Drivers and Consequences of CP Maize Cultivation:

A Socio-Economic and Environmental Analysis in Southern Shan State, Myanmar (2023–2024)

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Abstract

As hybrid maize cultivation continues to reshape agricultural livelihoods in Myanmar, understanding its complex socio-economic and environmental implications has become increasingly important. Since its introduction in the mid-1990s, CP hybrid maize has expanded rapidly across Southern Shan State due to its high yield potential, strong market demand, and contribution to household income. Existing studies have documented the economic opportunities and environmental consequences of CP maize cultivation before 2021; however, they provide limited evidence on how the post-2021 political crisis has altered farmers' experiences and the sustainability of maize production. This study addresses this gap by examining the drivers of CP maize cultivation and its socio-economic and environmental consequences in Southern Shan State, Myanmar, during 2023–2024. A qualitative research design was employed using purposive and snowball sampling. Primary data were collected through in-depth interviews and focus group discussions with 17 participants, including CP maize farmers, agricultural experts, community leaders, and environmental activists. The findings reveal that farmers continue cultivating CP maize because of its resilience, relatively low labor requirements, strong market demand, and perceived income opportunities. Nevertheless, they face escalating production costs, dependence on brokers, counterfeit seeds, inadequate technical support, unpredictable weather, and volatile market prices, all of which intensify financial insecurity. Environmentally, intensive monocropping and excessive chemical inputs contribute to soil degradation, biodiversity loss, and deforestation, threatening long-term agricultural sustainability. The study recommends strengthening agricultural research and extension services, improving farmers' access to technical knowledge and quality agricultural inputs, establishing fairer market systems to reduce price instability, and promoting sustainable farming practices, including crop rotation, organic fertilizer application, and improved soil management. These measures can enhance farmers' resilience while supporting environmentally sustainable agricultural development in Southern Shan State.

Keywords: *CP maize cultivation, socio-economic impacts, environmental impacts, sustainable agriculture, Market instability, Political crisis, Southern Shan State, Myanmar.*

List of Acronyms

CP	— Charoen Pokphand
CP Maize	— Charoen Pokphand Hybrid Maize
CPP Myanmar	— Charoen Pokphand Produce Myanmar
FGD	— Focus Group Discussion
NGO	— Non-Governmental Organization
MMK	— Myanmar Kyat
NPK	— Nitrogen-Phosphorus-Potassium (fertilizer)

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1. Introduction

Background Information, Literature Review, and Problem Statement

The Thai company Charoen Pokphand (CP) introduced Hybrid maize[1] to Myanmar in the mid-1990s (FAO, 2019 as cited in Fang & Belton, 2020a). The introduction of hybrid maize by Thai companies resulted in the expansion of maize cultivation in Myanmar, which led to increased demand from the domestic animal feed industry. These factors encouraged the export of maize to China which became one of the main drivers of Myanmar's maize cultivation development (USDA, 2019 as cited in Fang & Belton, 2020). For example, maize production increased from 298,000 tons to 1.91 million tons due to increased exports to China and the growth of the domestic animal feed industry in Myanmar. From that point on, maize has become the second main important crop in Myanmar, after rice (Prasanna et al., 2014). Maize cultivation played an important role in improving farming and the economy in Myanmar while Shan State produced the most maize in Myanmar (Htwe, 2020). Fang and Belton (2020a) reported that the hybrid maize seed market has expanded rapidly since 2012. The adoption of hybrid maize varieties increased significantly over time, with 81% of hybrid maize farms using CP varieties in 2007 and 2012. By 2017, approximately 86% of maize farmers in Southern Shan State had adopted hybrid maize seeds.

According to Rujivanarom (2020), Before the introduction of CP maize to farmers in Shan State, local farmers cultivated traditional crops such as rice, millet, and soybean using traditional farming methods. After that, CPP Myanmar, a subsidiary of Thailand's CP group, has become the dominant player in Myanmar's maize seed market by promoting CP maize cultivation, enabling local farmers to gain economic benefits from its adoption. Over the past decade, more than 80% of local seed varieties in Shan State have disappeared and been replaced by CP maize varieties. An increasing number of farmers are shifting from local maize seeds to CP maize cultivation to increase their income and improve their livelihoods.

Maize farmers from Shan State are hopeful of achieving higher yields and better profits from cultivating CP maize and they believe it can help improve their livelihoods in the future (Fang & Belton, 2020a). Some farmers have been able to invest in larger landholdings and use better equipment for growing CP maize aimed at increasing household income. Many farmers agreed that maize farming needs less labor compared to other crops. Additionally, farmers expressed positive views about maize cultivation, stating that it is easy to grow, more suitable than previous farming practices, and more resistant to adverse weather conditions than other crops (Fang & Belton, 2020).

[1] *Hybrid Maize is the first-generation (F1) offspring produced by crossing two genetically distinct, inbred parent lines, aiming to achieve higher yields and greater resistance to environmental stress.*

Although farmers hoped to improve their household income and food security through CP maize cultivation, they faced significant economic challenges in reality. Farmers with limited financial resources often obtain cash and agricultural input loans, such as seeds and fertilizer, from brokers during the CP maize planting season. After the harvest, they are required to repay these loans with interest and frequently sell their maize to the same brokers at below-market prices, as maize prices typically decline during the harvest season. As a result, many smallholder farmers fall into debt traps, leading to the loss of essential assets such as livestock and land. Overall, CP maize farmers has contributed to increased indebtedness, asset loss, and rising household debt levels among previously middle- and lower-income households (Woods, 2015). The cultivation of CP maize in Shan State has changed the farming practices, transforming low-input to high-input, which causes financial pressure.
Furthermore, CP maize cultivation requires a high amount of chemical fertilizers and herbicides over time which increase the input cost and has adverse effects on the environment. The application of compound fertilizer for long-term CP maize monocropping decreases soil fertility and quality (Fang and Belton, 2020).

Existing studies have highlighted the rapid expansion of CP maize cultivation in Southern Shan State, Myanmar, and have discussed the economic challenges faced by CP maize farmers as well as the environmental consequences of maize production prior to 2021. However, most existing research has overlooked the emerging challenges faced by CP maize farmers following Myanmar's 2021 political crisis which cause economic instability, high inflation, declining market prices, and transportation difficulties, all of which have further worsened farmers' economic burdens and contributed to increased uncertainty, anxiety, and psychological distress. Furthermore, limited research has examined the factors driving the continued cultivation of CP maize and its socioeconomic and environmental consequences in the post-2021 political crisis context of Southern Shan State. Therefore, this study explored the factors driving CP maize cultivation and examined its socioeconomic and environmental impacts in Southern Shan State, Myanmar, between 2023 and 2024.

2. Methodology

This study was carried out by three researchers from diverse regions and ethnicities, all with experience working in farming. This research explored factors influencing cp maize cultivation in Southern Shan State and the consequences of CP maize cultivation especially in socioeconomic and environmental impacts through qualitative methodology to get deeper insights.

The researchers used a purposive and snowball sampling method, which helped the study effectively in collecting the primary data from participants who have extensive experience, deep knowledge, and familiarity with the research topic.

Before conducting the interviews, the researchers sent consent forms to targeted interview participants to ensure that all participants clearly understand the purpose of the study and agreed to take part in this research voluntarily. After the participation agreements, the actual interview questions were sent to all samples in advance, allowing them to prepare their answers and readiness. The research interview sections were conducted through both online (Zoom meeting platform), and in person in April 2025.

This study involved 17 participants, including 12 CP maize farmers, 2 community leaders, 2 agricultural experts, and 1 environmental activist. These diverse participants were selected to provide a wide range of experience and perspective on maize cultivation. Their varied experiences helped the researchers obtain deeper and more comprehensive data regarding CP maize cultivation practices, economic challenges, and environmental concerns. The participants were chosen from different places in Southern Shan State: 24% from Pindaya township, 18% from Kalaw towns, 24% from Hopong township, and 35% from Taunggyi township. Additionally, the researchers balanced gender inclusivity with 53% of males and 47% of females *(see Figure 1)*.

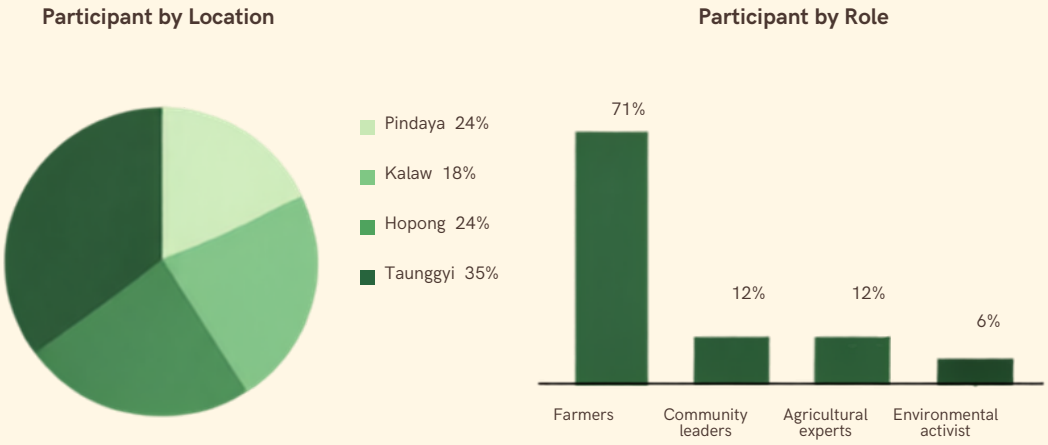

Figure 1. Composition of the 17 study participants, by location and by role.

During the implementation of the data-collecting process, the researchers faced some challenges. Firstly, the researchers could not reach the expected number of participants. Initially, the researchers planned to include more samples, but some participants were difficult to find, some canceled their participation due to security concerns. Therefore, the researchers were only able to interview 17 participants. However, the researchers carefully selected participants from different backgrounds that related to the study to ensure the reliability and validity of the findings. The researchers applied an in-depth interview, focus group discussion (FGDs) method to collect primary. To safeguard research participants' and organizations' safety, this report structures withinheld their names and other official displays.

3. Finding and Discussion

3.1 Drivers of CP Maize Cultivation and Farmers' Expectations

This research revealed the favorable qualities of CP maize, good advertisements and market demand and economic benefits which are key factors for farmers in Southern Shan State to cultivate CP maize. As CP maize is seen as resilient to weather, less labor required and quick to generate income than other crops. Furthermore, connection to strong market demand and storability also inspired farmers' decisions. These factors reflect both farmers' decisions and expectations on CP maize cultivation that can improve their socio-economic status. The first sections below discuss CP maize quality and external influence, market demand and income generation.

Farmers in Southern Shan State see CP maize as a practical and low-risk crop, which strongly shapes their decision to cultivate it. Several features of CP maize explain this preference. Farmers highlighted that the crop is resistant to strong wind and tolerant of heavy flooding, which reduces the risk of total crop loss during extreme weather events.In addition, they noted that the cultivation process is shorter and easier compared to other crops, since it mainly involves planting, weeding, and harvesting activities. One farmer explained:

> *"Growing CP maize is simple; we don't need many people, only a few steps, and then we can get the harvest."*

This simplicity means that CP maize requires less labor, which is particularly important given widespread labor shortages in the region due to migration and other livelihood shifts.

The access of information and external influences motivated and led to extension of CP maize cultivation for farmers in Southern Shan State. Farmers first learned about CP maize through peer sharing as well as from farmers in the surrounding area who had grown CP maize and had already adopted it successfully. As one farmer pointed out:

> *"We first learned about CP maize through neighbors' farmers and they said CP hybrid seeds would give good yields and we started planting it."*

On the other hand, the advertisements by CP company in 2007 and 2008, fertilizer companies and local traders promoted the interest on it as they introduced the crop's benefits through providing advice and input packages. This demonstrates that farmers' decisions to adopt new crops are influenced not only by technical characteristics but also by social networks and market actors. It highlights the important role of information flows and promotional strategies in shaping the transformation of local farming practices.

Another major influence on CP maize cultivation is strong market demand, leading to increase farmers' expectations on income generation. Farmers originally grow maize as for cattle feed, later it was transformed into a major activity of household income' source as farmers view CP maize as a crop with lower risk of loss, high yield potential and opportunities for getting extra income. Additionally, the storability of CP maize makes it an attractive option for farmers, as it allows them to store their maize until market prices become more favorable, providing greater flexibility in the timing of sales. Plus, the cultivation season for the crop is short starting from June to September during the rainy season enables farmers to generate income within a few months which supports them not only household income like food, healthcare, and school fees but also reinvent the earning as capital for farms. One of the CP maize farmers clarified the positive aspect of CP maize cultivation, saying that:

> *"We grow maize to support our basic needs like food and clothing. Though it's just one crop, it helps sustain us for extra income. After maize harvesting season, it serves as extra income. So, CP maize farming supports both our livelihoods and investment for other agriculture."*

So, CP maize is more than just a crop, highlighting it as a foundation for socioeconomic growth for farmers.

In short, the factors influencing farmers' decisions to cultivate the crop are the advantages features of the crop such as less labor inquiries, strong external promotion, and strong market demand which encouraged farmers to cultivate CP maize as a reliable source of income and livelihood growth.

3.2 Socio-Economic Challenges Throughout the CP Maize Production Cycle

Despite the CP maize cultivation presenting numerous advantages, CP maize farmers faced challenges that threaten their income, well-being, and livelihoods of farmers in Southern Shan State. Before cultivation, farmers faced some challenges like high input costs, less access to soil measurement materials, and the impact of uncertified seeds, which caused them significant financial challenges, and profit loss. Weed germination and unpredictable weather conditions, and lack of agricultural knowledge and technical support during the cultivation and growing stages, all of which decrease yields and profitability. After the harvesting period, farmers face price instability due to transportation sensitivity, unbalances between supply and demand, and maize quality, often forcing them to sell at a loss and becoming financial stresses. Therefore, this section explores the main challenges faced by CP maize farmers, including before cultivation, during cultivation, and after harvesting which collectively threaten farmers' socio-economic status.

3.2.1 Pre-Cultivation Financial and Input Challenges

Before the cultivation process, serious challenges were faced by CP maize farmers which threatened their ability to get profits from CP maize cultivation. Due to financial and technical barriers, that stage plays a significant role in determining crop success and this stage has become increasingly difficult, yet for most smallholder farmers in Southern Shan State. Limited access to information and agricultural support prevents farmers from making informed decisions about soil fertility and nutrient management. In addition, rising input costs, including fertilizer, seeds, and labor, place significant financial pressure on farmers. Farmers are increasingly affected by the use or availability of uncertified seeds. These seeds may be of poor quality or unreliable, putting farmers at greater risk of crop failure and financial losses. Therefore, this section addresses the key challenges farmers face before cultivating CP maize, specifically expensive input requires, the lack access to soil measurement materials, and the risk of purchasing uncertified seeds.

In 2023 and 2024, as a consequence of political instability and structural changes, the expenses required for CP maize farming such as labor wages, fertilizer and seed purchases have been gradually increasing. Farmers reported that before 2021, the price of fertilizer was around 100,000 MMK per bag, the price of CP maize seed was about 80,000 MMK per bag, and average daily labor wages were about 10,000 MMK. However, by 2024, the price of fertilizer reached 180,000 MMK per bag, seed prices have risen to 150,000 MMK per bag, and daily labor wages doubled to 20,000 MMK, showing an increasement compared to the pre-2021 period. *(see Figure 2)* Due to these general usage costs have risen, farmers suffer financial pressure for growing CP maize. Therefore, farmers who cannot afford to purchase agricultural inputs rely on cash and input loans from brokers to cover their production costs, increasing their risk of falling into debt. One of the farmers from Hopong Township stated:

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"When we do not have enough money to buy agricultural inputs for CP maize cultivation because input prices have increased following the political changes, we borrow cash, seeds, and fertilizers from brokers. After harvesting the maize, we have to sell our harvest back to the same brokers and repay the loan with interest. When maize prices fall during the harvest season, we lose our initial investment"

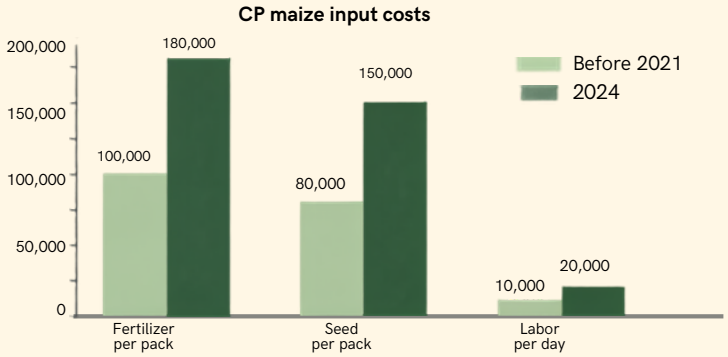

Figure 2. Reported CP maize Input costs, before 2021 versus 2024.

In addition, farmers often lack awareness considering the current condition of the soil quality due to limited access to soil analysis tools. Most are unaware of their soil condition and therefore rely on traditional practices rather than scientific analysis when planning to cultivate CP maize. This often resulted in farmers continuing traditional farming practices, applying inappropriate nutrient management, using crop rotation methods that are not suitable for soil conditions, and applying inputs inefficiently. These practices could reduce crop yields and profitability.

Another challenge faced by farmers was the risk of purchasing counterfeit CP maize seeds, as fake seeds were difficult to distinguish from genuine seeds due to their similar appearance. This resulted in poor growth and significant financial loss. One farmer explained that they could not really verify whether the seeds are fake or not as the seed appearance and packing looks the same. This shows that checking the expiration date, official license display, and certification stamps remains a crucial step in ensuring the purchase of genuine CP maize seeds.

To conclude, farmers face many difficulties such as high input costs, limited access to soil analysis tools, and the risk of buying uncertified seeds, before cultivating CP maize. These challenges make lower yields, reduce their income, and push farmers into debt.Thus, it is important to support farmers and make CP maize farming more sustainable by providing affordable inputs, access to soil testing and seed quality checks techniques.

3.2.2 Production Challenges During Cultivation

During the cultivation stages of CP maize, farmers face major challenges which directly impact productivity and income. Weeds significantly damage maize crops, while unpredictable weather conditions such as heavy rainfall and flooding often destroy entire farms. Furthermore, limited access to agricultural training and technical support hinders the adoption of effective cultivation practices. This section discusses the main challenges faced by farmers, including weed and pest infestations, unpredictable weather patterns, and limited agricultural knowledge and skills.

Weed infestation during the CP maize seedling stage was identified as one of the major challenges affecting crop growth and productivity. Farmers reported that weeds compete with maize plants for nutrients, water, and sunlight, resulting in reduced yields. One farmer from Taunggyi Township explained:

> *"In CP maize cultivation, there is a type of weed with leaves that look similar to bamboo leaves. It causes skin irritation and does not die even when herbicides are applied. Because it is very difficult to control, the maize plants cannot grow well, and our yields decrease."*

Furthermore, weather conditions play a crucial role in CP maize cultivation, as extreme weather events can significantly affect crop production. Farmers reported that heavy rainfall after planting damaged their maize crops, and they were unable to replant due to limited financial resources and unfavorable conditions. As a result, they experienced a total loss of their investment in seeds, fertilizers, and other cultivation costs. One farmer from Kalaw Township stated:

> *"The cultivation of CP maize is highly dependent on the weather conditions. In 2024, due to strong flooding, all the CP maize plants fell. Therefore, we lost everything and couldn't recover our investment."*

Limited access to agricultural knowledge and technical skills was identified as another factor contributing to reduced maize yields. Farmers reported that they lacked access to recommended CP maize cultivation practices, including proper land preparation, appropriate plant spacing, and timely fertilizer application, which are important for improving productivity. Due to limited training and technical support from agricultural organizations, farmers often relied on their own farming practices developed from experiences with traditional maize cultivation. However, these practices were not always suitable for CP maize cultivation, which requires specific management techniques. A farmer from Pindaya Township stated:

> *"At first, we were not aware of the proper methods for cultivating CP maize. We just simply followed our traditional practices, and as a result the yield was not successful and satisfactory."*

In conclusion, CP maize farmers face several challenges, including severe weed problems, unpredictable weather conditions, and limited agricultural knowledge during the cultivation period. Farmers lost their investment and negatively affected farmers' livelihoods due to these factors decreasing maize yields and profitability.

3.2.3 Post-Harvest Market and Price Challenges

After harvesting CP maize, it is critical for farmers, which is marked by significant challenges that threaten their income and livelihood. Prices are highly unstable because of transportation difficulties, supply-demand unbalances, and variety of maize quality. These factors often make farmers sell at low prices, leading to financial losses, while temporary storage strategies are limited by urgent cash needs and the risk of quality deterioration. During the post-harvest and selling periods following on the impacts of political instability, this section examines the challenges farmers face and socio-economic impact on households struggling to recover invested capital and maintain income.

Political instability following the 2021 military coup has significantly affected maize market conditions, particularly through disruptions in transportation routes, trade activities, and market access. Transportation challenges have become a major factor influencing maize price instability because Myanmar's maize market relies heavily on export demand, especially when domestic industrial demand remains limited. When transportation routes and export channels operate smoothly, farmers may benefit from higher market prices and improved income opportunities. However, political instability has created uncertainty in trade policies, increased transportation difficulties, and affected export processes, which have contributed to unstable maize prices.

In addition, changes in export regulations, including increased export-related costs and taxes, have reduced the competitiveness of Myanmar's maize in international markets. These challenges have indirectly affected farmers by reducing buyers' willingness to purchase maize at higher prices. An agricultural expert explained:
"Domestic industrial production in our country has weakened because of political structure changes, so maize needs to be exported to external markets. Therefore, maize prices depend heavily on transportation routes and export conditions. When export taxes and related costs increase, maize prices decrease, while improved market access and lower costs can contribute to higher prices."

Consequently, price fluctuations caused by political and market instability have negatively affected maize farmers. When maize prices decline, buyers become less willing to purchase large quantities, while many farmers harvest and sell their maize during the same period, creating an oversupply in the market. The imbalance between supply and demand further reduces market prices. Many farmers reported selling maize below their production costs, preventing them from recovering expenses for seeds, fertilizers, and labor. As a result, declining maize prices have reduced household incomes, increased financial stress, and intensified the socio-economic challenges faced by CP maize farmers.

Some households attempt to cope with CP maize price instability by temporarily storing their maize and waiting for more favorable market prices. While storage can provide an opportunity for farmers to obtain higher prices during some periods, this strategy is not always feasible for smallholder farmers. Many farmers are forced to sell their maize immediately after harvesting due to urgent financial needs, including loan repayment and household expenses. Furthermore, delaying sales involves risks, as market prices may decline or stored maize may lose quality over time.

Therefore, limited financial capacity and market uncertainty reduce farmers' ability to benefit from price recovery. As one farmer explained:

> *"We store CP maize when the price is low and sell it when the price rises. However, sometimes we have to sell it regardless of the price because we urgently need money. If we wait too long, the price may fall again. These price fluctuations affect our income."*

In conclusion, farmers face serious challenges at every stage of CP maize production, from pre-cultivation to post-harvest, which negatively affect their socio-economic well-being. Before cultivation, farmers face high input costs, limited access to soil analysis tools, and the risk of purchasing counterfeit seeds. During cultivation, they experience pest and weed infestations, unpredictable weather conditions, and limited access to agricultural knowledge and technical support. After harvesting, unstable maize prices further affect their income and ability to recover production costs. Together, these challenges increase financial pressure, reduce productivity, and worsen the socio-economic conditions of CP maize farmers.

3.3 Environmental Impacts of CP Maize Cultivation and Sustainable Farming Solutions

The expansion of CP maize cultivation has contributed to economic opportunities for farmers; however, intensive cultivation practices have created significant environmental challenges. The widespread adoption of CP maize monocropping, combined with excessive use of chemical fertilizers, herbicides, and pesticides, has resulted in soil degradation, biodiversity loss, deforestation, and ecosystem disruption. These environmental impacts threaten the long-term sustainability of agricultural production and farmers' ability to maintain productive farmland. Therefore, this section examines the environmental consequences of CP maize cultivation and discusses sustainable farming approaches, including crop rotation and organic fertilizer use, that can reduce environmental damage and support long-term agricultural sustainability.

One of the major environmental challenges associated with CP maize cultivation is the heavy dependence on chemical fertilizers and herbicides. CP maize cultivation requires fertile soil and sufficient moisture, and farmers commonly apply chemical fertilizers, including urea, armo, super and pearl (NPK-based fertilizers), to improve crop growth and increase yields (Soe, 2018). According to the research findings, farmers apply chemical fertilizers and herbicides multiple times during the CP maize cultivation cycle. Fertilizers are mainly used to increase productivity and improve maize quality, while herbicides and pesticides are applied to control weeds and pests.

However, the continuous and excessive use of chemical inputs has negatively affected soil quality. Farmers reported that long-term chemical application has contributed to soil acidification and reduced soil fertility. Although chemical inputs provide short-term benefits by increasing maize production, their excessive use creates long-term environmental consequences by reducing the ability of farmland to maintain productivity.
An environmental activist participant explained:

> *"In my experience, I have seen that overusing chemical fertilizers and herbicides increases soil acidification, which prevents plants from growing well."*

This finding demonstrates that intensive chemical-based farming practices create a cycle in which farmers depend increasingly on external inputs while the natural fertility of the soil continues to decline.

The decline in soil quality caused by intensive CP maize cultivation has contributed to another environmental challenge: agricultural expansion and deforestation. As soil fertility decreases and crop productivity declines in existing farmland, some farmers seek new cultivation areas to maintain maize production. This often involves clearing forest areas and converting new land into agricultural fields.

The expansion of cultivation areas creates a repeated cycle of environmental degradation. After several years of continuous CP maize monocropping, soil fertility declines due to heavy chemical use. Farmers then move to new areas by cutting down trees and opening additional farmland. This process contributes to deforestation, soil erosion, habitat destruction, and biodiversity loss.

Therefore, CP maize cultivation does not only affect the soil within existing farmland but also creates pressure on surrounding natural ecosystems. The continuous expansion of cultivation areas reduces forest resources and threatens species that play important roles in maintaining ecological balance.

In addition to soil degradation and deforestation, chemical use in CP maize cultivation has affected biodiversity. Farmers and agricultural experts reported that pesticides and herbicides can harm wildlife, including birds and other beneficial organisms. The reduction of biodiversity can disturb natural ecosystems and reduce ecological services that support sustainable farming.

One agricultural expert participant stated:

> *"The chemicals sprayed in CP maize farming can kill birds when they eat contaminated materials. Additionally, if pesticides and herbicides are accidentally sprayed on bird nests, the eggs may not hatch."*

This finding highlights that excessive chemical use creates impacts beyond agricultural fields by affecting surrounding ecosystems and wildlife populations.

Despite these environmental challenges, sustainable farming practices can help reduce the negative impacts of CP maize cultivation. Crop rotation and organic fertilizer application were identified as important approaches for restoring soil fertility and improving long-term agricultural productivity.

Crop rotation, particularly planting legumes such as beans after CP maize cultivation, can improve soil conditions and reduce pest problems by breaking pest life cycles. One agricultural expert explained:

> *"After harvesting CP maize, farmers should plant beans, especially legumes, black beans, and soybeans. They help reduce soil acidity."*

Similarly, organic fertilizers, including animal manure and composted maize residues, can restore soil nutrients and reduce dependence on chemical fertilizers. These practices improve soil health while reducing environmental damage.

An agricultural expert mentioned:

> *"Calcium contains zinc and magnesium, which are nutrients for plants. Therefore, calcium should be added almost every year. Salt should be added every three years."*

These findings suggest that promoting sustainable farming practices, including crop diversification, organic fertilizer use, and improved soil management, can help break the cycle of soil degradation and agricultural expansion.

In conclusion, the expansion of CP maize monocropping has created interconnected environmental challenges, including soil degradation, biodiversity loss, deforestation, and health risks. Excessive chemical use reduces soil fertility, encouraging farmers to expand cultivation areas and clear new land, which creates a repeated cycle of environmental degradation. However, sustainable practices such as crop rotation, organic fertilizer application, and crop diversification can improve soil quality, reduce pressure on forests, and support long-term agricultural sustainability.

4. Summary of Findings

This research acknowledges the binary nature of CP maize cultivation in Southern Shan State. Farmers grow CP maize with the expectation of improving their livelihoods, economic benefits such as increased yields, and high market demand. However, the CP maize cultivation poses problems for farmers, it also leads to significant challenges, including high input costs, less knowledge, price instability. The challenges and changes that arise before planting, during cultivation, and at the time of selling have brought both positive and negative impacts on their social and economic conditions. Farmers face serious challenges every stage from pre-cultivation to post-harvest that impact their socio-economic status negatively. Including high input costs, lack of soil analysis tools, and the risk of fake seeds before planting, pests, weeds, unstable weather, and lack of farming knowledge during cultivation, and price instability during the post-harvest period due to political crisis. These issues increase financial pressure, significantly reduce productivity, and worsen the economic conditions of CP maize farmers. The expansion of CP maize farming has affected the environment and biodiversity. However, the alternation of sustainable practices like crop rotation and using natural fertilizers can reduce damage to ecosystems, protect farmers' health and provide long-term land productivity.

5. Recommendations

The findings of this study demonstrate that CP maize cultivation provides important livelihood and income opportunities for farmers in Southern Shan State, while also creating significant socio-economic and environmental challenges. Farmers face difficulties throughout the production cycle, including rising input costs, limited access to agricultural knowledge and soil assessment, the risk of counterfeit seeds, unpredictable weather conditions, unstable market prices, and transportation difficulties. At the same time, intensive CP maize cultivation and excessive use of chemical inputs contribute to soil degradation, biodiversity loss, deforestation, and other environmental concerns. Therefore, addressing these interconnected challenges requires coordinated efforts from government agencies, agricultural research centers, non-governmental organizations, private-sector actors, and farmer organizations. Based on the findings of this study, the following recommendations are proposed to strengthen farmers' resilience, improve agricultural productivity and income, and promote environmentally sustainable farming practices in Southern Shan State:

5.1 Strengthening Agricultural Research and Extension Services

Government agricultural departments, agricultural research centers, and non-governmental organizations should strengthen agricultural research and extension services to provide farmers with locally appropriate and practical farming knowledge. The findings indicate that CP maize farmers have limited access to soil assessment, technical training, and effective guidance on land preparation, plant spacing, fertilizer application, weed and pest management, and climate-related risks. Agricultural extension programs should therefore provide regular field-based training, soil-testing services, and technical advice tailored to the conditions of Southern Shan State. Strengthening these services could improve farmers' decision-making, increase productivity, reduce unnecessary input use, and enhance their ability to respond to production challenges.

5.2 Improving Access to Quality Agricultural Inputs and Financial Support

Relevant government agencies, agricultural organizations, financial institutions, and private-sector actors should improve farmers' access to affordable and reliable agricultural inputs and financial services. The study found that increasing prices of seeds, fertilizers, and labor have placed considerable financial pressure on farmers, while limited financial resources have encouraged some farmers to rely on loans and agricultural inputs from brokers. The risk of purchasing counterfeit or uncertified seeds further increases the possibility of crop failure and financial loss. Therefore, stronger monitoring of seed quality and certification, improved access to genuine agricultural inputs, and affordable and transparent agricultural credit should be promoted. These measures could reduce farmers' dependence on broker-tied credit and help prevent cycles of debt and financial vulnerability.

5.3 Strengthening Market Access and Price Stability

Government agencies, local authorities, farmer organizations, and relevant private-sector stakeholders should work together to improve market access and reduce farmers' exposure to severe price fluctuations. The findings demonstrate that transportation difficulties, changes in export conditions, supply-and-demand imbalances, and political and market instability significantly affect maize prices and farmers' ability to recover production costs. Improving transportation and market infrastructure, strengthening market information systems, supporting collective marketing through farmer organizations, and developing accessible storage facilities could increase farmers' bargaining power and flexibility in deciding when to sell their produce. In addition, policies that promote fair and transparent market conditions could help reduce the vulnerability of smallholder farmers to sudden price declines.

5.4 Promoting Environmentally Sustainable Farming Practices

Government agencies, agricultural research institutions, and non-governmental organizations should promote environmentally sustainable farming practices to reduce the long-term ecological impacts of CP maize cultivation. The study found that intensive monocropping and excessive use of chemical fertilizers, herbicides, and pesticides contribute to soil degradation, declining soil fertility, deforestation, biodiversity loss, and ecosystem disruption. Farmers should therefore be encouraged and supported to adopt crop rotation, crop diversification, organic fertilizers, compost, and improved soil-management practices. Particular attention should be given to the use of legumes following maize cultivation because crop rotation can help improve soil conditions and reduce pest-related problems. Environmental awareness and practical training should also be strengthened so that farmers can maintain agricultural productivity while reducing pressure on surrounding ecosystems.

Overall, implementing these recommendations through coordinated efforts among relevant stakeholders could help address the interconnected economic, agricultural, market, and environmental challenges identified in this study. Such efforts would contribute to strengthening the resilience and livelihoods of CP maize farmers while supporting more sustainable agricultural development in Southern Shan State.

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