

Economics of upland paddy production at Namleythang, Tshangkha Gewog, Dagana Dzongkhag

Abstract

Rice holds a central role in Bhutanese culture, tradition, and economy, yet the nation faces a significant rice deficit, with imports covering 75% of the demand. Constrained by limited agricultural land, labour shortages, and water scarcity, Bhutan has been exploring upland rice cultivation as a viable alternative. This study, conducted in Namleythang under Tshangkha Gewog in Dagana Dzongkhag, evaluates the economic feasibility of upland rice production, specifically focusing on the Khangma Maap variety.

The study involved 25 households and assessed the costs, returns, and constraints of upland rice farming. Results revealed that upland rice cultivation is labour-intensive, with weeding being the most time-consuming task. The average yield of 817 kg per acre which is slightly higher than the national average but still lower than high-yielding varieties. The total production cost per acre was Nu. 52,422., while the gross return was Nu. 49,042, leading to a negative net return of -Nu. 3,380.

Key challenges included bird damage, labour shortages, and pest issues, particularly white grubs. Despite these constraints, 84% of farmers perceived upland rice as a sustainable farming option, especially in areas without irrigation. However, the study highlights the economic limitations of this practice, including the high labour costs and the negative profitability.

To enhance the economic viability of upland rice farming, the study recommends implementing labour-saving technologies, improving pest management, utilizing alternative soil fertility practices, and introducing mechanization for land preparation. These interventions could help increase productivity, reduce costs, and improve the sustainability of upland rice farming, contributing to food security and reducing Bhutan's dependence on rice imports.

Key Words: Upland rice, Yield analysis, Production costs, Economic viability, Sustainability

1. Introduction

Rice is indispensable in the Bhutanese culture, tradition, religion and farmers' livelihoods. Rice is the most preferred staple food of all the Bhutanese with an estimated per capita consumption of 147.70 kg per year (Tahi. et al, 2012). In last 17 years (2006-2022), despite productivity increase of 4.2%, annual area and production decreased by 5.6% and 2.9% respectively (DoA, 2023b). Rice is cultivated in 23,289.59 acres with the production of 40,804 MT (NSB, 2024). As per the National Rice Strategy paper (DoA, 2023b), only 25% of the total annual rice requirement could be met from domestic production and deficit of 79,324 MT. is met from rice imports.

The country's agricultural land is only 2.7% of total land, with 18% (70,927 acres) registered as wetland. Rice self-sufficiency is declining as wetland cultivation decreases yearly due to water shortages, human-wildlife conflict, and labour shortages. Rugged terrain also limits mechanization. The DoA's 13th five-year plan aims to raise rice self-sufficiency from 25% to 30% by 2029. Exploring alternatives like dryland farming is essential to meet this target. Upland cropping offers a viable solution, reducing the constraints of wetland farming and supporting climate resilience. In Bhutan, upland rice—traditionally called Pangbara or Kambara—is primarily grown in Eastern Bhutan at 1,500–2,300 masl (Katwal, et al, 2008). In 2024, 241.36 MT of upland rice was harvested from 304.87 acres, yielding 0.79 MT per acre (NSB, 2024). Improved varieties like Khangma Maap, initially released for irrigated systems, also perform well under upland conditions.

Agriculture is the backbone of Dagana's economy, with rice and oranges as its main crops. Rice is grown both as traditional wetland paddy and as upland paddy. About 74 farmers cultivated upland paddy on over 36.12 acres, producing 23.83 metric tons. This output places Dagana among the top five districts contributing significantly to the nation's overall rice production (NSB, 2024).

The study seeks to evaluate the costs and returns associated with upland rice production to determine its cost-effectiveness. Additionally, the research objectives include quantifying the inputs, labour, and materials required for upland rice cultivation and identifying key drivers and constraints that influence production. A comprehensive understanding of these factors will provide a basis for future recommendations on the adoption of upland rice cultivation by farmers.

2. Materials and Methods

2.1 Study Site

The economics of upland rice production was carried out in Namleythang under Tshangkha Gewog, Dagana Dzongkhag. The settlement consists of 55 households, with agriculture as the primary occupation operated in 135.05 acres. Due to the lack of irrigation farmers are unable to engage in wetland rice cultivation. To circumvent the issue of irrigation ARDC Bajo provided upland rice seeds (Khangma Maap) to 50 households for two consecutive years.

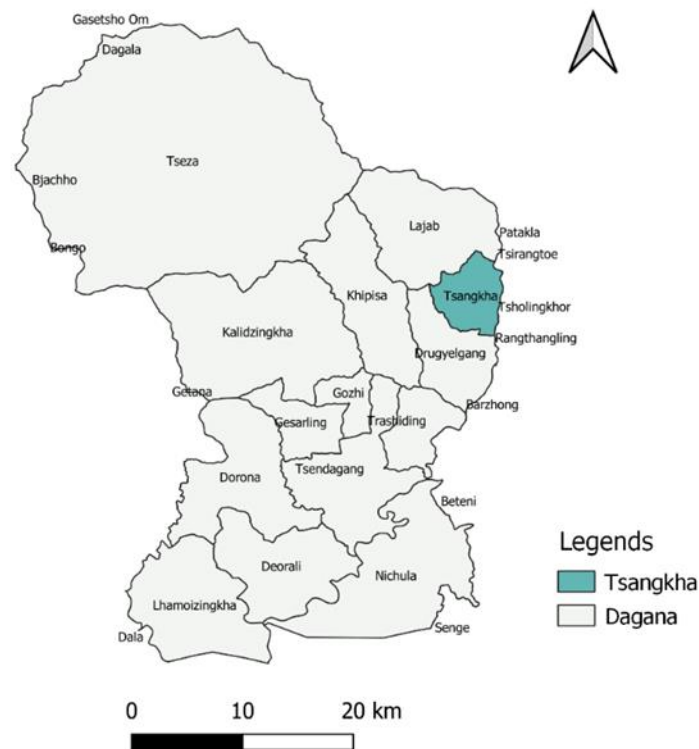


Figure 1. Map showing area of study – Namleythang, Tsangkha Gewog, Dagana

2.2 Data collection and analysis

The study on economics of upland rice cultivation was conducted in December 2023 using data gathered from a sample of 25 randomly selected households. These households were chosen by

selecting every second farmer listed in the Excel sheet, representing 50% of the community engaged in upland rice cultivation at Namleythang. While the sample size was relatively small, it represents half of the total households cultivating upland rice in the study area, making it a significant representation of the population. The study aimed to provide qualitative insights and context-specific data rather than broad generalizations. Previous research in similar contexts has shown that smaller sample sizes can still produce reliable and valuable findings. Moreover, the chosen sample size aligns with the study's objectives and ensures the feasibility of detailed data collection and analysis within the available timeframe and resources. Statistical methods were employed where applicable to validate the findings and enhance their robustness despite the smaller sample size. Future research could expand on these findings with larger samples to confirm trends and enhance the applicability of the results.

A semi-structured survey questionnaire was used to gather information on labour, material inputs, crop yields and other social economics data. Individual interviews with sample household provided qualitative insights into farmers' perceptions of upland rice cultivation and the key challenges. Additionally, data on farm machinery use and hire rates obtained from the farmers were validated from the Extension Agent, and Farm Machinery Corporation Limited (FMCL) record. The location was revisited in October 2024 to validate the data with the farmers.

The data were organized in a data entry form in Microsoft Excel. Economic analysis was conducted in Excel while qualitative data was analysed using SPSS Version 25.0.

2.3 Cost computation methodology

The cost computation methodology for upland rice cultivation encompasses material inputs, labour inputs, fixed costs, and variable costs to comprehensively account for production expenses. Material inputs include the cost of seeds, calculated as the average quantity multiplied by price per kilogram; farmyard manure (FYM), based on quantity applied and cost; and tools like grass cutters and power tillers, covering both rental and associated labour fees. Labour inputs involve expenses for land preparation, sowing, weeding, and harvesting. Fixed costs account for equipment, while variable costs cover hired labour and machine rentals, which vary with production scale. Data collection is supported by household surveys using semi-structured questionnaires, farm machinery records validated by the Farm Machinery Corporation Limited (FMCL) and local

Extension Agents, and market rates for prevailing prices of seeds, labour, and inputs. All input and labour costs are based on the prevailing rates in the village or market, regardless of whether the inputs are sourced from the farmer's own stock or family labour or labour exchange. For this study the land opportunity cost is excluded.

3. Result and Discussion:

3.1 Demographic Information, Land use and Livestock holding and soil fertility

Economic data on upland rice production were collected from a sample of 25 households (hhs), representing 50% of the total upland rice farmers in the community. The respondents included 15 males and 10 females, residing at altitudes between 1,530 and 1,719 meters above sea level (masl). The community cultivates a variety of crops, including upland rice, maize, barley, buckwheat, mustard, potato, soybean, radish, leafy greens, cole crops, chili and cardamom. Crop rotation is commonly practiced, with rotations such as potato-upland rice/vegetables, upland rice-wheat, and upland rice-maize/vegetables.

Table 1: Demographic information, land use and livestock holding

Demographics & Farm Resources	N	Minimum	Maximum	Mean	SD
House hold members	25	2	10	4.64	2.25
Active members involved in farming	25	1	7	2.40	1.19
Dryland (acre)	25	.43	3.60	2.11	.88
Upland Rice Area (acre)	25	.20	2.60	.68	.52
Cattle	9	1.00	5.00	2.11	1.45
Poultry	4	2.00	10.00	6.25	4.35
Pig	4	1.00	4.00	2.25	1.26

Table 1 presents the demographic information, land use, and livestock holdings based on the data collected from the interviews. The number of household members ranged from a minimum of two to a maximum of ten, with an average household size of 4.64 members. On average, 2.40 individuals per household contributed effectively to farming activities, while the remaining members were dependents, such as school-aged children and elderly family members. Only few farmers (n=6) owned wetland while all owned dryland on average of 2.11 acres (*SD 0.88*).

Irrigation is the main constraint in the community so they opted for upland rice. Over the past two years, an average of 0.68 acres of land has been cultivated with upland rice per household.

Approximately 36% of the respondents reported raising cattle, with an average of two heads per household, primarily for dairy and farmyard manure (FYM). Additionally, four respondents indicated raising poultry, with an average flock size of six birds, and two pigs, per household.

Farmers classified the soil into three categories: highly fertile, medium fertility, or low fertility. Among the respondents, the majority (92%) believed their soil to have medium fertility. This widespread perception likely stems from the land's history of prior use, which can lead farmers to assume that the soil retains adequate fertility for agricultural production.

The practice of using land intermittently or leaving it fallow for a period of time is a traditional agricultural method to allow the soil to recover naturally. When land is left fallow for an extended period, natural regeneration processes contribute significantly to restoring soil fertility. These processes involve the gradual buildup of organic matter as plant residues and decomposing vegetation accumulate on the soil surface. Over time, this organic matter decomposes, releasing essential nutrients like nitrogen, phosphorus, and potassium into the soil.

Additionally, fallowing facilitates the growth of natural vegetation and soil microorganisms, which further enhance soil health. The increased activity of beneficial microbes aids in nutrient cycling and improves soil structure, while vegetation cover helps reduce soil erosion and retain moisture. The combined effect of these natural processes results in a replenishment of soil fertility, making it more suitable for future cultivation.

This perception aligns with findings by Wangchuk and Tobgay (2015), who emphasize the critical role of fallowing in restoring soil productivity in traditional farming systems. The increase in organic matter and nutrients during fallow periods ensures that soil fertility is preserved or even enhanced over time.

3.2 Material inputs

The application of chemical fertilizers and herbicides is common in wetland rice cultivation. However, the study revealed that the community relies on minimal external inputs for upland rice

cultivation, with seeds being the primary input. The use of farmyard manure (FYM) is limited, and there is no application of chemical fertilizers, herbicides, or pesticides. For land clearing, most farmers use grass cutters, which are either personally owned or rented. Land preparation (ploughing) is typically done using power tillers.

Table 2: Material inputs used for upland rice production average per acre

Variable inputs	Quantity	Unit	Cost (Nu/acre)	SD	% Proportional
Seed	19.16	Kg	1360.50	188.84	8
FYM	941.99	Kg	941.99	752.38	5
Power tiller (hired)	3.03	No. of days	6763.08	1067.73	38
Grass Cutter (hired)	3.64	No. of days	8731.53	1862.81	49
Average cost per acre			17797.10		100

The materials inputs used for upland rice production is reflected in table 2. For upland rice cultivation, the average seed rate is 19.16 kg per acre, which is close to the recommended rate of 20 kg/acre (Tsuboi, 2012). The prevailing market price of Khangma Maap at the National Seed Centre (NSC) is Nu. 71/kg, making the seed cost for upland rice approximately Nu. 1360.50 per acre ($SD = 188.84$). The seed was supplied by ARDC Bajo for the first two years and now farmers are keeping their own seed.

Power tiller rental, including associated labour, accounts for 38% of the total costs. On average, it takes 3.04 days per acre, costing approximately Nu. 6763.08 ($SD = 1067.73$) per acre. This translates to an average cost of Nu. 2235 per day for the power tiller.

The most significant material expense in upland rice cultivation is the hiring of grass cutters for field clearing before land preparation, which constitutes 49% of the total costs. On average, 3.56 days are spent on grass cutting (land clearing) per acre, highlighting the substantial time and financial investment required for this initial stage of land preparation. This expense amounts to an average of Nu. 8731.53 ($SD = 1862.81$) per acre.

A limited number of farmers ($N = 8$) reported using farmyard manure (FYM) in upland rice cultivation, with an average application rate of 1,142.15 kg per acre ($SD = 752.38$). The cost of

FYM is estimated at Nu 1 per kg, based on farmers' calculations. For example, one power tiller load can carry 500 kg of FYM, costing them Nu 500. The relatively low usage of FYM is attributed to two main factors. First, some of the land being cultivated is newly developed, and farmers have not had the opportunity or resources to apply FYM. Second, there is concern over white grub infestations, which are more prevalent in fields where FYM is applied. This pest issue has prompted some farmers to avoid using FYM, as it may exacerbate the problem and negatively impact crop health. As a result, farmers have turned to alternative soil management practices to mitigate pest-related risks and manage newly cultivated land more effectively.

3.3 Labour inputs

The average labour input for upland rice cultivation and the associated costs are detailed in Table 3. Labour requirement per acre is 77.43 man-days, which is 0.57 man-days less than the 78 man-days typically required for wetland rice cultivation, as reported in the National Rice strategy, (DoA, 2023b). Despite the absence of nursery raising and transplanting in upland rice cultivation, labour input remains higher for activities such as sowing and weeding. Land clearing and ploughing are typically carried out using grass cutters and power tillers, which are either owned by the farmers or rented from neighbors. The labour cost for operating these machines is included in the material expenses, as the machine hire fees cover both equipment usage and labour. After cutting the grass, farmers clear the debris to prepare the land for ploughing.

In addition to the power tiller operator, approximately 4.47 man-days ($SD = 1.89$) are required to prepare the land for sowing. At Namleythang, farmers do not broadcast the seeds. Instead, once the field is thoroughly prepared, they dibble the seeds. Using a hoe, they dig small holes, place about 5-8 seeds in each, and cover them with a thin layer of soil. The holes are spaced approximately 10-15 cm apart. Although this method is time-consuming, farmers believe it ensures better germination, helps maintain proper spacing, and facilitates weeding later on. On average, about 9.38 man-days ($SD = 1.19$) are needed to sow seeds per acre. During the sowing process, farmers also remove weeds and stones from the field. This process takes longer compared to the seed broadcasting method.

Weeds present the most significant challenge to upland rice cultivation, making weeding a highly labour-intensive, as reported other upland rice study (Pandey & Minh, 1998). Common weed

species include *Ageratum conyzoides*, *Galinsoga parviflora*, *Fagopyrum dibotrys*, *Persicaria runcinata*, and *Persicaria nepalensis*, along with various grassy weeds. Farmers reported that weeding is performed at least two to three times during the growing season, accounting for the highest proportion of labour in upland rice cultivation, representing 57% of total labour distribution. On average, this task requires 33.78 man-days ($SD = 10.43$).

Harvesting, threshing, and storing accounts for 16% of the total labour. On average, these activities require 12.02 man-days ($SD = 2.91$) per acre.

The prevailing labour rate for on-farm tasks is Nu. 500 per day. However, aside from activities like grass cutting and land preparation using power tillers, farmers typically do not pay cash for other intercultural operations. Instead, labour exchange practices are common within the community, where neighbors trade labour services instead of hiring workers. For this study, the prevailing market rate of Nu. 500 per day per labourer was used to calculate labour costs, despite the practice of labour exchange. Based on this rate, the total labour cost for cultivating an acre of upland rice amounts to Nu. 34,625.27.

Table 3: Average labour inputs and cost per one acre of upland rice cultivation

Activities	Man-day/ac	<i>SD</i>	Labour cost (Nu/ac)	%
Land clearing and land preparation (N=25)	4.47	1.89	2233.36	6
Sowing (N=25)	9.38	1.91	4691.04	12
Weeding (N=25)	33.78	10.43	16888.64	44
Crop guarding (N=25)	17.78	2.10	4800.00	23
Harvesting and threshing (N=25)	12.02	2.91	6012.23	16
Total	77.43		34625.27	100.00

3.4 Crop Guarding

Among the 25 respondents surveyed, 19 reported crop damage caused by birds, emphasizing bird attacks as a significant challenge in upland rice cultivation. This issue leads to considerable yield losses, particularly because upland rice is typically grown in smaller parcels, making it highly vulnerable to such damage. Birds pose a threat from early morning until dusk, targeting crops from the grain-filling stage through harvest.

To mitigate losses, farmers often guard their fields for an average of 40 days, dedicating about four hours daily to this task. In most cases, elderly family members or young children are responsible for crop guarding. When such individuals are unavailable, fields frequently remain unguarded, exacerbating the already low yields of upland rice. The labour used for crop guarding is considered "unproductive" as it involves individuals who are not otherwise engaged in farm activities or labour exchange. For cost analysis, the opportunity cost of this labour is estimated at 75% of the standard labour rate, which is Nu. 500 per day. This adjustment reflects the fact that these individuals, though not participating in other productive activities, consume resources and contribute intermittently to crop guarding.

3.5 Rice Yields and Production Costs

Table 4 presents the average upland rice area and rice yield at Namleythang for the year 2023. The study recorded an average upland rice yield of 817.37 kg per acre ($SD = 200.56$), reflecting a modest increase over the national average yield of 791.68 kg per acre (NSB, 2024). This gain of 24.69 kg per acre suggests that specific factors in the study area, such as recently cultivated soil or other favorable agroecological conditions, may contribute to this slight yield advantage. However, it is lower when compared to other upland rice varieties like Bhur Kamja 1 and 2, which have yield potentials of 1,000 kg to 1,500 kg per acre, respectively (DoA, 2023c). While this difference highlights the potential for targeted interventions to enhance productivity in upland rice cultivation, it also underscores the need for further improvements. Enhancing yield stability and addressing factors such as labour constraints, pest management, chemical fertilizer application, and soil health could build on this progress to bring upland rice productivity closer to optimal levels. The average upland rice production for Dagana Dzongkhag in 2023 was computed at 659.75 kg per acre (NSB, 2024), which is 157.62 kg less than the study area's yield.

Several upland rice varieties from Nepal, such as Hardinath-1, Suka Dhan-1, 2, and 3, which have shown better performance under similar agro-ecological conditions in Nepal with an average yield of 1522.73 kg per acre (Chaudhary et al., 2024), are currently under performance evaluation trials at ARDC Bajo. In these trials, the variety Sukha Dhan-4 exhibited the highest yield, reaching 3362 kg per acre, followed by Sukha Dhan-5 with a yield of 2830.44 kg per acre (ARDC Bajo, 2024). Once these varieties are released the Khangma Maap can be replaced by these varieties which perform well

with higher yield. Releasing these varieties hold the potential to replace Khangma Maap as they demonstrate substantially higher yields under local conditions.

Effective fertilizer management is crucial in rainfed farming, significantly impacting yield levels in upland rice due to its reliance on precipitation during crop growth. The pattern, amount, and timing of rainfall, along with the onset and end of the monsoon, necessitate adjustments in fertilizer dosage and application schedules. Integrating chemical fertilizers with FYM is essential for sustainable upland rice production (Singh. et al., 2017).

Table 4: Average upland rice area and rice yield at Namleythang, 2023

Parameters	N	Minimum	Maximum	Mean	SD
Upland rice area (acre)	25	.20	2.60	.68	.52
Yield per acre (kg)	25	400.00	1318.00	817.37	200.56

3.6 Cost of upland rice production and Economic Returns

The average cost of production of rough rice is Nu. 64.14/kg and the total cost incurred for one acre of upland rice production is calculated at Nu. 52,422.38, encompassing both labour and material costs. Gross Return represents the total income generated from selling upland rice, although the farmers do not sell their produce it is calculated based on the quantity harvested and the prevailing market price. Total cost includes all expenses related to production. The gross return from upland rice cultivation is calculated at Nu. 49,042.17 per acre, assuming a market price of Nu. 60 per kg of rough rice. This price of Nu. 60 per kg is based on farmers' estimates, particularly for Khangma Maap rice, which they anticipate selling at this rate in the market. To determine the net return to land, we evaluate the profitability of the land used for agricultural production after accounting for all relevant costs. This involves subtracting both variable and fixed costs associated with the production process from the gross return, providing an insight into the economic feasibility of using the land for upland rice cultivation. Net Benefit = Gross Return - Total Cost. In the case of upland rice cultivation, the gross return per acre is Nu. 49,042.17, while the total cost of production amounts to Nu. 52,422.38. This results in a negative net benefit of -Nu. 3,380.21 per acre, indicating that the total expenses incurred in cultivation exceed the revenue generated from the harvest.

When compared to the net return of irrigated rice, which stands at -Nu. 916 per acre (DoA, 2023a), the losses in upland rice cultivation are considerably higher. This highlights the economic challenges associated with upland rice farming in Bhutan, where the lower productivity and higher susceptibility to risks, such as bird damage and reliance on labour-intensive practices.

The negative net return reflects the difficulty farmers face in sustaining upland rice cultivation as a viable economic activity. It underscores the need for targeted interventions, such as improved cultivation practices, pest management, mechanization, and support systems, to enhance productivity and reduce costs. Without such measures, the low profitability of upland rice cultivation may discourage farmers from continuing this practice, potentially impacting local food security and traditional agricultural systems.

3.7 Sensitivity Analysis

A sensitivity analysis was conducted to assess the effects of changes in key parameters on production costs and net benefits (Table 5). The results indicate that production costs are highly sensitive to variations in specific variables.

Table 5. Sensitivity Analysis: Under different assumptions

Assumption	Production Costs (Nu./kg)	% Change	Net Benefit (Nu.)	Difference (Nu.)
Base assumption	64.14	-	-3,380.21	-
All labour valued at 75% of hired labour cost (instead of 100%)	55.01	-14	4,076.11	7,456.32
All labour valued at 50% of hired labour cost	43.93	-32	13,132.43	16,512.64
Using high-yielding upland rice varieties (Nepal lines average yield of 1,522.73 kg/ac)	34.43	-46	38,941.42	42,321.63
Opportunity cost of land Nu. 10,000 (instead of no cost)	76.37	+49	-13,380.21	-10,000.00

When the price of labour is valued at 75% of the hired labour cost (instead of 100%), average production costs decrease by 14%, reducing to Nu. 55.01/kg, while net benefits increase by Nu. 7,456.32. If labour costs are further reduced to 50% of the hired labour cost, production costs decrease significantly by 32%, reaching Nu. 43.93/kg. This results in an increase in net benefits by Nu. 16,512.64. Adopting high-yielding upland rice varieties (e.g., Nepal lines with an average yield of

1,522.73 kg/ac) reduces production costs by 46%, bringing them down to Nu. 34.43/kg. Consequently, net benefits increase substantially by Nu. 42,321.63 per acre. Additionally, net benefits are most sensitive to changes in the opportunity cost of land. For example, if an opportunity cost of Nu. 10,000 per acre is factored in (instead of no cost), production costs rise by 49% to Nu. 76.35/kg, resulting in a net benefit decrease of Nu. 10,000 /ac.

3.8 Assessment of Threshing, Milling Practices, and Taste Quality

Table 6 presents farmers' perceptions on threshing and their taste preferences for the Khangma Maap rice variety. The data on upland rice reveals key trends in threshing, milling, and taste quality. Most farmers (64%) report easy threshing, but all rely on manual methods, highlighting the potential for mechanization, especially for those facing challenges. Community rice mills are used exclusively, with no individual milling, reflecting dependence on shared infrastructure.

Table 6: Farmers' perception on threshing and taste preference of Khangma Maap rice variety

Respondents' perception		Frequency	Percent	Cumulative Percent
Respondent's response on threshing quality	Easy	16	64	64
	Intermediate	7	28	92
	Difficult	2	8	100
Respondent's response on taste preference	Better	4	16	16
	Same	8	32	48
	Poor	13	52	100

The taste quality of the Khangma Maap rice variety shows notable variation among farmers. According to the data, 52% of respondents perceive the taste of this variety as inferior compared to local wetland rice varieties, while 32% rate it as comparable, and only 16% consider it to be better. This distribution of opinions indicates significant room for improvement in both processing methods and the selection of upland rice varieties to enhance taste and consumption appeal.

These findings suggest that while some farmers find the Khangma Maap to be acceptable, the majority do not regard its taste as satisfactory compared to local varieties. As a result, there is a clear opportunity for intervention in both agronomic practices and post-harvest processing. In

addition, investing in research and development for better upland rice varieties that prioritize taste could be beneficial.

3.7 Sustainability of Upland Rice Cultivation

Table 7: Farmers' respond on continuity

Continuity		Frequency	Percent	Cumulative Percent
Respondent's response	Yes	21	84.0	84.0
	No idea	4	16.0	100.0
Total		25	100.0	

The data presented in Table 7 reflects farmers' perceptions of the continuity of upland rice cultivation. A significant majority (84%) believed that upland rice cultivation is sustainable. The reason they have expressed was since they do not have irrigation facilities, they would adopt upland rice cultivation. However, 16% of the respondents were unsure, indicating that while most farmers are optimistic about its sustainability, a small proportion may lack sufficient information or experience to form a conclusive opinion on the matter. This suggests a need for further awareness and education about sustainable practices in upland rice farming.

3.8 Problem and constraints

The survey results highlight a range of challenges faced by upland rice farmers. A significant proportion of respondents (32%) identified a combination of bird damage, labour shortages, and crop lodging as the most pressing issue. These challenges often overlap, exacerbating the difficulties faced during the cultivation process.

Another 20% of respondents reported the combination of bird damage with wildlife interference and white grub infestations. Similarly, crop lodging on its own was identified as a key problem by an additional 20% of participants. This underscores the widespread nature of these individual and overlapping constraints.

Bird damage, as a standalone issue, was noted by 12% of farmers. Despite being less frequently reported in isolation, it remains a pervasive problem, contributing significantly to the broader combination of challenges experienced by farmers. Labour shortages and pest attacks, specifically white grubs, were each cited by 4% of respondents as individual concerns. Labour shortages

primarily arise from the intensive demands of weeding and bird guarding, while white grubs pose a severe threat during the vegetative growth stages, especially in dryland areas with continuous cultivation.

In summary, the survey findings reveal that bird damage—either alone or as part of a combination of issues—features prominently, affecting 63% of respondents. Labour shortages, in isolation or in combination, are a concern for 35% of participants. These results align with findings from previous studies, such as those in eastern Bhutan (Katwal, 2008), emphasizing the recurring and labour-intensive nature of these challenges in upland rice cultivation.

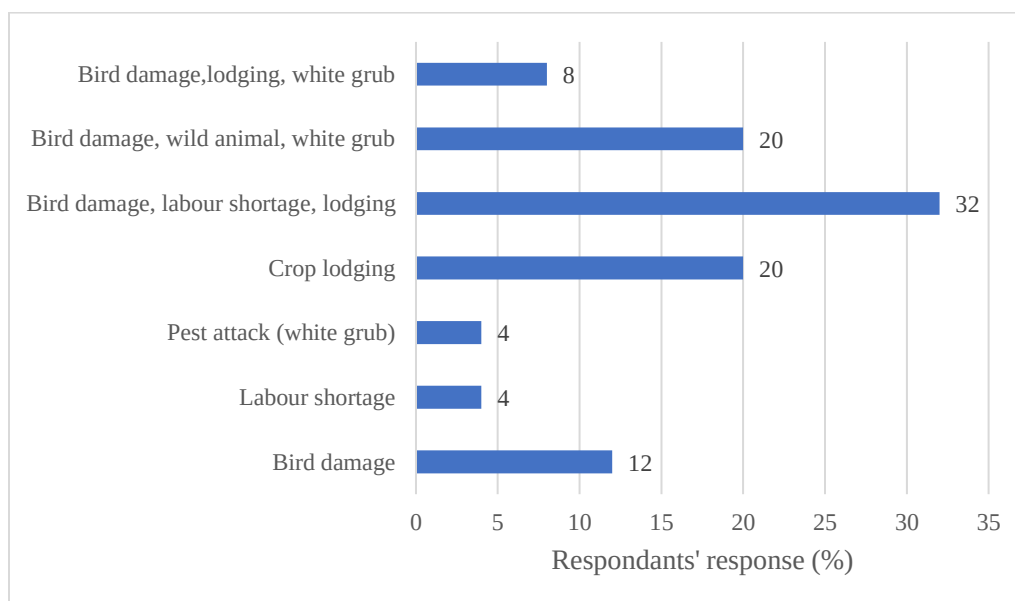


Figure 2: Problems and constraints of upland rice

4. Conclusion

Rice plays a vital role in Bhutanese culture, tradition, and livelihoods, yet its cultivation is increasingly constrained by challenges such as declining cultivation areas, labour shortages, and water scarcity. While rice productivity has increased by 4.2% over 17 years, the reduction in cultivation area and production has left Bhutan reliant on rice imports to meet 75% of its demand. Upland rice cultivation, practiced in areas without irrigation, presents a viable alternative but remains less productive and economically sustainable compared to wetland rice.

The study highlights that upland rice farming is highly labour-intensive, with tasks such as weeding and crop guarding substantially increasing production costs. While upland rice in Namleythang achieves slightly higher yields than the national average, with an average yield of 817.37 kg per acre, it faces a negative net return of -Nu. 3,380.21 per acre. This is primarily attributed to high labour costs and challenges such as bird damage. The productivity of upland rice is further constrained by limited input use and reliance on manual labour, resulting in higher production costs compared to conventional wetland rice.

Despite these challenges, 84% of farmers view upland rice cultivation as a sustainable solution for communities lacking irrigation. However, the persistence of issues such as bird damage, labour shortages, and wild animal intrusions highlights the need for targeted interventions. Mechanization, along with enhanced crop management techniques, is essential to improving productivity, reducing labour dependency, and enhancing the economic sustainability of upland rice farming.

5. Recommendations

To improve the productivity and economic viability of upland rice farming, targeted interventions in varietal improvement are essential. The introduction of high-yielding, pest-resistant, and taste-preferred rice varieties like Sukha Dhan-4 can address both productivity and marketability concerns. This shift will enhance farmers' confidence in upland rice as a viable crop and improve its competitiveness with wetland rice.

Mechanization should be a priority to reduce labour dependency and production costs. Providing farmers with affordable access to tools like power tillers, mechanical weeders, and threshers can significantly ease labour-intensive tasks.

Integrated pest and wildlife management must be strengthened to address bird damage and pest infestations. Promoting the use of bird deterrent systems, such as reflective materials, acoustic devices, or netting, can help reduce losses. Training farmers in integrated pest management practices, particularly for controlling white grubs, will further minimize pest-related yield losses.

Soil fertility management is another critical area of focus. Promoting integrated nutrient management practices, combining chemical fertilizers with organic amendments like farmyard

manure (FYM), can improve soil health and enhance yields. Addressing farmers' concerns about white grub infestations through safe and effective pest control measures is necessary to increase the adoption of such practices.

Economic incentives are crucial to encourage farmers to invest in upland rice farming. Subsidies for inputs, access to low-interest credit, and crop insurance schemes can mitigate financial risks and make upland rice cultivation more attractive. In addition, awareness and capacity-building programs should be organized to educate farmers about sustainable practices and the economic benefits of upland rice farming.

References

- ARDC Bajo. (2024). Annual Report 2023-2024. Agriculture Research and Development Centre, Bajo, Wangdue Phodrang, Royal Government of Bhutan
- Chaudhary, A., Mishra, A., Sah, M. K., Wagle, P., Chaudhary, R., Bohora, S., Paudel, P., & Sah, P. (2024). Evaluation of Upland Rice Varieties in Western Terai of Nepal. *International Journal of Scientific and Research Publications*, 14(1). <https://doi.org/10.29322/IJSRP.14.01.2024.p14519>
- DoA. (2023a). *Cost of production for major agriculture crops in Bhutan* Department of Agriculture 2022. Department of Agriculture (DoA), Ministry of Agriculture and Forest, Thimphu, Royal Government of Bhutan
- DoA. (2023b). *National Rice Development Strategy 2024-2034* Department of Agriculture (DoA), Ministry of Agriculture and Forest, Royal Government of Bhutan
- DoA. (2023c). *Inventory of Released and De-notified Crops in Bhutan (1988-2023)*. Department of Agriculture (DoA), Ministry of Agriculture and Forest, Royal Government of Bhutan
- Ghimiray, M., Dorji, K. D., Katwal, T. B., Penjore, U., Dorji, S., Pem, S., G., T., & Pradhan, K. (2008). *Rice in Bhutan - A Source Book*. Council for RNR Research of Bhutan (CoRRB). Ministry of Agriculture, Bhutan.

- Katwal, T. B., Wangdi, N., & Adhikari, N. B. (2008). Upland Rice in Eastern Bhutan Prospects and Perspective Working Document. RNR Research Centre, Wengkhar Council of RNR Research of Bhutan
- NSB. (2023) *Integrated Agriculture and Livestock Census of Bhutan 2023*. National Statistics Bureau (NSB), Royal Government of Bhutan www.nsb.gov.bt
- Pandey, B., Dahal, K. R., Amgain, L. P., Wasti, M., Gaire, A., & Shrestha, A. (2019). Exploring options for enhanced productivity of upland rice through suitable variety and better nutrient management. *Nepalese Journal of Agricultural Sciences*, 18. <https://cabidigitallibrary.org>
- Pandey, S., & Minh, V.D. (1998). A socio-economic analysis of rice production systems in the uplands of northern Vietnam. *Agriculture, Ecosystems & Environment*, 70 (2-3). [https://doi.org/10.1016/S0167-8809\(98\)00152-2](https://doi.org/10.1016/S0167-8809(98)00152-2)
- Singh, C.V., Mandal, N.P, Maiti, D. (2017), *Upland Rice Technologies: A Brief Overview* Central Rainfed Upland Rice Research Station (National Rice Research Institute) Hazaribag, Jharkhand, India
- Tashi, Tshering, Chezang Dendup, Ngawang., and Sonam Gyeltshen. 2022. "Rice Self-Sufficiency in Bhutan: An Assessment". *Asian Journal of Agricultural Extension, Economics & Sociology* 40 (2):18-28. <https://doi.org/10.9734/ajaees/2022/v40i230842>.
- Tsuboi T. (2012) *Upland rice cultivation guide* Promotion of Rice Development (PRiDe) Project, JICA
- Wangchuk, K., & Tobgay, S. (2015). "Land management practices for soil fertility restoration in shifting cultivation in Bhutan: Experiences and lessons learned." *Bhutan Journal of Agriculture*, 1(1), 30-41.