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A Time Series Analysis of the Effects of Agriculture Credit and Extension Services on Crop Productivity in Malaysia

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The primary purpose of the present study is to evaluate the impact of agricultural credit, technical efficiency, and extension services on the crop productivity. The context of the study was based in Malaysia and the paddy rice were used as the premier crop. The data was collected from the Malaysian farmers. The method of the study was based on the two-stage estimation process. The technique was used to first evaluate the determinants of the credit access and extension services. The first stage of the study used the Probit model and the second included the stochastic frontier approach. The findings of the study show that farmers are producing below the frontier with average technical effectiveness of 47 percent. The policy factors like credit access, education, extension, and farm size showed that the crop productivity is largely influenced by these factors. The access to agricultural credit and extension services was found to positively influence the crop productivity. Technical efficiency was also found to predict the crop productivity of the region. The results of the study hold implications for the agricultural sector. These findings can be used for the development of policies and procedures for the increase in productivity of the Malaysian agricultural sector.

Keywords: technical efficiency, agricultural credit, stochastic frontier, extension services, farm households, productivity.

1. INTRODUCTION

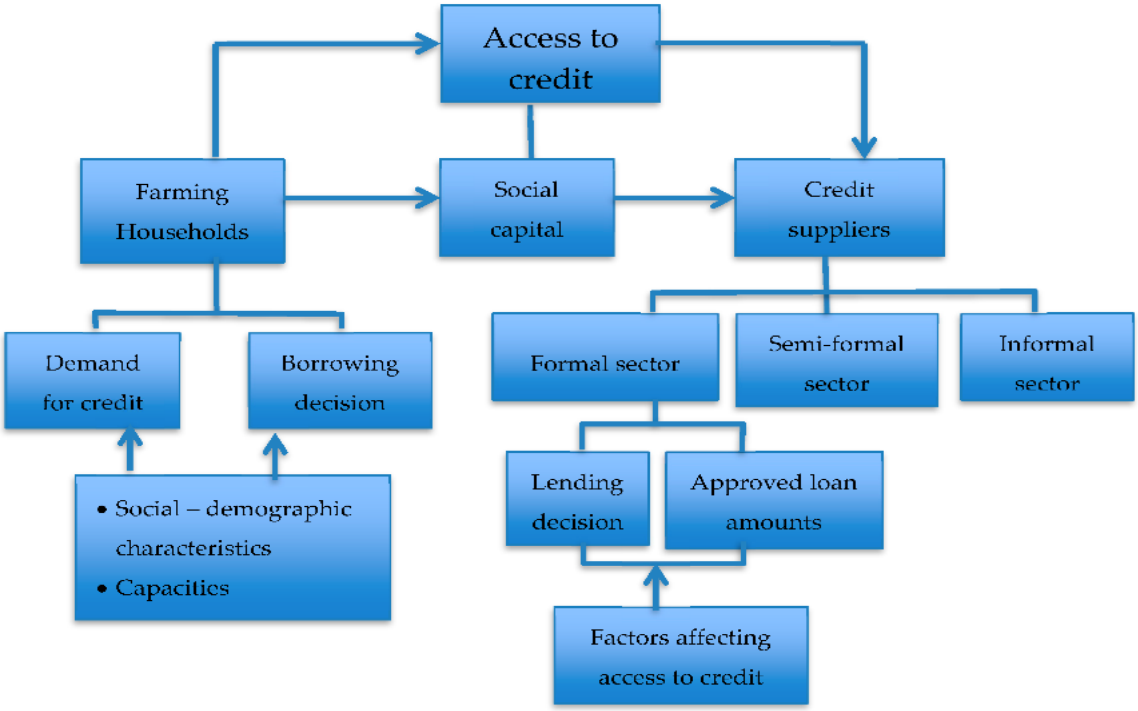
Using new farming techniques in the modern world could be difficult for the farmers initially as these practices require a lot of investment and time to be added to a daily routine. However, the farmers in such circumstances can be provided with adult learning by providing them knowledge through different seminars, educational walks, and surveys so that such knowledge can support them to develop their farming strategies as per the demand of consumers and to enhance the economic stability in the country with increased efforts carried out in the promotion of green plants by boosting the productivity. The impact of agriculture credit had a great impression on the economic stability of country as the business practices were increased due to the sue of sustainable development in agriculture (Fuzi, Habidin, Janudin, & Ong, 2019).

The agriculture education provided to the farmers has been provided to greatly impact their farming abilities as per the use of time series analysis in this practice. As a result, it can be seen that the farmers have boosted their abilities to attain a better quality of crops and to understand the demands of new world consumers. In addition, the farmers have enhanced their abilities to increase their financial resources so that the customers can attain better quality crops with increased efforts of farmers in the sustainable practices used in the improvement of agriculture (Hassan, Othman, & Abd Karim, 2011).

In different researches, it has been revealed that the time series analysis has been helpful to analyze the impact of sustainable development in the agriculture practices of Malaysia with the context of agriculture credit. The researchers have shown that the farmers provided with the agriculture extension services had attained great opportunity to increase the quality of their agriculture products to a level of 5%, as noted in Malaysia. Furthermore, the impact of such educational services conducted in Malaysia was proved to have a positive impact on farmers as they utilized the new techniques in their daily tasks to satisfy consumers' demands.

Agriculture credit is seen to have a positive impact on productivity of crops in Malaysia. The problem statement is based on the impact of agriculture extension services in Malaysia and the role of agriculture credit on the efficient quality of crops that are grown in agriculture department. The researchers in current study are required to gather information through time series analysis in order to gather data through different intervals and find out the actual significant impacts. The agriculture credit has increased the economic development as well as the standard of living of various farmers at a global level. Even in Malaysia a lot of campaigns have been established to encourage crop productivity with extension services.

The current study is based on solving the gaps that have been occurred to make the agriculture extension services better and the agriculture credit provided to farmers. This is the utmost need of modern era to provide considerable amount of credit to farmers for upgrading their business but a lot of studies are lacking in such aspects to mitigate the issues. It is required to highlight significant aspects that show the importance of agriculture credits and the literacy rate of farmers collectively working to promote crop productivity. The current study is based on illuminating essential roles of extension services and the agriculture credits in Malaysia (Shahbaz, Loganathan, Sbia, & Afza, 2015).



According to the reference of previous studies it was believed that the farmers did not utilize the actual amount of credits in the crop fields. The paid amount for the upgradation of agriculture resources was not fully equipped for the intended purpose. Various studies also recommend that the extension services provided to farmers were not that capable pf providing tem enough information about the agriculture issues and the framers could not hold up to difficult situations as revealed through time series analyses utilized in the previous studies. The current research paper fills up all such gaps and illuminates the awareness for farmers as a main source to increase their income level by using the provided amount of agriculture credit in right way. The study states to elevate the level of knowledge provided to farmers in accordance to sustainable development so that they can utilize their skills credit amount to enhance crop productivity (Utami, Indrianto, & Pratama, 2019).

According to the information provided in the background and justification rationale the current study objectives can be proposed to have a significant impact on crop productivity. It is evident from past researches that farmers were not that appreciated for their concerns towards cultivation of crops and providing better quality of grains in market. In relevancy to these issues the current study highlights following objectives:

- To track the fast development of crop productivity with reference to agriculture credit.
- To identify the flaws with time series analysis in extension services and farming practices in Malaysia.
- To highlight the need of farmer literacy with elevated level to build new skills in farming practices.

The probability of agriculture extension services was known to have a considerable positive impact on farming processes as the increase in rice yields and quality of other different crops was noted to be 61% compared to the previous estimates. The current study is based to fulfill the gaps highlighted in problem statement and to increase the crop productivity by having a strict evaluation system on farmers to utilize the agriculture credit amount for intended purposes. The main purpose of agriculture credit and extension services must be conveyed to farmers through different campaigns and programs for better performance in agriculture department (Austin & Baharuddin, 2012).

The significance of agriculture extension services is based on various essential aspects including implementation of farm managerial skills, technical knowledge enhancement and providing enough knowledge to farmers to utilize financial as well as other required resources in a meaningful way. The agriculture credit has its own importance to help the farmers in financial sector to increase the development of their land and to cultivate better quality crops to satisfy needs of consumers. Farmers must be aware of operating the finances and other raw materials in managed quantities.

The structure of study is based on standard research structure as in the first part introduction is discussed and second chapter provides information about literature review. The third chapter discusses methodology, fourth is based on results and findings while the last chapters shows the discussion and conclusion.

2. LITERATURE REVIEW

2.1. Agricultural credit and crop productivity

The agricultural credit is considered to play an essential in the modern development of agriculture. It leads to different opportunities in the agricultural field especially for rural areas of a country. According to De Janvry, Sadoulet, and Davis (1995), the models for agricultural household introduce the significance of self-financing along with the agricultural credit (Agbodji & Johnson, 2021). Such

models also help in determining the intervals between the inputs and the outputs. However, Malik, Mushtaq, and Gill (1991), discussed the "two-stage structure model". According to this model, the first stage consists of understanding the probability of use of the credit while in the second stage the already obtained information is analysed (Akhtar, Li, Nazir, Razzaq et al., 2019). Thus, it has been observed that the agricultural credit helps in maintaining the operations of the agriculture . Iqbal, Ahmad, Abbas, and Mustafa (2003), encouraged the capital investments for crop productivity especially for the small-scale agricultural sectors. This improved the agricultural operations for effective outcomes leading to the increased production of the crops (Chandio, Jiang, Gessesse, & Dunya, 2019).

Boucher, Guirkinger, and Trivelli (2006), states that the crop productivity in Peru constitutes of almost 40% of the reserved agricultural credit. Many past studies have been conducted that showed the significant impact of agricultural credit on crop productivity (Gershon, Matthew, Osuagwu, Osabohien et al., 2020). This also help in improving the socio-economic situations of the farmers especially in the case of developing countries around the globe (Rahman, Othman, Yajid, Rahman et al., 2018). The agricultural credits can be of short-term or the long-term. The short-term credit is used for purchasing the fertilizers as well as pesticides, hiring of the individuals and other mechanical services (Khan, Kamal, Ramazan, Khan et al., 2018). Whereas, for long-term credit, the investments are made for improvement of the land, purchasing of the machinery that could be used for long-term such as tractors, trawlers, boats and many other such machineries.

It has been observed that different issues are faced by the farmers for agricultural credit in Malaysia. According to "*Farmers' Organisation Authority (FOA)",* the middleman in this process, are found to be responsible for the exploitation of farmers. "*Bank Bumiputera Malaysia (BBM)"* supports the agricultural development in Malaysia especially by providing them with different funds (Saqib, Kuwornu, Panezia, & Ali, 2018). The "*Rural and Industrial Development Authority (RIDA)"* was developed in 1950. This authority helped in providing useful credits for the farmers to run their operations however, this organization didn't find better ways to resolve issues related to agricultural credit and other problems related to marketing. However, in 1965, the *"Federal Agricultural Marketing Authority (FAMA)"* was introduced. It encouraged the Malaysian government to put capital inputs for the agricultural development of the country (Bello, Baiyegunhi, & Danso-Abbeam, 2021). The "*First Malaya Plan (1956-60)"* as well as the "*Second Malaya Plan (1961-65)",* both showed the significance of the cooperate movements for the development of the agriculture in the rural areas of the country. Such reforms in the agriculture leads to the formation of the "Agricultural Bank of Malaysia (BPM)" in 1969 (Mastoi, Mastoi, Khetran, Alizai et al., 2021). This promoted the number of loans or credits provided to the rural farmers for effective production of crop. The agricultural development leads to better economic development. The increase in crop production helps in providing better economic growth. As per above discussion, the following hypothesis is developed for this research study:

H1: The agricultural credit has significant impact on the crop productivity.

2.2. Extension services and crop productivity

Different programs for agricultural extension have been introduced which help in spreading the insecurities of food as well as poverty. According to FAO, an extension is considered to be a tool that is used for the development of agriculture and this improves the economic development as well (D. Ahmad & Afzal, 2020). This helps in improving the production as well as standards of living. The technology plays an important role in providing the extension services for better crop production. The extension services play an important role in the "Agricultural Development Program (ADP)". Such programs help in improving the crop productivity (Berhane, Ragasa, Abate, & Assefa, 2018). The main of the ADP is to increase the crop production by improving the crop inputs as well as improving the infrastructure for this purpose. The agriculture extension services adopt the new technologies for improving the crop production (Danso-Abbeam, Ehiakpor, & Aidoo, 2018).

According to "Theory of Planned Behavior (TPB)" introduced by Ajzen (1991), the behavior of the rural farmers play a significant role in the agricultural management. According to Elahi, Khalid, Weijun, and Zhang (2020), the education of the farmers has an impact on their attitude towards various operations. The farmers with low intellectual knowledge were less able to adopt the professional behavior as compared to other farmers with more knowledge. The environmental knowledge of the farmers is also considered in this context. As the extension services, the farmers should have a good knowledge for the technologies being used for improving the agriculture system of the country (Khanal, Wilson, Lee, & Hoang, 2018; Maginga, Nordey, & Ally, 2018). According to Samiee (2019), the agents of extension services, were considered to be positive. Thus, the training sessions should also be held for improving the knowledge of the farmers in order to launch the new technologies for carrying out the agricultural development process easily. The practices related to agri-cultural environment are also introduced in such sessions. According to Knowler and Bradshaw (2007), the extension services have an important impact in presenting the required information to the farmers and they also help in providing better inputs for the technologies of the firm.

In Malaysia one of the serious challenges faced by the agricultural extension services is the climate change. This is found to have an impact on the sustainable development. The extension services are offered by different private as well as public sectors in Malaysia. The main focus of these extension services is to promote the technological services in the field by focusing the traditional style. Thus, these services also provided options to minimize risks related to the agricultural environment digitally (Shah & Wu, 2019).

It has been observed that the increasing adoption if such technologies help in improving the marketing as well as risks reduction for the agricultural environment in Malaysia. Even though Malaysia is found to have a lot of natural resources, it still faces different disasters such as floods, land sliding and even draughts. About 9% of the land is prone to be effected by the floods in Malaysia. However, the extension services play an integral role in this case. It helps in improving the agricultural sector in Malaysia (Shakoor, Northrup, Murray, & Mockler, 2019). However, due to less knowledge and information, still a lot of work is needed to be done in the agricultural sectors by focusing on the advanced technologies being used in today's world for improvement of the extension services in the agricultural sectors of Malaysia. Such discussion leads to the formulation of following hypothesis for this research study:

H2: Extension service has significant impact on the crop productivity

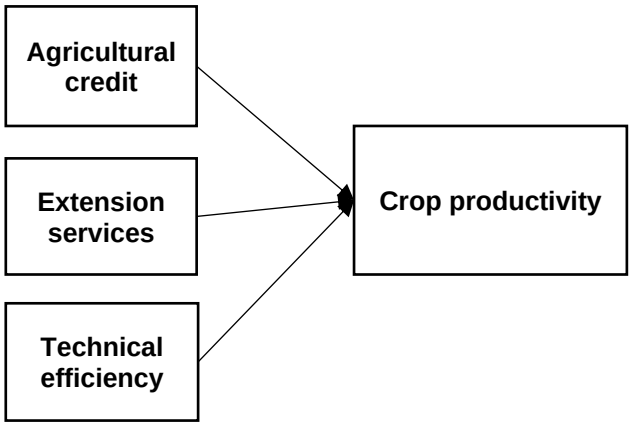
2.3. Technical efficiency and crop productivity

According to Masuku, Raufu, and Malinga (2014), the agricultural credit was found to have a significant impact on the technical efficiency thus leading to better and effective crop production. Abate, Dessie, and Mekie (2019), stated that the private as well as public sectors have been considered for the credit for the betterment of the agricultural sectors. Such credits help in improving the technologies used for environmental development (Corches, McBride, Robles, Rehman et al., 2020). Such technical efficiencies are also found to be effective for the crop productivity as observed in different countries around the globe. Different scholars were interested in determining the impact of agricultural credit on the technical efficiency (Abdulai, Nkegbe, & Donkoh, 2013). Such conducted studies showed the positive impact of the credit on the technical efficiency. According to Yu, Nin-Pratt, Funes, and Gemessa (2011), even though Ethiopia, plays an important role in improving the economic growth as well as sustainable development but still due to lower technical efficiencies as well as poor socioeconomic factors, the crop productivity is not found to be progressed there (Chandio et al., 2019). The inefficiencies lead to inefficient resources that could be used for agricultural development. According to Asfaw and Shiferaw (2010), even if the new technologies are implemented for the agricultural development, without the technical efficiencies, proper and effective outcomes will not be observed. The inputs provided should applicable effectively for better results (Dessale, 2019). However, different policies are being developed that focuses more on improving the efficiencies of the farmers rather than that of promoting more new and expensive technologies. The knowledge of the farmers is thus considered to be important for this purpose. The application of technical efficiency is to increase the output by comparative usage of the inputs. This helps the firms in utilizing the wastes from the inputs as well to have effective outcomes. This improves the overall performance of the firm (Gong, Battese, & Villano, 2019).

However, the agricultural credit has a direct impact on the technical efficiency. This shows the binary impact of technical efficiency on the crop productivity. The "probit model" is used for measuring the technical efficiency. This model determines the binary impact of technical efficiency for better and effective crop productivity (Jara-Rojas, Bravo-Ureta, Solis, & Arriagada, 2018). However, in Malaysia, the technical efficiency is considered very important especially for the agricultural sectors. Two methods are used in order to measure the level of technical efficiency which include: parametric as well as non-parametric. Such methods are conducted in determining the impact of technical efficiency on crop productivity small agricultural sectors mostly located in the rural areas of Malaysia (Khanal et al., 2018). Different factors are also considered to be effective for this purpose which include the investment of the capital, knowledge of the farmers, expenses, research and development and as well as the technologies being used in the agricultural sectors. The size of the firm is also considered to have an important impact on the technical efficiency observed (Mwalupaso, Wang, Rahman, Alavo et al., 2019). With the passing time, the use of technologies is being increased in the agricultural sectors of Malaysia especially for improving the sustainable growth by preventing the wastage of natural resources without hindering the economic growth of the country (Ngango & Kim, 2019). The main focus of technical efficiency is to improve the crop productivity. This explanation leads to the formulation of following hypothesis:

H3: Technical efficiency has significant impact on the crop productivity

Model



3. METHOD

3.1. Econometric framework

Agriculture is an essential sector for Malaysia, for many years, the sector has been providing support to the Malaysian economy and drives exports as well. The national Agro food policy of Malaysia is targeted to improve the agricultural production by 4% each year to attain a level of self-sufficiency. The government has been developing credit policies for ensuring the wellbeing and extending support to the local farmers. The relationship between credit policies, extension services, technical

efficiency with crop productivity is relatively unclear. Primarily the relationship between technical efficiency and agricultural credit is unclear. Moreover, the presence of unobserved endogenous associations and the possibility of biased selection has been pointed out as an issue in previous studies of this nature (Imbens & Wooldridge, 2009). For neutralizing the effects of these hindrances, a two stage impact assessment method has been recommended by Oduol, Binam, Olarinde, Diagne et al. (2011) and Abdallah (2016) and is being adopted in the present study. In the first stage of the analysis as recommended by Asante, Wiredu, Martey, Sarpong et al. (2014), the probability of accessing agricultural credit, access to extension services and technical efficiency is estimated and the scores for these factors are generated. In the next stage, the scores of credit access, extension services, technical efficiency along with other variables are regressed on the resultant scores of crop productivity to determine the direct effect of the explanatory variables on the explained variable. This approach adjusts for endogeneity in the explanatory factors before they are incorporated in the crop productivity estimation. Due to the binary nature of the dependent variable, the Probit model has been used for performing the econometric evaluation.

To determine the factors influencing the crop productivity, it has been stated that the variable is dependent on a latent variable which is unobservable and is denoted as

$$CP_i = \beta' X_i + \varepsilon_i$$

β is an estimable parameter vector of X_i and which is a vector of the independent factors that influence the crop productivity of the Malaysian farmers. From the first equation X_i is an index function that allows the estimation of the probability of the crop productivity through the following expression:

$$CP_i = P\left(CP\dot{i} = 1 | X_i\right) = P(CP*\dot{i} \leq CP_i) = \mathrm{P}(Z_1 \leq \beta' X_i) = \mathrm{F}(\beta' X_i)$$

In the above expression Z_i is representative of the standard normal variable assumed to be N(0, σ2); whereas F is representative of the cumulative normal distribution function. The second expression will be estimated through the MLE. The primary assumptions for the interactions between the factors influencing the crop productivity, the second stage of the estimation process involves the estimation of the stochastic frontier model. The STF is based on the stochastic frontier production function which includes the probability of the crop productivity. Therefore, the Cobb-Douglas production function will be used to estimate the association between the input and output factors

$$\mathrm{Ln}\ Y_i = ln\ \beta_0 + \sum_{j=1}^{5} \beta_j ln\ X_{ji} + v_i - u_i$$

In the above expression the subscript "I" refers to the farmer in the sample and "j" refers to the index of inputs. The term β_j is a vector of technology, institutional and credit factors and v_i is the random error term that is assumed to be independent. The term u_i refers to the technical inefficiency that is independently distributed among the factors. And lastly, the term βi is representative of the elasticity of production with respect to the input used and is one of the most essential parts of the Cobb-Douglas production function.

3.2. Data and variable description

The cultivation of Paddy in Malaysia is one of the primary crops under the agricultural sector (Firdaus, Leong Tan, Rahmat, & Senevi Gunaratne, 2020). First, rice is a basic food product for the Malaysian population and averagely Malaysian adults consume 2.5 plates of rice per day. Secondly, for the paddy farming community the crop is the primary income source and livelihood. Therefore, the present study considers data from the perspective of Malaysian farmers and concentrates primarily on the factors focusing on paddy rice production.

The variable selection was based on the evidence generated through previous studies. The previous studies on agriculture have indicated that household output can be used to ascertain the value of the farmer (González & Lopez, 2007). Thus, the output and productivity of the crop is represented by the crop value and the results indicates that on average the total average volume of the crop output is GH¢ 234.128. This is the output of crop that is produced utilizing averagely less than a hectare of land, GH¢ 12.223 of labor, GH¢ 21.566 of seeds, and GH¢57.819 of agricultural chemicals for production. Thus, as specified the application of stochastic frontier method in the study makes it probable to identify the inefficient factors. Several technical and socioeconomic variables have been incorporated in the model for observing the variable associations. The education and experience of the farmers was incorporated to capture the human capital in the rice production of the Malaysian farmers. The results in table 1 show that mean age of the farmers was 59.2 and schooling was 6.7. Indicating that the rice farming industry is dominated by middle aged farmers having minimal education. For accounting the characteristics of the farm household, the factors of gender and credit were also included. Gender distribution indicates that 67% of the farmers were male. Moreover, the factors for extension i.e., attendance in community meetings, received advice from DA, visited by DA, visited government office, and usage of radio for access to production information indicated that on average 23 percent of the farmers received advice from DA, 45% attend community meeting, 78% visited the DA, 21% visited the governmental office, and 58% had access to production information. On average the access to extension services was menial.

Additionally, the irrigation access was evaluated through a dummy variable having value 1 if the farmer had access to agricultural credit and technical efficiency and 0 for others. The farm size informs of the resource situation of the farmers and the revenue indicates of the effective resource utilization. The results show that the farmers were equipped to utilize their resources effectively. At last, the statistics indicate that less than 30% of the farmers had credit guarantors, thus, showing that the access to credit was limited.

Table 1: descriptive statistics

	Mean	SD
Revenue (GH¢)	234.128	526.211
Farm size (ha)	0.890	3.007
Labor cost (GH¢)	12.223	75.133
Fertilizer cost (GH¢)	21.566	57.818
Seed cost (GH¢)	57.819	359.052
Agro-chemicals cost (GH¢)	37.412	18.284
Gender (dummy)	0.671	0.352
Age of farm manager (in years)	59.269	12.944
Education (in years)	6.757	6.375
Irrigation (dummy)	0.286	0.558
Attended community meetings	0.453	0.322
Received advice on fertiliser or seed from DA	0.231	0.415
Visited by DA in last 5 years	0.789	2.007
Uses radio to get production information	0.581	2.17
Visited government office	0.214	0.351
Credit access (dummy)	0.247	0.431
Yields (kg)	394.080	774.581
Guarantor (dummy)	0.285	0.531
Default (dummy)	0.506	0.500

4. RESULTS

As discussed before, a Probit model is being implemented for studying the factors for influencing crop productivity. The results of the Probit estimation is depicted in table 2. For controlling the effects of heteroscedasticity, the model was estimated using robust standard errors. Moreover, only the signs of the coefficients are used for interpreting their effects on the dependent factor and not their magnitude as the Probit model is non-linear. The results show that gender has a positive association with crop productivity. This indicates that the probability of the crop being productive is higher among male farmers as compared to the female counterparts. The results are plausible in the Asian context as most of the households are dominated by the male members and male farmers are more abundant. Also, the productivity of the crop refers to the overall revenue and considers factors like overall production and labor as well. As these resources are within the control of the males and are managed more abundantly by them. Thus, within the Asian context farming is a career option functional by the male counterparts of the families. Also, it implies that access to credit is also affected by the gender. As indicated by Abdallah (2016) the male counterparts of the farming families have greater access to agricultural credit. In another study, Weber and Musshoff (2012) showed that the probability of credit accessibility is independent of gender and is modulated by the productivity of the crop. Another study, Armendáriz and Morduch (2010) indicated that females have higher access to credit. The next factor that influences the credit access is age of farmers. The results of the present study are insignificant. While the age of the farmers shows an insignificant association with credit access, age square reflects of a negative association with credit access. This factor is a proxy for old age and indicates that farmers who are of old age have a declining probability to access agricultural credit. The knowledge variables like education and extension show a negative access to credit. The negative and significant relationship of education indicates the access to credit decreases as the number of years expended in formal education increases. These results are consistent with Weber and Musshoff (2012) and disputes the findings of Akudugu, Egyir, and Mensah-Bonsu (2009) who found an inverse association between formal education and credit access. Another study by Khanal et al. (2018); Khantachavana, Verteramo Chiu, Turvey, and Kong (2012) indicated that level of access to credit increases with the number of years spent in formal education in Mexico. Extension services indicate of a negative association as well. The access to credit is lower among the farmers that have access to extension. Two variables were used for the evaluation of the collateral security of the farmers. The yield of crop from the preceding season and the access to guarantor were used to study the collateral security of the farmers. The access to guarantor is negative and indicates that the farmers that have some collateral security or validation from some guarantors have a higher chance of accessing agricultural credit. These results are contradictory to the findings of Dzadze, Aidoo, and Nurah (2012). Also, the yield of crop is positive and significant thus indicating that credit access increases as the yield from the crop increases. Thus, the yield of crop plays an essential role in leveraging the credit access for farmers.

Table 2: factors affecting the access to credit

Variable	Coefficient	Robust SE	Z
Gender	0.3284486	0.1487068	2.21**
Age of farm manager	0.006857	0.0096676	0.71
Age square	−0.0001847	0.0001047	−1.76*
Education	−0.0323595	0.0093325	−3.47***
Farm size	−0.0042221	0.0186346	−0.23
Extension	−0.2239864	0.1238716	−1.81*
Group membership	0.2401831	0.1455278	1.65*
Default	0.6217361	0.1445002	4.30***
Guarantor	−0.0239167	0.1189668	−0.20
Yield	0.0001441	0.0000836	1.72*
Constant	−0.4753776	0.2687007	−1.77*
Goodness of fit measures			
Wald χ^2	94.28		
Prob$W\chi^2$	0.0000		
Log likelihood	−332.85085		
Pseudo R^2	0.1511		

The access to extension services was studied through 5 indicators. The Probit model is used here as well, thus, only the sign will be used to study the association and not

the magnitude. The first factor is attending community meetings. The attendance of community meetings is significant and indicates that access to the extension services increases as the farmers move around in the community. The community meetings allow the farmers to socialize in their community and learn facets relating to farming activities (Deressa, Hassan, Ringler, Alemu et al., 2009). The access to extension services is affected by the fertilizer or seed advice. These results are significant as well and are positive. The next three factors are insignificant but depict of a positive association.

Table 3: access to extension services

Variable	Coefficient	Robust SE	Z
Attended community meetings	0.009*	0.568	0.568
Received advice on fertiliser or seed from DA	0.225***	46.260***	0.556***
Visited by DA in last 5 years	0.301	1.000	0.063
Uses radio to get production information	0.106	0.641	0.424
Visited government office	0.003	1.122	0.258***
Goodness of fit measures			
Wald $\chi^2(10)$	92.38		
Prob$W\chi^2$	0.0000		
Log likelihood	−432.84094		
Pseudo R^2	0.1612		

The results from the MLE are depicted in table 4. The stochastic frontier function is used for the estimation of the production function. The coefficient of the function is representative of the proportional change in the output factors where all input factors in the model are changing by approximately 1.53%, which shows that the scale returns are increasing. From the depicted results in table 4, the parameters of farm size, seed cost, labor cost, extension services, fertilizer cost, and credit access are significant. Also, all of the factors except farm size are significant at the 1% level of significance other than farm size which is significant at the 5%. These findings suggest that the crop productivity could increase through the increase in the amount of the seed, fertilizer, and land invested in the crop production. Also, the increases access to credit and increasing access to extension and educational services can increase the productivity of the crop. In other words, if the land under the rice cultivation, with the required input of fertilizer, seeds and labor was increased by 1 percent than the mean productivity of the rice crop would increase by 0.2, 0.22, 0.7 and 0.39 percent. Moreover, if the access to credit and extension increases by 1 percent than the crop productivity reduces by 0.3 and 0.13 percent respectively.

The next series of findings relate to the association of technical efficiency and productivity of the crop. The results show that the parameter of γ is statistically significant at the 5 percent level of significance. These results show that the inefficiency of the model is significant among the studied households. These results are also indicative of the fact that the differences between the observed and actual output is modulated through the technical ineffectiveness i.e., the factors that the farmers have no control over. This suggests that the technical ineffectiveness is stochastic within the region. The human capital variables like education and age of the farmer show that education and age of the farmers influence the technical efficiency and therefore affects the productivity of the crop in a similar trend. These results are supportive of the findings of the previous studies (Abdallah, 2016; M. Ahmad, Mustafa, & Iqbal, 2016). Also, the gender of the farmers is found to influence the productivity of the crop. The results indicate that the efficiency of the male headed households is superior and thus by trend the productivity of these farms or households is greater as well. The findings also indicate of the experience of positive influence of the experience of the farmers. The farming households with greater experience were aligned with technical efficiency.

Table 4: stochastic production function for Malaysia

Variable	Coefficient	Robust SE	Z
Lnfarmsize	0.20783	0.11859	1.75*
Lnseed	0.22367	0.04185	5.34***
Lnlaborcost	0.70100	0.04629	15.34***
Lnfertilizercost	0.39917	0.06788	5.88***
Lnextension services	−0.33881	0.15937	−2.13***
lnCreditaccess	−0.13957	0.15963	−0.87***
Constant Inefficiency model	2.74010	0.06030	4.05***
Gender	−0.72615	0.24663	−2.94***
Age	−0.01569	0.00504	−3.11***
Education	0.01495	0.01462	1.02
Farm size	−0.290	0.033	−0.51***
Irrigation	−0.13957	0.15963	−0.87
Score of credit access	−1.58338	0.22559	−7.02***
Constant Variance parameters	1.62500	0.23610	3.03***
$\sigma^2 = \sigma_v^2 + \sigma_u^2$	0.659	0.086*	
$\gamma = \frac{\sigma_u^2}{\sigma^2}$	0.937	0.018**	
σ_v^2	0.618	0.088*	
σ_u^2	0.041	0.010**	
Mean technical efficiency	0.476		
Mean credit access	0.456		
Mean access to extension services	0.47		
Function coefficient	1.532		
Log likelihood	−1099.7104		

5. DISCUSSION

A “probit model” is developed for this research study in order to determine the impact of different variables on crop productivity. The “robust standard errors” were used to estimate this model. Due to the “non-linearity” of the model, only the interpretation of the coefficients was done and no magnitude was determined. The results obtained included: “significant levels” as well as “sign of the coefficients”.

The results obtained from this research study showed that the gender plays a significant role in obtaining the agricultural credit. As it has been observed that the males in Malaysia are the in-charge of the homes and they are the ones who control the usage of all the resources so, they are more likely to get agricultural credit contrary in the case of

females in Malaysia. However, according to Weber and Musshoff (2012), the probability of obtaining an agricultural credit was not impacted by the gender. According to Armendariz and Morduch (2010), the females were more likely to get the credit as compared to the males. The impact of age on the agricultural credit was found to be mixed. However, it was observed that the age had an insignificant impact as well as a "positive relationship" with the access to the credit. The access to the credit is found to be increased as the age increases however, it gradually decreases at the old age. Whereas, Tadesse (2014), states that age has both significant as well as positive relation with the access to the credit. This contradicts the findings of the research. The findings also showed that the knowledge and educational factors have a negative impact on the agricultural credit.

However, according to Khanal et al. (2018), the number in the educational sector increases the access to the credit. The guarantors were also found to have least impact on the agricultural credit. The farmers with no guarantors were more likely to have an easy access to the credit. According to Dzadze et al. (2012), a positive relationship was observed between the guarantors and an access to the credit. The extension services also found to have a negative impact on the access to the credit but Tadesse (2014), shows contrary results to this. According to "Cobb-Douglas stochastic frontier model", for technical efficiency, four determined variables were determined which included: "size", "seed", "labor cost" and "fertilizer cost" which showed that with the increasing input, the output also increases. Jaforullah and Premachandra (2003) and Ogundari (2008) also supported these findings in their studies. However, the technical efficiency in the agricultural sector of Malaysia was found to be much lower as compared to other western as well as eastern countries. Therefore, the use of improving technologies in the agricultural field, have also found to be effective. Such technologies reduce the labor as well as time and more work is done in the minimum time possible. Thus, the technical efficiency is found to be significant in this case as it helps the farmers especially from the rural areas to work more effectively to improve their crop production. This also includes many other significant factors to have better output for sustainable development. However, the extension services were also found to have a significant impact on the agricultural credit which in return helps in improving the crop productivity. It has been observed that the farmers who have extension services are more likely to have technical efficiency which helps them in utilizing the resources to achieve the higher crop productivity in Malaysia.

6. CONCLUSION

This study was conducted to determine the impact of agricultural credit, technical efficiency and extension services on crop productivity in Malaysia. Three important results obtained from this research study. First, the findings of the study concluded that different factors including: "gender", "membership", "social organization" and "default" have positive impact on the agricultural credit whereas, "old age", "educational level", "extension services" and "yields" show negative impact on access to the credit. Second, the output of crop productivity increases with the increase in an input. Different significant factors determined by this research study include: "farm size", "seeds", "labor" and "fertilizer". These factors help in improving the output. Different characteristics of households are effected by technical efficiency and significant factors play an important role in this case. Third the extension services are also found to have significant impact on the agricultural credit which in return improve the crop productivity.

In case of the policy, different variables such as "credit access"; "human capital" such as "extension access" and "farmer's resource" such as "farm size" are considered to play important role in this case. However, for agricultural credit, different reforms should be made including different procedures of application as well as promoting education. Different communication methods should also be used to promote farmers knowledge. However, the variables of the human capital, are used for methods for extension services in order to educate the farmers to improve technical efficiencies.

7. LIMITATIONS AND FUTURE RESEARCH INDICATIONS

For this research study, a limited no. of past research studies were considered as no proper literature review was available. However, this research study will provide better data for the future studies in order to have proper understanding as well as analysis of the data.

Few variables are considered for this research study in order to determine their impact on the crop productivity. These variables include: technical efficiency, extension services and agricultural credit. However, there might be many other such variables that have an impact on the crop productivity. Thus, for future studies many other important variables such as environment, technologies, politics etc. should also be taken into count. This will help in determining the impact of different input variables as well which will help in improving the required outputs.

The current research study was conducted in the context of Malaysia. This only depicts the situation of crop productivity in the developing countries. However, for future studies, cross-sectional studies should also be conducted including the developed as well as developing countries to have a better analysis of crop productivity. However, the "policy point of view" should also be elaborated in such cases in order to have quality regulations to have an effective crop productivity in a country.

8. IMPLICATIONS

This research study not only helps in determining the impact of different variables on crop productivity. It helped in determining the importance of education of the farmers especially in the rural. As this could help in improving the technical efficiency of the farmers for better crop productivity. Different policies are developed by the

Malaysian government to educate the farmers. The extension services are also found to be effective in this process. The extension services are offered by different private as well as public sectors in Malaysia. The main focus of these extension services is to promote the technological services in the field by focusing the traditional style. Thus, these services also provided options to minimize risks related to the agricultural environment digitally. Different means of communication such as televisions, newspapers as well as radios are being used for educating the farmers. Many banks in Malaysia have also increased their no. of applications for agricultural credit. This helps in proper utilization of the human capital thus increasing the output in the form of better crop productivity.

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