AgBioForum, 23(2): 72-81. ©2021 **AgBioForum**

Climate Change and Extension Services' Effects on Farm Level Income in Malaysia: A Time Series Analysis

Sobhia Saifan
AL-Ahliyya Amman University,
Hourani Center for Applied Scientific Research
Email: s.saifan@ammanu.edu.jo

Rida Shibli
AL-Ahliyya Amman University,
Hourani Center for Applied Scientific Research
Email: r.shibli@ammanu.edu.jo

I.A Ariffin
Management and Science University
Email: indang@msu.edu.my
https://orcid.org/0000-0002-1376-7126

Mohd Shukri Ab Yajid
Management and Science University
Email: shukri@msu.edu.my
https://orcid.org/0000-0001-5688-4392

Jacquline Tham
Management and Science University
Email: jacquline@msu.edu.my
https://orcid.org/0000-0003-0966-2425

It is important to explore and understand the role of climate change adaptation and agricultural extension services at farm level to understand their effectiveness for outcomes like increase in farm-level income actions at the policy level. In the current study, has explored the impact of climate change adaptations and agricultural extension services on the farm level income of rice Paddy farmers in Malaysia. The study is based on collection of primary data from X farmers by use of structured interviews across Malaysia. The researcher has used logistic regression analysis to find the determinant of adaptation climate change and extension services and then use propensity score matching technique for estimation of causal impact of these factors on the from level income. the findings showed that extension services and climate change are vital factors that can affect the farm level outcomes like income and output. The differences in the education and experience levels, the dependence of the household on the crop income, resources and tenancy status of the farmers were found to be influence their status of adapting to the climate change initiatives. Whereas increased access to education and experience of farmers was related with the extension services of the farmers. The effect of the climate change and extension propensity scores were found to significantly influence the farm-level income.
Moreover, the study indicates that adapters and non-adapters are both oriented towards extension services and these services include better outcomes for the performance of the crop and result in increased productivity. Overall, it can be summarized with that this study implies and increased need of farmers education, ease of access to extension services, information dissemination about role of climate change in farm outcomes and sustainable food production, local food security is needed to develop productivity in income and other crop level outcomes.

Keywords: Climate change Adaptation, Agricultural extension services, Farm-level income, Malaysia

1. INTRODUCTION

Any change in climate makes it difficult for the farmers to grow the crops on land as there are a lot of factors involved in such processes to establish agriculture practices. The change in climate, such as drought, can make the soil barren and infertile, due to which the nutrients in crops are not available, and the crops are also not able to grow due to increased scarcity of water. The agriculture extension services have been seen to mitigate such issues. The farmers would be educated enough to control the situations with better handling skills so that climate change does not impact their farms (Shobande, 2021). Different circumstances may also occur during climate change as the growing season of crops in agriculture can be shortened due to aggravated situations in the climate changes. The farmers face many difficulties during the production phases as the land issues may also arise due to climate change, such as global warming can increase the negative impact on the crops and the soil fertility. However, suppose farmers are provided with better skills to utilize in agricultural practices. In that case, soil infertility can be controlled and mitigated with better practices, and farmers can have unique ideas to overcome the situation.

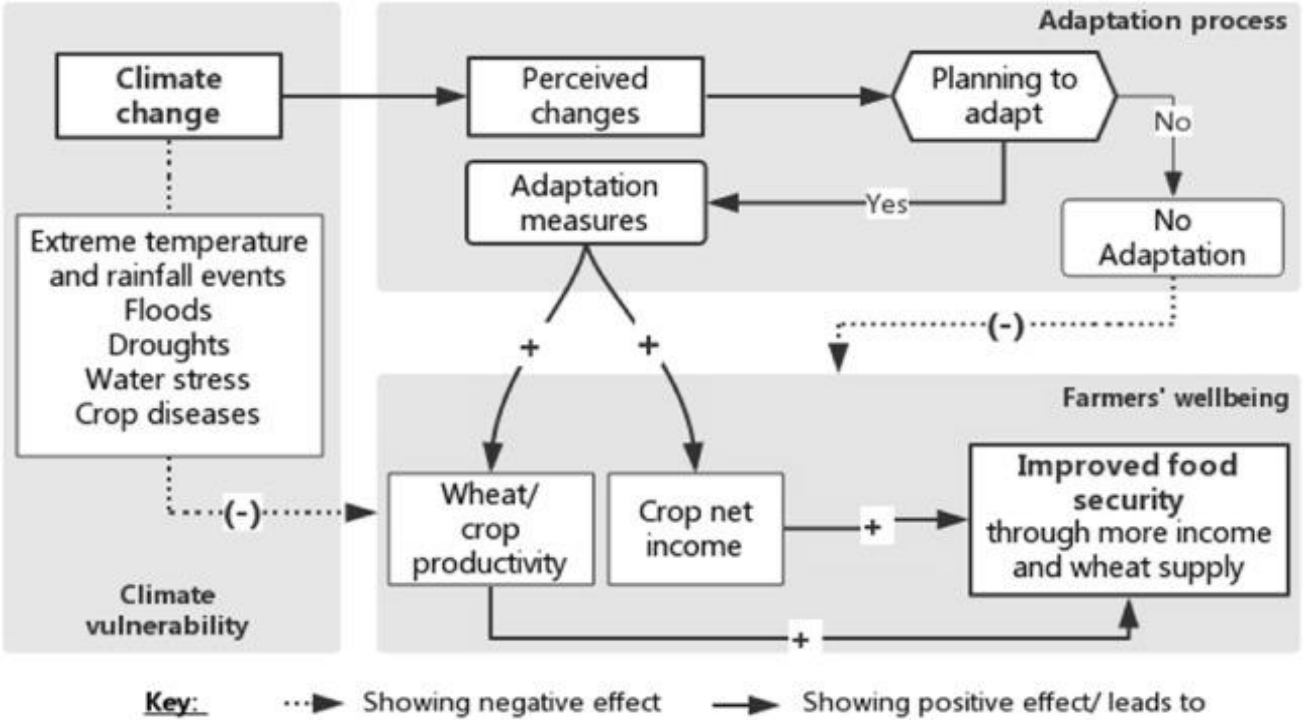
According to time series analysis, the impact of climate change on agriculture may have a minor to a huge effect on crops, land, soil, and production. The extreme climate changes make the soil unable to grow many productive crops, and the quality of plants is also reduced, which can threaten the farmers with a challenging note for food scarcity that might impact their future income. Moreover, the damage to crops can be increased as the changes in climate and environment can give rise to other major factors such as soil infertility, water scarcity, barren land, and many other issues (Masud, Azam, Mohiuddin, Banna et al., 2017).

The climate change issues have a considerable impact on the agriculture and the crop production as the extreme changes in weather patterns may also make framers stressful to deal with these issues. The problem statement for this study can be stated s the famers must be provided with better education and standard information about changes in climate and how to deal with these issues. The significant use of extension services in Malaysia is the need of hour to help framers sin such circumstances. With the help of better knowledge to overcome climate issues farmers can manage the intervals without any impact on their income level (Akhtar, Masud, & Afroz, 2019).

Literacy rate of farmers is being considered to increase at a global level in accordance to changes in climate that may have a great effect on crops productivity as well as income level of farmers. Malaysian government is also working to provide the farmers with enough knowledge to handle the

extreme climate issues as the drought and flood. The current study is based on promoting the extension services for farmers to provide them adequate knowledge to manage their crops fields in unfavorable weather patterns. The researchers are trying to fill up gaps in agriculture department of Malaysia to provide farers with better skills to manage the farm land in a professional way.

It is revealed from past studies that agriculture department of Malaysia did not provide enough attention towards the extension services of farmers and it was considered useless to literate farmers as they were considered proficient in their traditional practices to hold various circumstances. Various past researches have shown the evidences that farmers are not able to manage the natural weather effects as per traditional practices. The current study is based on resolving the conventional gaps in farming techniques and utilizing the extension services in agriculture to provide farmers with basic knowledge to keep their farm level income in progress and manage the climate issues on crop productivity in a professional way. The study highlights the main issues that farmers have to undergo during climate issues as they could not earn better income in drought or flood season as 20% to 30% of farmers have to face extreme poverty in those time intervals for not financial resources or income is attained.



As described the main issues of climate change on agriculture in the above section of interdiction the objectives of the particular study can be highlighted here. The agriculture extension services are provided to farmers to increase their managerial skills to have a firm control on the crop production and to tackle the impacts of weather pattern son their fields (Alam, Siwar, Murad, & Toriman, 2017). Following are some objective for the current study:

- To explore ideas in improving the farm level income of farmers
- To study the different aspects of climate change and managerial skills of farmers in mitigating the issues.
- To implement a drastic change in farmer behavior in order to eradicate their difficulties

The current study is established to overcome the climate issues in farming practices and to provide enough information to framers to manage their resources in a meaningful way. The Malaysian government must have to implement some policies to educate the framers according to advanced techniques and innovative measures keep their farm level income in progress even during extreme climate issues. The scope of study is to illuminate the consequences of agriculture extension rate and providing farmers with the best equipment to bring a considerable change in their abilities to mitigate the climate issues in farm land (Al-Amin, Masud, Sarkar, Leal Filho et al., 2020).

Significance of this research is to develop some concern for the agriculture department as the government of Malaysia can initiate the educative programs for the farmers to enhance their skills and to promote the literacy of farmers in the country. In such a way the farmers can have better livelihood to keep going their expenditures in extreme climate issues. The quality of crop fields will be upgraded and farmers could be able to utilize their efficient skills in a productive way. The farmers specifically from rural areas would be able to improve their lifestyle and poverty issues might be resolved.

Current study structure is followed by introduction as the first chapter. The literature review is discussed in second part of study followed by methodology in next chapter. The forth chapter discusses findings of research conducted while the last part is based on discussion and conclusion.

2. LITERATURE REVIEW

2.1 Theory of Environmental and Climatic Changes and Sustainable Development

About half a century ago climatologists in different reports published the mild changes being observed in the climate of the planet. They also stated the reason behind these changes and entitled them as the result of the human activities. With the passage of time and developments in the industrialization the fear of these changes keeps on increasing. Intergovernmental Panel on Climate Change (IPCC) was established in 1988, because of these theories and growing concern of the World Meteorological Organization. The theory defines the climatic changes as mild to severe changes in the pattern of climate that can be due to natural variability and may be because of human activities. However it comparatively emphasizes more on the effect of human activities that have direct or indirect effect that also has an alternating effect towards the composition of the atmosphere (Brönnimann, 2015). While relating the human activities with the climatic changes' theory states the emission of greenhouse gases that have drastically increased. The emission of greenhouse gases is related to the burning of fossil fuels (Dansgaard, Johnsen, Reeh, Gundestrup et al., 1975). The theory also presents a threat of significant increase in the temperature of the planet after each decade. Climatologists have also expressed their fear that the climate changes will keep on taking place if no sustainable development goals will be set to protect the environment and ecosystems. Negative impacts of urbanization can be clearly observed in social, economic, and environmental aspects. 17 Sustainable Development Goals (SDG's), which aims to direct the global economies towards state sustainability. The sustainability science is no less than a milestone that aims to explain the relation between natural and social characters in world and also states the factors that can improve this interaction and pave the way towards a more sustainable trajectory (Bossel, 1999). To achieve the sustainable development, it is mandatory to emphasize on four different capitals natural capital, manufactured capital, human capital, and social capital. The idea of weak sustainability is based on the human centred view, that natural capital can be replaced by the manufactured capital, therefore as long as the total capital keeps increasing in the process of development despite of degrading the natural capital to an unrecoverable extent, the development is sustainable (Ab Yajid, 2020; Dasgupta, 2007). Contrarily the idea of strong sustainability is based on natural capital view and is of the idea that natural capital is irreplaceable. It believes in the development of the human beings without threatening the natural environment and depleting natural resources (Van den Bergh, 1996). This idea sums up by stating that economic development must not exceed the natural limits posing harm to natural capital.

2.2 Climatic Changes and Farm Level Income

Over the past century, rapid changes in the human activity have led to a drastic change in the look of the planet which is termed as urbanization. This has led to development of industries across the globe that have negative consequences towards the environment and human health. Urbanization is result of activities like deforestation, burning of fossil fuels which have intensely affected the climate of the planet and local, regional, and global level. Thus, global warming is regarded as the core reason behind the climatic changes taking in the world. A comparison between the climate in pre-industrial period and the current industrial and urbanized age, a drastic change in the pattern of the climate is observed. Global warming is regarded as the average increase in the temperature being observed on annual basis which have significant negative influence on the human life, wild life, environment and ecosystems (Alcamo, Flörke, & Märker, 2007). The effects of industrialization are severe towards the environment that an increase of emission of carbon dioxide which was 280 parts per million in the pre-industrial where it has increased to 413 parts per million in 2020. Emission of such heavy amount of carbon dioxide not only contributes to global warming but also has negative consequences towards human life. Global warming has significantly affected the agriculture and the farm level income of the farmers. An average increase of 2-3^{o}C has been observed in the temperature of the world and a noticeable change in the rainfall patterns has also been observed (Telo da Gama, Loures, Lopez-Piñeiro, Quintino et al., 2021). This affects the rural livelihood and the crop production and yield being produced at different geographical locations of world. Therefore, resilience of the agriculture sectors towards the climate changes is especially important, as agriculture sector is of vital importance contributing towards the economy of many countries (Aklilu & MAKALELA, 2020). Moreover, the pattern of rainfalls has also greatly changed. Broadly considering the rate of precipitation across the globe, the rate has decreased two to three folds compared to the pre-industrial times (Gleick, 1989). However sudden unexpected spells of heavy rainfall have become a norm across the globe in the seasons which cause damage to the crops. Moreover emission of carbon dioxide along with other polluting gases also negatively affect the crop production and cause severe compromise on the quality of crops that also effect the income level of farmers (Alam, Siwar, Talib, & Toriman, 2014). Studies have revealed that the climatic changes being observed across the globe have affected the land productivity and income of farmers. A decline in the income of farmers have been observed because of the climatic changes affecting the crop production and crop quality. Depending upon the region in the world and the effect of climate changes, farmers have been observed to suffer in terms of both crop productivity and income. Findings of research have concluded that a change in the precipitation patterns and increase of temperature have affected on average 5-20% of the farmer income across the globe (Hekstra, 1986). Therefore, the climatic changes significantly affect the farmer's income level.

2.3 Extension Services and Farm level Income

Extension service is considered as the prime force and of vital importance in development of rural agriculture areas and farmers of these areas. Extension service has become

a norm across the world especially in the agricultural countries with the aim of up bringing the rural areas and the lifestyle of farmers. In the last century Information and communication technology along with other diverse branches of science have led to stupendous developments and inventions for the welfare of mankind and have also improved the lifestyle of the mankind (Labarthe, 2009). Knowledge of correct use of technology by the concerned people can result in overwhelming outcomes and can also save humankind from disasters. Extension service deals in educating the people of the rural areas by offering them advice to help them deal and tackle with their problems. This is done to increase the efficiency of the farm families, to increase and enhance their production and thus leads towards the improvement of their lifestyle. Extension agents are set to interact with the farmers, investigate their difficulties, discuss their matters, and give them the best possible solution and educate them enough to broaden their insight ensuring they are capable enough to deal with all the hurdles. With the monumental developments of science and technology encompassing all the aspects of human life agriculture has no exceptions. Implementation of the technology in the domain of agriculture can help to improve the yield, productivity and also boost the life style of the farmers (Maffioli, Ubfal, Vazquez-Bare, & Cerdan-Infantes, 2013). This results in the prosperity of the economic development. The idea of extension service further expands to assist and educate the farmers regarding the use of modern technology to enhance and improve their farming. This can help the farmers and economy to develop better with the use of technology and make the achievement of the agricultural goals more efficient. The vast amount of research being conducted to improve the agricultural practice need to be effectively conveyed to the farmers to ensure the practical implication of the findings of this research. Agents of service extension also communicate the findings of new research to improve the farming practices and boost the farming outcomes. Moreover, the extension service agents also aim to guide the farmers regarding the economy and marketing rules and techniques and ensure to keep them aware of the changes taking place in the markets and prices. The practice of extension service therefore has a positive influence on the income level of the farmers. Therefore development of extension service can help build resilience of the farmers towards the climatic changes and other hazards towards the crop production and crop quality (Reynolds, 2011). Agents of extension service educate the farmers regarding the global warming and climatic changes taking place and assisting them towards the environmental shocks can safeguard the crops as well as the income of farmers. It has been predicted that if no considerable attention is given towards the issue of climate changes and global warming it is expected that agriculture sector around the world will have to face the most severe effects. Therefore, timely knowledge regarding these changes and educating farmers to tackle with these changes can help the farmers from great economic losses and crop losses. Application of new scientific techniques like new variants of crop, changing the plantation times, use of new fertilizers can help to prevent great setbacks expected by the climatic changes. Therefore, extension service has a strong influence on the farmer's income level.

The following hypothesis can be generated for this study:

H1: Climatic changes have a considerable effect towards the farm level income.
H2: extension service significantly influences the farm level income

3. MATERIAL AND METHODS

3.1. Study Area and Data Collection

The study area in the current research is Malaysia which is a Southeast Asian country categorized as equatorial and is usually hot and humid across the year (Muhammad, Man, Abd Latif, Muharam et al., 2018; Tan, Fam, Firdaus, Tan et al., 2021). In granary areas of the country, rice production is major as it is cultivated twice yearly between March to July and August to February. Rice is a major crop in Malaysia and accounts for over 70% of the overall agricultural production of the country. Therefore, rice farmers are selected as unit of analysis in this study. Initially, the researcher interviewed four hundred different farmers from agricultural zones of Malaysia selected by use of a multi-sampling technique. Later, farmers that do not grow rice crop were dropped. Finally, a sample of 362 farmers was maintained. The researcher used a structured questionnaire that was composed of pre-tested items for conducting face-to-face interviews for the collection of information about the various characteristics of the farmers in terms of socio-economic characteristics, access to different extension services and climate change adaptation strategies.

3.2. Adaptation decisions

In this study the researcher has used the factor of climate change adoption as a measure of avoiding losses that may occur due to changes in the climatic indicators such as humidity and temperature. The farmer will be termed as an adaptor in case he/she has implemented some rice management measures against climate changes and as a non-adapter if no adaption or management strategy were implemented. For modelling of the random utility framework for t random utility framework adaptation decisions made by rice farmers, the study of Kato, Ringler, Yesuf, and Bryan (2011) was followed. It was assumed that the i^{th} farmer will only choose to use some adaptation strategy for rice crop to manage climate change if the expected benefits are considered as positive Abid, Scheffran, Schneider, and Ashfaq (2015). The followed latent variable, U_i^*, is used for representing the difference of net benefits:

$$U_i^* = \beta X_{ik} + \mu_i \quad (1)$$

In the above equation, X_{ik} represents the Vector X of k explanatory variables in the study, β is the logistic regression coefficient vector, and μ is representing the error term.
However, the above latent variable is unobservable, and it can only be represented as:

$$U_i = \begin{cases} 1 \; if \; U_i^* > 0 \\ 0 \; f \; U_i^* \leq 0 \end{cases} \quad (2)$$

In above equation, U_i is the i[th] farmer that will adapt their rice cultivation to climate change in case net benefits are positive ($U_i^* > 0$) and not adapt in case net benefits are negative ($U_i^* \leq 0$). To measure the overall adaptation impact on rice productivity, it is vital to measure self-selection and a reduced form of ordinary least square (OLS) equation is used as followed.

$$Yij = \lambda Xij + \psi Ui + \epsilon i \quad (3)$$

In above equation,
Y_{ij} represents the vector of outcome variables for the ith farmer, and
ϵ_i represents the error term.

3.3. Propensity score matching

Propensity Score Matching (PSM) is also used in this study to resolve the issue of selection bias. In this technique, adapter and non-adapters groups are paired based on the similarity of the observable characteristics (Dehejia & Wahba, 2002). In accordance with Rosenbaum and Rubin (1983), PSM is defined as a conditional probability variable used for representing the probability of a farmer to adapt to climate change. PSM is represented as:

$$p(Xik) = Pr\,[Ui = 1|\, Xik] \quad (4)$$

In above equation,
p is the propensity scores of X_{ik},
Pr is the probability,
U_i is adaptation to climate change, and
Xik represent pre-adaptation characteristics.

Overall, PSM can be divided into five steps. First step is to use theoretical assumptions to select some pre-test covariates. Secondly, propensity scores (p-value) need to be estimated by use of logistic regression. Nearest neighbour method is used next for and the fourth step is to calculate the causal effects of adaptation on the outcome variables. In the last step, the adequacy of the results is tested by use of sensitivity analysis.

3.4. Causal Effect of Adaptation to Climate Change

ATE (average treatment effect) or ATT (average treatment effect on the treated) is used for calculation of the effect of climate change adaptation on outcome variables. Following the work of Ali and Abdulai (2010), causal effects are represented as followed:

$$\tau_{U_{i=1}} = E(\tau|U_i = 1) = E(Y_1|U_i = 1) - E(Y_0|U_i = 0) \quad (5)$$

Where,

τ is ATE, and
Y_1 are outcome variables for adapter group, and
Y_0 are outcome variables for non-adapter group.
Furthermore, ATT can be computed as followed:

$$T = E\,\{Y_1 - Y_0 \mid U_i = 1) = E\,[E\,\{Y_1 - Y_0 \mid U_i = 1, p(X)\}] = E\,[E\,\{Y_1 \mid U_i = 1, p(X)\} - E\,\{Y_0 \mid U_i = 0, p(X)\} \mid Ui = 0] \quad (6)$$

Where,

T is representing ATT, and
p(X) represents propensity scores.
ATT is obtained by calculation of the difference between the selection bias effect and the value of ATE.

3.5. Sensitivity analysis

The purpose of using PSM can be explained as stabilization of covariates distribution among adapter and non-adapter groups (Lee, 2013). a hidden bias issue may arise in case of an unobserved factor simultaneously impacting decision factor and its outcome variables causing the matching estimates to be inaccurate (Rosenbaum, 2002). Therefore, after matching the estimates, model adequacy tests are carried out to make sure that such a bias does not exist between the two groups (Ali & Abdulai, 2010). Several indicators are used for this sensitivity analysis such as Hosmer and Lemeshow test, F-statistics, R^2-statistics, etc. Furthermore, The bound test by Rosenbaum (2002) is also used to calculate the average adaptation effects (ATT) by calculation of the Wilcoxon signed rank.

4. RESULTS

4.1. Descriptive summary

Table 1 is depicting the descriptive summary for the variables being used in the study. The table presents the specification of the factors with reference to the adapters and non-adapters i.e., the farmers and farms adapting to the climate control practices and those that are not. this information was collected through a one-to-one interview with various rice farm owners and rice farmers in Malaysia, as discussed in the previous section. The differentiation between the non-adapters and adapters indicates of the importance of these factors and how essential these are to understand the local adaptation to climate change. The table indicates that the farm income or the net crop income was found to be slightly higher in case of the adapters than the non-adapters. Similarly, the adapters were found to have more experience, education, greater access to extension services, education, and more land under cultivation in comparison with the non-adapters. These findings are consistent with the previous findings of Abid et al. (2015); Antwi-Agyei, Stringer, and Dougill (2014); Bastakoti, Gupta, Babel, and van Dijk (2014) which indicated that educated and experienced farmers sought extension services more keenly and adapted with the climate control requirements more compared to the less experienced and educated farmers. It is possible that the experienced and educated farmers are more informed and observant compared to the lesser experienced and educated ones about the ongoing changes in the environment. Also, better education correlates with increased access to and knowledge of the extension services. Likewise, the adapters were also the ones who had greater access to and sought the extension services. Thus, the adapters had large-scale farms and increased access to the institutional services like credit, weather forecasts, market information and of course extension. These findings substantiate that extension services and adaptation to climate change led practices lead to increased farm income. Moreover, access to institutional services has

a positive effect on the farmer adaptation decisions. These findings are consistent with Bastakoti et al. (2014) and Bryan, Ringler, Okoba, Roncoli et al. (2013). However, the non-adapters can be seen to support a larger household size and increased dependence on agricultural income. Thus, showing that increased dependence on the agricultural income is a factor mitigating the adaptation to the climate change practices.

Table 1: Descriptive statistics

	Adapters	Non-adapters	Difference
Total farm income (thousand MYR)	1080	1061	19
Farming experience (years)	30.55	23	7.55
Education (years of schooling)	10.62	6.95	3.7
Household (HH) size (numbers)	12	9	3
Household head (1 if farmer is HH's head, zero otherwise)	0.86	0.81	0.05
Agricultural source of income (1 if agriculture is the main income source, zero otherwise)	0.75	0.63	0.12
Crop area (hectares)	8.35	6.18	2.17
Tenancy (1 if farmers is owner-cultivator, zero otherwise)	0.83	0.71	0.12
Tube well (1 if farmer owned a tube well, zero otherwise)	0.78	0.63	0.15
Soil fertility (1 if soil is fertile, zero otherwise)	0.55	0.67	0.12
Credit services (1 if farmer had access, zero otherwise)	0.12	0.09	0.03
Extension services (1 if farmer had access, zero otherwise)	0.27	0.25	0.02
Market information (1 if farmer had access, zero otherwise)	0.70	0.65	0.05
Weather forecasting information (1 if farmer had access, zero otherwise)	0.92	0.79	0.13

4.2. Propensity score

As explained previously, the matching process initiates with the estimation of the propensity scores for the dependent variable. For this purpose, a logistics regression model has been used where the probability of increased farm level income was regressed to numerous covariates. The results of the estimation of the propensity scores are depicted in table 2. The results are showing that most of the households and farm-specific variables influence the probability of increased farm-level income. Particularly, farming experience, adaptation to climate change practices, extension services, education, market information, agricultural source of income and information on weather forecasting tend to expedite the increased farm level income. These findings are in line with the previous studies of adaptation to climate change requirements and farm and crop level income (Ahmad, Mustafa, & Iqbal, 2016; Bryan et al., 2013; Deressa, Hassan, Ringler, Alemu et al., 2009). The negative coefficient of the tenancy status in the present study indicates that the owners of farms were less likely to adapt to the changes required by climate change compared to the tenants. The difference in the levels of education, household access, resources, and experience of the tenants and owners is indicative of the differences in the levels of adaptation. Moreover, the study indicates that adapters and non-adapters are both oriented towards extension services and these services include better outcomes for the performance of the crop and result in increased productivity.

Table 2: propensity scores

	Estimate	Standard error	z-value
Farming experience (years)	0.04	0.01	3.46***
Education (years)	0.13	0.03	4.16***
Household size (numbers)	0.02	0.02	0.94
Household head (dummy)	0.15	0.29	0.54 1.94**
Agricultural income source (dummy)	0.56	0.29	
Area under wheat crop (hectares)	0.00 0.84	0.01	0.09 3.00***
Tenancy status (dummy)	0.29	0.28	1.18
Tube well (dummy)		0.24	
Soil fertility (dummy)	0.33	0.25	1.32
Farm credit (dummy)	0.12	0.40	0.29
Agricultural extension (dummy)	0.11	0.29	0.36
Market information (dummy)	0.65	0.27	2.39**
Weather information (dummy)	0.86	0.36	2.38**
(Intercept)	2.88	0.70	4.11***
Hosmer p-value		0.33	
Pseudo R-squared		0.23	

4.3. Effects of adaptation and extension services on farm level income

After the calculation of the propensity scores, the nearest matching neighbour or the NMN method was used for the matching of the control group (non-adapters) to the treatment group (adapters and enforcers of agricultural extension) based on the propensity scores. During the process of matching, the NNM removes the unmatched adapters and levelled enforcers of agricultural extension and hence it leads to the reduction in the sample size by 30%. The next step is to calculate the average adaptation effects on the crop productivity, the per hectare crop income before matching, and the access to agricultural extension (table 3). The result of the post-matching indicates that the adaptation to climate change reflects positively on the crop productivity and farm income. Moreover, the agricultural extension is also resulting in significant effects on the farm income. The value of the ATT indicates that the adapters generate MYR 5243 per

hectare more returns for the farms and farmers that are implementing the climate change practices. However, the ATE values are indicative of MYR 7271 per hectare and indicate of higher crop income compared to the ATT estimates. Also, the AGE results in MYR 2451 benefit for the application of agricultural extension. Thus, the difference between these values is due to selection bias that is occurring because of the other observable variables and was reduced during the propensity matching. If the test had not been performed before the estimation of the extension and adaptation effects, the results might be misleading and biased. Higher productivity and farm level income for adapters also implies that a positive impact of the adaptation and extension on the wellbeing of the farmers. Additionally, the higher yield of extension and adaptation leads to increased supply of crop to the market as well resulting in increased farm level income.

Table 4 is demonstrative of the indicators that have been tested for verification of matching model. The results are showing that a decline in the goodness of fit after matching, which implies that after matching there is no systematic difference in the distribution of the covariates between the adapters, applicators of agricultural extension and non-adapters. Thus, any differences in the outcomes of all three groups would only result due to adaptation and application of agricultural extension. Moreover, the significance level of the likelihood ratio indicates a shift from a significant model to the insignificant model after the matching process. This indicates that the covariates are no longer associated with extension and adaptation after matching. The F-value of the model is indicative of the overall insignificance of the model and comparable results have been generated for Hosmer and Lemeshow test which shows a decline in the model estimation propensity after matching. The mean difference for the distance has also decreased and the overall matching indicates that there is 61% reduction in selection bias. All the results are indicating that there is substantial reduction in the bias obtained through matching and the model is not dependent on the observed factors before matching. The results for the sensitivity analysis have been indicated in the table 3 as well.

Table 3: Sensitivity analysis

	Net crop income (MYR/ha)
Number treated (Adapters)	139
Number control (non-adapters)	139
ATE	7271 (2.85) *
ATT	5243 (1.39) *
AGE	2451 (1.37) **
Wilcoxon signed rank (WSR) P-value	0.04
Confidence interval for treatment effect (C.I.)	1.10e1.15

It can be concluded that adaptation and extension have a positive and significant impact on the crop yield and farm income. These results imply that the farmers who adopted more climate adaptation and agricultural extension achieved higher net income at the farm level compared to the non-adapters and lack of agricultural extension.

Table 4: covariate balance

Indicators of covariates balancing	Before matching and access to extension services	After matching and gaining access to extension services
Pseudo R2	0.21	0.03
p-value of Likelihood ratio	0.00	0.73
F-stat value	78.42 (0.00)	12.41 (0.27)
Hosmer and Lemeshow test values	12.16 (0.36)	9.1(0.19)
Mean standardized difference	0.16	0.06
Total% bias reduction	e	60

5. DISCUSSION

For this research study, a model was designed to determine the impact of climate changes as well as extension services on the farm level income in Malaysia. A time-series method was conducted for this study. The empirical study has been conducted for better analysis of the study. Three important results have been obtained from this research which are discussed as follows:

Firstly, it has been observed that the climate change is a natural phenomenon and many of the farmers adapt themselves to such change. However, in this case both adapters as well as non-adapters are observed. The households of non-adapters are usually dependent on their "agricultural incomes" (Chu, Venevsky, Wu, & Wang, 2019). This depicts the reason for non-adapting to the climate change by different farmers. However, the land under the adapters, is found to produce more crops as they adapt the climate change effectively. The extension services are found to play a key role in this regard. The adapters are mostly educated farmers who have a good knowledge about the crop productivity as compared to non-adapters. The education and knowledge, both are considered to be important factors in this regard (Goglio, Williams, Balta-Ozkan, Harris et al., 2020). The "institutional services" are also found to have a positive impact on the decisions made by the farmers for adapting to the changing environment.

Secondly, the findings obtained from this research study show that different variables specific to the households as well as farms, have important impact on the adapting of the climate changes by the farmers. Other factors such as education, experience, information from the market and income, are also found to play an important role in this decision-making processes (Jha, Gupta, Chattopadhyay, & Sreeraman, 2018). This research study showed that the tenants were more educated as compared to the owners and this was the reason that the tenants were more adapted to the climate changes. However, the responsibilities of the tenants were also more as they must set off the rents as well as to manage a larger household. This also improves the overall income at the farm level. These are some of the reasons for such adapting intentions of the tenants.

Thirdly, the empirical statistics show that the adaptation to the climate changes increase the overall crop productivity as well as the income at the farm level. This encourages the farmers to adapt to such changes more effectively to obtain better outcomes as the proper use of natural resources can lead to better outcomes. A number of other resources including the fertilizers, land, seeds etc. are also found to play an efficient role in this process (Lan, Xu, Sheng, Yu et al., 2018). The overall "agricultural income" is found to be increased when the adaptation to the climate changes become common among the farmers especially at the farm level. However, the extension services are also found to play a significant role in better crop productivity leading to an increase in the income at farm level. Different studies have also found to support this argument (Oduor, Waweru, Lenchner, & Neustaedter, 2018). The more educated the farmers are, the more they are capable to obtain a better income by improving their adaptability to the natural environment. Thus, both adaptation to the climate changes as well as the extension services, are found to have a significant impact on the farm level income.

6. CONCLUSION

The change in the climate is considered to have a drastic impact on the crop production if no timely adaptation to such changes is carried out. Such timely adaptation process helps in lowering the experienced losses by the farmers under such conditions. For this study, the impact of climate changes and extension services on the farm level income in Malaysia is considered. This research study helped in determining the impact of different external as well as internal factors on the adaptability as well non-adaptability of the farmers at the farm level, to the climate changes (Roesch-McNally, Arbuckle, & Tyndall, 2018). The extension services were also found to have a significant impact on improving the crop productivity which in return increases the farm level income. The trainings as well as education helps in improving the technical efficiencies of the rural farmers as well which help them in improving the overall income at the farm level. However, the household attributes were also considered in case of the non-adapters as they must manage such households. However, the adapters were more likely to increase crop productivity for an increase in farm level income.

The empirical statistics of this research study also showed that the current adaptation methods being used by the farmers are short-term as well as less costly. It has been concluded that a combination of adaptation methods, was found to be more effective if a single method is used for this purpose. The adaptability of such changes not only help the farmers to improve their agricultural incomes, but it also improves the "food security" of the society.

7. RESEARCH LIMITATIONS AND FUTURE RESEARCH STUDY INDICATIONS

Even though the adaptation to climate changes is still considered to be a hot topic in today's world but still almost no such research study has been conducted in the past to determine its impact on the farm level income. This research study will help in improving the literature for this topic and encouraging more researchers to opt for determining its impact on the income at farm level. This will be significant as every country around the globe is promoting sustainable development. It will not help in determining diverse ways to retain the natural resources, but it will also help in increasing the economic growth.

For this study, only Malaysia was considered, and the time-series data was obtained that only showed the impact of the discussed variable on the farm level income for a particular country. The cross-sectional studies should be promoted to improve the analysis for obtaining effective measures to increase the agricultural income of the farmers especially in the rural areas of different countries.

This study helped in providing empirical statistics as well as policy implications to improve the farm level income. This will encourage the governments to develop such important policies for improving the crop productivity ensuring the security of food for the residents.

8. IMPLICATIONS

The significance of the adaptation to the climate changes by the farmers, is being considered by different governments of the countries. Many policies have also been developed to improve the farm level income around the world by encouraging the adaptation to the climate changes by the farmers. For this purpose, both public as well as private sectors along with different NGO's, are also found to play a vital role. The implementation of extension services is also encouraged to improve the overall income of the agricultural sector in Malaysia. This helps in providing different combinations of the adaptation methods to improve the overall income at the farm level. The education of the farmers is also considered important for this purpose. The Malaysian government has introduced different educational programs as well as training programs for such farmers especially of the rural areas to encourage them to promote the adaptability to the climate changes. Proper awareness is also provided to the farmers thus promoting the adaptation methods of climate changes. This will help in providing the security of the food for the overall society thus increasing the crop productivity which will result in an increase in the farm level income.

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