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Effects of Climate Change on Orange Cultivation: A Case Study of Orange Cultivators of Jatinga Village, Dima Hasao

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Abstract

It has been a common expression of the dwellers of Jatinga that 'mother nature has always been kind to Jatinga', a village of Dima Hasao District of Assam, known for its favourable climate and thriving orange production. But the changing climatic condition including fluctuation of rainfall, wind pattern, and temperature, frequent occurrence of wind storms and landslides faded the glory and fame of the village and put forth a challenge to the cultivators. Through qualitative case studies, this study gathered insights from six orange cultivators in Jatinga to understand how orange production has evolved in the midst of increasing climate change. Respondents reported shortened fruiting periods, slow growth, and alterations in fruit size and shape, leading to an overall decline both in quantity and quality over a period of time. The economic strain caused by reduced productivity has also raise concerns about their food security. The study also highlights the need for community

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Effects of Climate Change on Orange Cultivation: A Case Study...

147

resilience in dealing with the issue suggesting three key strategies including fostering collective action, strengthening knowledge networks, and enhancing social ties. These approaches could help farmers adapt to changing conditions thereby sustaining their livelihoods

Keywords: Climate change, Orange, Jatinga, community resilience, livelihood.

Introduction

Climate change is an undeniable reality that is no longer uncertain 'but an unavoidable event that is damaging the planet at an alarming pace, an outcome of over 200 years of excessive greenhouse gas (GHG) emissions from fossil fuel combustion in energy generation, transport and industry, deforestation, and intensive agriculture' (Kais & Islam, 2016). The consequences are far reaching, posing significant risks to human societies through shifts in temperatures, precipitation patterns, sea-level rise, disruption in seasonal cycles, and increased occurrenceof floods, cyclones, wildfires, and other natural disasters. This has a longlasting impact on various sector of which agriculture is one. It has been estimated that for every degree Celsius rise in the global mean temperature, the global rice yield drops by an average of 3.7%, the global maize yield drops by 4.5%, the global wheat yield drops by 2.9%, and the global soybean yield drops by 3.1% (Zhao et al., 2017). Future projections suggest that by the year 2100, the global temperature may experience an increase ranging from 1.8 to 4.0°C, with a heightened likelihood of more significant increases occurring over terrestrial and arid areas. Furthermore, the anticipated rise in sea levels is expected to exacerbate the vulnerability of agricultural lands situated in coastal zones to flooding (Wheeler & Von Braun, 2013). In the Asian continent, it has been documented that the productivity of rice and wheat has experienced a reduction since the 1980s, approximately amounting to an 8% decrease for each incremental rise in temperature of 1°C (Bandara & Cai, 2014). It has been projected that the summer temperature in some parts of this region is likely to increase by '3°C-6°C at a scenario of 4°C global warming and by 2°C at a scenario of 2°C global warming by 2100' (Bandara & Cai, 2014). Such prediction indicates major crop productivity will decline in South Asian countries. This presents a considerable risk to a

148 Emerging Dimensions of Business, Economics, Media and Financial..

region wherein more than 70% of the population (approximately 1.1 billion individuals) resides in rural localities predominantly engaged in agricultural activities and constitutes nearly 75% of the poor within the region. (Bandara & Cai, 2014).

In India, climate events like the droughts of 2002 and 2009 caused a big drop in food grain production. The extreme cold wave in the winter of 2002-2003 hurt fruit trees like mango, litchi, wheat, and mustard, as well as boro rice in Assam. And the sudden rise in temperature in March 2004 caused wheat crops to mature early, apples to flower early, and rapeseed and mustard plants to fail to make pods, and productivity losses of 10-25% in crops like onion, garlic, broccoli, carrot, radish, and turnip (Singh, 2016). Similarly, the 2012–2013 drought in nine villages in Maharashtra's Jalna district, as studied by Vedeld et al. (2014), also resulted in most farmers experiencing significant crop losses averaging around 50% to 60%. Zhao et al. (2017) estimated that an average of 3.8% of rice crops in India decline for each 1° increase in temperature. It has been predicted that variations in temperature, solar radiation, and precipitation will significantly impact agricultural productivity of both crops and livestock in India (Khan et al., 2009), with states such as Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, and Uttar Pradesh being categorized as highly and extremely vulnerable from the years 2021 to 2050 (Rao et al., 2013).

In view of the climatic impact on agricultural production on a global, regional, and national scale, this study shifts its focus to the local scale, specifically Jatinga, a village historically known for its robust orange production. The objective is to understand how orange cultivation has evolved over a period of time in the face of increasing climate change. To achieve this, the study brings in case studies from six orange producers in the village, taking into account their perspective of climate change and its effects on orange production over the years. This localised approach provides valuable insights into the real-time challenges faced by farmers.

History of climate change in Jatinga Village (source: Jatinga centennial souvenir, 1905-2005, village council secretary)

Jatinga village is located in Dima Hasao district of Assam and was founded in 1905. It covers an area of 48 sq km and approximately

440 households and 2500 people. The main occupation of the village comes from jhum cultivation, with 90% of major production being oranges, pineapples, ginger, and culantro.

Jatinga village has long been recognized for its favourable climate, characterised by fog and light rainfall from August to October, followed by clear skies in November. The village soil is also found to be fertile, enriched with all the thirteen elements of plant nutrients, making it highly suitable for agriculture. Orange cultivation in the village began in 1914 as the village's second major economic crop after betel vine. It quickly flourished with remarkable yield, with a single tree producing an average of 2000 and 2500 oranges, and each family cultivating an average of 1000 trees. This success earned Jatinga widespread recognition for its orange production. By the 1930s the village had become so prosperous that the villagers even donated money to the Britishers during the war, as there was a good relation between them. In fact, it was regarded as the richest village in Asia during those days. They also contributed to the infrastructure development, particularly the market shed in Haflong town.

However, after 1947, the orchards were devastated by Dieback (locally known as KjutBainong), leaving only 10% of the orchard to survive. Farmers then relocated their plantations to a different land, which initially restored productivity and economic prosperity. In 1952, when the district council was formed, the people of Jatinga contributed a huge sum of money during its initial state of formation. In the 1970s and 80s, the villagers could supply all requirements to the fruit factory set up at the outskirts of the village. This indicates the prosperity of the village's orange production. Unfortunately, in 1990, the disease resurfaced, once again threatening orange cultivation, and the economic condition of the people was greatly affected as a result. In 2000, experienced farmers, in collaboration with the field officers of the agriculture departmentof the government, once again conducted a trial, and it brought promising results. In the year 2004-05, the Horticulture Technology Mission provided financial support for a 25-hectare expansion of orange plantations, making another effort to restore Jatinga's reputation as a thriving centre for orange farming.

149

150

Methodology

This study was guided by two key research questions: "What significance does orange production hold for the community?" and "In what way has climate change affected orange production in the village?" Six participants engaged with orange cultivation were selected purposively based on their long-standing relationship with orange farming, allowing for a detailed understanding of trends and changes over the years. Through detailed narratives and firsthand accounts, the study aimed to capture the complexity of the issue beyond statistical trends. By documenting the experiences of orange farmers and highlighting their voices, the study aspires to guide researchers, policymakers, and stakeholders in crafting effective, context-specific interventions to address the issue.

Results

Case 1. An orange cultivator with nearly 20 years of experience described the fruit as an integral part of the village's identity, also serving as a primary source of income and playing a crucial role in household food security. Reflecting on production trends, the participant recalled a time when orange yields were consistently high, and fruit quality was remarkable and famous. However, in recent years, both have shown a marked decline. Regarding climate change, the participant expressed their opinion that there have been changes in the environment, specifically rising temperatures, unseasonal rain, and stronger wind patterns, along with an increase in extreme weather events such as storms and landslides. They even attributed the decrease in fruit production to these conditions. The participants also reported that fruiting periods had become shorter and growth had slowed, leading to a simultaneous decline in both yield and quality. The participant also perceived a significant decline in household income as a result of poor production in the current day. The respondent also reported a feeling of anxiety about the future of the village's agricultural production and disappointment; however, they expressed a willingness to explore alternative strategies to sustain their livelihood.

Case 2. Another respondent with 5-10 years of experience perceived orange cultivation to be a primary source of income for

their household, critical for their food security. Additionally, it also acts as a key source of employment for local labourers, making it an essential aspect of the community's economic fabric. Similar to the first case, the respondent recalled a period when orange production was consistently high both in quantity and quality. However, in recent years, they have observed a noticeable decline and attributed the issue to the stronger wind patterns and frequent occurrence of landslides and storms that have been frequently evident in recent years. Beyond declining yields, the respondent also observed noticeable changes in the fruit characteristics, specifically insize and shape, alongside a significant slowdown in tree growth. The participant also expressed deep concern about the possibility of losing their livelihood due to these climatic changes, as they have noticed a substantial decrease in their income in recent years, making it difficult to afford food. As a result, their family has faced instances where they had to reduce meal portions or eat less than they desired. This highlights the economic strain caused by the declining orange yield.

Case 3. The third respondent, with almost 10 years of experience in orange cultivation, sees orange farming as a source of pride for the village, taking into account the reputation of good quality it carries through the years and its significant yield. According to the participant, oranges have historically symbolized the village's prosperity. However, they expressed concern that both the quality and quantity of production have declined over time. The respondent reported experiencing significant climatic changes, including an increase in the frequency of landslides and hailstorms in recent years. They also perceived a change in the rain and wind patterns, which have resulted in delayed flowering, a shortened fruiting period, and slow growth. Additionally, the frequent occurrence of hailstorm caused extensive damage to the fruit; further exacerbating the decline in yield and quality. For this respondent, orange cultivation serves both as a primary and a secondary source of income. However, as climate-related challenges continue to disrupt production; their financial stability is impacted, raising concerns about the future of their livelihood.

Case 4. The fourth respondent, who has been cultivating oranges for more than 20 years, considers orange farming their primary source of income. Reflecting on the past years, they recalled

151

that orange production was once marked by both high quality and substantial yields. However, over time, they have observed a significant decline in both aspects, with the quantity of production decreasing drastically in recent years. The respondent attributed this decline to multiple climate events, including the rise in temperature, increased pest infestation, and decreasing soil fertility as major challenges. Additionally, extreme weather events such as storms, unseasonal rains, and strong winds have further disrupted production. These climatic changes have led to an early yet shortenedfruiting period. While the quality at times still remains good, the overall quantity has become insufficient, directly impacting their income. The respondent expressed deep concern over their financial stability, stating that the reduced harvest has significantly affected their ability to meet daily expenses, recalling instances when their household struggled to afford enough food, sometimes having to limit their meals due to this constraint.

Case 5. A female cultivator with almost 20 years of experience perceives orange farming as an integral part of her village's identity and prosperity. She recalls that orange production historically maintained a high yield, which served as a marker of economic stability and a key source of employment for local labourers. However, over the years, she has witnessed significant changes that have affected cultivation patterns and overall productivity. The respondent reported a steady rise in temperature, increased pest infestation, and a decrease in soil fertility. In recent years, extreme climate events such as unseasonal rains, strong winds, delayed monsoons, and changes insoil moisture levels have become more frequent. These changes have led to a substantial decline in the quantity of production, though she noted that the fruit's quality has remained relatively stable. She also observed noticeable changes in the fruit's growth cycle, including early fruiting and fast growth yet a shortened fruiting period. Additionally, she pointed out that the size and shape of the fruit have altered over time. There is a sense of fear expressed by the respondent that she might lose their livelihood source as climate change worsens. Like many others, she also faces financial hardship, often struggling to afford sufficient food due to reduced income from declining orange yields.

Case 6. A cultivator of around 6 years of experience reflected on the history of orange cultivation in Jatinga village, recalling how it was successfully cultivated, prospering the people and the community. Given their limited experience, the respondent found it difficult to differentiate production trends over the year of their practice. However, they expressed dissatisfaction with the quality. Despite acknowledging the experience of less rainfall and changes in the wind pattern, the respondent is unable to determine whether these factors are responsible for the crop's poor quality. However, there is a slow growth process observed by them. The respondent also raises a concern about their financial stability if the quality of the fruit is not improving. And although income has been affected, the respondent stated that their household has not yet faced any sort of food insecurity. Furthermore, they are willing to opt for alternative crops or income strategies.

Discussion and Recommendation

Findings from the case studies indicate a clear pattern of climateinduced challenges affecting orange cultivators in Jatinga village. Across all six cases, respondents acknowledge the thriving orange cultivation in the past. However, a consistent decline in quantity and, in some cases, the quality of orange production was pointed out in the present times. There is also a consensus in almost all the cases concerning the climate change conditions that are prevalent in the present times, including rising temperatures, changing wind and rain patterns, frequent storms and landslides, and pest infestations, and an agreement that these environmental shifts have led to shorter fruiting periods, slower tree growth, and alterations in fruit size and shape. These findings align with Khan et al.'s (2009) prediction of the effects climate change conditions, including changes in temperature and precipitation, will have on crop productivity.

A significant concern across all cases is the economic strain placed on cultivators due to reduced yields. As orange cultivation is a primary source of income for many, its decline directly impacts food security. Several respondents reported struggling to afford food, with some even reducing their meal portions. A village that once was thriving economically because of orange production now faces challenges to afford food. This finding is not something

154 Emerging Dimensions of Business, Economics, Media and Financial..

new.There exists empirical evidence indicating economic losses attributable to climate change, as demonstrated in the works of Vedeld et al. (2014) and Rahman et al. (2021).

While there is a sense of willingness to explore alternative strategies, the situation indicates the need for community resiliency. Infact, Magis (2010) widely acknowledges community resiliency as an important indicator of social sustainability. Kais & Islam (2016) further assert that only a resilient community can successfully overcome stresses including climate disruptions.'Amoak et al. (2022) further underscore that the persistent ramifications of climate change are 'expected to intensify in the face of minimal adaptation capacities in poor-resource contexts. 'This necessitates the need tofoster a resilient community for the cause. The following section provides some of the strategies that have helped build community resilience against climate-induced challenges.

One way is through fostering collective action. It was observed in a study how locally organised farmer groups in Kenya and eastern Uganda engaged in collective efforts in response to the challenges of negative crop productivity they encounter as a result of erratic rainfall and land degradation that further exacerbates the looming crisis of hunger and starvation in the region. These groups come together and take action in response to the ill climate-driven unproductivity. Their collective action revolves around pooling of resources, group savings and loans, knowledge production, and networking with external entities. In resource pooling, group members shared essential agricultural inputs such as seeds and tools. They also organised labour pooling, where they worked on each other's plots and engaged in joint cultivation of group plots. Further, they collectively engage in the construction and management of shared infrastructure, including water ponds for irrigation, drainage systems for wetland cultivation, soil and water conservation structures, manure production, and fish farming facilities. Group members also contribute to a collective fund, from which they can access low-interest loans. The fund's savings are also distributed among the members annually and are used for activities, particularly those related to food production and off-farm diversification, as well as for essential services like health checkups, medication, etc. Additionally, the savings also serve as a safety net, helping

members avoid selling household assets during emergencies. The group members also exchange and produce knowledge through exchanging insights on various agricultural practices, techniques, and approaches. They also engage in joint experimentation and innovation, as well as share market information, enabling them to make informed economic decisions and therefore improve productivity. Furthermore, the group networks and collaborates with external members by conducting trainings to share farming techniques and natural resource management practices within the community. All these components contribute to building a more sustainable, cooperative approach that helps them cope and with stand the climate-induced challenges they encounter (Andersson & Gabrielsson, 2012). Given the absence of farmers's association in the village, this study strongly recommends implementing this strategy.

Secondly, community resilience against climate-induced challenges can be achieved through fostering knowledge networks. It was observed that knowledge networks where communities have access to information about climate extreme events, access to weather forecasts, rain forecasts in advance, and information related to fertilisers, agrochemicals, seeds, etc. have a positive influence on the uptake of all adaptation practices as they facilitates the implementation of sustainable farming techniques, including soil conservation measures like micro-catchments and terracing, the introduction of high-yielding and more resistant crop varieties, the introduction of drought-tolerant, diseaseresistant, and pest-resistant crop varieties, the management of pests and crops, and the adoption of using fertilisers and agrochemicals, each of which is an option or approach for coping with the effects of climate change (De Jalon et al., 2018). Such agricultural knowledge networks play a critical role in fostering innovation in practices, such as the introduction of novel crops, alternative methodologies, advanced planting techniques, contemporary pest management strategies-including the employment of innovative pesticides-non-chemical weed control methods like plastic mulch, chemical applications such as hormones to promote flowering, the utilization of soil enhancers, the deployment of heavy machinery, or sophisticated water management practices including novel irrigation systems, as

156 Emerging Dimensions of Business, Economics, Media and Financial..

well as seedling development within the agricultural framework, particularly observable in smallholder farming communities across the Caribbean region (Saint Ville et al., 2016). Furthermore, these platforms offer opportunities to sustain the production of traditional varieties by preserving traditional knowledge of seed saving and processing, thereby increasing production (Helicke, 2019).

Another way that can help build community resilience is through fostering social ties among community members. This is critical during or after shocks. It was observed that shocks like drought negatively affect food consumption levels in Ethiopian rural households. However, the help and support households receive from individuals they are close to, consider important, or can rely on during hardships, both within and outside the village, smooths the food consumption level during such situations (Wossen et al., 2016). It appears that these ties can increase chances for individuals who are vulnerable to food to ask for assistance. Similarly, it enables individuals and communities to band together in response to the impact of floods in Australia (Boon, 2014). In the context of Jatinga village, this practice can help people address food insecurity issues during landslides and storms.

Conclusion

The data presented regarding the adverse effects of climate change on the production of oranges indicates a significant imperative to implement measures aimed at mitigating negative climatic influences and to bolster this vital source of livelihood for the community. The Intergovernmental Panel on Climate Change (IPCC) has additionally cautioned that 'Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all (IPCC2022, as stated in Amoak et al., 2022).' This underscores the urgency of the need. While multiple initiatives have been taken to combat climate change issues, the study acknowledges the existence of a small but dedicated group that facilitates collective action, knowledge networks, and social support and celebrates their critical role in the matter. Moreover, it underscores the necessity for governments to recognize these local social institutions for their essential contributions to the establishment of resilient communities and the mitigation of climate-induced challenges. Furthermore, there is a pressing need for policies that facilitate the integration and amplification of these isolated initiatives to disseminate and scale locally validated strategies and practices.

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157

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