The San Diego County Orchid Society funded Final report on

Distribution, Habitat Assessment and Conservation status of Critically Endangered *Paphiopedilum fairrieanum* (The Lost Orchid) in Zhemgang district, central Bhutan.

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1. Introduction

Paphiopedilum fairrieanum is classified as critically endangered by the International Union for Conservation of Nature (2015). It is popularly called as 'the lost orchid' due to its rarity (Chowdhery,2004). The population is estimated to be less than 50 mature individuals in wild IUCN (ver.3.1). In Bhutan, occurrence of *Paphiopedilum fairrieanum* was first reported by Pradhan (1976) and Pearce & Cribb (2002). The occurrence was reported from Surelakha in Sarpang District (Pearce & Cribb 2002), Gomdar in Samdrup Jongkhar District (Gurung 2006), and Kalikhola in Dagana District (Dorji 2008). However as per Rankou & Kumar (2015), the orchid was being considered possibly extinct in Bhutan but later it was re-discovered by National Biodiversity Center in few places of Bhutan. Recently, Dan etal., (2019) has reported on presence of Endangered *Paphiopedilum venustum* in Bhutan.

In Bhutan, threats on orchid habitat are increasing with rapid expansion of developmental activities. The farm road constriction in remote areas and hydro power construction projects are some of the major threats found in Bhutan. Because of such developmental activities, recent survey conducted by Dan etal., (2019) indicate that *P. fairrieanum* which was once reported from Surelakha under Samtse district is no more found in that place.

Therefore, having more valid scientific data might help in convincing community and policy makers to make timely intervention. It is also important to create conservation awareness to general public as most of communities who mostly depends on nearby forest for fire wood, timber, fodder and Non-Wood Forest Products might have cause threat to *Paphiopedilum fairrieanum* habitat. Lack of substantial information on the status and distribution has hindered conservationists and policy maker to develop policies and guidelines for better management of orchids species in Bhutan

2. Problem statement

The proposed project area caters important habitat for *Paphiopedilum fairrieanum*. However, there is no scientific documentation with respect to distribution and population status in the areas. Lack of such information has received less priority for conservation

activities in this particular area. With limited information available in Bhutan as well as worldwide, it is crucial to have adequate information for effective conservation and management of this rare orchid both at local and global level.

3. Objectives:

1. To determine conservation status of *Paphiopedilum fairrieanum* in study area.
2. To assess environmental parameters and habitat condition
3. To create public awareness through community participation and suggest appropriate conservation strategies

4. Materials and Methods

4.1. Study area

Ngangla Block lies in south-east part of Zhemgang District Administration covering an area of 315 sq. km. The Block is located at one of the remotest sites of the District. The Block is administered from the Block Centre established at Kamalung Village, which is 31 km away from the Drungkhag Administration, Panbang. The Block lies at an elevation ranging from 150 m to 1600 m above the sea level. The Block consist of eleven villages and 623 numbers of households with total population of 3056. The development infrastructures in the Block includes Renewal Nature Resource Centre, Forest Beat office, Community Centre, farm shop, two health centers, community primary schools and farm road

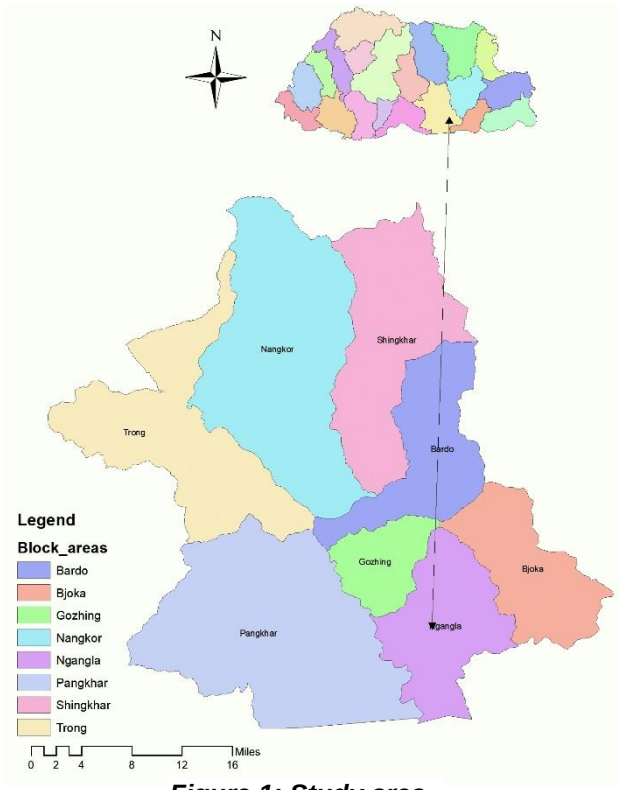

Figure 1: Study area

The Block shares its boundary with Ngangla and Goshing Block to west, Bardho Block to north and Mongar District to east. The Block is popular for cane and bamboo handicrafts

and is the major cash income sources besides mandarin and potato. In addition, the people also raise cattle and horses in order to generate cash income for their livelihood.

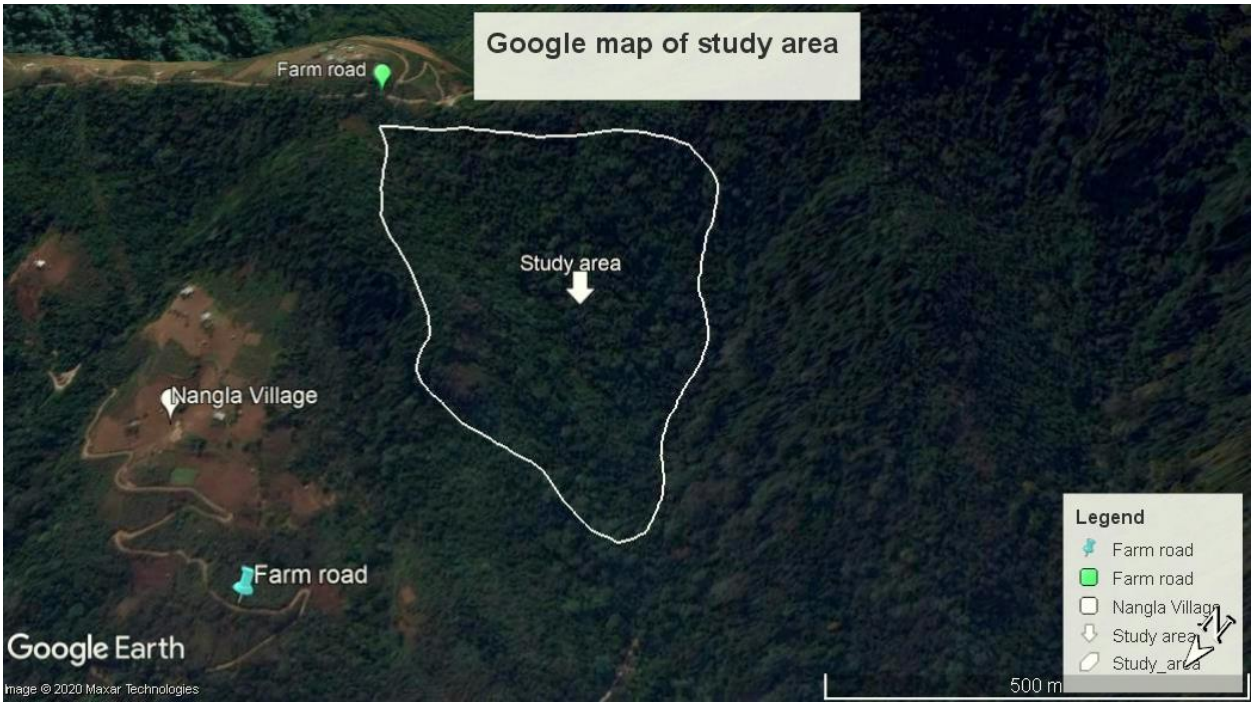

Figure 2: Google map of study area

4.2. Study design

Preliminary assessment was conducted prior to commencing surveys works with series of orchid expedition during flowering season to ascertain presence of orchid species. Household residing vicinity of study area were also interviewed to get orchid sighting location. In addition, peer literature review was done to collect the available sighting along study area. To back up the information, visits to Divisional Forest offices, Forest Range office, Government Extension Offices and local government office were made. Based on preliminary information collected from different sources, potential orchid growing habitat

was map out for survey. Total of 60 hectares of broad leaf forest area was selected to assess *Paphiopedilum fairrieanum* and other terrestrial and epiphyte orchids species.

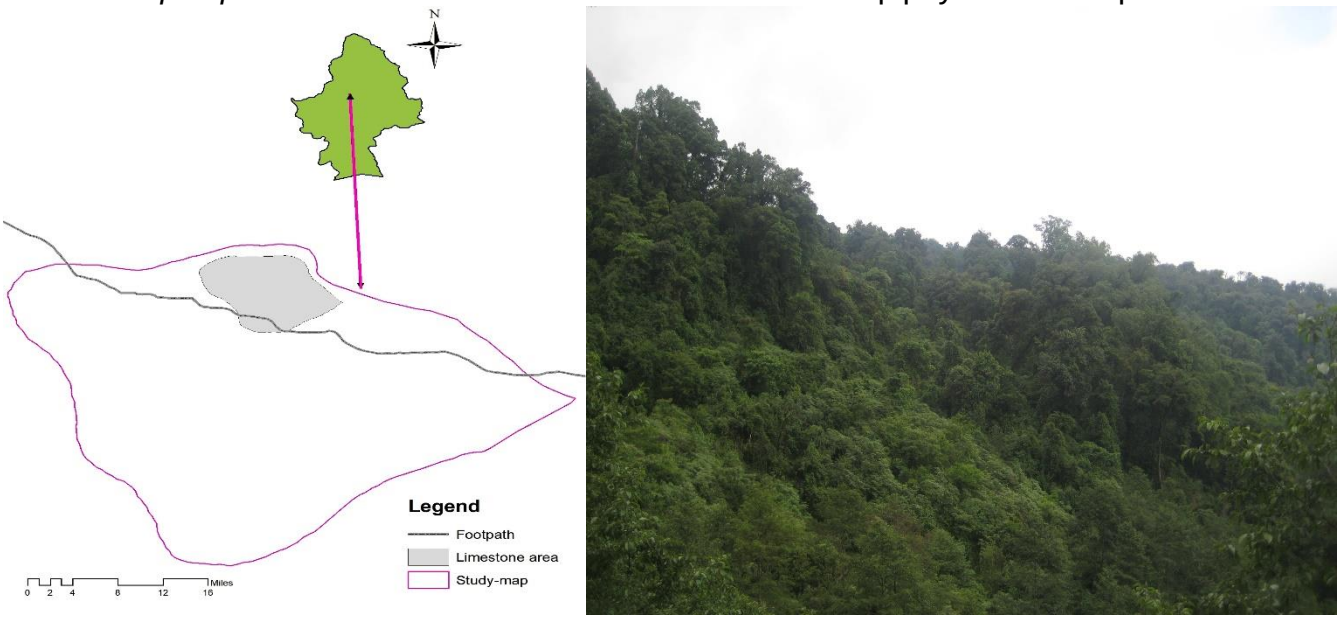

Figure 3: Study area map selected for assessment of Paphiopedilum fairrieanum

4.3. Field survey methods

The potential habitat map was divided into three blocks for systematic search and also to make sure that entire area is covered by survey team. As and when orchid growing is spotted, we took habitat information like GPS coordinates, elevation, Soil PH, distance from nearest road and settlement. For vegetation analysis plot size of 10m × 10m for the tree layer, (plants above 2m height), 4m × 4m for the shrub layer (woody plants below 2m in height), and 1m × 1m plots for herbs (plants up to 1m in height) were laid out. However, since there were very limited herbs species growing in study area, we have omitted laying out of 1m x 1m plots. Further, in each plot DBH, height and crown cover of trees as well as ground cover were recorded.

4.4. Questionnaire survey

All the household within vicinity of orchid potential areas were selected for interview. The questionnaire survey was conducted to get local people's opinion and understand level of awareness towards *Paphiopedilum fairrieanum*. The door-to-door interviews of the

households were conducted covering total of 250 Households. The respondents were selected based on their availability and convenience. The questions were set to get specific information on the occurrence of species, emerging threats and their perceptions. To inculcate sense of responsibility towards conservation and to make people aware of importance of protecting and conservation of this critically endangered orchid, awareness program for local people were conducted in all villages residing near orchid study area.

Figure 4: Awareness program and social survey with local community people

4.5. Vegetation data analysis

After the collection and compilation of raw data in the micro soft excel, the species basal area of individual tree species was calculated from the DBH data of individual trees and relative basal area in percent (RBA %) were also calculated. The RBA of each species were used to find out the abundance measure of species in a community and the dominant species of the altitudinal plots will be determined by the dominance analysis (Wangda and Ohsawa, 2006).

4.6 Field equipment

The different field equipment's were used for the measurement and recording of data from the field. The Global Positioning System (GPS), GPSMAP 60Cx was used for recording plot locations and measurement of plot distance. Sunto compass was used for measuring aspects and sunto clinometers to measure slope and tree height. The tree diameter was measured using freeman diameter tape (5 meter) and Freeman's 50 m measuring tape was used for laying plots. Digital Camera (Canon 7D mark II) were used for taking

photographs. Orchids of Bhutan A field guide book by Dr. Dan Bahadur Gurung was used for identification of orchids

5. Result and discussion

5.1. Distribution of *Paphiopedilum fairrieanum & Paphiopedilum venustum*

The occurrence of *Paphiopedilum fairrieanum* was first reported in Bhutan by Pradhan (1976) and Pearce & Cribb (2002). In Bhutan, *Paphiopedilum fairrieanum* habitat are widely distributed in limestone formations areas and outcrops of subtropical forests (Gurung etal.,2019). From Ngangla under Zhemgang District, total population 60 individuals along with *P.venustum* were reported by Pradhan (1978). The occurrence of *Paphiopedilum venustum* were reported from few places of Bhutan. Although occurrences of P.venustum was also reported in 1976 by Pradhan, there was no specific location mentioned in the report. However, later in (2008) 20 individuals of P.venustum was reported from Kalikola under Chukah District by Dorji. Further, in 2009 40 individuals of P.venustum were reported from Zhemgang district. In 2016, over 15 individuals were reported from the current study area. This study site is the only habitat where both P.fairrieanum & *P.venustum* coexist

During this recent field survey, 5 numbers of *P. fairrieanum* and 3 number of *P.venustum* were recorded from study area. All individuals were found growing at different elevations. The *P.fairrieanum* with three individuals was highest individual recorded growing in same area. The number of *P. venustum* observation was very low with only three individuals recorded within entire study area. All *P.venustum* population were recorded at elevation of 974m followed by *P.fairrieanum* at 1004m. The average pH value recorded was 7.5 (Table 1).

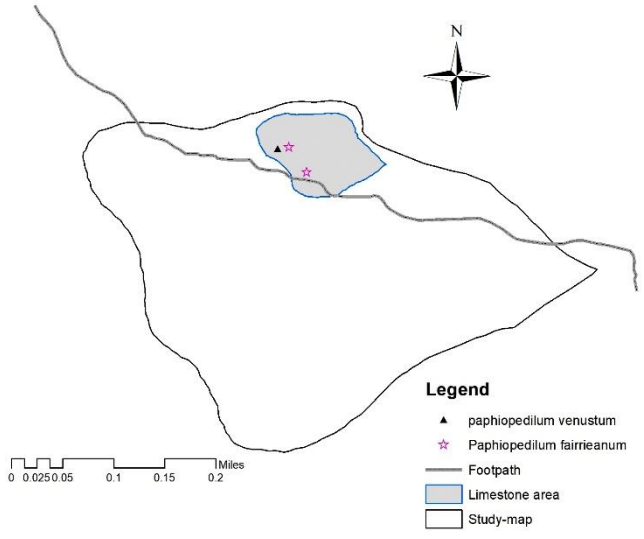

Figure 5: Distribution map of two rare orchid species inside study area

Table 1: Showing information of P.fairrieanum & P. venustum at Naganla study site

Species	Elevation	Latitude	Longitude	Number	Dist. Settlement	Distance road	Soil pH
Paphiopedilum fairrieanum	983m	26°56'19.26"N	90°59'47.77"E	3	350m	470m	7.7
Paphiopedilum fairrieanum	1004m	26°56'20.54"N	90°59'46.87"E	2	320m	550m	7.3
Paphiopedilum venustum	974m	26°56'20.45"N	90°59'46.29"E	3	288m	340m	7.5

From this survey report, it is clear that both orchid species preferred growing in areas where soil has high contained of limestones. All five individuals were found growing in the limestone dominated areas. The same habitat findings were reported by Gurung etal., 2019 where both *P.fairrieanum & P. venustum* found growing inside dense broadleaf forest with dense canopy coverage and in limestone formation areas.

Figure 6: P.fairrieanum growing in limestone dominate area in study area

The population of both the species could have been higher if entire Ngangla block was included for survey. However, owing to vastness of area, time limit and budget limitation we have selected only one portion of area for this study.

Figure 7: P. venustum in bud and flowering stage observed at study area

5.2. Vegetation composition in *Paphiopedilum fairrieanum* & *Paphiopedilum venustum* habitats

In both orchid species habitat, the tree vegetation composed of 58 different species with 30 families. The vegetation composition of the habitat was classified into four major life-forms consisting of evergreen broad-leaved forest (33 species), deciduous broad-leaved forests (11 species), evergreen broad-leaved shrub (7 species), deciduous broad-leaved shrub (4 species). In terms of percentage, 60% of vegetation was represented by evergreen broad-leaved trees, 13% evergreen broad-leaved shrubs, 20% deciduous broad-leaved trees, 7% deciduous broad-leaved shrubs. The result indicated dominance of evergreen forest from 840 m till 1190 m along the gradient (Figure 9).

Figure 8: Picture showing vegetation data collection from study area

Evergreen forest was mainly dominated by Betulaceae (*Alnus nepalanis*), Aceraceae (*Acer laevigatum, Acer oblongum*) Sapotaceae (*Aesandra butyracea*), Fagaceae (*Castanopsis indica* and *Castanopsis tribuloides*), Magnoliaceae (*Melia cathcartii, Terminalia tomentosa, Talauma hodgsonii),* Lauraceae (*Beilschmiedio sikkimensis, Phoebe lanceolata.* The deciduous broad-leaved forest was mainly Fabaceae (*Acrocarpus fraxinifolius),* Moraceae (*Morus laevigata)*.

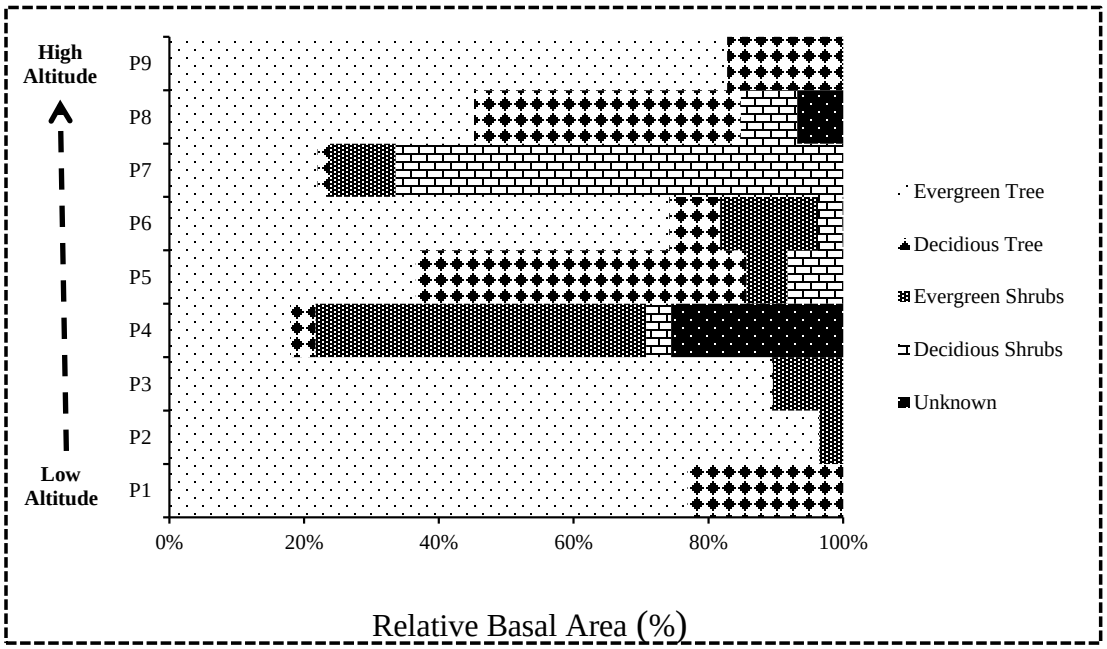

Figure 9: Distribution of major life-forms of trees along the altitudinal gradients

The maximum diameter at breast height was recorded 96 cm at the elevation of 975m and maximum height was recorded 24 m at elevation 987m. The tree DBH recorded at lower elevation were found minimum however, as elevation increase there was slight increase in tree DBH. The lower DBH at lower altitude could be due to anthropogenic activities such as human settlement and timber harvesting for construction, fire wood collection and grazing area. Further, Forest composition and structural traits were found changing along elevation. The change must have been triggered due to anthropogenic disturbance and environmental factors like temperature, humidity, rainfall, and light and soil condition.

Figure 10: anthropogenic disturbance like tree logging were observed in the vicinity of orchid growing areas

6. Other orchid species

Total of 15 species of both terrestrial and epiphytes orchids belonging to five families were also recorded from study area. The epiphytes flowering orchids, the genus *Cymbidium* are being collected from the wild for use as vegetables. Among these *Cymbidium hookerianum* and *Cymbidium erythraeum* are seen collected in huge quantity by local leaders. In Bhutan orchids are protected by the Forest and Nature Conservation Act of 1995, yet due to lack of advocacy and awareness program on conservation of orchids in far flung areas, the people still enjoy this orchids as local delicacy.

Figure 11: Cymbidium hookerianum & Eria amica species from study area

Figure 12: Gastrochilus acutifolius & Pleione humilis

7. Social part

7.1. People's perception towards *Paphiopedilum fairrieanum*

Maximum respondents were aware of *Paphiopedilum fairrieanum* presence in their locality. Out of 250 respondents 92%, (*n* = 230) were aware of *P. fairrieanum* presence in their area. Majority of respondents (80%, *n* = 184) knew through personal observation, where 11% (*n* = 26 were informed by government and neighbor (9%, *n* = 20) (Figure 13, A). This indicates that *P. fairrieanum* habitat is close proximity to their village. About 78% (*n* = 195) of respondents felt that *P. fairrieanum* is common like any other orchids. Only 13% (*n* = 33) felt that it's rare (Figure 13, B). Therefore, it is crucial to create additional awareness on it threaten status to gain public support for effective conservation in the study area. However, 84 % (*n* = 210) of respondents were not aware about the existence of

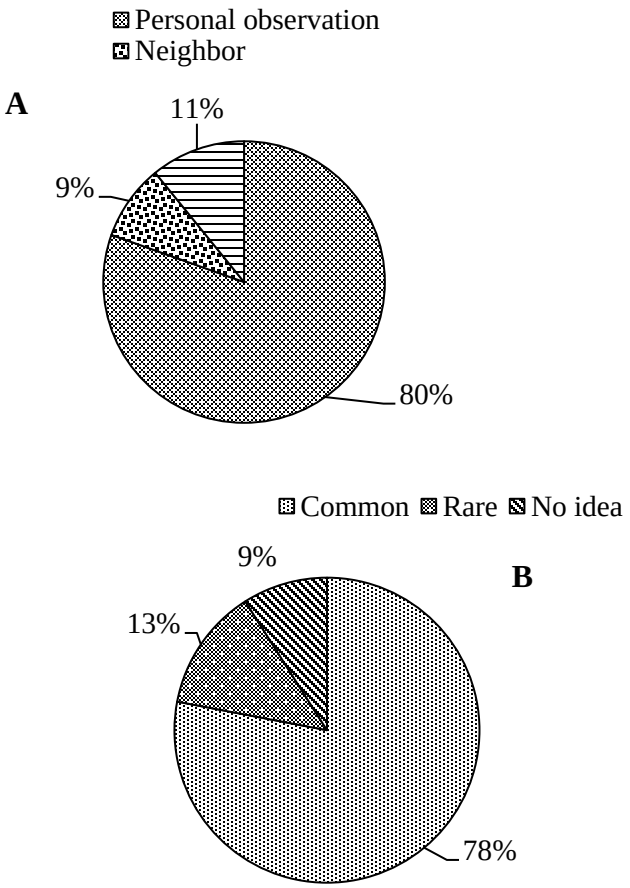

Figure 13: Perception and awareness of people on orchids

Paphiopedilum venustum in their locality. This could be because *P.venustum* population were found very minimal in the study area and until awareness program, the local people has been considering both *P. fairrieanum* and *P.venustum* as one species.

7.2. Local peoples view on population trend

Within last five years 22% (*n* = *55*) respondents felt that population of the *P. fairrieanum* in their locality has decreased. Only 4% (*n* = 5) respondents felt increase in population. Half of respondents 50% (*n* = 125) could not confirm the population trend as they hardly care about the orchids though *P. fairrieanum* is growing near their village. Regarding conservation, 16% (*n* = 40) respondents strongly agree, where 60% (*n* = 150) did not agree. Therefore, it is crucial to provide additional educational awareness program covering wider audience to make understand current population status of *P. fairrieanum* and *P.venustum* conservation importance of their habitats. 24% (*n* = 60) respondents did not reveal on conservation need as they were not aware of orchids.

Figure 14: Awareness campaign to local community people on importance of orchid conservation

Conclusion

Present study, reveal that both *Paphiopedilum fairrieanum* & *Paphiopedilum venustum* are preferably growing in evergreen forest with limestone dominated areas. We observed that in near future if proper management strategies are not introduced, major threats like trampling by cattle, human disturbance like logging, deforestation and forest fire incidents is likely to have major impact on orchid habitat. The local people also felt that, the presence of footpath, forest road and logging activities in orchid growing areas are seen as significant threat to orchid population which might bring adverse impacts on conservation of this critically endangered orchid in future. This study would form new ground for future researchers to carry out long-term study on habitat ecology, population status and distribution range to understand status of critically endangered orchid *Paphiopedilum fairrieanum* in Bhutan

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