table 6 and Table 7, the farmers' structure aspects are displayed, this part incorporates the availability of supports from local institutions, the government, and community-based institutions. Overall, the Sabahan highland farmers had a low aspect of structure (M=2.83).

Table 6: Highland farmers' structure mean score

Level	Frequency	Percentage	Mean score
			2.83
Low	49	24.5	
Moderate	129	64.5	
High	22	11.0	

Previously it was stated that the Sabahan highland farmers yielded high scores on cognitive and practice aspects of adaptation. However, their structure support yielded a low score. There were a lot of employment opportunities related to agriculture in their areas (M=4.10) but very few jobs offered outside the agricultural industry (M=2.60). However, there seemed to be many organizations in their area that can help farmers diversify their economic resources (M=3.14) and government agencies that provide loans to farmers. On the downside, the farmer's community development did not meet the farmer's requirement as it did not meet their capabilities and the farmers themselves claimed that the disaster relief aids were not distributed fairly. In terms of weather information, the Sabahan highland farmers professed that they usually find the information on their own.

Table 7: Highland farmers' structure statement

Statement	Mean score
There are other employment opportunities (related to agriculture) here	4.10
There are many organizations in this area that can help farmers diversify their economic resources	3.14
The government agencies provided loans to farmers to mend their infrastructure/equipment that are affected by climate change	3.09
Usually decisions made by government agencies are in line with farmers' requirements and abilities	2.89
The farmer community's development planning to face climate change has been carried out by government agencies	2.68
There are other employment opportunities (which are not related to agricultural activities) here	2.60
When a disaster occur due to climate change, the disaster relief will be distributed equally among farmers	2.52
In this area, the government agencies provide advices to farmers regarding the effects of climate change on their crops	2.25
The government agencies in this area provide weather information to farmers	2.18

Conclusion

Overall, the phenomenon of climate change in Sabah is for real. Sabahan highland farms are not excluded when it comes to enduring the dangerous shifts in weather patterns and their ecosystems. These highland farmers have a high cognitive awareness towards the changes in their ecosystem, they claimed that the changes in climate had become unpredictable and their harvest productivity had been decreasing. However, they overcame it through practices by diversifying their crops, extending their harvest land and also learn other skills related to agriculture and skills impertinent to agriculture to convalesce their household income. Noticeably, their structure support was weak, from the look of it Sabah highland areas are mostly surrounded by nature, therefore they do not have many livelihood options other than agriculture. Their foremost side income would be related to tourism but typically as mountain guides. Sadly, even as mountain guides the job itself is vulnerable to climate change as it may endanger tourist lives if the weather is not suitable for mountain climbing. Moreover, 80% of them are full-time farmers, with an average RM703.20 of monthly income per household, the highland farmers were able to survive through the help of organizations that help diversify their economic resources and government loans. However, their disadvantage was due to decisions made by concerned parties often did not adhere to the capabilities and requirement of the highland farmers. Plus, the farmers often complained they were not provided with weather information and disaster aids were not distributed evenly, besides the aid given were insufficient.

Overall, drastic changes were noticeable with the increase in temperature and unpredictable rainy season. Landslides usually occur when there is heavy rain, during the data collection

process the farmers in Kundasang and Moyog claimed that the rainfall season has shifted and severe heat have caused an increase in the number of insects and rodents in their farm. Furthermore, the effect of climate change has led to a stunted growth of vegetables. Apparently these changes has been more prominent, hence it will present greater challenges to Sabahan highland farmers. As the temperature has quickly escalated, several major consequences have affected not only their harvest productivity but also the farmers themselves. Thus, if suggestions were made, the related agencies should actively involve the farmers to partake in the farmer's community development meetings and provide help for these highland farmers in Sabah on how to be capable of tackling problems that arise with the impacts of climate change. The related agencies should also address the needs and requirements of the farmers and their family and provide autonomous resources impertinent to agriculture, especially jobs that do not require stable climate. With the importance of the agricultural sector in Malaysia, the Malaysian government should consider allocating a much higher portion of financial assistance for Sabahan highland farmers to be able to afford advanced equipment. Therefore, this paper hope to assist the related agencies such as scholars, stakeholders and existing policy makers to come out with several climate-change adaptation strategies by addressing Sabahan highland farmers' needs, abilities and interests. In turn, this paper hope it can fill in the gaps on studies regarding this matter for future reference and replication.

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