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Farming in Protected Areas (PAs) of Bhutan; challenges and mitigation measures taken by farmers

Kezang Wangchuk*, Mani Prasad Nirola, Jamyang Choden, Leki Wangchuk, Pema Lhamo & Tshering Zangmo

Abstract

In Protected Areas (PAs) of Bhutan, we recorded the farming system practiced by the farmers residing in the PAs, their challenges while farming and the measures they take against the challenges. The study area encompassed eight PAs covering 43 gewogs. Semi-commercial and open-ended questionnaires were used to interview the residents of the PAs. We interviewed 254 participants of which 206 were male and 48 were female. The study recorded that the farmers in the PAs practice subsistence farming however, now most of the farmers have ventured into semi-commercial farming. Rice and maize were found to be the main crops grown by the farmers in the PAs and chilies and potatoes were their mainly grown vegetables. As a part of the farming system, livestock was also reared by the farmers in the PAs and Cattle were reported to be the most raised livestock. However, they reported challenges too while farming such as crops damaged by pests and diseases, human-wildlife conflict (livestock and crop depredation by wild animals), and invasive species. For such problems, farmers have taken measures against them which were cultural as well as Agri extension methods. They also reported other farming challenges such as labour shortages, lack of market, limited land holdings, and reduced yield.

Key words: Commercial, human-wildlife conflict, protected areas, subsistence, semicommercial

Introduction

Bhutan lies between China to the North and India to the South with an area of 38,394 sq. km. The country's elevation extends from 160 meters in the south to more than 7,000 meters above sea level in the north (NATIONAL STATISTICS BUREAU [NSB] 2020). The country falls under two biogeographical realms with 70 % forest cover and has extraordinarily rich biodiversity (Namgay 2003). Bhutan currently has four Wildlife Sanctuaries, five National Parks, one Strict Nature Reserve, and eight Biological Corridors, accounting for 51.44% of the country's total area (WILDLIFE CONSERVATION DIVISION [WCD] 2016).

The country's population is agrarian, with 79% of the population practicing subsistence farming (Namgay 2003). The country has only 2.93% cultivated land (Dorji et al. 2021, NATIONAL SOIL SERVICES CENTRE [NSSC] & POLICY AND PLANNING DIVISION [PPD] 2010, Shresta et al. 2021). People who reside in protected areas in South Asia and the Trans-Himalayan region, including Bhutan, use different types of land for different purposes, including agriculture, raising livestock, and gathering forest products (Wang 2008). Jigme Singye Wangchuck National Park alone has 5000-6000 people living in the park (Wang et al. 2006) depending on agriculture, livestock, and forest. Bhutan is divided into six agroecological zones for agriculture planning (Kumar 2022).

Despite being an agricultural nation, pests and diseases pose a threat to the nation's ability to produce enough food on its own. Old pests and diseases are now adapting to new crops, or new pests and diseases are appearing on old crops (Dorji et al. 2019). Moreover, the human-wildlife conflict has impeded the goal of food self-sufficiency. The crop damage caused by wild animals has been known for a long time, but it has increased drastically (Wangdi et al. 2018). Livestock raising is an essential part of Bhutan's agriculture system (MINISTRY OF AGRICULTURE AND FORESTS [MOAF] 2019, Tshering & Thinley 2017) for milk, meat, manure, eggs, ploughing, and so on. However, the loss of livestock to wild predators is a source of unending conflict between farmers, predators, and wildlife managers (Tshering & Thinley 2017).

Farmers in the country had reported that their crop productivity has been reduced due to invasion from invasive species, and farmers are losing their rice productivity to invasive the alien waterweed *Potamogeton distinctus* (Pallewatta et al. 2003). It was also reported that herbaceous invasive species were found growing in agricultural land competing with crops, barren land, roadside, and forest (Gurung et al. 2022). The invasive species are not studied properly, and they have the potential to bring greater harm to biodiversity, local communities, and the country as a whole (Dorji 2012). The majority of farmers in Bhutan depend on subsistence farming and are vulnerable to the impact of invasive species (Dorji et al. 2021).

Therefore, the study focuses on the farming practices of the people residing in protected areas of Bhutan such as the different practices of farming, crops grown, pests and diseases and their methods of protection against them, livestock they rear, livestock predation by predators, crop depredation by wild animals, and invasive species that compete with their crops. However, Biological Corridors (BCs) and two Wildlife Sanctuaries (Jomotshangkha Wildlife Sanctuary (JWS) and Phibsoo Wildlife Sanctuary (PWS)) in the south were not covered by the study.

Material and Methods

Study area

The study was carried out in the eight PAs (Jigme Singye Wangchuck National Park (JSWNP), Jigme Khesar Strict Nature Reserve (JKSNR), Royal Manas National Park (RMNP), Wangchuck Centennial Park (WCP), Phruemsingla National Park (PNP), Bumdeling Wildlife Sanctuary (BWS), Sakteng Wildlife Sanctuary (SWS), and Jigme Dorji National Park (JDNP)) covering 43 gewogs in the PAs (Fig. 1).

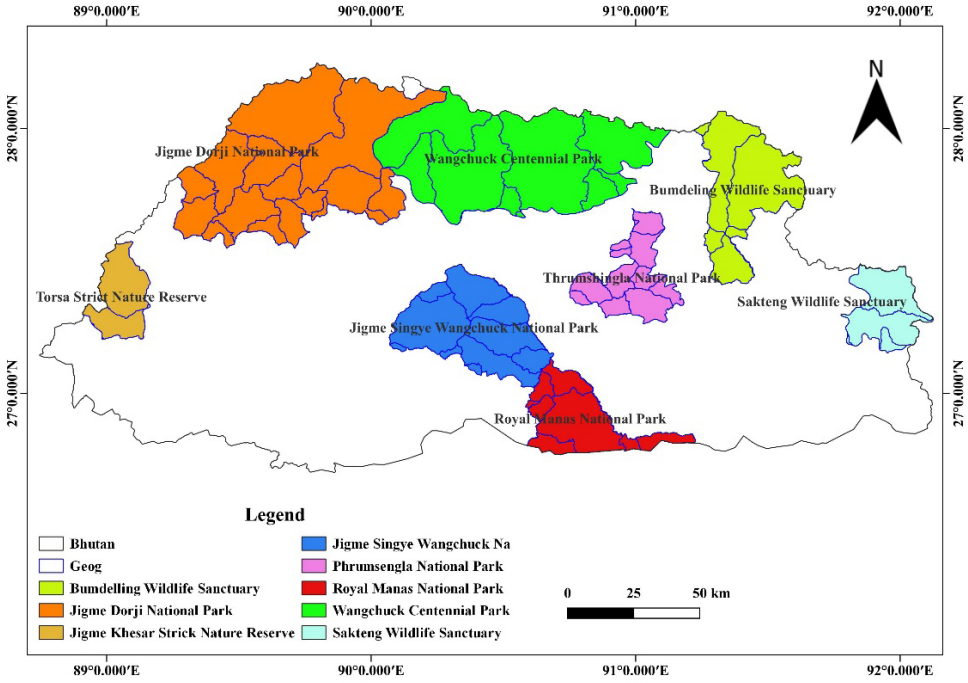

Fig. 1. Study Area Map

Data collection and data analysis

A desktop review of the Gewogs that fall under the jurisdiction of the PAs has been done prior to planning the field trips. Administrative approvals were obtained from both gewogs and dzongkhag (districts) to document the Farming System. Gewogs were asked to nominate one participant (who has sufficient knowledge about the community and farming systems) from each chiwog within the gewog. Prior to the study, a focused group meeting was convened in which a PowerPoint presentation was presented to set the context and obtain responses during the interview. Those meetings were also attended by the local government officials; Gups, Mangmis, Gewog Administrative Officers, and Tshogpas. The study took place from February 2020 to December 2020.

Semi-structured and open-ended questionnaires were used to interview and collect the information. The data collected were analysed using a Microsoft Excel Worksheet (xlsx), Microsoft Word 2016, and qgis version 3.24.1. The results were presented in Tables and Figures form.

Results and Discussion

A total of 361 participants attended the community consultation and awareness meeting, of which 290 were male and 71 were female. Through the consultation and awareness meeting, 254 participants were identified for the focused group meeting and the interview. Out of 254 participants, 206 were male and 48 were female.

Farming Practices

As per the findings of the study, it is evident that the farming systems have largely evolved from subsistence to semi-commercial over time. Out of the 43 gewogs, local communities of only 14 gewogs (33%) are practicing subsistence farming while the remaining 29 gewogs (67%) have ventured into semi-commercial farming. According to the local communities, they follow intensive farming which involves the growing of multiple crops in the same area. From the study, it was found that none of the communities has ventured into only commercial farming. Out of 43 gewogs, 36 gewogs practice sedentary farming while two gewogs practice nomadic farming mainly in Merak and Sakteng gewogs in Sakteng Wildlife Sanctuary. The remaining five gewogs follow both sedentary as well as nomadic farming. Similarly, NSB (2020) also reported that a decade ago the farming practice in the country was mainly subsistence-based however, now it is shifting to modern agriculture due to development. Moreover, Dendup (2018) reported that Bhutanese farmers traditionally practiced integrated subsistence farming however, now the farmers are increasingly venturing into entrepreneurial farming due to good opportunities in agribusiness. Conversely, (MOAF 2019) reported that Bhutanese farming is primarily subsistence in nature producing only for self-consumption and little for sale (53%), followed by only for self-consumption (37%) and then only a few producing for sale and little for consumption or sale only. They also found that 87% of farmers in Bhutan practice sedentary pastoral, followed by 10% semi-nomadic and then 3% totally nomadic. Furthermore, (ASIAN DEVELOPMENT BANK [ADB] 2013, NEPAL 2022) reported that the majority of the farmers in Bhutan are small-scale subsistence farmers who produce for their survival. According to URA (1993), the farmers in the northern part of Bhutan practice both sedentary and nomadic farming.

The respondents from the PAs of Bhutan reported that they raise livestock for manure, meat, milk, transportation, ploughing, and other purposes. From the study, it was found that most of the communities dwelling in PAs of Bhutan raise cattle followed by horses and then pigs. However, due to developmental activities and religious sentiments, their number had dropped sharply, and they are often now replaced by improved breeds such as Jersey cows. Similarly, Tshering & Thinley (2017) found that cattle were the most raised livestock in the three western districts of Bhutan (Thimphu, Gasa and Punakha) due to their multiple uses. Moreover, (NSB 2020) reported that in Bhutan, different kinds of livestock were reared by farmers for the purpose of draught, milk, meat, eggs, and others however, now due to mechanized farming new breeds such as Jersey cows are introduced, replacing the native ones. It was also reported that in Bhutan, 77% of farmers rear bovine animals (the most common being cattle) however, they found that only 36% of the farmers have ventured into rearing improved breeds of cattle (MOAF 2019).

Table 1: Different types of crops grown by farmers in PAs of Bhutan (n=254)

crops grown	n	%
Vegetables	188	74
Paddy (*Oryza sativa*)	170	67
Maize (*Zea mays*)	132	52
Wheat (*Triticum aestivum*)	109	43
Barley (*Hordeum vulgare*)	96	38
Sweet Buckwheat *(Fagopyrum esculentum*)	88	35
Finger millet (*Eleusine coracana*)	86	34
Mustard (*Brassica juncea*)	83	33
Bitter buckwheat (*Fagopyrum tataricum*)	83	33
Soya beans (*Glycine max*)	76	30
Cardamom (*Amomum subulatum*)	62	24
Oranges (*Citrus sinensis*)	50	20
Beetle nut *(Areca catechu)*	29	11
Lentils *(Lens culinaris)*	18	7
Avogadro *(Persea americana)*	16	6
Ginger (*Zingiber officinale*)	15	6
Quinoa (*Chenopodium quinoa*)	15	6
Litchi *(Litchi chinensis)*	15	6
Agar wood *(Aquilaria malaccensis)*	15	6
Apple (*Malus domestica*)	40	16
Amaranthus sp.	13	5
Watermelon *(Citrullus lanatus)*	13	5
Ground apple (*Smallanthus sonchifolius*)	12	5
Strawberry (*Fragaria vesca*)	11	4
Sunflower *(Helianthus annuus)*	10	4
Hazelnut (*Corylus avellana*)	8	3
Kiwi (*Actinidia chinensis)*	6	2

The study recorded that 74% (n=188) of farmers inhabiting in PAs of Bhutan were growing vegetables. Among vegetables, chili and potato were given the most importance. Paddy (67%, n=170) and maize (52%, n=132) were reported as the primary cereal crops while bitter buckwheat (33%, n=83) and soya beans (30%, n=76) were secondary crops. The most important cash crops that were grown in PAs were cardamom (24%, n=62) and oranges (20%, n=50) whereas Hazelnut (3%, n=8) and Kiwi (2%, n=6) were the least grown cash crops (Table 1). As per the MOAF (2019) in Bhutan, the main cereal crop grown is Maize followed by Paddy whereas Wheat, Barley, Buckwheat, Millet, *Amaranthus* and Quinoa were secondary crops. Similarly, Cardamom was found to be the most-grown cash crop in the country. Among vegetables Spanish (69.40%), Sag (69.40%), chili (64.36%) and Radish (57.53%) were found to be mostly grown and Potato was found to be the most exported tuber of the country (MOAF 2019). Moreover, URA et al. (2009) also reported that maize (76%) and paddy (58%) were the main cereal crops in Bhutan. Conversely, they reported that maize was the major followed by paddy.

From the study, it is evident that in the olden days, the focus was to grow all the crops mainly low-yielding and traditional but now mostly hybrid and improved crops of selected crops are grown going with the demands for high-yielding and productive crops. Similarly, Dendup (2018) also reported that same.

Pests and diseases

Farmers in PAs of Bhutan stated that their agricultural crops are infested by pests and diseases, and it has drastically increased over time. The farmers said that they encountered pests such as Cutworms, Weevil, Potato moths, Armyworms, Paddy moths, Maize moths, Orange Ant, Caterpillar, Beetles, Chili pod borer, White grub, Green stink bugs (which damages vegetables), Grasshoppers, Dark headed stem borer, Red ant, Aphids, Snails, Water mould and other Insects. The highest pest reported by farmers in the PAs of Bhutan were Armyworms (36%), followed by Green stink bugs which attacked vegetables (32%) and then Water mould (31%). The least reported pests by the farmers were snails 3% (Figure 2) causing diseases such as chili blight, rice blast, stalk rot, wheat smut and rust, potato blight, leave disease and stem diseases of crops, citrus greening, maize leaf blight, and cardamom fungal disease. The major crop diseases that farmers reported were potato blight (54%) and chili blight (52%) and the least was rice rust and smut (5%) as shown in figure 3. According to MOAF 2019, pests and diseases were found to be the fourth most constrained of farmers in Bhutan (14.33%). Similarly, due to pest and diseases in high-altitude areas, 80-90% of their rice was lost to blast diseases in 1996, and in 2007 50% of maize was lost to leaf blight of maize (Chhogyel & Kumar 2018)

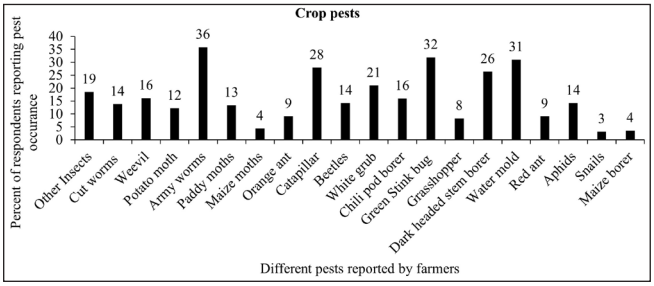

Figure 2: Different types of pests reported by farmers in PAs of Bhutan

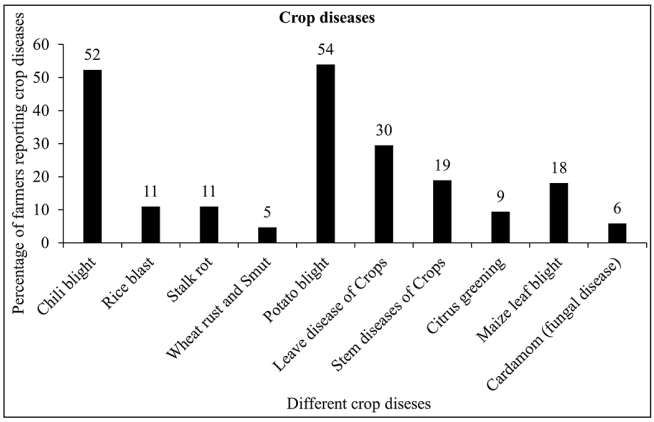

Figure 3: Diseases that the crops suffer in PAs of Bhutan

Table 2: Measures practices against pests and diseases (n=254)

Measures against pests and diseases	n	%
Rituals (La-sey Lu-sey and Jinsey)	52	20
Ash application	161	63
Leaving the land fallow	4	2
Manually picking insects	30	12
Solution of garlic and coriander application	11	4
Artemisia mulching	27	11
Cow urine and water solution application	24	9
Allowing Hens to eat insects	11	4
Application of cow dung, water, and chili solution	14	6
Watering	6	2
Application cow urine	22	9
Application of cow dung ash	24	9
Application of cow dung	4	2
Weeding	17	7
Application of lime	8	3
Application of rotten ginger	18	7
No interventions	29	11
Agri-chemicals (pesticides and herbicides)	54	21
Crop rotation	15	6
Uproot the infected plants	7	3
Solution of Garlic, Cow dung and urine, and artemisia application	27	11
Application of artemisia leaf solution	9	4
Baba solution application	5	2

Mitigation measures practiced against pests and diseases

Many different measures practiced against pests and diseases from their crops were reported by respondents from the PAs of Bhutan. The most practiced method against pests and diseases was the application of ashes (63%, n=181), followed by Agri-chemicals (pesticides and herbicides provided by gewog agriculture extension) (21%, n=54) and then rituals (La-sey, Lu-sey, and Jinsey) (20%, n=52). Leaving the land fellow (2%, n=5), application of cow dung (2%, n=5), and application of baba solution (2%, n=5) were reported least practiced measures against the pests and diseases in PAs of Bhutan (Table 2). However, due to developmental activities, the people were using Agri chemicals provided freely by gewog extensions. According to Satti (2012), the cultural methods of combating pests and diseases are the cheapest, safest, and simplest approach. He reported that sanitation and removal of alternative hosts, tillage operations, sowing and harvesting time, plant population and stand thinning, irrigation practice, crop rotation, weeding, fertilizers, intercropping, mechanical and physical methods were means used against the pests and diseases.

Human-wildlife conflict

In almost all the local communities that took part in the focused group meeting and interview, the issue of human-wildlife conflict (rather a coexistence) was reported. With the designation of State Reserve Forest (SRF) land as the PAs and with the ban on hunting of wildlife, more predation by wildlife on crops and as well as on domestic animals has been reported. It was reported that wildlife such as deer and wild boar even enter the house or roam freely along with the domestic animals. Major Wildlife that damaged their crops were Wild Boar (*Sus scrofa*) (86%), Barking Deer (*Muntiacus muntjak*) (78%), Macaque monkey (*Macaca* sp.) 63%, and the least was Gaur (*Bos gaurus*) (2%) as shown in Figure 4. Similarly, in JSWNP, Wild Boar was reported to be a major crop raider, followed by Barking Deer, then Macaque and then Sambar (Wang et al. 2006). Furthermore, in Eastern Bhutan of Gangzur and Kengkhar, they reported that Wild Boar was responsible for most of the crop damage (Wangdi et al. 2018). Moreover, similar results were reported by Dorji et al. (2021). In the country, it was reported that farmers on average lose about 8,250 metric tonnes of crops worth Nu 171.75 million (M) every year to wild animals (Wangdi 2022). Moreover, Crop damage by wild animals was ranked as the third most faced constraint of farmers in Bhutan (19.56%) (MOAF 2019).

Similarly, predators such as Tiger (*Panthera tigris*) and common Leopard (*Panthera pardus*) were reported to be highest with 66% (n=167) respectively followed by Dhole (*Cuon alpinus*) 61% (n=155) and then followed by Wolf (*Canis lupus*) 57% (n=146) predating their livestock whereas Snow Leopard (*Panthera uncia*) 2% (n=5) was reported to be the least predating farm animals. Predation of livestock by wild predators in Bhutan was reported to be 0.63% by farmers (MOAF 2019). Similarly, in JSWNP the major livestock depredators were found to be Tiger, Common Leopard, Black Bear and Dhole (Wang & Macdonald 2006). However, as a whole in Bhutan, 966 (70%) of livestock were killed by leopards, 263 (19%) by tigers, 114 (8%) by bears, and only 32 (2%) by snow leopards (Sangay & Vernes 2008). Moreover, Ura et al. (2009) reported that leopards and dholes were suspected to be the most common livestock predators. Furthermore, (Tshering & Thinley 2017) reported that in three western districts of Bhutan, 177 livestock (49.9%) were lost to dhole, 121 (34.1%) to common leopard, 38 (10.7%) to the tiger and 19 (5.3%) to Asiatic black bear *(Ursus thibetanus)* and also reported that the predators attacking the livestock animals differs from region to region. Therefore, the difference in results may be due to differences in the study area, size and other factors.

Participants from the Norbugang Gewog in Pemagatshel specifically mentioned the project "Hunter to Hermit" which made local hunters in the gewog sacrifice hunting. After this conversion, even if they wish to kill the wild animal damaging their crops or predating their domestic animal, they are compelled to shy away because of the damcha (oath) they had taken while converting from 'Hunter to Hermit'.

Table 3: Mitigation measures taken by farmers in PAs to reduce crop depredation (n = 254)

Method	n	%
Guarding	148	58
Electric fencing	125	49
Fencing	74	29
Scarecrows	64	25
Religious rituals	51	20
Planting trees	43	17
Animal trap	36	14
Tin bells	32	13
Hunting	14	6
Guarding with dog	14	6
Rotten cheese in and around the fence	18	7
Lighting around the field	13	5
Hang a dead monkey in the field to scare the monkey	11	4
Build stone walls	10	4
Others[a]	58	23

[a] other (below 10 respondents) include Making a fire around the field, Keeping a toy tiger, Cut bamboo and splitting it and making a fence, Mud wall, Local devices, Fermented cheese, Clearing bushes around the field, Cement sack fencing, Burn cow dung and chili on the animal route and Hanging chili seed around the garden

Mitigation measures against Human-wildlife conflict

To reduce crop loss to the wild animals, the top three most practiced measures against wildlife by the farmers in PAs were guarding their fields (58.3%) followed by electric fencing (49.2 %) and then fencing (29.1%) as shown in Table 3. The respondents said that guarding was mostly practiced because it needs low capital investments although tiresome and time-consuming. However, other methods were mostly short-lived, involved more capital investments, and were ineffective once animals get used to them. Dorji et al. (2021) also reported that 96% of the respondents in 17 districts in Bhutan were guarding their crop fields against wild animals. Wang et al. (2006) and Wang & Macdonald (2006) also reported that farmers in JSWNP employ methods such as guarding, fencing, religious rituals and others against wildlife. It was also informed that electric fencing is ineffective against Monkeys, Barking Deer, and rodents. Dorji et al., (2021) also reported that electric fencing was ineffective against Monkeys, Barking Deer, Sambar, Porcupines and Elephants. However, the respondents from Sakteng Wildlife Sanctuary said that in their locality they faces no issues regarding crop loss to wildlife due to their nomadic lifestyle as they mainly depend on livestock.

Invasive species as weeds and measures against it

Table 4: List of Invasive species reported by farmers in PAs (n=254)

Invasive species	n	%
Ageratum conyzoides	87	34
Sigesbeckia orientalis	81	32
Chromolaena odorata	80	31
Bidens pilosa	66	26
Ageratina adenophora	57	22
Schoenoplectus juncoides	55	22
Solanum viarum	42	17
Pennisetum clandestinum	42	17
Cynodon dactylon	39	15
Imperata cylindrica	26	10
Galinsoga parviflora	25	10
Parthenium hysterophorus	25	10
Cannabis sativa	23	9
Lantana camara	15	6
Acorus calamus	12	5
Rumex nepalensis	11	4
Persicaria runcinata	11	4
Trifolium repens	11	4
Tithonia diversifolia	10	4
Agrotis mycrantha	9	4
Mikania micrantha	8	3
Potamogeton distinctus	8	3
Paspalum distichum	6	2
Agave lurida	6	2
Cosmos bipinnatus	5	2
Juncus inflexus	5	2
Sida acuta	4	2
Amaranthus sp.	4	2
Cuscuta campestris	4	2

The study also recorded 29 Invasive Alien Species (IAS) which were competing with their crops. The most common IAS reported during the study were: *Ageratum conyzoides* (34%), *Sigesbeckia orientalis* (32%), and *Chromolaena odorata* (31%) whereas *Paspalum distichum, Agave lurida, Cosmos bipinnatus, Juncus inflexus, Sida acuta, Amaranthus* sp. and *Cuscuta campestris* were reported least with 2% (table 4). Almost all the farmers residing in the PAs reported the presence of invasive species hampering crop productivity. According to the locals, the incidence of IAS has drastically increased over time. It may be due to the purchase of fertilizers and herbicides from India. Similarly, 95% of respondents from the Samtse and Punakha districts informed that invasive species were problematic to agriculture, reducing crop yield. They reported that *Ageratum conyzoides* and *Trifolium repens* were confined to agricultural land. However, *Lantana camera* and *Mikania micrantha, Potamogeton distinctus, Cynodon dactylon*, and *Bidens pilosa* were given the highest impact in Samtse and Punakha respectively whereas *Ageratina, Chromolaena,* and *Ageratum* were reported

to be less impactor. Similarly, they also reported that the arrival of invasive species was due to the import of contaminated herbicides and chemical fertilizers (DORJI et al. 2021).

Table 5: Mitigation measures taken by farmers in PAs against the competition by invasive species to their crops (n = 254)

Methods	n	%
Feeds for domestic animals	11	4
Uprooting	70	28
Weeding	79	31
No interventions	18	7
Cutting and burning	63	25
Weedicides	16	6

In PAs of Bhutan, 31% (n=79) of respondents practice weeding of invasive species which are competing with their crops followed by uprooting by 28% (n=70), and then 25% (n=63) of the respondents reported that cutting and burning as measures against invasive species in their field. Around 7 % (n=18) of the respondents informed that there were no effective and specific measures against the invasive species. Using it as feed for domestic animals was reported to be the least practiced method against the competition by invasive species to their crops in PAs (4%, n=11) (Table 5). The farmers from Punakha reported that they use *Opuntia vulgaris* as feed for the cattle and *Mikania micrantha* and *Chromolaena odorata* as cattle beddings (Dorji et al. 2021).

Other challenges of farming

The respondents also reported other challenges that they faced while farming. All the respondents (n=254) reported that there is less rain or insufficiency of irrigation water, farm labour shortage (n=195), less yield of crops (n=105), a low market rate for farm produce (n=87) and limited land holdings (n=31) (Figure 5). Similarly, such challenges of farming were also reported by (INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE [CIAT], WORLD BANK 2017) in Bhutan. It was found that on average, each household owns around 3.48 acres of arable land and more than 60% of the families own less than 3 acres of land in Bhutan leading to subsistence farming (Kumar 2022). It was also found that the top three challenges faced by farmers in Bhutan were irrigation problems 25.44%, followed by labour shortage 19.95% and then crop damage by wild animals 19.56% as reported in RNR Census 2019 by MOAF (2019). In the State of Nation Report 2021, it was reported that there were 78,000 acres of land left fellow due to a shortage of irrigation water in the country (ROYAL GOVERNMENT OF BHUTAN [RGOB] 2021). The shortage of labour is a challenge to the present farming system, and it is fuelled by rural-urban migration due to better facilities and more employment opportunities (Sakurai et al. 2011).

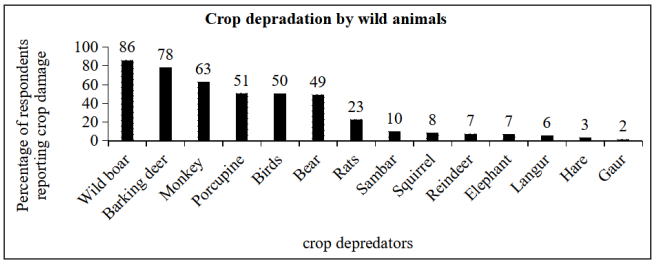

Figure 4: crop depredation by wild animals in PAs of Bhutan

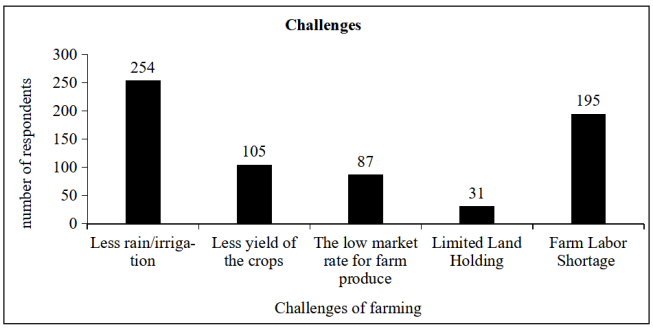

Figure 5: other challenges faced by farmers while farming in PAs

Conclusion and recommendations

The farmers in PAs of Bhutan have ventured into semi-commercial farming, followed by subsistence farming, and then few have ventured into commercial farming. Paddy and maize were found to be the most grown crops, and cattle were the most raised livestock. However, many challenges against farming and mitigation measures that were practiced by farmers were recorded, such as pests and diseases, invasive species, human-wildlife conflicts (livestock and crop depredations), and mitigation measures. The study also recorded other challenges of farming in PAs such as less land holding, problems with access to the market, irrigation water problems, farm labour shortage, and less yield of crops.
Such studies should also be taken in biological corridors and two wildlife sanctuaries (Jomtshangkha Wildlife Sanctuary and Phibsoo wildlife Sanctuary), that were left out during this study, to know the overall farming practice and challenges of farming in PAs of Bhutan.

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