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Ekológia (Bratislava) - Journal of the Institute of Landscape Ecology, Slovak Academy of Sciences Vol. 41, No. 3, p. 283–290, 2022

DOI:10.2478/eko-2022-0029

CLIMATE CHANGE ADAPTATION STRATEGIES BY RICE PROCESSORS IN EBONYI STATE, NIGERIA

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Received: 11.2.2022 / **Accepted:** 31.5.2022

Abstract

Onyeneke R.U., Amadi M.U., Njoku Ch.L.: Climate change adaptation strategies by rice processors in Ebonyi State, Nigeria. Ekológia (Bratislava), Vol. 41, No. 3, p. 283–290, 2022.

The paper examined adaptation strategies used by rice processors in Ebonyi State to manage climate risks. The paper used random sampling technique to select respondents and questionnaire was used to collect data from the respondents. Cross-sectional data collected from 98 rice processors were analysed using descriptive statistics and multivariate probit regression model. The results indicated that majority of the rice processors perceived prolonged dry season and increased rainfall intensity as the main climate risks in the state. Livelihood diversification, storing of paddy, and reliance on climate information were the major adaptation strategies used by the rice processors to manage the climate risks. The main determinants of climate change adaptation strategies of rice processors were education, membership of cooperative societies, income, training on rice processing and climate risk management, experience of climate hazards, and ownership of assets. The processors faced various barriers to adoption which are mainly related to capital needs, competition from foreign brands, access to basic infrastructure and roads and information, high cost of labour. It is recommended that government support be given to the rice producing communities in terms of basic infrastructure and policies to protect the industry. Also, regular workshops/trainings should be held to train processors on best climate risk management practices and encourage registration of processor cooperatives/relevant associations.

Key words: rice processing, adaptation, cross-sectional data, multivariate probit regression, barriers, Nigeria.

Introduction

Climate change is projected to progress over the years with its accompanying negative effects on the agricultural sector of different regions in the world (Ghile et al., 2014; Dai, Zhao, 2017; Onyeneke, 2010). In the south of Sahara, most countries are faced with climate change challenges of hot-dry conditions and shifts in the onset and cessation of rains (Allen, 2015) leading to the most devastating climate hazards of flood and prolonged dry periods (Fuwape et al., 2016), seriously affecting human and economic activities. Agriculture supports a large proportion of the populations in Africa and contributes about 22.35% of real gross domestic product value of Nigeria in the first quarter of 2021 (National Bureau of Statistics Nigeria, 2021). Thus, the climate situation spells greater problems and challenges for such parts of the world with much reliance on an 'expected normal' trend of climate variables like rainfall, which is a leading cause of crop yield reduction in the West African region (Kima et al., 2014), and other climate variables concerned with agricultural production activities.

Climate change threatens food production (Mulenga et al., 2017; Ayanlade et al., 2018) with dare consequences for staple food supply. Food systems especially staple food which is of high importance to developing economies are affected, and these fall short of the supply margins due to climate change effects on agricultural production. In sub-Sahara Africa (SSA), there are records of negative effects of climate change on rice yield, significant crop income losses, reduction in grain quality (Kima et al., 2014; Harvey et al., 2014; Bosello et al., 2018; van Oort, Zwart, 2018), and rice processing. Climatic variables (such as CO_2 concentration, humidity, temperature, rainfall, etc.) create atmospheric conditions which affect food crops in the field and storage and in production and processing. Sub-Sahara African food systems and value chains are plagued by climate change with manifestations such as drought, declining rainfall, flooding, and rising temperatures (Niang et al., 2014). The effect on the grains (rice) value chain is not spared.

Rice is one of the most important food crops especially in developing countries, where there is high dependence on staple food crops (such as rice) of high calorie content (Saito et al., 2015; Onyeneke et al., 2021). Investment in post-harvesting activities of grains (rice) enhances firms' commercial and market competitive advantage to accrue more returns to the industry (Demont et al., 2013; Fiamohe et al., 2015). Value addition activities, such

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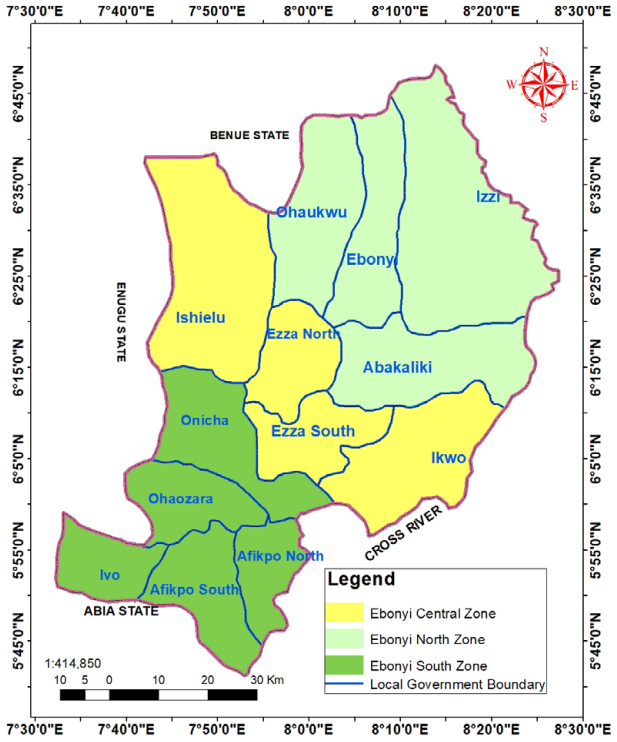


Fig. 1. Map of Ebonyi State showing the agricultural zones and the local government areas.

as processing, are important to the rice market especially in West Africa. This is to improve the sustainability of rice value chain (RVC), and also to curtail the market segmentation between imported and domestic rice products due to consumer preferences. Rice post-harvesting activities (especially processing) reduce the vulnerability of the RVC and improve its economic globalisation (Johnson, 2016; Terdoo, Feola, 2016). Lack of investment in rice post-harvest processing and inefficiencies in the market lower the capacity of RVC by increasing the marginalisation of the actors and exposing the industry to external shocks and climate change vulnerability. Considering that investment in post-harvest processing of rice through the RVC betters the capacity of the supply chain to compete internationally and also handle demand pressures (Demont et al., 2013; Fiamohe et al., 2015), losses at this stage due to climate change conditions will have daunting effects on the value chain.

Climate change affects rice value chain (RVC) right from production, to the extent that domestic supply capacity rarely meets demand in developing countries (van Oort et al., 2015). However, the effect of climate change on the processing node of rice value chain is largely neglected in literature. Attempts have largely focused on the effect of climate change on farm production rather than post-harvest handling (World Bank, 2011). There is also scarcity of empirical information on climate risk management strategies by rice processors in the whole of Africa in the face of climate changes. A reduction in the marketable rice product will result in more difficult economic situations of price instability, and may increase the dependency of the growing population of Nigerians and Africans on rice imports from other regions of the world (Bosello et al., 2018). Rice post-harvest handling contributes to marketing efficiency, and when distorted increases RVC vulnerability and hampers the ability of the sector to match internal demand and international competition for large parts of the SSA (Demont, Ndour, 2015; Johnson, 2016).

Rice processing and milling in Nigeria grew tremendously over the years in a bid to match domestic production. Processing has proven to be crucial to the sustainability of the RVC. Inefficiencies in milled rice production for Nigeria only increased economic pressures by allowing for international rice market price shocks to be transferred to the domestic economy (Dawe, 2002). Ebonyi State is one of the major States making significant contribution towards Nigeria Africa's attainment to self-sufficiency in rice production. There is conscious effort and plans by the Government to develop the rice value chain in the State. The State Agricultural Policy; the 'One-man, One-hectare' initiative; arrangements to promote the development of the RVC through increasing agricultural mechanisation and installation of large capacity modern rice mills in all agricultural zones of the state (Okorie et al., 2012; AgroNigeria, 2016; Itumo, 2016; Olawale, 2017). These efforts yield gains in terms of the productive employment in the rice sub-sector, the uptrend in rice production and the increased share of the commodity in Nigeria from Ebonyi State (Liverpool-Tasie, 2017). However, challenges remain which constitute drawbacks to the accelerated growth of the sector to desired levels. Climate change is at the core in this respect, with its impacts affecting rice value-chain-based livelihoods in the rural communities of the state thereby increasing the vulnerability of the sector to risks and leading to declining agricultural productivity (Onyeneke et al., 2018; Choko et al., 2019; Onyeneke, 2021; Onyeneke et al., 2021). Hence appropriate strategic adaptation practices are essential to reduce vulnerabilities and effectively manage the climate risks and retrace the productivity of the rice sub-sector on the path sustainable growth to generate large markets for the largest economy in Africa.

Understanding existing local adaptation practices in rice processing is important towards planning the best coping strategies applicable to value chain actors, develop mitigation strategies to checkmate climate events, minimize costs in the RVC and improve its efficiency in production and distribution process. The study therefore identified climate change adaptation practices by rice processors, the determinants of the choice of adaptation strategies and the constraints to the adoption of adaptation strategies at this level of value chain.

Methodology

Study area

The study was carried out in Ebonyi State. The Statistical Bulletin of the Central Bank of Nigeria puts the population of the State at 2,880,383 persons as in 2016 (Central Bank of Nigeria, 2016). The state is bordered with Abia State and Cross River State in the east, Abia State in the south, Enugu State in the west, and Benue State in the north (Fig. 1).

Meteorological data obtained from the Federal College of Agriculture, Ishiagu, show that average annual temperature in the state ranged from 27 to 34 ^{0}C with an average of 31.32 ^{0}C

Table 1. Minima, maxima, and averages of climatic variables of Ebonyi State.

Climatic Variable	Mean	Minimum	Maximum
Rainfall (mm)	1766.86	1312.90	2185.50
Average temperature (^{0}C)	31.32	27.00	34.00
Relative humidity (percent)	77.74	62.17	87.67

Data source: Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria

between 1997 and 2017, rainfall ranged from 1312.90 to 2185.50 mm between 1997 and 2017, while the range of relative humidity for the same period was 62.17–87.67% with an average of 77.74% (Table 1).

The climatic conditions of the state support the production of rice. The livelihoods of the inhabitants of the area are dependent on agriculture. Ebonyi State has three agricultural zones – Ebonyi South, Ebonyi Central, and Ebonyi North – and thirteen local government areas (LGAs). There are also rice mils owned by the government and private sector across the state. These rice mills are found in each agricultural zone.

Sampling technique and data collection

We included the three agricultural zones of the state for the study. In each zone, three local government areas (LGAs) were selected. In each LGA, four communities were selected. In each community, the study randomly selected three rice processors. In all, the study administered the questionnaire to 108 processors as proposed. However, 98 copies of completed questionnaire were returned and we used the returned questionnaire for final analysis.

Data analysis

The study employed descriptive statistics and multivariate probit regression to analyse the data collected. We used Stata 17 for the data analysis. The paper followed Lin et al. (2005) in stating our multivariate probit model which has 6 dependent variables, Y_1, …, Y_6 such that

$$Y_{ij} = 1 \; if \; \beta_{ij} X_{ij} + \varepsilon_{ij} > 0 \qquad (1)$$

and

$$Y_{ij} = 1 \; if \; \beta_{ij} X_{ij} + \varepsilon_{ij} \leq 0 \quad i = 1, 2, ..., 6 \qquad (2)$$

where j = 1,2, …, k rice processors; X_{ij} is a vector of the independent variables of the rice processors; β_{ij} is parameter estimates of the explanatory variables of the rice processors; ε_{ij} is error term (Mulwa *et al.,* 2017). The explanatory variables are defined as follows:

- X1 = education (years spent in school)
- X2 = age (years)
- X3 = household size (number of persons)
- X4 = income (Naira)
- X5 = rice processing experience (years)
- X6 = ownership of radio (dummy variable; yes = 1, no = 0)
- X7 = ownership of car (dummy variable; yes = 1, no = 0)
- X8 = membership of cooperative societies (dummy variable; yes = 1, no = 0)
- X9 = training on climate risk management (dummy variable; yes = 1, no = 0)
- X10 = experienced climate event before (dummy variable; yes = 1, no = 0).

The dependent variables are listed as follows:

- Y1 = reliance on climate information for rice processing decisions (dummy variable; yes = 1, no = 0).
- Y2 = storing paddy (dummy variable; yes = 1, no = 0).
- Y3 = selling off paddy (dummy variable; yes = 1, no = 0).
- Y4 = insurance (dummy variable; yes = 1, no = 0).
- Y5 = buying small quantities of paddy (dummy variable; yes = 1, no = 0).
- Y6 = livelihood diversification (dummy variable; yes = 1, no = 0).

Results and discussion

Socioeconomic characteristics of rice processors

The socioeconomic characteristics of rice processors are presented in Table 2. The table reveals that rice processing in Ebonyi State is dominated by males (86 percent) with 90 percent of the processors being married with average age of 44.46 years and average household size of 7 persons. Onyeneke et al. (2019a) found similar average household size in their study in Ebonyi and Imo States. The gender of value chain actors determines the ease of access to certain resources and vulnerability to climate change impacts (Opiyo et al., 2016). The age of the processors indicates that they are relatively young. This category of value chain actors belongs to the vibrant economically active groups in the society with higher commitment to fulfil family responsibilities and dependents.

Processors on the average spent 10.58 years in formal schooling and had average rice processing experience of 9.56 years. There is poor access to credit (22%). The processors own some assets which aid in communication and access to information. Ninety six percent (96%) owned phones, 81% owned television, and 82% owned radio, while almost a third (32%) owned a car. Majority (78%) of the processors had experienced at least one climate event and they were less dependent on government for support (26%) when such events occurred. The processors' membership of cooperative societies is low (31%) with also little participation (24%) in trainings and workshops. This implies that the processors rarely gain from their social capital networks and possible relevant information dissemination options.

Processors perceived climate risks

The climate risks perceived by the processors are presented in Table 3. The table shows that majority of the processors (88.78%) had observed/perceived increased rainfall intensity as well as prolonged dry season. Frequent floods, rising temperature, severe wind storm, unpredictability of the rain, and late onset of rains were all perceived by 70.41% of the processors while

Table 2. Socioeconomic characteristics of rice processors.

Variable	Mean / percentage
Years in school (years)	10.58
Age (years)	44.46
Household size (number)	6.53
Gender (percent of male)	0.86
Marital status (percent of married)	0.90
Processing experience (years)	9.56
Access to credit (percent of yes)	0.22
Television owner (percent of yes)	0.81
Phone owner (percent of yes)	0.96
Radio owner (percent of yes)	0.82
Car owner (percent of yes)	0.32
Membership of cooperatives (percent of yes)	0.31
Training/workshop participation (percent of yes)	0.24
Frequency of participation in training	0.63
Experienced climate event (percent of yes)	0.78
Reliance on government for support (percent of yes)	0.26

Table 3. Processors perceived climate risks.

Climate risks	Frequency	Percentage
Increased rainfall intensity	87	88.78
Prolonged dry season	87	88.78
Frequent floods	80	81.63
Rising temperature	69	70.41
Severe wind storm	69	70.41
Unpredictability of the rain	73	74.49
Late onset of rain	69	70.41
Early cessation of rain	63	64.29

64.29% perceived early cessation of rains. The level of awareness is a starting point to the decisions to adopt adaptation strategies. Combinations of these atmospheric conditions create largely unfavourable situations like insect pests and disease infestation for grains post-harvesting and at storage which may easily diminish the output of the processor (Tefera, 2012).

Climate adaptation strategies in rice processing

Rice processors have adapted to the perceived/experienced climate events and the adaptation strategies chosen are presented in Table 4. The table shows that the common adaptation strategy among the processors was livelihood diversification adopted by 87.76%. Approximately 51% in each case relied on climate information for making rice processing decisions and stored paddy. This result implies that the processors combine rice processing business with other means of livelihood. Producers tend to diversify their income by engaging in other livelihood activities. Several researchers have reported livelihood diversification as an important strategy in climate risk management in agriculture (Onyeneke et al., 2012; Nwosu et al., 2014; Tarfa et al., 2019; Onyeneke et al., 2019). Reliance on climate information is also an important climate risk management strategy in rice processing because processors tend

Table 4. Climate adaptation strategies in rice processing in Ebonyi State.

Adaptation strategies	Frequency	Percentage
Reliance on climate information	50	51.02
Storing paddy	50	51.02
Selling off paddy	28	28.57
Insurance	8	8.16
Buying small quantities of paddy for processing	40	40.82
Livelihood diversification	86	87.76

to rely on climate predictions and early warning information to adjust their processing activities. Such information help them to know the volume of paddy to process so as to avoid any losses associated with climate risks. Chiputwa et al. (2020), Kumar et al. (2021) and Baffour-Ata et al. (2022) recognised the importance of climate information on agricultural decision-making. Onyeneke et al. (2022) also found that rice marketers relied on climate information and stored paddy rice as climate risk management strategies in paddy and milled rice marketing. Insurance was the least adopted adaptation strategy in managing climate risks in rice processing in the area. This is not unexpected as uptake of insurance among farmers and other actors along agricultural value chains is low (Onyeneke et al., 2020).

Determinants of adaptation strategies by rice processors

The determinants of adaptation strategies by rice processors are presented in Table 5. The adaptation strategy of reliance on climate information for the processors is positively affected by years of schooling, household size, and receiving training on processing/climate management but negatively influenced by their membership of cooperatives. There are evidences of positive relationship between household size and climate change adaptation strategy (Abid et al., 2015; Ali et al., 2016). Processors' choice of storing of paddy was affected positively and significantly by their total income, membership of cooperative, and their receiving training on processing/climate management at 1, 10, and 5% levels of significance, respectively. Similarly, Omotilewa et al. (2018) found that the choice of storing grains in the supply chain in Uganda was very much dependent on the liquidity (available income) and the proven efficiency of the storage technology, otherwise the technical know-how in a 'safety-first' approach.

The adaptation strategy of selling off paddy has only a positive relationship with the age of the processors, which means that as they grow older they tend to adopt this strategy. This can be related to the usual trend of older people who are more reluctant to adopting new and more involved technological innovations. It is quite reasonable that this group would rather settle for common local adaptation measure like selling-off paddy in the face of adverse climate events. Older persons are more likely to adjust to less tasking climate risk minimising strategies (Boansi et al., 2017). The adaptation strategy of insurance had no significant factor determinant for variables relative to the processors.

The climate change adaptation strategy of buying paddy to process in small quantities is positively influenced by the experi-

Table 5. Multivariate probit result of determinants of adaptation by rice processors.

Variables	Reliance on climate information (Y1)	Storing paddy (Y2)	Selling off paddy (Y3)	Insurance (Y4)	Buying small quantities of paddy to process (Y5)	Livelihood diversification (Y6)
Education (X1)	0.069 (2.42)**	-0.044 (-1.35)	0.009 (0.30)	-0.001 (-0.02)	0.021 (0.66)	-0.119 (-1.89)*
Age (X2)	-0.002 (-0.11)	-0.006 (-0.30)	0.044 (2.06)**	0.009 (0.29)	-0.006 (-0.25)	0.013 (0.34)
Household size (X3)	0.084 (1.78)*	-0.038 (-0.88)	0.003 (0.07)	0.004 (0.06)	-0.069 (-1.41)	0.159 (1.52)
Income (X4)	-4.80e-07 (-0.49)	9.10e-06 (3.41)***	-4.37e-08 (-0.04)	2.40e-06 (1.57)	2.00e-06 (1.32)	-2.19e-06 (-2.03)**
Experience (X5)	-0.022 (-0.99)	0.020 (0.90)	-0.037 (-1.49)	-0.012 (-0.33)	-0.022 (-0.88)	-0.041 (-0.96)
Ownership of radio (X6)	-0.042 (-0.11)	-0.498 (-1.29)	0.353 (0.85)	-0.003 (-0.01)	-0.186 (-0.44)	-1.283 (-1.81)*
Ownership of car (X7)	-0.212 (-0.65)	-0.786 (-2.13)	-0.429 (-1.15)	-0.893 (-1.26)	-0.970 (-2.44)**	-0.017 (-0.03)
Membership of cooperative (X8)	-0.844 (-2.20)**	0.606 (1.67)*	-0.505 (-1.37)	0.473 (1.01)	-0.209 (-0.53)	0.076 (0.15)
Training on climate change response (X9)	0.301 (1.93)*	0.323 (2.02)**	0.108 (0.74)	-0.462 (-1.20)	0.095 (0.60)	0.145 (0.60)
Experienced climate event (X10)	-0.104 (-0.30)	-0.043 (-0.13)	-0.271 (-0.76)	0.530 (0.87)	1.968 (3.59)***	1.362 (2.59)**
Wald chi^2		83.47**				

Note: values in parentheses are z-values ***p < 0.01; **p < 0.05; *p < 0.10.

ence of climate events and negatively influenced by the ownership of a car. This is related to the scale of the processor and the alternative use of the car. This means that rice processors processing rice paddy in small quantities may not have serious need of using their cars to buy the small quantities of paddy to process. This may increase the cost of rice processing through fuelling the car. Such processors may opt to using public transport to buy the small quantities or where the farm is close to the processing mill, the processors may choose to walk down to the farm/market to buy the small quantity of paddy to process. The positive relationship of climate events to adoption of adaptation strategies is in conformity with finding of Onyeneke et al. (2020, 2022) in Nigeria, who found positive relationship between climate event experienced and climate adaptation in paddy rice marketing and fish farming, respectively.

Livelihood diversification strategy is positively influenced by processor experience of climate event and negatively affected by the number of years schooling, the total income of the processor, and ownership of a radio asset. This strategy implies processors taking up other income-earning activities to augment the current source of income. This is expected in the instances of lowering income from rice processing activities which may be also due to a rise in the climatic challenges (evidenced from the positive association with experienced climate events). The education variable (years of schooling) with a negative effect on livelihood diversification for the processors may be connected to the processors being highly engaged in multiple activities in the form of combining their rice processing with schooling making it more difficult to further diversify due to limited time.

Interdependency of climate change adaptation in rice processing

The correlation coefficients in Table 6 show weak associations between combinations of the climate adaptation practices by the processors. The significant combinations of practices include between reliance on climate information versus selling off paddy (negative association); reliance on climate information versus livelihood diversification (negative association); storing of paddy versus selling off paddy (positive association); storing of paddy versus insurance (positive association); and storing of paddy versus livelihood diversification (negative association).

Constraints to climate change adaptation in rice processing

There are various constraints to climate change adaptation reported by rice processors in Ebonyi State as presented in Table 7. The common ones include price fluctuations (78.57%), inadequate capital (71.43%), inadequate storage facility (69.39%), high labour cost (69.39%), competition from foreign brands (67.35%), seasonality of paddy supply (64.29%), poor power supply (64.29%), inadequate climate information (57.14%), and poor access road (50%). Processors seem to be less constrained by flood occurrence (34.69%).

Price fluctuations present serious constraints to the RVC through the economic pathway. Rice as a global crop has a large presence in the international market where quantity and qual-

Table 6. Pairwise correlation coefficients of adaptation practices by rice processors.

	Reliance on climate information (Y1)	Storing paddy (Y2)	Selling off paddy (Y3)	Insurance (Y4)	Buying small quantities of paddy to process (Y5)	Livelihood diversification (Y6)
Reliance on climate information (Y1)	1.000					
Storing paddy (Y2)	-0.103	1.000				
Selling off paddy (Y3)	-0.194*	0.258**	1.000			
Insurance (Y4)	-0.006	0.218**	-0.106	1.000		
Buying small quantities of paddy to process (Y5)	-0.100	0.066	0.026	0.132	1.000	
Livelihood diversification (Y6)	-0.242**	-0.179*	-0.108	-0.002	-0.070	1.000

Notes: ***p < 0.01; **p < 0.05; *p < 0.10.

Table 7. Constraints to climate change adaptation by rice processors.

Constraints	Frequency	Percentage
Inadequate capital	70	71.43
Inadequate storage facility	68	69.39
Seasonality of paddy supply	63	64.29
Poor access to markets	43	43.88
Flood	34	34.69
High labour cost	68	69.39
Poor power supply	63	64.29
Inadequate climate information	56	57.14
Poor access road	49	50.00
Price fluctuation	77	78.57
Barriers to industry entry	45	45.92
Competition from foreign brands	66	67.35

ity are used to dominate the less efficient domestic markets of developing countries making them susceptible to external price shocks. Price instability in the domestic economy creates serious challenges to the RVC because of this international market influence thus reducing the returns to the rice sector to provide the financial capacity of the actors to adopt adaptation strategies in the face of climate change challenges and maintain supply. This may well result in a downward spiralling trend of hardship for the sector without proper intervention. Climate change is known to increase the price volatility of these food commodities with a reduction in supply (Adams et al., 1998).

Inadequate capital is a major constraint interrelated with almost all the other barriers to adoption of climate adaptation strategies. Literature widely acknowledges the challenges of financing the adoption of new technology and the liquidity constraints applicable especially in the business of agriculture (Abid et al., 2015; Omotilewa et al., 2018; Ojo, Baiyeghuni, 2020). The processors highlighted the inadequacy of storage facility as a major barrier to adoption. Storing is a major facilitative function of these groups of value chain actors such that it may seem they are the 'storage bank' of the other actors aggregating large quantities of paddy and un-milled rice while processing regularly. They otherwise bear the cost of the crop deterioration induced by climate changes and insect pest and diseases infestation in store. Hence, they fail to reap all benefits accruing from their services but rather incur quantitative and qualitative losses which further limit their capacity to adapt.

Rice processing is a labour-intensive process involving both manual and mechanical operations (Akpokodje et al., 2001). High cost of labour contributes to the barriers to adoption of adaptation strategies by increasing the liquidity constraints making it difficult for the RVC actor to satisfy the financial implications and installation of the adaptation measure. Locally produced rice has continued to face a stiff competition from the foreign brands since the era of trade liberalisation and importation of the various brands of polished rice. This is also exacerbated with smuggled of cheap foreign rice into the country (Johnson, Dorosh, 2017). The unfair competition has always existed because the countries exporting to Nigeria are developed countries with a rice sub-sector well advanced beyond the stage of the developing countries. Hence, the slightest inefficiencies of the domestic rice market are quickly replaced by the readily available imported rice commodities. A reduction in demand for the domestic rice commodity creates a disincentive towards investment in the issues of the rice domestic sector like adaptation and proper climate risk management.

Seasonality of paddy supply is associated with the seasonality of rice production which is as a result of the large dependence on rain-fed agriculture in many parts of the country. This simply means the RVC actors like the processors will be out of work for certain periods of the year, hence limiting the income earnings and proper investment in the rice industry. Seasonality also affects the price of the commodity. Processors also identified constraints of power supply and access road networks which are common with the Nigerian business environment more especially in the rural areas. The regular activities of rice processing ordinarily consume a lot of electric power supply which is mostly personally generated by these processors in the first place. Hence, additional activities which involve more electric power energy supply entail more costs of production and reduction in little profit margins, a burden the processors are not usually willing to bear. Whereas, bad road networks to both the farm gate and processor plants/mills compound the cost challenges because the processors have to devise a means to haul truckloads of paddy and un-milled rice on hardly motorable terrains to stay in production. This frustrates the idea of other investment activities.

Conclusion

The adaptation practices among rice processors include reliance on climate information for making rice processing decisions, storing of paddy, selling-off paddy, insurance, buying paddy in small quantities, and livelihood diversification. Certain socio-economic and institutional characteristics determined the use (singly or combined) of adaptation strategies by rice processors. The major factors include years of schooling, membership of co-operatives/associations, training on rice processing and climate change management, income earnings, ownership of assets, and experienced climate change hazards. On the other hand, the processors were faced with various barriers to the adoption of climate adaptation strategies. These constraints cut across market situations, capital and resource availability for the industry, basic infrastructure, and access to information.

The various findings have important policy implications for policymakers and rice value chain actors. Local adaptation practices are important as first line course of action in climate risk management. Capacity of rice processors must be built through government support. This is necessary to scale up adaptation strategies in processing. Policies and programmes that would improve processing facilities, storage equipment, promote uptake of weather-based index insurance in rice processing, and build the adaptive capacity of rice processors will reduce the vulnerability of the rice value change to climate change impacts. Policies that will protect the rice sub-sector from undue foreign influence are recommended to achieve the desired sustainable development and efficiency of the domestic industry to face global competition. There is the obvious need to adequately educate and regularly train rice processors on the importance of being members of cooperatives/associations. Regular workshops for rice processors and other value chain actors on international and local best practices on climate change risk management in rice value chain will also enhance the resilience of the rice sector to climate change. Also the relevant government ministries and agencies should provide communities with regular climate change information in comprehensible and economically clear terms.

Acknowledgements

This study is part of the output of the research funded by the Tertiary Education Trust Fund (TETFund) of the Federal Republic of Nigeria. The Grant ID is FUNAI/FA/BI/18/002. We are grateful to TETFund for providing the fund for the research.

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