Research article

Rice Varietal Assessment for Climate Change Adaptation from a Socioeconomic Point of View: A Study in Myittha Township, Myanmar

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Received 31 December 2020 Accepted 9 July 2021 (*Corresponding Author)

Abstract Myanmar is the second most vulnerable country in the world to the effects of climate change, with agriculture highly vulnerable. This study was conducted to determine farmers' knowledge on how to respond to the impacts of climate change, to identify climate-resilient adaptation technologies in rice farming, to also identify the desired characteristics of chosen rice varieties, and to estimate the cost and benefits for different rice production systems for the chosen varieties. The study was carried out in Myittha Township, a major rice-growing area in the middle of Myanmar. Most of the rice areas are irrigated. Primary data were collected by conducting a socio-economic survey. Descriptive analysis and cost benefit analysis were applied. More than 95 percent of the farmers adopted an adaptation strategy of using quality seeds. A change to the time of sowing, was favored by only 27% of respondents. About 41% of farmers grew Manaw Thukha rice variety, followed in popularity by Ayeyar Min (33.62%), and Shwe Manaw (20.49%) varieties. The traits of rice variety most desired were high yield and high marketability. The farmers practiced two different methods of rice establishment: direct seeding and transplanting, and grew in both monsoon and summer seasons. In monsoon, direct-seeded Ayeyarmin achieved the highest BCR (1.75) whereas the Manaw Thukha variety yielded the highest BCR in summer (1.70). The study area is an irrigated rice-growing area and has not yet suffered much from climate change impacts on rice production. This is despite a trend to scarcity of rainfall, which implies that improved irrigation facilities will comprise an essential adaptation strategy.

Keywords farmers' perception, knowledge, climate change adaptation, rice variety, irrigation facilities

INTRODUCTION

In many empirical studies, climate change is manifest in various forms, such as changes in temperature and rainfall patterns, more frequent extreme climate events (e.g. floods, typhoons, droughts, storms, etc.), unusual timing of seasons, and sea level rise (Apata et al., 2009; Deressa et al., 2011; Mertz et al., 2009; Smit et al., 1996; Thomas et al., 2007; Vedwan and Rhoades, 2001). Climate change adaptation is one policy option to reduce the negative consequences of the climate change. Adaptation to climate change is a critical issue for many developing economies. The issue is particularly important to agriculture, as this sector which relies substantially on climate-sensitive resources, is highly vulnerable to climate change. Rice remains the staple food in Myanmar, and Myanmar is the world's sixth-largest rice producing country. Rice is the country's most important

crop and is grown on over 8 million hectares, or more than half of the arable land. Rice is also the most important crop for millions of small farmers who grow it on millions of hectares throughout the region, and to the many landless workers who derive income from working on these farms. Empirical studies assessing the rice varieties best suited for climate change adaptation are limited in the Myanmar context.

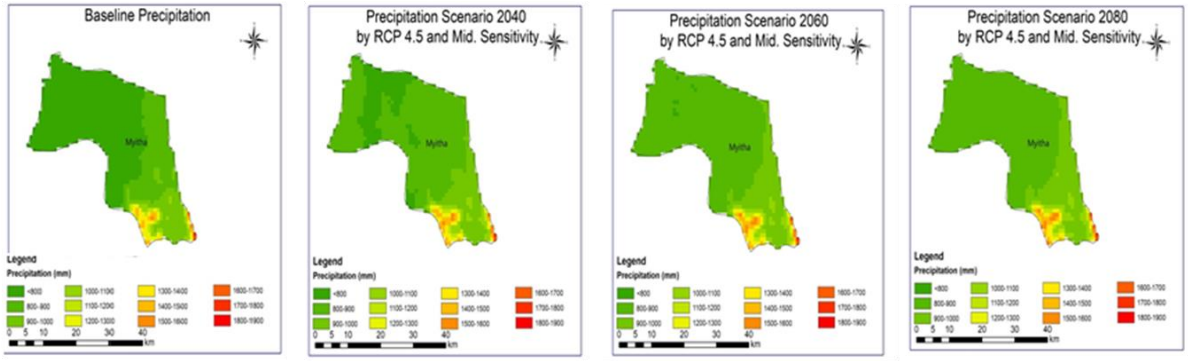

Fig. 1 Climate change scenario maps for Myittha Township with RCP 4.5 scenario

Previously, monsoon began in mid-May and ended in mid-October whereas it now begins at the end of May and ends at the end of September. That is, the monsoon season has shortened by about 40 days (Aung, 2019). A longer pre- and post-monsoon period has been observed, and may result in extreme weather such as thunder, lightning, hailstorms and thunder showers. To reflect probable climate change impacts on the study area, the climate change scenario maps were developed for rainfall patterns for a Representative Concentration Pathway (RCP) 4.5 scenario (Fig. 1). A RCP 4.5 is a scenario that stabilizes radiative forcing at 4.5 W m^{-2} in the year 2100 without ever exceeding that value (Thomson et al., 2011). These scenario maps convinced the continuation of climate change in future.

OBJECTIVES

This paper makes a general investigation of a rice variety to determine its suitability for climate change adaptation from a socioeconomic point of view. However, the specific objectives of the study are as follows:

- to determine farmers' knowledge of responses to the impacts of climate change on agriculture,
- to explore location-specific climate resilient adaptation technologies in rice farming,
- to determine the desired characteristics of any rice varieties chosen, and
- to estimate cost and benefits of different rice production systems for the chosen varieties

METHODOLOGY

Selection of the Study Area

Myittha Township, which is located in Kyaukse District, Mandalay Region, central Myanmar, was selected as the study area. It is situated at 21˚ 25' North, and 96˚ 8' East. It is a major rice growing area and most of the rice grown is irrigated. The survey was conducted in Yit Kan, Yakhaing Gyi, Ku Phyu and Ngar Su villages in 2018. The total number of respondents was 122. Data collection was carried out using a simple random sampling method and by the use of a structured interview schedule.

For data analysis, descriptive analysis and cost and benefit analysis were calculated using Microsoft office excel and the software, STATA (Version 14). Mean, minimum, maximum, standard deviation, frequency and percentage values were applied to reveal the indigenous knowledge of farmers on how to respond climate change impacts, the preferences of farmers of traits for suitable rice varieties, and any climate adaptation strategies practiced by farmers in the study area.

Enterprise Budget

The following equations were used to do enterprise budgeting and to estimate the benefit-cost ratio; Costs for cash and non-cash material inputs, hired labor, family labor and interest on cash, were calculated to obtain the total production cost.

Return above variable cash cost = Total gross benefit – Total variable cash cost
Gross margin = Total gross benefit – Total variable cost
Benefit Cost Ratio (BCR) = Total gross benefit / Total variable cost
Return per unit cash cost = Total gross benefit / Total cash cost ×100

RESULTS AND DISCUSSION

Characteristics of the Farmers in the Study Area

The average age of the respondents in the study area was 51.69 years. The youngest age was 19 years and the oldest age was 80 years. The range of farming experience was from 0 to 53 years with an average of 24.75 years. Average length of schooling of respondents was 4.66 years, with a range from 0 (illiterate) to 20 years (tertiary qualifications). Respondents had an average 5.69 acres of lowland farming area. Land ownership ranged from 0 (landless) to 50 acres. The average upland farming area possessed by the respondents was 2.44 acres. The minimum and maximum upland ownership areas were from 0 to 15 acres. Farmers also had 0.39 acres of orchard area on average. In general, the respondents can be described as elderly with low (primary) formal education but with high levels of farming experience.

Table 1 Demographic information of respondents in the study area

Item	Unit	Average	SD
Age	Year	51.69 (19-80)	12.18
Farming Experience	Year	24.75 (0-53)	12.29
Education (Schooling years)	Year	4.66 (0-20)	3.10
Ownership of Lowland	Acre	5.69 (1-50)	5.92
Ownership of Upland	Acre	2.44 (0-15)	3.70
Ownership of Orchard	Acre	0.39 (0-8)	1.25

**Values in parentheses represent range.*

Indigenous Knowledge of Farmers to Respond Climate Change Impacts

Seventeen agricultural practices, based on farmers' indigenous knowledge of climate change adaptation, were identified in the survey. More than one quarter of respondents (25.41%) have changed varieties grown and another 25 percent have changed crops, for example, by now growing summer rice instead of sesame. Changed cropping systems and crop management practices were practiced by 17.22% of farmers. Other indigenous responses to climate change impacts were through changing sowing time (6.56%), growing varieties of shorter duration (5.74%), using chemical inputs differently (4.92%), applying FYM (3.28%), using better quality seeds (3.28%), using underground water (2.46%), practicing the line sowing method (2.46%), changing cropping patterns (1.64%), using irrigation water (1.64%), growing more marketable varieties (1.64%), practicing crop rotation (0.82%), growing low-cost crops (0.82%), changing seeds yearly (0.82%) and the willingness to adopt organic farming (0.82%) (Fig. 2). In the study area, it can be assumed that farmers are aware of climate change and are actively adapting to changes.

Climate Resilient Adaptation Technologies

Adapting to climate change requires that the correct measures, utilizing appropriate adjustments and changes, are made to reduce negative effects.

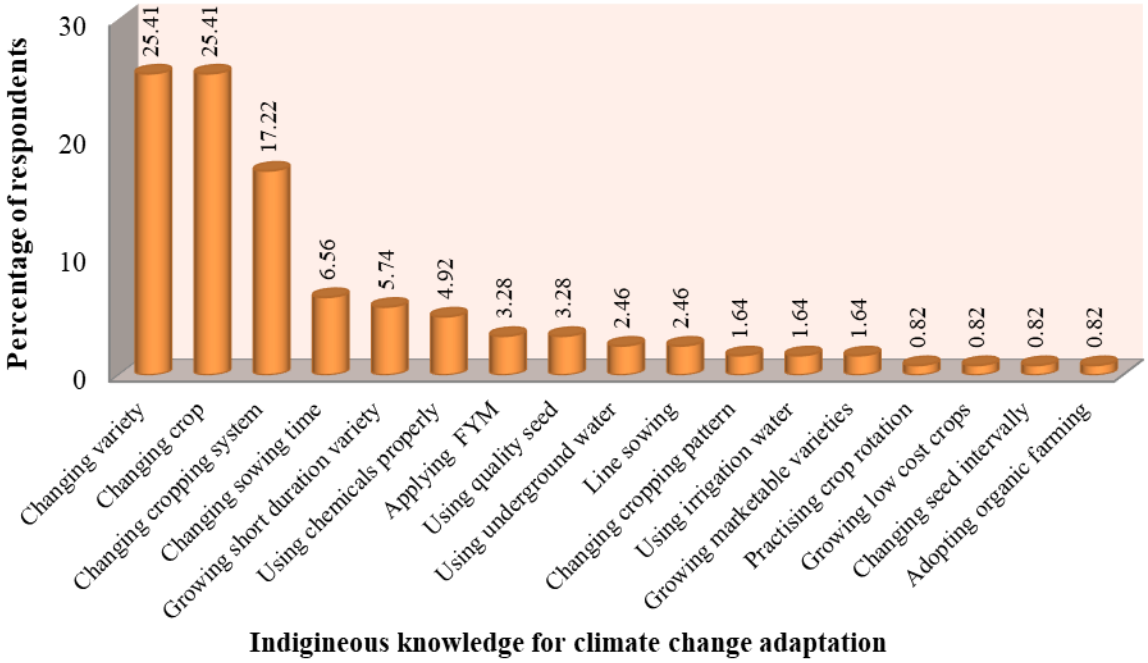

Fig. 2 Indigenous knowledge of farmers to respond climate change impacts (n=122)

Table 2 Climate change adaptation strategies practiced by farmers in Myittha Township (n=122)

No.	Adaptation Strategies	Frequency	Percent (%)
1	Using quality seeds	115	95
2	Using fertilizers	108	89
3	Using Farm Yard Manure (FYM)	98	81
4	Changing crop types	98	81
5	Changing varieties	96	79
6	Practicing crop rotation	92	76
7	Changing cultural practices	91	75
8	Using traditional varieties	43	36
9	Using underground water	38	31
10	Changing sowing time	33	27

Table 2 ranks ten climate adaptation strategies, practiced by farmers in the study area. Almost all respondents (95%) used quality seeds. Most were using fertilizers (89%), using farm yard manure (FYM) (81%), changing crop type (81%), changing variety (79%) and practicing crop rotation (76%) followed by using traditional varieties (36%), making use of underground water (31%) and changes to sowing time (27%). Results show almost all respondents were using quality seeds as a climate change adaptation strategy. This reflects that seed is the basic and most vital input of agriculture. Without high quality seed, other inputs and better technologies remain worthless.

Desired Characters of the Rice Varieties

Rice variety traits and characteristics such as high yield, market price, eating quality, seed quality, pest and disease resistance, good milling recovery and resistance to climate change were found to be what respondents prioritized. Most farmers (76.47%) desired high yielding varieties with high market price, whereas good eating quality, good quality seeds were the desired characteristics sought by 46.93%, 44.16% and 41.05% of farmers respectively. Fewer farmers (22%), (12.31%) and (10.95%) prioritized pest and disease resistance, good milling recovery and resistance to climate change (Fig. 3). From this it can be assumed most farmers in the study area have not suffered severely from the impacts of climate change to this point.

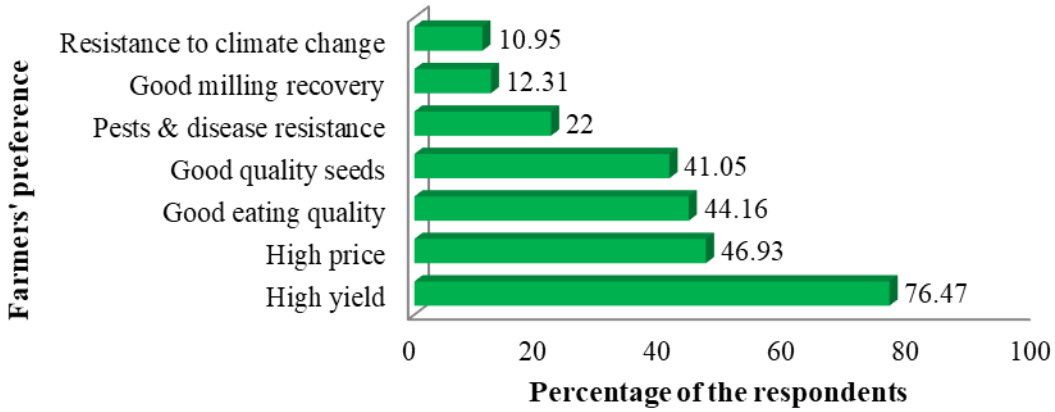

Fig. 3 Farmers' preference on rice variety traits (n=122)

Cost and Benefit Analysis of Rice Varieties

Cost and benefit analysis of selected rice varieties in both summer and monsoon was made and the results are presented in Table 3. Farmers practiced two different rice establishment methods: transplanting and direct seeding and grew throughout both seasons. Only the Manaw Thukha rice variety was grown, using both methods, in summer, with other varieties not grown in summer using only direct seeding. The Manaw Thukha rice variety exhibited a higher Benefit Cost (BC) ratio (1.70) when transplanted compared to the direct seeding method (1.64), in summer. Also in summer, GW1 gave the highest BC ratio (2.16) of all rice varieties grown after transplanting. GW1 is a Chinese hybrid rice, and although it showed the highest BC ratio, few farmers grew it. It is a newly introduced variety whose plant characteristics and yield potential are not well known. In monsoon season, the Shwe Manaw variety gave the highest BC ratio (1.65) of all rice varieties using transplantation, and the Ayeyar Min variety gave the highest BC ratio (1.75) when the direct seeding method was used.

Table 3 Cost and benefit analysis of selected rice varieties by establishment methods

Name	Transplanting method			Direct seeding method		
	Total cost (MMK)	Total revenue (MMK)	BCR	Total cost (MMK)	Total revenue (MMK)	BCR
Monsoon season						
Shwe Manaw	325,302	535,441	1.65	379,487	652,500	1.72
Ayeyar Min	354,823	556,341	1.57	329,250	567,500	1.75
Manaw Thukha	346,598	473,666	1.37	366,485	584,450	1.59
Summer season						
Great Wall (GW1)	266,050	575,000	2.16	-	-	-
Manaw Thukha	306,192	519,089	1.70	317,666	520,000	1.64
Ayeyar Min	260,500	375,000	1.44	-	-	-
Shwe Manaw	351,750	382,500	1.09	-	-	-

CONCLUSION

According to the survey results, farmers in the study area appear to have a good knowledge, and developed local strategies to adapt to the effects of climate change, evidenced by practices such as using quality seeds, using fertilizers, employing FYM and changing crop types in their efforts to cope with the impacts of climate change. Switching to high yielding varieties is mostly favored. During monsoon, direct seeding methods yielded higher BC ratios for all varieties. In summer, farmers did not practice direct seeding method much because they are able to irrigate to manage their nursery. Thus, irrigation facilities become essential infrastructure for successful climate change adaptation strategies.

ACKNOWLEDGEMENTS

We would like to gratefully acknowledge the Japan International Cooperation Agency (JICA) for their technical and financial support, not only for the Project of Capacity Development of Yezin Agricultural University, but also for financial support for this study. We also would like to thank Yezin Agricultural University for giving us an opportunity to do research. Special thanks to Government officials and staff from the Department of Agriculture (Myittha Township) and the farmers in the study area for their keen cooperation, support and participation throughout the study.

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