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Practices, Profitability, and Challenges of Green Chilli Farming in Water Scarce Phangyul and Rubesa Gewogs, Wangdue Phodrang, Bhutan

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Abstract

Chilli (*Capsicum* spp.) is an important crop cultivated in Bhutan. However, studies on chilli farming practices and profitability in water-scarce locations are scant. Thus, this study assessed practices and profitability of green chilli farming in two water-scarce areas, i.e., Phangyul and Rubesa gewogs of Wangdue Phodrang district. A total of 109 progressive chilli growers were sampled from five chiwogs of two gewogs using proportionate random sampling. Face-to-face interviews were done using semi-structured questionnaires. Descriptive statistics, including the farm accounting method, were used for analysis. Results showed that most farmers (n = 92, 84.40%) cultivate Indian chilli. Farmers in Rubesa usually sow chilli seeds in winter and harvest in summer, whereas farmers in Phangyul usually sow chilli in summer and harvest in winter. Chilli farming in Phangyul is more profitable than Rubesa because farmers in Phangyul bear the minimum cost for irrigation as they sow and transplant during the rainy season. Pests and diseases, lack of irrigation facilities, extreme weather events, and marketing were common constraints among chilli growers in the study area. Common marketing challenges reported by farmers include price fluctuation, competition from other farmers, and poor transportation facilities. We conclude that with adequate support from relevant stakeholders, chilli farming can be an essential means of livelihood even for farmers in relatively water-scarce communities.

Keywords: Constraints, economic analysis, green chilli, water scarcity

Introduction

Chilli (*Capsicum annuum* L.) belongs to the *Solanaceae* family. It is an essential crop grown globally, both as a spice and vegetable (Hasan *et al*., 2014; Quresh *et al*., 2015). Around 126 countries cultivate green chilli (Tripodi and Kumar, 2019). About 89% of the world's chilli cultivated areas are in Asia (Pinto *et al*., 2016). The top chilli producing countries in Asia include India, China, Korea, Thailand, Vietnam, Sri Lanka, and Indonesia (Food and Agriculture Organization, 2018). People consume fresh, dried, or powdered chilli (El-Ghorab *et al*., 2013).

Chilli contains rich proteins, lipids, carbohydrates, fibres, mineral salts, and vitamins. Chilli is also a source of phytochemical compounds, including ascorbic acid, carotenoids,

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tocopherols, flavonoids, and capsaicinoids (Alvarez-Parrilla, 2011; Olatunji and Afolayan, 2019). Phytochemical compounds from chilli help treat cancer, asthma, coughs, sore throats, toothache, diabetes, and cardiovascular diseases (El-Ghorab *et al*., 2013; Wahyuni *et al*., 2013). Chilli has antioxidant, anti-mutagenesis, hypocholesterolemic, and immuno suppressive properties (El-Ghorab *et al*., 2013). Chilli also inhibits bacterial growth and platelet agglomeration (Wahyuni *et al*., 2013).

Even though chilli is grown worldwide, it is rarely of national priority in agricultural development in many countries. Thus, chilli cultivation remains traditional, facing biotic (e.g., pests and diseases) and abiotic (e.g., drought and salinity) stresses, causing severe yield losses (Adigun, 2001; Rai *et al*., 2020). Other challenges of chilli farming include poor genetics, poverty, low income, price fluctuation, inadequate irrigation, labour shortage, poor quality inputs, access to credit, and distant markets (Fajinm, 2006; Biradar and Chandrgi, 2013).

Chilli is said to have initially come to Bhutan from China via Tibet (Fukuda, 1993). Now, it is grown in different parts of the country (Tshering *et al.*, 2010). Bhutan is also regarded as a hotspot of hot pepper biodiversity (Lin *et al*., 2013). Bhutanese consume chilli as a vegetable rather than as a spice – making it an integral part of the Bhutanese diet. The popular Bhutanese dish, *ema datshi*, consists of chilli and cheese (Ueda and Samdup, 2010). In 2019, Bhutan produced 7,673 metric tons (MT) of fresh chilli, while exporting 10.96 MT worth Nu. 2.78 million (Ministry of Agriculture and Forests [MoAF], 2019). However, the quantity produced is not adequate to meet the people's demand due to the seasonal gap or consumers' preference for different types of chilli; therefore, Bhutan also imports chilli from India (Dorji *et al.*, 2009). For instance, 7.67 MT of chilli worth Nu. 0.19 million were imported in 2019 (MoAF, 2019).

In the past, the people of Phangyul and Rubesa mainly depended on paddy for their livelihoods. However, an increasing number of farmers are now cultivating chilli as their primary source of income. Water shortage has forced farmers to shift from water-intensive paddy cultivation to less water-intensive chilli farming. Nevertheless, studies on practices and profitability of chilli farming in water-stricken communities are generally scant in Bhutan. Research on practices and economic performance would offer development practitioners first-hand information towards promoting and diversifying sources of income through green chilli farming in water-scarce communities, such as Phangyul and Rubesa. Therefore, the objective of this study was to assess practices and profitability of green chilli farming in water-scarce Phangyul and Rubesa gewogs of Wangdue Phodrang.

Materials and Method

Description of study area

The study was conducted in Phangyul (27.4862°N 89.8992°E) and Rubesa (27.4765° N 89.9085°E) gewogs in Wangdue Phodrang (Figure 1). These two gewogs were chosen purposively because paddy cultivation was the primary source of livelihood in the past. However, these two gewogs are gradually shifting towards green chilli farming due to acute water shortages. Phangyul is one of the smallest gewogs covering 32.70 km^2 with five chiwogs (Phangyul-Kumchi, Goenkha, Chhungoen, Chunsey-Domkha, and Hampeykha). The gewog has 210 households (National Statistics Bureau [NSB], 2017). Ruepisa gewog covers 163.6 km^2. It has 309 households across six chiwogs (Jalla, Ulla, Zamding, Bangtoekha, Shelley, and Bjaphu). The average annual rainfall for Phangyul and Rubesa is 500-1,000 mm and 500-1,000 mm respectively. Phangyul lies between 1200-3000 meters above the sea level (m.a.s.l.); whereas the altitude of Rubesa ranges from 900-2400 m.a.s.l. People are smallholder farmers practising integrated farming of mostly cropping and rearing livestock. Rice is the main staple food for most farmers. However, paddy production has declined in the recent past due to water shortage. In response, an in-

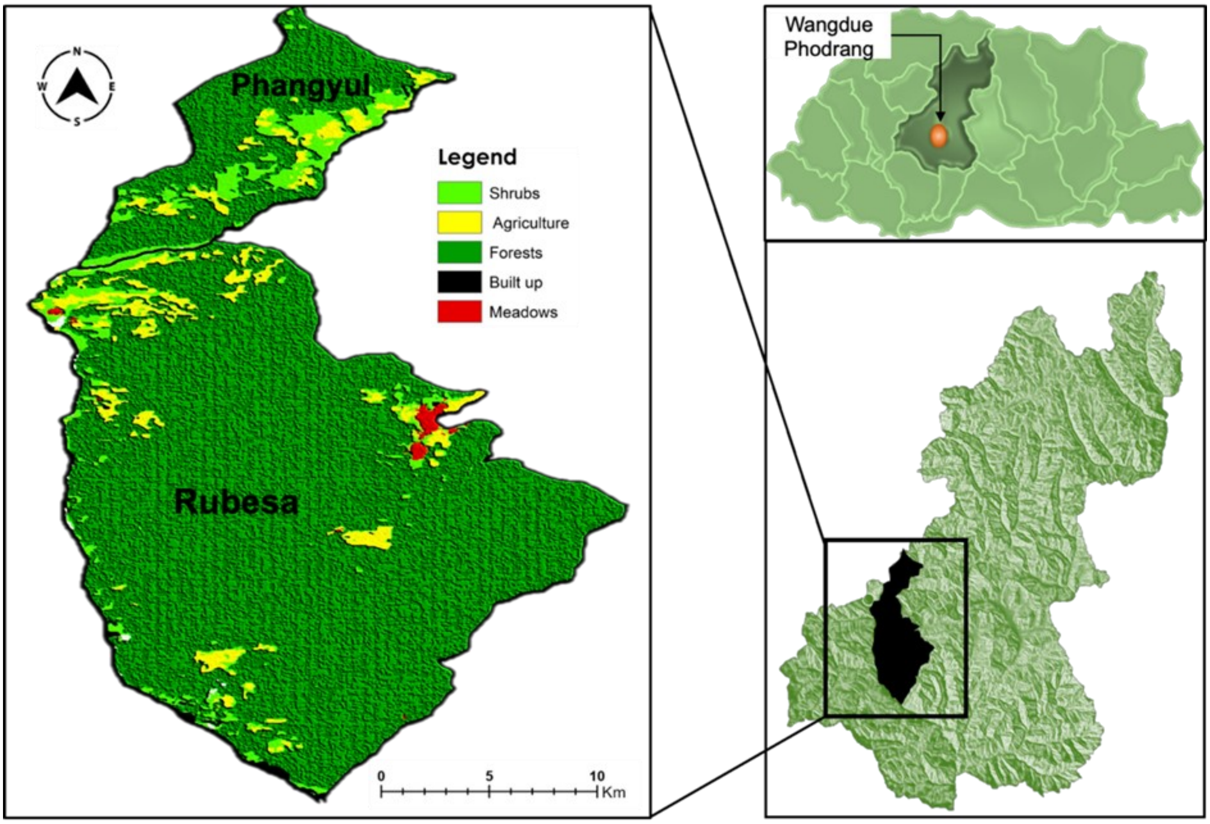

Figure 1: Phangyul and Rubesa Gewogs under Wangdue Phodrang Dzongkhag, Bhutan

creasing number of farmers are shifting towards green chilli farming.

Sample size and sampling method

Two chiwogs from Phangyul gewog and three chiwogs from Rubesa gewog were purposively selected for three specific reasons. Firstly, farmers in both chiwogs produce green chilli. Secondly, Phangyul and Rubesa have acute water shortages. Thirdly, these two gewogs are located adjacent to each another. These three features ensured reasonable justification for the comparison of chilli farming between water-scarce and relatively water-abundant areas. The target population was all progressive chilli growers in five selected chiwogs. The list of progressive chilli growers was provided by the agriculture extension officer of the respective gewog. More than 70% (109 out of 155) of the progressive chilli growing households were taken as a sample size for the current study. The proportionate random sampling was employed to ensure representative samples in each selected chiwog (Table 1).

Data collection

Data collection included face-to-face interviews of chilli growers using semi-structured questionnaire. Face-to-face interviews were necessary because most farmers were illiterate. Moreover, face-to-face interviews are best used when the chance to interview someone is only once (Bernard, 1988). It also reduces the non-

Table 1: Sample size in five chiwogs

Gewogs	Chiwogs	Population	Sample
Phangyul	Phangyul – Kumchi	33	23
	Goenkha	13	09
Ruepesa	Bangtoedkha	58	41
	Zamding	25	18
	Bjaphu	26	18
	Total	**155**	**109**

response rates (Krysan *et al*., 1994). At the same time, the semi-structured questionnaire helps guide the conversations and keeps respondents on the topic (Bernard, 1988). A semi-structured questionnaire also enables two-way communications. Data were collected from February to March 2021 after the farmers had finished harvesting their chilli to ensure that farmers remembered the most details about chilli farming. The duration for the interview was set to a maximum of 30 minutes to avoid interview fatigue. The questionnaire was pretested with ten chilli growers (five in each gewog) and necessary corrections were made to improve clarity. Enumerators were trained to interview and record responses on the structured questionnaire. Researchers got formal approval from relevant authorities (College Research Committee of the College of Natural Resources, Wangdue Phodrang District Administration, and Gewog Administrations). Study participants were explained about study objectives and confidentiality matters. Researchers also sought informed consent verbally from all respondents. Secondary data, i.e., rainfall data of Wangdue Phodrang and Samtengang Weather stations were extracted from NSB (2020) to show the year-round rainfall pattern in the study area.

Data analysis

Data entry, coding and cleaning were done in Microsoft Excel Spreadsheet 2010. Data were descriptively (mean, standard deviation, frequency, and percentages) analysed in the Statistical Package for the Social Sciences (SPSS). Farm accounting technique was used to analyse the costs, returns and profitability of chilli production.

Results and Discussion

Farmers' socio-economic profiles

The socio-economic characteristics of the chilli growers are presented in Table 2. Sampled chilli growers comprised more women (n = 66, 60.55%) than men (n = 43, 39.45%). The economically active people were engaged in chilli farming with the mean age of 48.69 ± 12.58 years. More farmers without formal education (n = 82, 75.23%) reflect low litera-

Table 2: Farmers' socio-economic characteristics (N=109)

Variable	Category	Overall	Phangyul	Rubesa
Gender	Male	39.45	50.00	35.06
	Female	60.55	50.00	64.94
Age	-	48.69(12.58)	46.63(13.12)	48.71(12.44)
Formal education	Yes	24.77	15.63	24.68
	No	75.23	84.37	75.32
Chilli farming experience	0.5-10.5 years	54.13	93.75	48.05
	10.5-20.5 years	14.68	6.25-	20.78
	20.5 years & above	31.19	-	31.17
Non- farm income	Yes	42.20	46.88	40.26
Farm-income	≤ Nu. 71,400	40.37	25.00	46.75
	Nu. 71,400- Nu 142,800	30.28	31.25	29.87
	Nu. 142,800 & above	29.36	43.75	23.38
Landholding	2 acres & below	52.29	43.75	55.85
	3-4 acres	23.85	15.62	15.62
	5 acres & above	23.85	40.63	16.88
Family size	1-3 (small)	53.25	59.38	50.65
	4-6(medium)	38.53	28.13	42.86
	>7 (large)	8.26	12.50	6.49

Note: Percentages are reported for categorical data, while means and standard deviations are reported for scale data cy rates. NSB (2017) also reported low literacy rates among rural people (63.6%) than urban people (84.1%) in Bhutan. About 40% (*n* = 44) of farmers earned income less than Nu. 71,400. More than half of farmers had small family (*n* = 58, 53.25%) and small landholding (*n* = 57, 52.29%), which are not appreciable in an agrarian-based society whose livelihood depends on land and labour. Most respondents (*n* = 59, 54.13%) had chilli farming experience of 0.5-10.5 years, implying that many farmers have started chilli farming within the past decade. A plausible reason is that water shortage in the study area has forced farmers to shift from water-intensive paddy to less water internship chilli farming.

Varieties of chilli grown

Phangyul and Rubesa gewogs grow seven varieties of chilli (*Capsicum annum* L.), *Sha Ema, Chachab Ema, Boegup Ema*, *Yangtsep Ema*, *Ema Oto, Dolley Ema*, and Indian chilli (SHP-4884 variety and SV-2319HA variety) (Figure 2). Overall, the top four chilli varieties grown by farmers were small Indian chilli (*n* = 92, 84.40%), *Sha Ema* (*n* = 62, 56.88%), and *Ema Oto* (*n* = 62, 56.88%). Significant farmers (*n* = 58, 53.25%) also grow *Dolley ema*, particularly in Ruebesa. Preference for these three varieties over others was because they have high demand in the market, and they can be harvested multiple times. *Boegup ema, Chabcha ema*, and *Yangtsep ema* are cultivated only for self-consumption. Farmers in Rubesa cultivated more *Dolley ema* than farmers of Phanyul due to the existing *Dolley ema* processing plant currently being operated by a farmers' group in Rubesa. Although some farmers (*n* = 31, 28.13%) in Phangyul are gradually cultivating *Sha ema*, most farmers (*n* = 75, 68.83%) in Rubesa are already cultivating Sha ema for commercial purposes. Farmers' preference for other varieties of chilli largely remains the same in Phangyul and Rubesa gewogs.

Chilli cultivation practices

Figure 3 shows rainfall patterns and some essential activities of green chilli farming in Phangyul and Rubesa gewogs. In Phangyul, farmers sow their chilli seeds in summer. The plausible reason is that Phangyul experiences severe irrigation water shortage; they sow and transplant chilli in summer, taking advantage of monsoon rain. In October, most farmers (*n* = 51, 47.19%) had their first harvest. However, farmers also had their first harvest between August (the current year) and the end of January (the following year). Accordingly, most farmers (*n* = 72, 65.63%) in Phangyul had their last harvest in December, while some farmers had their last harvest from September till February of the following year. On the other hand, most farmers (*n* = 65, 59.74%) in Rubesa sow chilli seed in winter (i.e., around January). However, farmers in Rubesa also sowed seeds from November (the previous year) till July. Less dependence of Rubesa farmers on rainfall for

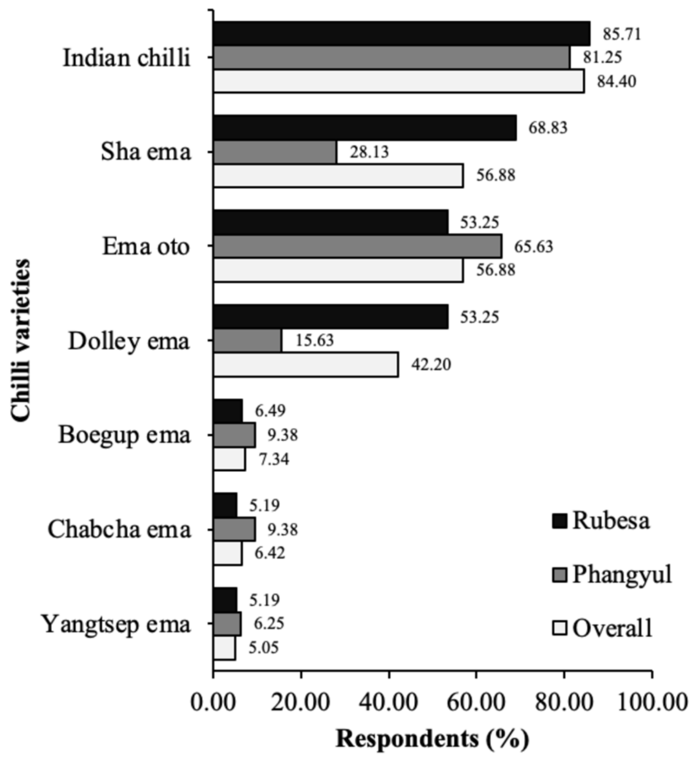

Figure 2: Farmers' preferences of varieties of chilli

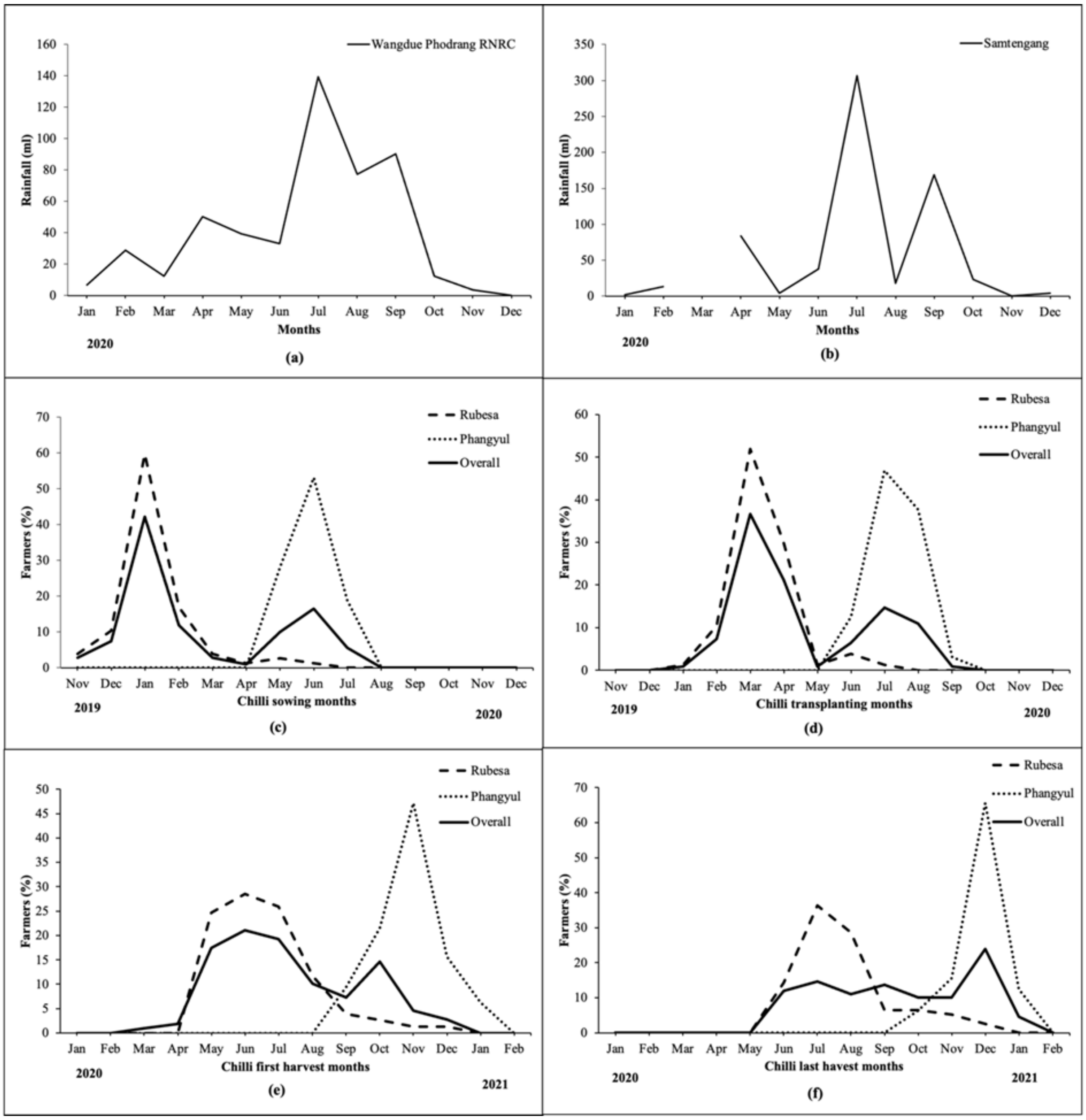

Figure 3: Rainfall pattern and some essential activities of green chilli farming. Figure 3(a) shows the rainfall pattern in the Wangdue Phodrang RNRC weather station. Figure 3(b) shows the rainfall pattern in Samtengang (another nearby weather station). However, there was a missing data in March. Weather data were derived from NSB (2020). Figure 3(c) shows chilli sowing months, and Figure 3(d) presents transplanting months. Figures 3(e) and 3(f) present the chilli's first and last harvesting months, respectively.

chilli sowing and transplanting indicates that Rubesa has relatively enough irrigation water compared to Phangyul. Most households had their first harvest in June (*n* = 31, 28.57%); however, farmers also harvested as early as April to January (following year). Most farmers had their last harvest in July (*n* = 40, 36.36%), while farmers also had their last harvest between May and February (following year).

Most farmers (*n* = 86, 78.90%) practised manual weeding, i.e., hand weeding and hoeing. The weeding frequency was four times in a season. Multiple weeding indicates the requirement of intensive labour. Only 21.10% (*n*

= 23) of farmers used weedicides such as Butachlor (pre-emergence) and glyphosate (post-emergence). Interactions with farmers revealed that farmers were aware of synthetic chemicals; still, they do not use them. Most farmers (*n* = 30, 93.75%) in Phangyul did not irrigate chilli field as they transplant chilli during rainy summer. Contrarily, most farmers (*n* = 68, 88.31%) in Rubesa do manual irrigation of chilli fields after transplantation. Therefore, stakeholders concerned could assess the feasibility of introducing drip irrigation, especially during chilli transplantation in winter. Farmers manage pests and diseases by removing infested chilli plants, disposal of pests, applying wood ashes, introducing crop rotation, raising of bed, and practising shifting cultivation. A few farmers used chemicals including Cypermethrin and Malathion to control pests.

We also explored farmers' access to essential inputs required for chilli farming (Table 3). Farmers could access chilli seeds or seedlings from the market (*n* = 75, 68.81%). Some farmers buy dry chilli from the market and extract seeds. Later, farmers sow seeds either in open-field or polytunnel for seedling production. Others directly buy seedlings from the market for direct transplantation. More than 54% (*n* = 59) of farmers also accessed seeds of small Indian chilli (mostly SHP 4884 and SV2319HA) from the government through agriculture extension personnel. While 50.46% (*n* = 55) of farmers produced seeds or seedlings themselves, only 17.43% accessed from their neighbours. Farmers (*n* = 95, 87.16%) mainly used farmyard manure, produced at home, to fertilize their chilli field. Use of farmyard manure by farmers indicates integrated farming of crops and animals. Farmers produce farmyard manure using paddy straw and leaf litter as bedding materials for their cattle. Few farmers use chemicals supplied by the Agriculture sales and service representatives. Agriculture extension officials also arrange chemicals for farmers based on their pre-orders.

Marketing of chilli

Most farmers (*n* = 107, 98.17%) sold fresh and green chilli. Only 9.17% (*n* =10) sold chilli in the form of chilli powder, blanched chilli, and dried red chilli. Overall, the quantity of processed chilli is very minimal. In Rubesa, it is exceedingly difficult for farmers to dry chilli as they harvest it in rainy season. Farmers in Phangyul also do not process chilli as they reported selling green chilli to be more profitable. Farmers usually sell their chilli soon after the harvest. The maximum duration for storing chilli after the harvest was only about one night. Farmers use diverse marketing channels to sell their chilli (Figure 4). Smallholder farmers without a private vehicle for transportation sell chilli at farmgate (*n* = 45, 41.28%). Local buyers or middlemen pick up chilli from the farmgate. In contrast, farmers who can hire vehicles or own private vehicles could take their chilli to the local market, i.e., Bajo weekend market (*n* = 98, 89.91%) or regional markets, including Thimphu and Punakha (*n* = 42, 38.53%). Farmers usually sell chilli in bulk by packing in 25 kg sack. Moreover, farmers having a limited formal or informal contract with buyers indicate the need for stakeholders concerned to initiate contract farming between

Table 3: Source of different farm input access to farmers

Inputs	Market (%)	Self (%)	Neighbours (%)	Government (%)
Seed/seedling	68.81	50.46	17.43	54.13
Farmyard manure	-	87.16	-	-
Urea	23.86	-	-	-
Suphala	34.86	-	-	-
Weedicides	18.35	-	-	20.18
Pesticides	-	-	-	30.28
Fungicides	-	-	-	8.26

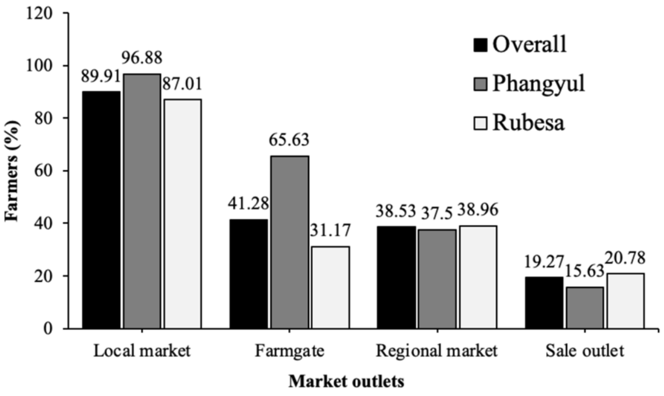

Figure 4: Graph showing market available for the chilli producer in Phangyul and Rubesa

smallholder chilli growers and potential buyers. As shown in Figure 4, the marketing patterns are very similar in both the gewogs.

Economic performance of green chilli farming

The cost and return analysis was done based on an acre of cultivated land (Table 4). On average, the net return was Nu. 3,71,474 (Nu. 3,82,708 in Phangyul and Nu. 3,60,240 in Rubesa). The mean market price for a kilogram of chilli was Nu. 380 in Phangyul and Nu. 350 in Rubesa. The overall unit production cost of Nu. 46 per kilogram of chilli was slightly higher than Nu. 39 reported by the Department of Agriculture (2020). Overall, a benefit-cost ratio of 8 in this study is desirable as it is greater than 1 (Plastina, 2015). The result also showed high marginal returns. Similarly, high marginal returns on chilli farming were reported in Pakistan (Ali *et al*., 2016). Basic economic analysis of chilli farming shows that chilli farming is profitable in both the gewogs. The findings suggest that chilli production can be profitable even in water-scarce areas.

Production and marketing challenges of green chilli farming

The "pests and diseases" was the major constraint (*n* = 101, 92.66%) for chilli growers in the study area. Supporting the current study, World Bank (2017) and Rai *et al*. (2020) also reported pests and diseases as significant challenges for chilli farming in Bhutan. Another major constraint reported by 88.07% (*n* = 96) of farmers was extreme weather events, including heavy hailstorms, erratic rainfalls, and drought. Bhutan's agricultural system is highly prone to the vagaries of climate change (Chhogyel and Kumar, 2018). Therefore, it is recommended that Bhutan should strive for climate-smart agriculture (Tenzin *et al.,* 2019). Crop depredation by wild animals (especially Deer and Porcupine) is also one of the significant constraints reported by 85.32% (*n* =93) of the farmers. Human-wildlife conflicts are reported in many parts of Bhutan (National Plant Protection Centre and World Wildlife Fund, 2016). Another major constraint of chilli production in the study area is the irrigation water shortage (*n* =88, 80.73%). Low yield, lack of labour force and non-availability of seeds are other minor constraints faced by the chilli growers in the study area (Figure 5a).

Most chilli growers (*n* = 80, 73.39%) claimed price fluctuation as a major constraint (Figure 5b). Farmers reported that they could

Table 4: Cost and return analysis of green chilli production per acre

Variables	Overall	Phangyul (Nu.)	Rubesa (Nu.)
Gross return (A)	4,25,811	4,24,971	4,26,650
Variable costs	44,373	35,586	53,160
Fixed costs	9,964	6,678	13,250
Total costs (B)	54,337	42,263	66,410
Net return (A-B)	3,71,474	3,82,708	3,60,240
Benefit-cost ratio	8	10.05	6.36
Unit cost (kg)	46	37.8	54.47
Marginal return	898	1,094.20	702.57

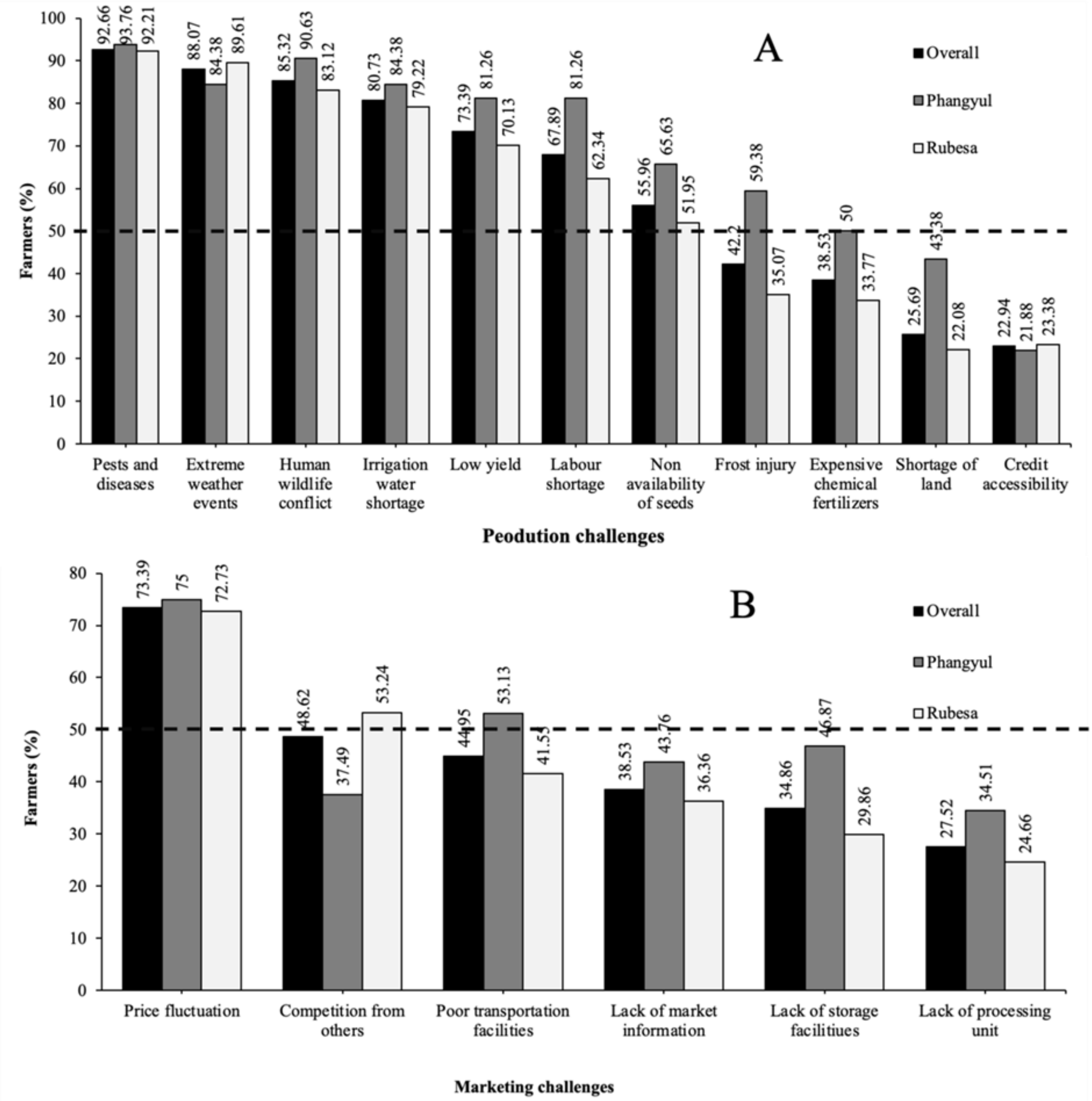

Figure 5: Challenges among chilli growers: Production challenges (A) and Marketing challenges (B)

fetch higher chilli prices during the early and late harvest. However, the price drops drastically during the peak production season. Many farmers producing chilli at the same time is a challenge for them. For instance, the fall in the price of chilli in the market sometimes imparts loss to some farmers. Although Phangyul and Rubesa have different chilli farming seasons, price fluctuation is primarily due to competitors. For instance, more than half of farmers in Rubesa (n = 41, 53.24%) reported competition from others as a challenge. They claimed that even though they tried to grow chilli as early as possible, their selling time always coincides with other growers from Kazhi, Baylandra, and Dangchu under Wangdue Phodrang district and Kabisa under Punakha district. Farmers in nearby areas also sow and transplant chilli in winter and harvest in summer to prepare their land for paddy cultivation. Therefore, there is a need to promote the processing of chillies into other products such as dry chillies, chilli powder, blanched chilli that can be preserved for extended period and enable marketing during off

-season. Additionally, more than half of the farmers (n = 17, 53.13%) in Phangyul also reported difficulty in transporting chilli to the markets. Transportation problem is pronounced by the fact that 62.50% (n = 68) of the chilli growers do not have private vehicles; therefore, they must bear the high cost of hiring taxis or pickup trucks to transport their goods.

Conclusions

Cultivation of green chilli was an essential source of household income for the increasing number of farmers in Phangyul and Rubesa. Green chilli farming was profitable in both the gewogs. The finding suggests that green chilli farming can be an important alternative crop for small households to generate family income even in water-scarce areas. However, adequate support by different stakeholders should be continuously provided to chilli growers to minimize production and marketing challenges. The support could include in areas of integrated pest management, heat and drought-resistant varieties, and electric fencing. Introducing small-scale efficient water management practices, including rainwater harvesting, drip irrigation, and mulching could further increase the profitability of chilli farming. On the other hand, the value addition of chilli and support in marketing through the establishment of reliable contractual agreements would address much of the marketing issues reported by small scale farmers.

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