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DOES WILD FOOD CONTRIBUTE TO FOOD SECURITY? EVIDENCE FROM RURAL BHUTAN

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Abstract

We use primary data to examine the potential role of wild foods in alleviating food insecurity among rural farmers in Bhutan during the COVID-19 pandemic. We find that food-insecure households are more likely to collect wild foods, suggesting that food-insecure households are consuming wild foods as a coping mechanism. Therefore, it is crucial to include wild food considerations in regional, national, and international food security policy to promote resilience and reduce vulnerability in rural communities. Food security policies may enable the use and consumption of wild foods as a complementary source of food and nutrition, especially in remote areas. Further, the government should implement policies on managing wild foods as it is a public good, and its conservation is crucial for preserving biodiversity.

Keywords: wild foods, food insecurity, rural farmers, Bhutan

JEL Classification: Q18, Q20

Contents

1. INTRODUCTION

It is estimated that the world's population will reach almost 10 billion by 2050, increasing the global food demand by about 50% compared to 2013 (FAO 2017). While the global food demand is expected to rise sharply, the global food supply development may fall behind due to the challenges arising from rapidly changing climatic conditions. According to the FAO (2017), global food security—including food supply, food access, food quality, food utilization, and food stability—has been adversely affected by climate change. Furthermore, it is estimated that the adverse effects of climate change are strongest in low- and middle-income countries, where millions of vulnerable households depend on agriculture and are prone to food insecurity (FAO 2017). To meet the rising global food demand—in terms of both energy and nutritional needs—the domestication of additional food-producing species and promotion of the consumption of underutilized food resources, including wild foods, is necessary (FAO 2019).

Wild foods are defined as food products obtained from nondomesticated species, including plants, bacteria, animals, and fungi (FAO 2019). Contrary to popular belief, a substantial proportion of the wild foods used can be found around the house or in areas used for livestock and/or crop production (Powell et al. 2014). The mean number of wild food species used per location has been found to range between 90 and 100 (Bharucha and Pretty 2010). The consumption of wild foods—on a regular basis or in times of scarcity—can directly contribute to households' food security. Wild foods can be important nutritional and livelihood safety nets for the poor and vulnerable, especially in times of shock and shortage (Shumsky et al. 2014; Vinceti et al. 2013).

Wild foods can also be traded to increase income, which can be used for purchasing other food items. It has been discovered that wild foods are rich in micronutrients such as vitamins, minerals, protein, and antioxidants (Bharucha and Pretty 2010; Chalise et al. 2010; van Huis 2013). Consuming wild foods can ease micronutrient and/or protein deficiencies, resulting in a more balanced and nutritious diet (Broegaard et al. 2017; Kuyper, Vitta, and Dewey 2013). Therefore, consuming wild foods can be an important strategy for the rural poor to mitigate against food insecurity and malnutrition.

Although Bhutan has seen rapid socioeconomic development in the last three decades, a key concern remains in terms of diet and nutrition, especially for pregnant and nursing women and young children (Leao and Lhaden 2018). According to the National Nutrition Survey 2015, fruit and/or vegetable consumption among most Bhutanese adults is lower than the recommended level of 400 grams per person a day (Ministry of Health 2015). Although most of the population depends on agriculture for their livelihoods, Bhutan's food system remains dependent on food imports due to limited arable land (only 2.6% of the land), vulnerability to natural hazards, and increased climate variability (WFP 2022). Due to Bhutan's physical geography, which consists of mostly steep, tall, and rugged terrain and mountains, access to a reliable and diverse diet throughout the year among people living in remote areas remains a challenge (Leao and Lhaden 2018). Wild foods thus play a crucial role in ensuring a healthy diverse diet, especially for people living in remote areas.

The COVID-19 pandemic and its effects on health and economic activities have exacerbated food security and nutrition issues in Bhutan. The poverty rate in Bhutan rose from 8.8% in 2020 to 9.4% in 2021, based on US$3.65 per day (World Bank 2022). Similarly, the youth unemployment rate doubled from 11.9% in 2019 to 20.9% in 2021 (World Bank 2022). Therefore, the role of wild foods in contributing to food security, nutrition, and poverty alleviation in rural Bhutan became even more significant during the COVID-19 pandemic.

There has been a significant number of studies identifying the important contribution of wild foods to nutrition and household food security, particularly amongst the poor and vulnerable (Arnold et al. 2011; Barbara, Eyzaguirre, and Johns 2008; Erskine et al. 2015; Fentahun and Hager 2009; Koffi et al. 2020; Legwaila et al. 2011; Mavengahama, McLachlan, and de Clercq 2013; Sunderland 2011; Tshering et al. 2014; Vinceti et al. 2013). However, only a few studies provide quantitative evidence on the extent of this contribution (i.e., Chakona and Shackleton 2019; Hickey et al. 2016; Shumsky et al. 2014). Various authors have called for more empirical evidence to better inform policy makers about the significant contribution of wild foods to nutrition and household food security (Arnold et al. 2011; Johns and Eyzaguirre 2006; Sunderland 2011). More importantly, to date, no study has examined the importance of wild foods during the COVID-19 global pandemic.

This paper aims to fill this gap by studying the contribution of wild foods to food security among subsistence farmers in rural Bhutan during the COVID-19 pandemic. Specifically, this study aims to: (1) document the prevalence of wild food consumption during the COVID-19 pandemic; and (2) describe the socioeconomic and demographic characteristics of households that collected and consumed wild foods during the COVID-19 pandemic.

The remainder of this paper is structured as follows: Section 2 provides a brief background to wild foods in Bhutan; Section 3 describes data sources and the empirical strategy; Section 4 discusses empirical findings; and Section 5 provides a discussion and policy recommendations.

2. WILD FOODS IN BHUTAN

Known as the world's first carbon-negative country and the only carbon-negative country in Asia in 2023, Bhutan has an overall forest cover of about 71%, and the Constitution of Bhutan mandates maintaining at least 60% of the land under forest at all times (Royal Government of Bhutan 2016). With a large forest cover and a wide range of agroecological zones, Bhutan is known for its rich biodiversity, being home to an estimated 11,248 species as of 2017 (National Biodiversity Center 2019). These species provide many benefits for the people: They can be used as food, medicine, livestock feed, timber, fuel, and for other household applications (Wangchuk and Olsen 2010; Yangdon et al. 2022). Over 40 species of edible wild vegetables and over 350 species of edible mushrooms have been identified in the forests throughout Bhutan (FAO 2019). As a result, a wide range of edible wild plants and mushrooms are collected and consumed, which substantially contributes to the diet and nutrition of rural people (Tshering et al. 2014).

The most important category of wild food collected in Bhutan is mushrooms. A wider variety of mushrooms can be found in temperate than in tropical regions (Penjor, Peldon, and Punjabi 2014). Among the most commonly consumed mushrooms are Matsutake, Chanterelle, Oyster mushroom, Shiitake mushroom, Shimeji, Wood Ear, Coral mushroom, Short Stem Russula, and Gypsy (Penjor, Peldon, and Punjabi 2014). Commonly exported to Japan, the Matsutake mushroom is one of the most expensive mushrooms in the world (Ping 2021). There is a growing market demand for mushrooms; therefore, mushroom collection has been an important source of income for rural people living in remote areas with difficult terrain (Penjor, Peldon, and Punjabi 2014). Another valuable functional wild food famous in Bhutan is a type of caterpillar fungus called *Cordyceps sinensis*, which is also found in the high mountain regions of the People's Republic of China (PRC), India, and Nepal. *Cordyceps* is believed to have

numerous medicinal benefits and thus has a high market value (up to US$2,625 per kilogram) (Chakraborty, Chowdhury, and Nandi 2014). In Bhutan, only people from the higher regions of Paro, Thimphu, Wangdue Phodrang, Gasa, Lhuntse, Trashigang, Trashiyangtse, Haa, and Bumthang can legally collect *Cordyceps* during a one-month window period every year (Gurung 2019).

The Government of Bhutan has included nonwood forest product development as one of the important strategies aimed at poverty reduction and economic growth. The important contribution of wild foods in alleviating poverty and food insecurity has been widely acknowledged in Bhutan (Penjor, Peldon, and Punjabi 2014). Although the conservation and management of nonwood forest products are legally under direct government authority, the practices often lack effective management and implementation (Penjor, Peldon, and Punjabi 2014). With the increase in the market demand for some nonwood forest products such as *Cordyceps*, *Paris polyphylla*, and *Cymbidium Erythraeum* (edible orchid), there has been a growing call for biodiversity conservation in Bhutan to avoid overexploitation of nonwood forest products.

3. METHODOLOGY

3.1 Data Source

This study utilizes the *Bhutan Rural Agricultural Livelihoods Survey*, which was conducted from late 2021 to early 2022. A total of six districts, namely Paro, Punakha, Bumthang, Zhemgang, Trashigang, and Mongar, were purposively selected to capture agroecological variation across the eastern, central, and western regions of Bhutan. Districts in the southern region were not included in this survey due to COVID-19 pandemic travel restrictions in this part of the country.

A total sample of 834 farm households (about 135–143 from each district) were selected using a simple random sampling method. Thirty-one gewogs (administrative blocks) were selected from the six chosen districts through a simple random sampling method. To include as many representative samples as possible, the farm households were selected in the area after consultation with the local agriculture extension officials and local leaders, as well as on-site visits and assessments. From homogeneous clustered settlements, five to nine representative farm households were selected, and from heterogeneous scattered settlements, 12–15 respondents were selected.[1]

The respondents were interviewed face-to-face using semi-structured questionnaires. The survey includes questions related to the farming population's demography, household assets, shocks, wild food collection, food security and hunger, farmers' perception of climate change, and their coping mechanisms. After dropping the observations with missing data, a total of 783 households are used for the analysis.

[1] A settlement can be a village or a subset of a village. Classification of the settlements was based mainly on the local socioeconomic status, through consultation with field extension officials.

Table 1: Number of Surveyed Households in the Sample

District	Number of Households
Bumthang	135
Mongar	139
Paro	137
Punakha	139
Trashigang	141
Zhemgang	143
Total	834

3.2 Empirical Strategy

To examine the socioeconomic and demographic characteristics of households that collect and consume wild foods, this study employed the logistic regression model as follows:

$$\Pr(Y_i = 1 \mid \boldsymbol{X}_i) = \mathrm{F}(\boldsymbol{X'}_i\boldsymbol{\beta})$$

$$\Pr(Y_i = 1 \mid \boldsymbol{X}_i) = \frac{1}{1+\exp[-(\boldsymbol{X'}_i\boldsymbol{\beta})]}, \quad (1)$$

where Y_i is the binary outcome variable that equals 1 if household *i* collects wild foods, $\boldsymbol{X}_i$ is a vector of observed household characteristics (including, but not limited to, food insecurity status, household head's age, age squared, gender, marital status, education, household size, asset index, livestock index, and regional fixed effects), and *F* is the cumulative standard logistic distribution function.

The indicators for food insecurity status are derived using the Food Insecurity Experience Scale (FIES), which consists of eight questions regarding the respondents' experiences with difficulties in accessing food. The eight questions ask: "During the last 12 months, was there a time when, because of a lack of money or other resources:

1. you were worried you would not have enough food to eat?
2. you were unable to eat healthy and nutritious food?
3. you ate only a few kinds of food?
4. you had to skip a meal?
5. you ate less than you thought you should?
6. your household ran out of food?
7. you were hungry but did not eat?
8. you went without eating for a whole day?"

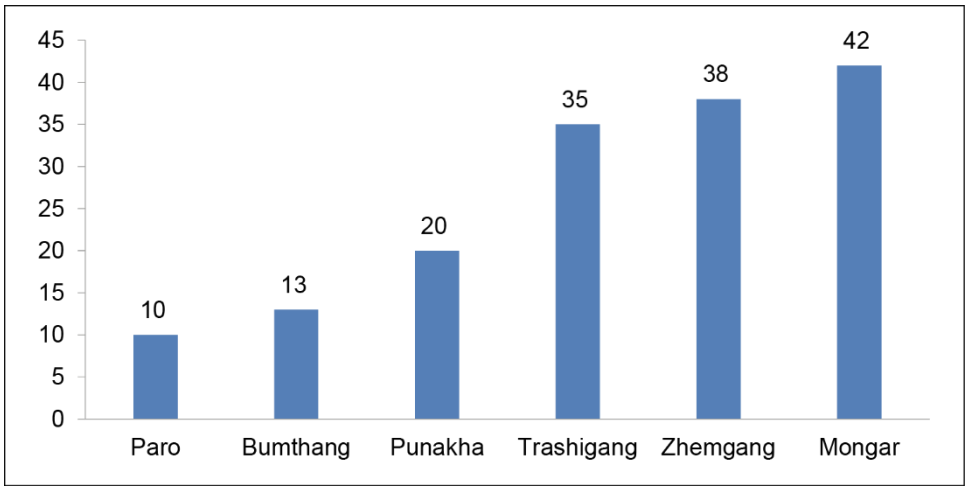
According to the Voices of the Hungry (2015), when food insecurity is used as an independent variable, the severity of food insecurity may best be represented by a set of dummy variables based on a raw score of the FIES. A raw score of 1 to 3 represents mild food insecurity, a raw score of 4 to 6 indicates moderate food insecurity, and a raw score of 7 to 8 represents severe food insecurity (Voices of the Hungry 2015). Our indicators of the severity of food insecurity follow the recommendations of the Voices of the Hungry team described above.

4. RESULTS

4.1 Descriptive Results

Figure 1 shows the prevalence of food insecurity (by district). Since households reporting moderate to severe food insecurity comprise only 1.1% of the whole sample, we group mild, moderate, and severe food insecurity statuses together. Figure 1 shows that the prevalence of food insecurity is highest in Mongar (42%), followed by Zhemgang (38%), Trashigang (35%), and Punakha (20%), while it is lowest in Paro (10%), followed by Bumthang (13%). It can be inferred from this figure that the prevalence of food insecurity among rural farmers varies significantly among districts. Mongar, Zhemgang, and Trashigang are relatively poor districts with low agricultural productivity, while Paro and Punakha are affluent districts with high agricultural productivity, which is also reflected by the food insecurity indicator in Figure 1.

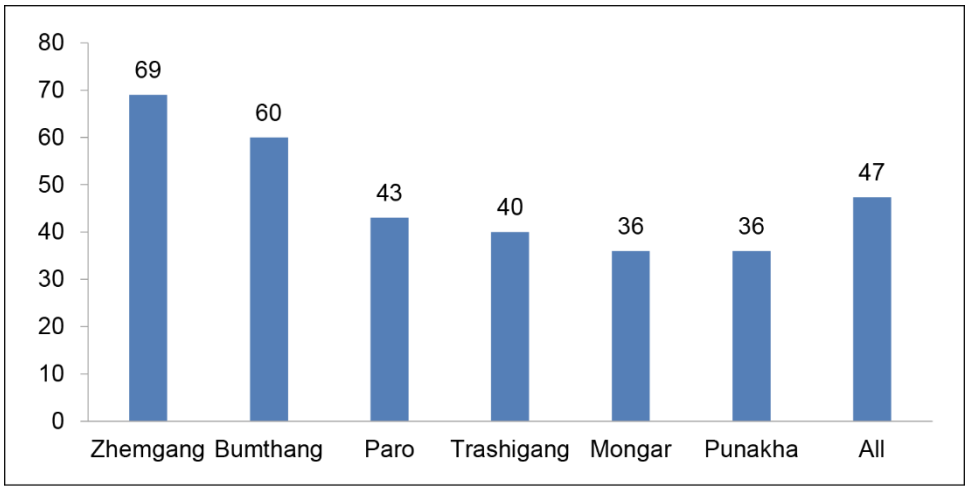
Figure 1: Prevalence of Food Insecurity (by District)
(%)



Source: Authors' calculation based on the Bhutan Rural Agricultural Livelihoods Survey

Figure 2 presents the percentage of households collecting wild foods by district. It shows that wild foods were collected and consumed, on average, by approximately 47% of the whole sample, which shows a high prevalence of wild food collection among rural farmers in Bhutan. These statistics indicate that wild foods are an important source of livelihood in rural Bhutan, even among farmers in our sample. Figure 2 also shows significant differences in the percentage of households collecting wild foods across districts, with Zhemgang having the highest share (69%), followed by Bumthang (60%), Paro (43%), Trashigang (40%), Mongar (36%), and Punakha (36%). However, it is important to note that a significant proportion of the households in all the surveyed districts collect wild foods, as they are widely available and considered both healthy and a delicacy in Bhutan. Large varieties of wild vegetables, such as different types of mushrooms, ferns, cane shoots, nettle leaves and other green leafy vegetables, are collected and consumed in Bhutan.

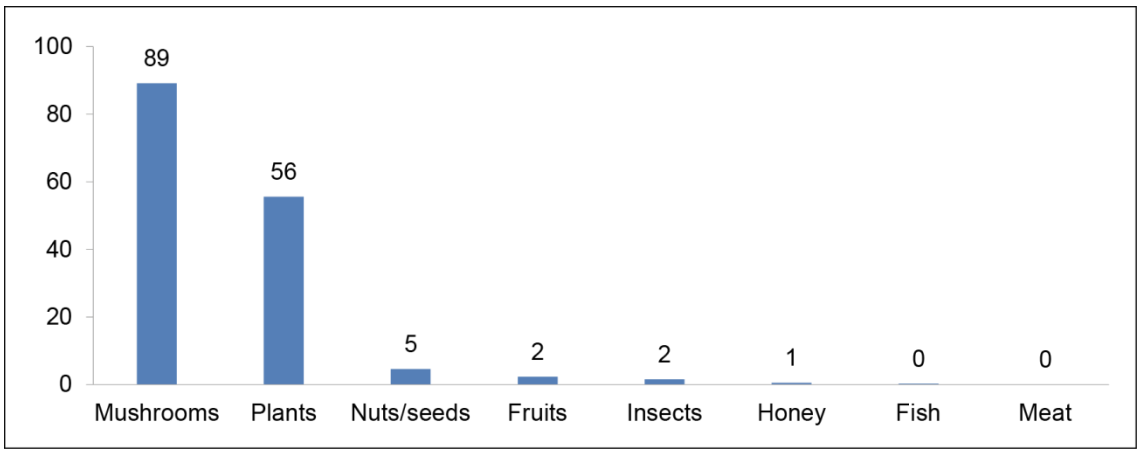
Figure 2: Percentage of Households Collecting Wild Foods
(%)



Source: Authors' calculation based on the Bhutan Rural Agricultural Livelihoods Survey.

Figure 3 shows the types of wild foods collected. The most commonly collected wild foods were mushrooms (89%) and plants (56%). Only about 5% of households collected nuts/seeds, 2% fruits, another 2% insects, 1% honey, and less than 1% fish and meat. It should be noted that while the majority of households collected mushrooms, our sample does not include highlanders who have a permit to harvest *Cordyceps*. Please refer to Section 2 for general information regarding wild foods in Bhutan.

Figure 3: Types of Wild Foods Collected by Households
(%)

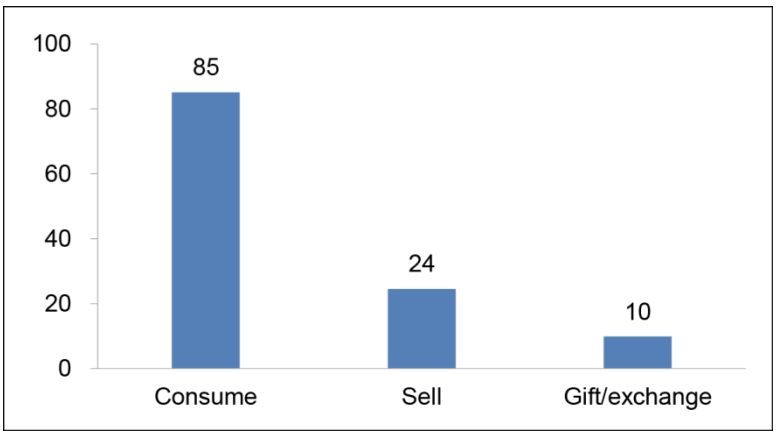


Source: Authors' calculation based on the Bhutan Rural Agricultural Livelihoods Survey

Figure 4 presents the purposes of collecting wild foods among rural Bhutanese farmers. The figure shows that the main purpose of collecting wild foods is self-consumption. A high proportion of respondents reported consuming them (85%), while about 24% reported collecting wild foods for sale and about 10% for gifts or exchange. These data reaffirm that wild foods contribute to rural livelihoods either by providing an additional food source or by increasing household income. Since the majority of the responses point toward subsistence consumption as the main purpose of gathering

wild foods, the main role of wild foods in contributing to household welfare in rural Bhutan is through diet and nutrition.

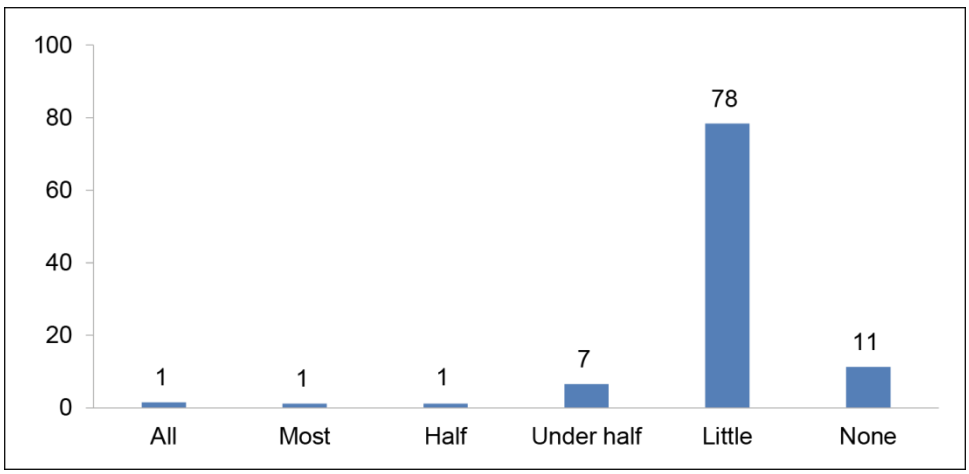
Figure 4: Purposes of Collecting Wild Foods
(%)



Source: Authors' calculation based on the Bhutan Rural Agricultural Livelihoods Survey

Figure 5 reports the share of wild foods in the total food consumption among households collecting wild foods. Given a range of categorical answers—"all, most, half, under half, little, none"—households were asked how much of their households' food consumption comes from wild foods. The data show that most households collecting wild foods reported that their share of wild foods in their total food consumption is "little." However, it should be noted that approximately 7% of the households reported that almost half of their food consumption comes from wild foods. Furthermore, at least 3% of households rely heavily on wild foods as more than half of their food consumption comes from such foods. Approximately 11% of the wild food collectors reported not using them directly for their household consumption.

Figure 5: Share of Wild Foods in Total Food Consumption
(%)



Source: Authors' calculation based on the Bhutan Rural Agricultural Livelihoods Survey

4.2 Characteristics of Households Collecting Wild Foods

Table 2 compares the characteristics of households collecting wild foods and their counterparts. The summary statistics show considerable differences, confirmed by the results of t-tests of mean differences. Significant differences were found regarding food insecurity (mild and aggregate), where households consuming wild foods had a higher prevalence of food insecurity than their counterparts. Since households reporting moderate to severe food insecurity comprise only 1.1% of the whole sample, we did not find a significant difference in this variable between the collectors and noncollectors of wild foods.

On average, the mean household head's age of households collecting wild foods is 53, while the mean household head's age of households who don't collect wild foods is 56. Although the difference is statistically significant, the economic difference is quite small in terms of household age. Due to the data limitation, we do not know which household member is the one collecting wild foods. Thus, the comparison between collectors and noncollectors of wild foods in terms of household head's age may be less than ideal. The share of female-headed households is significantly higher among households collecting wild foods. More than half of the sampled households are headed by a woman (57.8%). The share of female-headed households among households collecting wild foods is 61%, compared to 55% among the noncollecting households. The difference in the share of female-headed households between collectors and noncollectors of wild foods is statistically significant at the 10% level.

The average years of schooling of the sample is quite low at about one year. The t-test of the mean difference between the two groups shows that households collecting wild foods have more years of schooling by approximately 0.3 years. Although this difference is statistically significant, the economic difference of 0.3 years is quite small between the two groups. Therefore, we use a categorical variable to represent levels of education. The majority of the sample (79.3%) reported having absolutely no education, 13.5% having less than or having completed primary education, 3.1% having less than or having completed lower-secondary education, 3.3% having less than or having completed higher-secondary education, and less than 1% having tertiary education.

Table 2 also shows that households collecting wild foods have a larger household size by about 0.2 members, which is very small in the economic sense. Among the households collecting wild foods, the share of households receiving aid from the government or NGOs is up to 72%, while the share is only 61% among the noncollecting households. Since households receiving aid from the government and NGOs are more likely to be the poorest in the region, it suggests that collectors of wild foods, on average, have lower incomes and fewer resources than noncollectors. On the other hand, there are no significant differences in terms of assets and livestock index between the two groups, indicating that wild foods can be accessed and consumed by every household regardless of their wealth status.[2] The t-test also shows that the share of households experiencing a sudden job loss is significantly higher among wild food collectors, suggesting that wild foods are being used as a coping mechanism when households experience economic shocks.

[2] The livestock index was constructed by adding weight to different kinds of livestock when calculating the total number of livestock owned by each household. Cattle are given a weight of 1; sheep, goats, and pigs are given a weight of 0.7; and chicken and other poultry are given a weight of 0.1. The asset index was constructed by using principal component analysis (PCA) of 20 key asset ownership variables.

Table 2: Characteristics of Households Collecting Wild Foods

Variables	Mean (SD)	Noncollecting	Collecting	Δ
Outcome Variables				
Food-secure	0.711 (0.453)	0.733	0.687	0.046
Food-insecure (mild)	0.278 (0.448)	0.256	0.303	–0.047*
Food-insecure (moderate and severe)	0.011 (0.103)	0.011	0.010	0.001
Food-insecure (aggregate)	0.289 (0.453)	0.267	0.313	–0.046*
Household Characteristics				
Head's age	54.437 (13.435)	55.665	53.085	2.580***
Female head	0.578 (0.494)	0.551	0.608	–0.057*
Widowed	0.103 (0.304)	0.100	0.107	–0.007
Divorced	0.056 (0.230)	0.046	0.067	–0.020
No education	0.793 (0.405)	0.821	0.671	0.061**
Less than or completed primary school	0.135 (0.342)	0.124	0.147	–0.023
Less than or completed lower-secondary school	0.031 (0.172)	0.017	0.045	–0.028**
Less than or completed higher-secondary school	0.033 (0.179)	0.027	0.040	–0.013
Tertiary education	0.008 (0.087)	0.009	0.005	0.004
Years of education	1.121 (2.767)	0.963	1.295	–0.332**
Household size	4.212 (1.935)	4.095	4.340	–0.245**
Receive aid	0.667 (0.471)	0.614	0.724	–0.110***
Number of livestock	6.448 (28.924)	5.235	7.804	–2.569
Asset index	–0.0000 (1.408)	2.068	1.997	0.071
Have debt	0.447 (0.497)	0.440	0.454	–0.013
Health shock	0.146 (0.353)	0.139	0.154	–0.014
Job loss	0.120 (0.325)	11.391	14.352	–2.961**
Observations		438	396	834

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

To see whether the differences in household characteristics between collectors and noncollectors of wild foods are related to food insecurity status, we first divide the sample into two subsamples based on food insecurity status and then conduct t-tests of the mean differences of all household characteristics in each subsample. The results of these tests are presented in Table 3. For the variable widowed household head, the differences between collectors and noncollectors of wild foods are only significant among food-insecure households, which comprise about 9.7%. Households headed

by a widow comprise approximately 12.6% and 2.8% among wild food collectors and noncollectors, respectively. Similarly, for the variable years of education, the differences between collectors and noncollectors of wild foods are only significant among food-insecure households, at about 0.6 years. The average years of schooling among wild food collectors is approximately 1.4 years, compared to only about 0.7 years among the noncollectors. Another stark difference between food-secure and food-insecure households is the number of livestock. The difference in livestock index between collectors and noncollectors of wild foods among food-insecure households is up to 9.4, while the difference is only 0.4 among food-secure households.

Table 3: Comparison of Household Characteristics between Collectors and Noncollectors of Wild Foods by Food Insecurity Status

	Food-insecure			Food-secure		
Variables	**Noncollecting**	**Collecting**	**Δ**	**Noncollecting**	**Collecting**	**Δ**
Head's age	52.821	51.932	0.887	56.657	53.625	3.032***
Female head	0.462	0.512	–0.050	0.582	0.653	–0.071**
Widowed	0.028	0.126	–0.097***	0.125	0.098	0.026
Divorced	0.056	0.042	0.014	0.042	0.078	–0.035**
No education	0.820	0.739	0.081*	0.822	0.771	0.050*
Less than or completed primary school	0.132	0.168	–0.035	0.121	0.137	–0.016
Less than or completed lower-secondary school	0.018	0.058	–0.039*	0.016	0.039	–0.022**
Less than or completed higher-secondary school	0.018	0.033	–0.014	0.029	0.043	–0.013
Tertiary education	0.009	0.000	0.009	0.009	0.007	0.002
Years of education	0.771	1.428	–0.657**	1.029	1.233	–0.203
Household size	4.084	4.268	–0.184	4.098	4.374	–0.275**
Receive aid	0.641	0.677	–0.036	0.604	0.746	–0.141***
Livestock index	3.952	13.356	–9.404*	5.686	5.273	0.412
Asset index	–0.583	–0.158	–0.425**	0.228	0.054	0.174*
Have debt	0.444	0.459	–0.015	0.439	0.452	–0.012
Health shock	0.119	0.250	–0.130	0.146	0.110	0.036*
Job loss	0.145	0.104	0.040	0.112	0.125	–0.012
Observations	117	124		321	272	

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

4.3 Food Insecurity and Wild Food Collection

Table 4 shows the estimation results of the logistic regression analysis used to model the decision to collect wild foods. Coefficients are reported as the average marginal effects that show the impact of a change in a particular variable on the probability that a household engages in wild food gathering. Robust standard errors clustered at the commune (gewog) level are presented in parentheses. Household head and household characteristics are included in all three specifications (Columns 1 to 3). In Column 2, we add district-fixed effects, while in Column 3, we add commune-fixed effects. The results from all three specifications indicate that households experiencing food insecurity—even in a mild form—are more likely to collect wild foods as a coping mechanism. Specifically, the probability that a household experiencing a mild form of food insecurity collects wild foods is approximately 10 percentage points higher than its counterpart. The results are not statistically significant for moderate and severe food

insecurity, which can be explained by the very low prevalence of households reporting moderate to severe food insecurity (only 1.1% of the whole sample).

Table 4: Average Marginal Effects: Factors Influencing Wild Food Collection

	Collecting Wild Foods		
Variables	**(1)**	**(2)**	**(3)**
Food insecurity (mild)	**0.0726***	**0.0696**	**0.1000****
	(0.0421)	**(0.0428)**	**(0.0406)**
Food insecurity (moderate and severe)	–0.0177	0.0387	0.0451
	(0.179)	(0.157)	(0.207)
Head's age	0.0132	0.0101	0.0110
	(0.008)	(0.008)	(0.0084)
Head's age-squared	–0.00014*	–0.00012	–0.00013*
	(0.00008)	(0.00007)	(0.00008)
Female head[a,b]	0.0515	0.0256	0.00208
	(0.0422)	(0.0401)	(0.0394)
Widowed[a]	0.0800	0.100	0.125**
	(0.0655)	(0.0630)	(0.0518)
Divorced[a]	0.0814	0.0814	0.104
	(0.0834)	(0.0776)	(0.0705)
Less than or completed primary school[a,c]	0.0606	0.0603	0.0595
	(0.0612)	(0.0561)	(0.0557)
Less than or completed lower-secondary school[a,c]	0.229**	0.213*	0.184*
	(0.104)	(0.111)	(0.106)
Less than or completed higher-secondary school[a,c]	0.135	0.128	0.139
	(0.0870)	(0.0999)	(0.0880)
Tertiary education[a,c]	–0.0893	–0.105	–0.0195
	(0.152)	(0.143)	(0.136)
Household size	0.0196*	0.0155	0.0166
	(0.0103)	(0.0104)	(0.0108)
Receive aid[a,d]	0.108**	0.0623	0.0610
	(0.0462)	(0.0511)	(0.0479)
Livestock index	0.000761	0.000560	0.000666
	(0.000906)	(0.000614)	(0.000593)
Asset index	–0.0142	0.000912	0.0123
	(0.0163)	(0.0157)	(0.0149)
Have debt[a,e]	–0.0108	–0.00736	–0.000849
	(0.0402)	(0.0373)	(0.0363)
Health shock[a,f]	0.0340	0.0493	0.0422
	(0.0523)	(0.0500)	(0.0514)
Job loss[a,g]	–0.0215	–0.00253	0.0114
	(0.0670)	(0.0645)	(0.0598)
District fixed effects	No	Yes	No
Commune (gewog) fixed effects	No	No	Yes
Observations	783	783	782

[a]Dummy variable, [b]base category—male-headed household, [c]base category—no education, [d]base category—did not receive aid, [e]base category—did not have debt, [f]base category—did not have health shock, [g]base category—did not lose job.

Notes: Robust standard errors clustered at the commune level are presented in parentheses.

*** p < 0.01, ** p < 0.05, * p < 0.1.

With the use of commune-level fixed effects in Column 3, the coefficients of variables representing household characteristics are statistically insignificant, except for "widowed household head" and "education level of less than or completed lower-secondary school," which were found to be more likely to collect wild foods. This means that when food insecurity status, regional differences, and other household attributes are controlled for, households headed by a widow are more likely to extract forest resources, probably due to lower income. Although our model controls for household and livestock assets, the exact information on household income is not available and thus cannot be controlled for. The results also show that, compared to those with no education, those with an education level of lower-secondary school are more likely to collect wild foods, while the same results are not found for those with a higher level of education. Although education may provide people with knowledge regarding the availability and benefits of wild foods, those with a high level of education may be busy with their existing income-generating activities. Similarly to the studies by Broegaard et al. (2017) and Kuyper, Vitta, and Dewey (2013), the coefficient on wealth index is not statistically significant, indicating that wild foods can be accessed and consumed by every household regardless of their wealth status, although they tend to be more important to low-income households (Chakona and Shackleton 2019; Mavengahama, McLachlan, and de Clercq 2013).

5. DISCUSSION AND POLICY RECOMMENDATIONS

Our main finding that up to 47% of the total sample collect wild foods to cope with food insecurity points toward the importance of the inclusion of wild food considerations in regional, national, and international food security and forest policy in order to promote resilience and reduce the vulnerability of food and livelihood systems in rural communities. Our findings provide empirical evidence on the important role that wild foods play in Bhutanese rural livelihoods. A large proportion of respondents reported collecting mushrooms and plants (89% and 56%, respectively), with the majority (85%) of respondents reporting collecting wild foods for subsistence consumption. This finding supports the literature on the important role that nonagricultural biodiversity plays in household nutrition and diet diversity and its potential role in reducing the ecological footprint of food production.

However, the sustainability of wild food harvesting is likely compromised by the continuing processes of biodiversity degradation, land use change, and loss of knowledge about traditional food systems (Bharucha and Pretty 2010; Johns and Eyzaguirre 2006). A potential concern is the emergence of markets for wild food products that have traditionally been used for local subsistence, particularly the commercialization of wild animal products and bioprospecting (Bharucha and Pretty 2010). In the case of Bhutan, this concern has not yet become acute: Less than 1% of the respondents in our data reported collecting wild animal products, and the majority of them are engaged in subsistence consumption of wild foods, predominantly mushrooms and plants. But in any case, policies that integrate wild foods as a potential solution to cope with food insecurity have to consider the aspect of its sustainability. Although the subsistence-based gathering of wild foods may cause less deterioration to biodiversity than commercial collection, it is challenging to distinguish between these two activities due to low barriers to market entry and high participation in wild food gathering (Arnold 2008). This challenge makes it difficult to formulate regional, national, and international food security policies that equitably manage forest resources while preventing biodiversity from overexploitation.

Wildlife conservation policies may mitigate some sustainability concerns over wild food harvesting; however, such policies have the potential to negatively affect not only household food security but also household resilience to shocks and climate change (Angelsen et al. 2014; Shumsky et al. 2014a). The formation of protected areas, restricting local communities from accessing wild foods they previously relied on, tends to disproportionately affect more vulnerable and poorer populations, pushing them further into poverty and malnutrition. The appropriate policy framework should focus on the extent to which the regulation and utilization of wild food resources are best governed and by whom, and the answers to these questions depend largely on the local context, stakeholders, and formal and informal institutions (Hickey et al. 2016). Notably, local benefactors play an important role in ensuring effective and sustainable utilization and management of wild foods, potentially through existing formal and informal institutions (Hickey et al. 2016). Inclusive dialogue and collaboration among global conservation practitioners, local government, and residents are needed to work toward equitable and sustainable wild food utilization and management (Salerno et al. 2021).

It should be noted that while wild foods make an important contribution to rural household dietary diversity and nutrition and they are used as a coping mechanism for food insecurity, depending solely on wild foods may not settle food security challenges (Arnold 2008; Bharucha and Pretty 2010; Chakona and Shackleton 2019). Food security policies may promote the use and consumption of wild foods as a complementary source of food and nutrition for both low- and high-income households. Knowledge and information on nutrient composition, contribution to diet, methods of production, domestication and consumption, sustainable use/harvesting, and the economic importance of wild foods should be collected and distributed widely (Borelli et al. 2020), so that rural households are aware of the benefits of wild foods and are able to minimize their food expenditure when necessary and conserve the resources for future use/need. As global food prices continue to increase—more so recently due to the war in Ukraine—the role of wild foods in alleviating rural household food insecurity has become even more important. Although wild foods alone may not solve persistent food security issues, they do make an important contribution to rural household nutrition, dietary diversity, and income (Arnold 2008; Asprilla-Perea and Díaz-Puente 2019; Bharucha and Pretty 2010). At the same time, efforts should be made to promote and increase households' awareness of the convenience and advantages of their own food production, which is also an important solution to the food insecurity issue of poor households (Chakona and Shackleton 2019).

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