Poverty of Malaysian rice farmers in a changing climate - An empirical investigation in Kedah, Malaysia

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Abstract. This research aims to assess the economic impact of climate change on the poverty of rice farmers in Kedah. A personal interview was conducted in a sample of 400 farm households in Kedah, Malaysia. To achieve the goal of the analysis, a logit model was used. The findings indicate that education and non-farm have major positive effect on the probability of being poor for the rice farmers. For Malaysian policymakers, the evidence from this study may be useful in promoting greater preventive measures during the key and off-seasons to counteract climate instability and vulnerability.

1. Introduction

While agriculture is heavily dependent on climate patterns, changes in climate conditions contribute to year-to-year and area-to-area variation in crop production, which has a negative impact on the economic conditions of the farmers. Climate change is affected by many variables, which, in essence, contribute to changes in agricultural sustainability variables and their effect on the agricultural system and farmers' socio-economic characteristics. The factors related to agricultural sustainability, such as volume/yield, area and value of production, often change as a result of changing climate factors. Vulnerable agricultural sustainability can lead to inconsistencies in total output quantity, crop profit margin, final product profit margin, production and import profit margin, farm and off-farm wage rates, etc. The adverse climate change thus leads to a decrease in the income of farmers, which is likely to cause poverty. In addition, climate change triggers regular natural disasters, resulting in full-time farmers becoming unemployed for a substantial portion of the year.

The unexpected behaviour of climate variables can also cause farmers to suffer from disease, injury, recurrent illness and other health risks, which in turn contribute to long periods of unemployment. Agriculture plays an important role in the economy of Malaysia as well. Based on the Central Intelligence Agency (CIA) survey, 8.2% of the national GDP is generated by agriculture, 37.8% by the manufacturing sector and 54% by the services sector [1]. For two reasons, rice in Malaysia is the most important food. First, the consumption of 500-799 calories of rice in Malaysia per capita per day makes rice a staple food in the Malaysian diet [2]. Second, the main source of income is agriculture among small-scale farmers. There are currently around 296,000 rice producers in Malaysia, and almost 40% of them are full-time farmers. There are about 300,000 rice farmers, according to Man and Sadiya [3], who depend on rice farming for their survival. Throughout the peninsular, Malaysia has eight major granaries and some small sheds [4]. To date, Malaysia's rice production self-sufficiency level is 73 per cent. Overall, climate change has a negative effect on
agricultural sustainability in Malaysia, making people dependent on agriculture more vulnerable in socio-economic terms than other social classes in Malaysia [5-7]. Climate change is leading to the widening of this income gap even within the farming community, as poor farmers are more impacted by the adverse effects of climate change.

In addition, in rural areas, the incidence of poverty has been more severe than in urban areas. The issue of poverty has therefore been generally seen as a concern for rural and Malay families, while Chinese and Indian poverty, as well as urban poverty, have been increased. The Malays were synonymous with the poor, i.e., the poor were the Malays in general, and the Malays were generally poor, because the majority of rural households were Malays [8]. At the time of independence in 1957, Malaysia was a low-income, predominantly agricultural and rural economy. Around half of the country's households lived below the national poverty line, and until 1970, when 49% of the households were poor, relatively little had changed. At the time of independence in 1957, Malaysia was a low-income, predominantly agricultural and rural economy. Around half of the country's households lived below the national poverty line, and until 1970, when 49% of the households were poor, very little had changed. Since 1957, with a strong focus on national unity, the government has introduced different policies to alleviate poverty and redistribute income between ethnic communities. The government formulated its Twenty-Year New Economic Policy (NEP) in 1970 as a basic strategy to eliminate poverty. The objective is to promote national development by eliminating poverty and economic restructuring, by eliminating the connection between ethnicity and economic assets [9].

Under the NEP, the government has invested a total of RM 32.9 billion, or 19.1% of the total development budget, in poverty reduction programmes, especially for rural people. Poverty fell to 15.1%, compared to 16.7% of the NEP at the end of the 20-year program, and the Gini coefficient fell to 0.466 by 1990, from 0.513 in 1970[10-13].

The objective of this research is to examine the impact of climate change on the poverty of rice farmers in Kedah. This study contributes to limited quantitative research on assessing the potential impacts of climate change in Malaysia, where there are few accurate estimates of the impacts of climate change and variability. There are three main contributions to this research. First, we determine the climatic and non-climatic indicators of rice farmers' farm profitability in Kedah, Malaysia. Second, we estimate the effect of climate change (temperature, rainfall and precipitation changes) on farmers' poverty levels. Third, from a statistical point of view, as is commonly done, we use a single cross-section of farm level data as opposed to aggregate district or county level. New opportunities and challenges are posed by the use of individual farm data. A rich collection of data on the characteristics of individual farmers is one of the opportunities. There are several socio-economic and demographic features of individual farm data that are likely to influence farm productivity. Such detailed data is generally not available at the district or county level. A micro-level analysis therefore controls non-climatic variables more closely than studies that rely solely on aggregate data. Detailed farm-level data, on the other hand, may pose new challenges, as the study would have to explain the differences between farmers within a particular climate zone, in addition to the differences between farmers between climate zones. Therefore, an empirical issue that needs to be answered is whether it is beneficial to switch to individual data. The majority of this paper is arranged as follows. The next section explains the material and methods of this study. The findings of this analysis are summarized in Section 3. The conclusion and recommendation of this study is provided in Section 4.

2. Materials and Methods
This research was conducted in Kedah, Malaysia, in the Muda Agriculture Development Authority (MADA) area (Figure 1). The area under MADA is the location of the Muda Irrigation Scheme, consisting of 27 farmer organizations, Pertubuhan Peladang Kawasan (PPK) with 55,130 farmers, as shown in Figure 1. The place of the Muda Irrigation Scheme is the zone under MADA. Roughly 76% of the region produces rice, which is 96,558 ha. In 2001, as the nation's largest rice producer, it contributed 50% to rice production. With a population of 1,890,098, it has a total area of 9,500 km2 (3,700 sq. mi.) and is the 8th largest state by land and the 8th most populous state in Malaysia [14].
There are 27 farmers’ organizations (PPK) in MADA, where 55,000 farmers exist. Therefore, all farmers from 27 PPK were included in our sample frame.

We used stratified, basic random sampling techniques in this analysis. We stratified the entire study region into 27 PPK strata based on the homogeneous population of approximately 55,130 farmers using the stratified proportionate sampling technique. Due to time and budget limitations, it is relatively difficult to cover all industries. Thus, for this analysis, we selected 7 strata (7 PPK) using simple random sampling. Then, at the required pace, we have randomly chosen respondents from each stratum. A total of 450 questionnaires were distributed via face-to-face interviews between the farmers. Only 50 of the 450 questionnaires were incomplete, which resulted in 400 usable questionnaires for study purposes. The rate of response was around 89 per cent. To collect the data, the principal individual of the agricultural households who worked as farmers in the village was interviewed. A and B, two sections of the questionnaire, were presented to the respondents. Section A asked selected farmers about their household features, such as household size, gender, ethnicity, religion, education level, etc. Section B notified farmers about their expenses and earnings.

3. Results of the study

To obtain the net income of the farm, the gross profits and total expenditures are determined. The gross earnings included rice sales. The net cost included the fixed cost and the cost of various inputs that were used on the farm to grow rice. The fixed cost includes owned rice land, farm buildings, machines and draft animals. The buildings on the farm are connected to the storage house and the cattle shed. The machines include not only massive machines, but also agricultural machinery and agricultural equipment. The shooting of livestock refers only to buffaloes and cattle. The value of rice land and draft animals was calculated according to the market prices given by the farmers in the interview. The amount of production or fertility was the determinant factor in the price of land. The prices of livestock deposits, warehouses and equipment were calculated on the basis of the original costs and linear depreciation. In calculating the depreciation, both for the stable and the warehouse, a standard life of twenty years with zero disposal value was assumed. It was also assumed that a pedestrian had zero disposal value after ten years of life, as the second-hand market for tractors had not yet developed in this region. This estimate was based on the assumption that the price of the animal is divided evenly between the owner and the lifter of the animal when the animal is sold, under the pawah scheme. Under this arrangement, the calves produced by the animal in question are owned...
by two parties; the first calf goes to the lifter, the second to the owner, the third to the lifter, etc. In addition, Raiser has absolute permission to use the animal for its plow. For the draft animals raised under the Powah or distribution system, just half of their market prices were determined. Two sets of variable cost components were evaluated; one was calculated by the process performed and the other by the expenditure type. The cost estimate was made using the following assumptions. The cost of hired labour is the actual expense, covering both the labour wage and expenditure on food and drink served to hired labour. The price of unpaid family labour was measured according to the wage prevailing in the village (RM 50 per day, regardless of sex). The per-grant seeds were priced at sixty cents. Rice revenue was converted into monetary terms, assuming that the price of rice was eighty cents per grant. The price of fertilizers and pesticides are the real expenses charged by farmers. Fertilizers provided by landlords under common crop ownership were not included in the cost estimate. Again, real expenses incurred by the farmers were the land tax and water rate and those paid by the landlord for leased land were omitted from the calculation. Interest on agricultural assets was estimated at an annual rate of six percent. The farm's net income was measured after subtracting the total cost of operating the farm's gross profits. It then calculated the per person per month income. The profitability analysis is shown in Table 2. Compared to RM 5256.87 for the net yield per farmer, the total profit per farmer was estimated at RM 6353.26. This shows that rice production was generally profitable in the study area. The table shows that the overall expense to farmers was more than double the gross revenue. Increased efforts to grow rice would, under the same circumstances, increase the incomes of farmers.

Table 1. Net return of the farmers.

| Variables      | Average | Smallest | Largest | Standard deviation |
|----------------|---------|----------|---------|--------------------|
| Total revenue  | 8342.91 | 1200.00  | 500000  | 7843.83            |
| Total Cost     | 3094.73 | 200.00   | 34000   | 4062.89            |
| Total variable cost | 1989.65 | 50.00    | 17100   | 2646.13            |
| Total fixed cost | 1105.07 | 30.00    | 16900   | 1854.62            |
| Gross margin   | 6353.26 | 700.00   | 42350   | 5854.35            |
| Net return     | 5256.87 | 200.00   | 33970   | 4884.79            |
| Farm size      | 1.8692  | .29      | 8.63    | 2.50               |

In Malaysia, RM 740 was the rural poverty line and RM 770 was the urban poverty line in 2009, and in 2012, RM 790 was the rural poverty line and RM 840 was the urban poverty line[15]. We calculate poverty as the proportion of the population living under the national poverty line index, described as "the minimum income needed by a household to satisfy each of its members' basic food and non-food needs in order to allow them to have a healthy and comfortable life." Therefore, in this analysis, a farmer with a family income equal to or above RM790 is considered not to be poor, while those with a family income of less than RM790 are classified as poor. We use a binary choice model based on the maximum likelihood approach when evaluating the effects of many factors on the probability of a farmer being bad. There is a variable of fictitious dependence used as 0 and 1. For an underprivileged farmer, the value of 1 is given if the family income of the farmer is lower than the poverty line. On the other hand, if the family income of the farmers is equal to or greater than the poverty line income, the value of the non-poor farmer is defined by 0.

It is clear that in the literature on technology adoption and adaptation to climate change, both the profit model and the logit are well-established approaches [16-18]. The logit model was used in this analysis to examine whether the farmer had implemented some solution to cope with climate change. If a policy has been implemented by the farmer, it will count as 1 and 0 otherwise. This research raises
the hypothesis that a shift in temperature or a change in precipitation is now experienced by farmers who adapt. We also hypothesize, on the other hand, that farmers who do not adapt do so because of challenges based on individual experiences. In this research, therefore, the decision of each farmer to adapt is a dummy variable described as follows:

\[ Y_i = \begin{cases} 1 & \text{if the farmer’s gross income is below poverty line} \\ 0 & \text{if the farmer’s income is above the poverty line} \end{cases} \]

The if \( P_i \) is defined as the probability of the farmer being poor, then \( (1 - P_i) \) is defined as the probability of the farmer being non-poor. So, \( \frac{P_i}{1 - P_i} \) is the odds ratio in support of poverty that is the ratio of the probability that a farmer is poor to the probability that he is not poor. The logistic regression model shows that the ratio log is not only linear in x but also linear in parameters, as the equation (1) shows

\[ L_i = \ln\left( \frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_1 x_i \quad (1) \]

where \( L_i \) is the log of odds ratio, \( \beta_0, \beta_1 \) are the parameters and \( x_i \) are the independent variables.

Table 2 presents the independent variables. The parameters were calculated using the maximum likelihood method. In this research, data analysis was conducted using version 16.0.0. of the Statistical Package for Social Science (SPSS).

| Variable                      | Definition                                      |
|-------------------------------|-------------------------------------------------|
| Age group                     | 1= less than 25                                 |
|                               | 2= 25 to 50                                     |
|                               | 3= 50 to 75                                     |
|                               | 4= above 75                                     |
| Educational background        | 1= no formal education                          |
|                               | 2= primary education                            |
|                               | 3= secondary education                          |
|                               | 4= tertiary education                           |
|                               | 5= university education                         |
| Size of land                  | In hectare                                     |
| Cost of labour                | RM                                             |
| Farm size                     | In hectare                                     |
| Non-farm income/month         | RM                                             |
| Average temperature           | °C                                             |
| Square of average temperature | °C²                                            |
| Average precipitation         | mm                                             |
| Square of average precipitation| mm²                                           |
| Average rainfall              | mm                                             |
| Square of average rainfall    | mm²                                           |

Table 3 presents the results of the estimated logit model. The findings of the logit model show that the R-squared value of McFadden is 0.342. The results show that among the socio-economic variables, age, land size, labor cost and farm size are not statistically significant to explain the probability that a farmer is poor. However, the level of education is significant, as expected, and has a negative relationship with the probability of being poor. This implies that, as the degree of education of the farmer increases, the probability of the farmer becoming poor decreases. The reason for this outcome
is very clear. Abdulai and Crole Ress [19], Bogale and Hagedorn [20] and Chaudhry [21] found similar findings to this study. It is also necessary to assess the importance of the interest variable in this study, i.e., non-farm income, and the farmer's probability of being low. This suggests that farmers are less likely to become poor if their income sources are to be diversified by engaging in non-farm activities. This finding seems to validate the results of other research, for instance, Canagarajah et al. [22] also stated that non-farm income is relevant for both men and women in Ghana and Uganda at all levels of the income spectrum. In addition, non-farm income continued to favour upper income groups on a larger scale than lower income groups, but lower income groups still benefited from increases in non-farm income. Similarly, De Janvry et al. [23] noted that income derived from non-farm activities helps to increase the capacity to invest in farm activities, to reduce volatility in income, to play a role in the insurance system and thus to encourage household agricultural production.

Table 3. Factors that affect the poverty of the farmers.

| Variables                      | Coefficients | t-value |
|-------------------------------|--------------|---------|
| Constant                      | 20.417       | .50     |
| Age                           | -.014        | -.214   |
| Educational Background        | -.183        | -2.95***|
| Size of Land                  | .856         | .88     |
| Cost of Labour                | -.185        | -1.5    |
| Farm size                     | -0.321       | 0.89    |
| Non-farm income               | -3.24        | -2.93***|
| Average Temperature           | -1.473       | -.631   |
| Square of Average Temperature | .577         | 2.12*** |
| Average precipitation         | -.134        | -.366   |
| Square of Average precipitation| .160         | .449    |
| Average rainfall              | -.264        | -1.454  |
| Square of Average rainfall    | .280         | 1.535   |
| R²                            | .342         |         |

The square temperature coefficient is positive and important. The square temperature coefficient indicates that temperature rises in the region observed in recent years may be attributed to increased human interventions resulting from the efforts of MADA to improve rice production in order to achieve the objectives of self-sustainability. Additionally, this model shows that rice productivity is not changed by a small rise in temperature; instead, it increases farm productivity. Masud et al. [24] stated that this is because the temperature range of MADA for the cultivars grown there is within the optimum level: 26.6 °C-29.7 °C. Nevertheless, this model shows that rice productivity is not harmed by a small rise in temperature; instead, it increases farm productivity and decreases the risk of poor farmers. In addition, both the precipitation and rainfall coefficients were negative and not significant. Similarly, Masud et al. [24] found that higher precipitation levels throughout the dry and main season reduce the total disposable income from rice per hectare, which is not significant

4. Conclusions and Recommendation

The results of this suggest that total revenue is more than double the total expense, which means that the production of rice is generally profitable in the field of research. The results of logit model indicate that education and non-farm income have major positive effect the poverty of the rice farmers in kedah Malaysia. Hence, our results indicate that the poor farmers can decrease their poverty if the government will explore the initiative to increase their level of education. If the farmers are educated, they will be able to produce in the least costly measures. In addition, non-farm income activities among agricultural households should be encouraged, as this would increase their income and thus reduce poverty among them. It can, however, concentrate on value-added operations, in particular on the lower income group. The results of this study also indicate that a holistic approach to growth
should concentrate not only on the divide between rural and urban areas, but also within the rural areas themselves.

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