 documentation and on farm conservation of neglected and underutilized plant species in Lamjung district, Nepal

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1. Introduction

The transformation of our agriculture system has contributed to increasingly organized patterns of crop production and consuming habits around the world. In the world, 250,000 to 400,000 species belong to higher plants. Among them, 95% of the world’s food supplies are provided by about 30 crop species, and it is considered that 7,000 species are being used for food and are either partially or completely cultivated (Williams and Haq, 2000). Only 12 species cover 75% of food and 4 species cover 50% of the food we consume. Nonetheless, when studying food supply at the sub-regional level, more crops emerge as essential that are dietary staples and play a crucial role in the food certainty, nutrition, and livelihood development of millions of the world poorest people. These are neglected and underutilized species (NUS) that attract little recognition or are completely overlooked by academics, breeders, and decision-makers (Padulosi et al., 2009). They are native or sub-domesticated species, and non-wood tree plants suited to specific local ecosystems that have the ability, which has not been completely exploited, to lead to nutrition security and hunger amelioration.

Nepal is an agro-biodiversity rich mountainous country. The three agro-ecological regions of Nepal (Terai, Mid Hill, and High Hill) are experiencing a wide range of climates from sub-tropical to temperate and alpine cold semi-desert, resulting in the evolution and maintenance of various crop gene pools. Nepal is ranked 49th throughout globe for its biodiversity richness (Joshi et al., 2019). Of Nepal’s 577 cultivated species approximately 85 percent of these crop species are neglected and underutilized (Joshi et al., 2019). Plant estimates were made for 6,500 flowering plant species in Nepal (WCMC, 1994) 1,500 of which are labeled beneficial (Manandhar, 2002). Of aforementioned 651 species including 440 wild species are commercially valuable, and nearly 200 are consumed as vegetables (Shrestha, 2013), but most are considered to be underutilized or neglected.

In recent years, agricultural intensification has become largely dependent on a limited variety of crops (Schmidt et al., 2010). The dependency on this comparatively limited number of food species creates severe concerns regarding sustainability today as well as the future of feeding the world (Raschke and Cheema, 2008). Currently, more than 100 million people suffer from hunger and food scarcity, although the challenge of adequate diet seems to be more severe (FAO, 2009). It has
also been confirmed that NUS is rapidly disappearing due to uniformity of farming practices, mono-cropping patterns, and shifts in food preferences resulting in a few staple crops that dominate local, national and international food systems (Rojas et al., 2009).

There is a need for more research investment to investigate the ways to improve on-farm NUS conservation. It is also necessary to address a range of critical factors such as the understanding on-farm distribution of conventional varieties, the status of custodian farmers, and the difficulties they encounter. The research thus aimed to explore the diversity and identify the prioritized species, explore the use-values, and identify the role of a socio-demographic factor in its conservation and promotion in the Lamjung district of Nepal. In particular sociodemographic factors and related hypothesis is presented as “Education status, primary occupation, ethnicity, and gender of the household head help in the characterization and conservation of NUS in the research area.”

2. Methodology

2.1. Data collection and analysis

Data were collected from different sites during research using techniques such direct field observation, household sampling, key informant interview, personal interviews, and field visits during January 2020. The research was performed in two rural municipalities viz. Marsayndi Rural Municipality-01, Ghanpokhara (28.2905° N, 84.30326° E) and Kholosothar Rural Municipality; ward no-03, Ghalegaun (28.2783° N,
Location wise cluster sampling was conducted where a structural and semi-structural questionnaire was used to interview 105 respondents (35 respondents from each study area). Furthermore, a checklist was designed for interviews with key informants. Key informants were the president of the rural municipalities, the coordinators of the home-stay, and the lead farmers. The respondents of the research were chosen by convenient sampling concerning the objective of the study where the respondents were directly or indirectly involved in agriculture and conservation of NUS. The authors confirm that informed consent was obtained from all the patients of experiments i.e., rural municipalities, homestay management committee, and both the Gurung and Dalits community during the field survey. For documentation, key informants were identified and focused group discussion (FGD) was carried out. In Bhujung, FGD was carried out with the staffs of the National Trust for Nation Conservation (NTNC). Moreover, FGDs were carried out in the rural municipality of Ghanpokhara and Ghalegaun along with the local leaders and lead farmers of that area.

The well identifiable pictures of the plants listed in the documentation were shown to the respondents for assurance of correct documentation. Plants other than those listed were identified by direct observation on-site with the help of the respondents. Some main information on each of the identified species was reported through discussion. These were local names of the species, plant form, uses, importance, and parts used. Five cereals and pseudo-cereals among those species were addressed for three different headings (area of cultivation, production quantity, and food sufficiency). It was then accompanied by a listing of value-added products with their price.

SPSS 25 and Microsoft Office 16 were used for data analysis. Descriptive (frequencies, percentages, means, etc.) and inferential statistics were used to interpret the data to create summaries and tables at various levels. Observations for the non-parametric test included finger millet area, finger millet production, foxtail millet area, foxtail millet production, proso millet area, proso millet production, buckwheat area, buckwheat production, barley area, and barley production. Data were assigned to Kruskal-Wallis test for primary education status (basic, secondary, and higher secondary) of household head and Mann-Whitney U test.
Table 1. An average food sufficiency status of different crops in the research areas.

| Crops                      | Ghalegaun   | Ghanpokhara | Bhujung    |
|----------------------------|-------------|-------------|------------|
| Finger millet *(Eleusine coracana)* | 6–9 months | 6–9 months | >12 months |
| Foxtail millet *(Setaria italica)*    | -           | >12 months | 9–12 months |
| Proso millet *(Panicum miliaceum)*   | -           | 9–12 months | 9–12 months |
| Buckwheat *(Fagopyrum esculentum)*   | -           | 3–6 months  | <3 months  |
| Barley *(Hordeum vulgare)*           | 3–6 months  | 3–6 months  | 3–6 months |

Table 2. An availability of crops and their products with price detail in the research areas.

| Crops                      | Ghalegaun Products | Unit Price | Ghanpokhara Products | Unit Price | Bhujung Products | Unit Price |
|----------------------------|--------------------|------------|----------------------|------------|------------------|------------|
| Finger millet *(Eleusine coracana)* | Bread              | 35         | Bread                | 30         | Bread            | 35         |
|                             | Nepali Doughnut    | 35         | Nepali Doughnut      | 25         | Nepali Doughnut  | 35         |
|                             | Porridge           | 150        | Porridge             | 100        | Porridge         | 150        |
|                             | Alcohol            | 25         | Alcohol              | 35         | Alcohol          | 50         |
|                             | Soup               | 50         | -                    | -          | Cake             | 200        |
| Foxtail millet *(Setaria italica)* | -                  | -          | Bread                | 30         | Bread            | 35         |
|                             | Nepali Doughnut    | -          | Nepali Doughnut      | 30         | Nepali Doughnut  | 35         |
|                             | Porridge           | -          | Porridge             | 100        | Porridge         | 150        |
|                             | Rice               | -          | Rice                 | 150        | Rice             | 170        |
|                             | Alcohol            | -          | Alcohol              | 35         | Alcohol          | 50         |
|                             | -                  | -          | Soup                 | 50         | -                | -          |
| Proso millet *(Panicum miliaceum)* | -                  | -          | Bread                | 30         | Bread            | 35         |
|                             | -                  | -          | Alcohol              | 50         | Alcohol          | 50         |
| Buckwheat *(Fagopyrum esculentum)* | -                  | -          | Bread                | 30         | Bread            | 35         |
|                             | -                  | -          | Porridge             | 100        | Porridge         | 150        |
|                             | -                  | -          | Alcohol              | 35         | Alcohol          | 50         |
|                             | -                  | -          | Flour                | 300        | -                | -          |
| Barley *(Hordeum vulgare)*    | Bread              | 35         | Bread                | 30         | Bread            | 35         |
|                             | Porridge           | 150        | Porridge             | 100        | Porridge         | 150        |
|                             | Alcohol            | 25         | Alcohol              | 35         | Alcohol          | 50         |
| Name          | Scientific Names          | Family        | Habit   | Parts used           | Uses                          | Importance | Location |
|--------------|---------------------------|---------------|---------|----------------------|-------------------------------|------------|----------|
| Phapar       | Fagopyrum esculentum Moench | Polygonaceae  | Herb    | Seed                 | Pancake, Fodder               | Medicinal  | 1 2 3    |
| Kodo         | Eleusine coracana (L.) Gaertn. | Graminaceae   | Herb    | Seed                 | Pancake, Beverages, Fodder, Porridge | Nutritional | 1 2 3    |
| Cino         | Panicum miliaceum L.      | Graminaceae   | Shrub   | Seed                 | Pancake, Beverages, Fodder, Porridge | Nutritional | 1 2 3    |
| Saghara khand | Ipomoea batatas (L.) L.  | Convolulaceae | Herb    | Tuber                | Eaten raw or roasted          | Religious  | 1 2 3    |
| Til           | Sesamum orientale L.      | Pedaliaceae   | Herb    | Seed                 | Pickles, religious worship    | Religious  | 1 2 3    |
| Mansyan      | Vigna umbellata (Thunb.) Obwi & Ohashi | Leguminosae  | Climber | Seed                 | Pulse                         | Nutritional | 1 2 3    |
| Ghari taral   | Dioscorea alata L.        | Dioscoreaceae | Climber | Stem, twigs, fruit   | As vegetable and sometime by boiling | Nutritional | 1 2 3    |
| Ban taral    | Dioscorea battifera L.    | Dioscoreaceae | Climber | Undergrown stem      | Vegetable, Medicine           | Nutritional | 1 2 3    |
| Gaba         | Colocasia esculenta (L.) Schott | Araceae      | Shrub   | Leaves, tuber        | Vegetable                     | Nutritional | 1 2 3    |
| Ghahat       | Macrotyloma uniforum (Lam.) Verdc | Leguminosae  | Shrub   | Seed                 | Pulses, medicine to cure kidney stone | Nutritional | 1 2 3    |
| Kubindo      | Benincasa hispida (Thunb.) Cogn | Cucurbitaceae | Climber | Fruit                | Vegetable, used to prepare pickle and sweets | Nutritional | 1 2 3    |
| Asare simi   | Phaseolus vulgaris L.     | Leguminosae   | Climber | Pod, seed            | Vegetable and Pulses          | Nutritional | 1 2 3    |
| Khesari      | Lathyrus sativus L.       | Leguminosae   | Herb    | Seed                 | Pulses, fodder                | Nutritional | 1 2 3    |
| Rayo         | Brassica nigra (L.) Koch | Crucifereae   | Herb    | Leaves               | Vegetable                     | Nutritional | 1 2 3    |
| Skush        | Schism edule (Jacq.) Sw.  | Cucurbitaceae | Climber | Twigs, fruit         | As vegetable, pickle or eaten by boiling | Nutritional | 1 2 3    |
| Kaphal       | Myrica esculenta BuchHam.ex D. Don | Myricaceae  | Tree    | Fruit                | Fruit                         | Nutritional | 1 2 3    |
| Bel          | Aegle marmelos (L.) Correa | Rutaceae      | Tree    | Leaves, Fruits       | Fruit                         | Medicinal, aesthetic | 1 2 3    |
| Chyuri       | Aesandra buxaceae (Roxb.) Baehni | Sapotaceae   | Tree    | Fruit                | Fruit, seed to prepare ghee   | Aesthetic   | 1 2 3    |
| Anamla       | Phyllanthus emblica L.    | Euphorbiaceae | Shrub   | Fruit                | Fruits, Pickle                | Medicinal   | 1 2 3    |
| Bhogate      | Cattu maxim (Burn. ex Rumph.) Merr | Rutaceae   | Tree    | Fruit                | Fruit                         | Nutritional | 1 2 3    |
| Jamun        | Syzygium cumini (L.) Skeels | Myrtaceae     | Tree    | Fruit                | Fruit                         | Medicinal   | 1 2 3    |
| Nuuro        | Dryopteris cocheleata (D. Don) C. Chr. | Aspidiaceae | Herb    | Stem                 | As vegetable                  | Nutritional | 1 2 3    |
| Besar        | Curcuma angustifolia Roxb. | Zingiberaceae | Shrub   | Root                 | As condiments in vegetables   | Medicinal   | 1 2 3    |
| Maa          | Vigna mungo (L.) Hepper   | Leguminosae   | Shrub   | Seed                 | As pulses                     | Nutritional | 1 2 3    |
| Pharsi       | Cucurbita pepo L.         | Cucurbitaceae | Shrub, Creeper | Fruit, Young twigs | As vegetable, medicinal       | Nutritional | 1 2 3    |
| Kurilo       | Asparagus racemosus Willd | Liliaceae     | Shrub   | Twigs, stem          | As vegetable, and pickle      | Medicinal, Religious | 1 2 3    |
| Palungo      | Spinacia oleracea L.      | Chenopodiaceae | Herb    | Leaves               | As vegetable                  | Medicinal   | 1 2 3    |
| Kagati       | Cattu aurantifolia (Christ.) Swingle | Rutaceae | Tree    | Fruit                | Fruit, pickle                 | Medicinal   | 1 2 3    |
| Nibhuva      | Cattu limon (L.) Burn f.  | Rutaceae      | Tree    | Fruit                | Fruit, pickle                 | Medicinal   | 1 2 3    |
| Jira         | Cuminum cymnun L.         | Umbelliferae  | Herb    | Seed                 | Condiments                    | Nutritional | 1 2 3    |
| Kalli jyamir | Cattu junos Tanka         | Rutaceae      | Tree    | Fruit                | Fruit                         | Nutritional | 1 2 3    |
| Mula         | Raphanus sativus L.       | Crucifereae   | Herb    | Stem, leaves         | As vegetable, pickle          | Nutritional | 1 2 3    |
| Bakula       | Vicia faha L.             | Leguminosae   | Herb    | Pod, seeds           | Vegetable, Pulses             | Nutritional | 1 2 3    |
| Bhatmas      | Glycine max (L.) Merr.    | Leguminosae   | Herb    | Seed                 | Vegetable pulses, oil extraction | Nutritional | 1 2 3    |
| Amba         | Psidium guajava L.        | Myrtaceae     | Tree    | Fruit                | Fruit                         | Nutritional, aesthetic | 1 2 3    |
| Dhantiya     | Coriandrum sativum L.     | Umbelliferae  | Herb    | Seed                 | Used as condiments             | Nutritional | 1 2 3    |
| Khursani     | Capsicum annuum L.        | Solanaceae    | Shrub   | Fruit                | As spicy condiments            | Nutritional | 1 2 3    |
| Okehar       | Juglans regia L.          | Juglandaceae  | Tree    | Fruit                | As fruit and oil extraction    | Nutritional, medicinal | 1 2 3    |
| Jau          | Hordeum vulgare L.        | Graminaceae   | Shrub   | Seed                 | Beverage, used in baking industries | Religious | 1 2 3    |
| Ghion toria  | Luffa cylindrica (L.) Roem | Cucurbitaceae | Herb    | Fruit                | As vegetable                  | Nutritional | 1 2 3    |

(continued on next page)
| Name                | Scientific Names                  | Family               | Habit         | Parts used | Uses                        | Importance | Location |
|---------------------|-----------------------------------|----------------------|---------------|------------|----------------------------|------------|----------|
| Junelo              | Sorghum vulgare Pers              | Gramineae            | Shrub         | Seed       | Used as food after frying, fodder | Nutritional | 1 2 3    |
| Sinu                | Urtica dioica L.                  | Urticaceae           | Herb          | Leaf       | Vegetable, Hedge            | Medicinal  | 1 2 3    |
| Bhagu               | Cannabis sativa L.                | Cannabaceae          | Shrub         | Seed       | To make pickle              | Nutritional | 1 2 3    |
| Angheri             | Melastoma malabathricum L.        | Melastomataceae      | Shrub         | Fruit      | Fruit                      | Nutritional | 1 2 3    |
| Ankhe timur         | Zanthoxylum armatum DC.           | Rutaceae             | Shrub         | Fruit      | Vegetable                  | Nutritional | 1 2 3    |
| Ausali              | Rubus ellipticus Sm.              | Rosaceae             | Shrub         | Fruit      | Fruit, Nutritional, aesthetic |           | 1 2 3    |
| Padina              | Mentha spicata L.                 | Lamiaceae            | Herb          | Whole part | Vegetable                  | Nutritional, medicinal | 1 2 3    |
| Ban lasun           | Allium wallichii Kunth            | Amaryllidaceae       | Herb          | Whole part | Vegetable                  | Nutritional, medicinal | 1 2 3    |
| Tama                | Dendrocalamus hamiltonii Nees & Am. | Poaceae              | Tree          | Young stem | Vegetable                  | Nutritional | 1 2 3    |
| Vyakur              | Dioscorea deltoidea Wall. ex Griseb. | Dioscoreaceae      | Tree          | Fruit      | Vegetable, Medicine         | Nutritional | 1 2 3    |
| Thotne              | Polygonum molle D. Don            | Polygonaceae         | Shrub, Climber| Young Leaf | Vegetable                  | Nutritional | 1 2 3    |
| Chhatre             | Cyanea spinulosa Wall. Ex Hook.   | Cyaneaceae           | Climber       | Young Leaf | Vegetable                  | Nutritional | 1 2 3    |
| Chipile             | Oreocnide ruascencet (Thumb.) Miq. | Urticaceae           | Climber       | Root       | To make Nepalese Bread (Like Ring) | Nutritional | 1 2 3    |
| Chhuto              | Berberis asiatica Roxb. Ex DC    | Berberidaceae        | Shrub         | Fruit      | Fruit, Medicine and Hedge   | Nutritional | 1 2 3    |
| Dalchini            | Cinnamomum verum J. Presel       | Lauraceae            | Tree          | Bark, leaf | Spices and Tea              | Nutritional | 1 2 3    |
| Ghodtiare           | Centellia asiatica (L) Urb       | Apiaceae             | Herb          | Whole part | Pickle and Medicine         | Nutritional | 1 2 3    |
| Golkakro            | Coccsia grandis (L) Voigt         | Cucurbitaceae        | Climber       | Fruit      | Salad, Vegetable and Fruit  | Nutritional | 1 2 3    |
| Halhale             | Rumex nepalensis Spreng.          | Polygonaceae         | Herb          | Whole part | Vegetable                  | Nutritional | 1 2 3    |
| Jamune mandro       | Mahonia nepalensis DC.            | Berberidaceae        | Shrub         | Fruit      | Fruit                      | Nutritional | 1 2 3    |
| Chhato Chhau        | Agaricus campestris L.            | Agaricaceae          | Herb          | Whole part | Vegetable                  | Nutritional | 1 2 3    |
| Rate Chhau          | Amamia muscaria                   | Amamitaceae          | Herb          | Whole part | Vegetable                  | Nutritional | 1 2 3    |
| Berulo              | Ficus sarmentosa Buch – Ham. ex. Sm. | Moraceae            | Tree          | Fruit      | Fruit                      | Nutritional | 1 2 3    |
| Katus               | Castanopsis indica (Roxb. Ex Lindl.) | Fagaceae            | Tree          | Fruit      | Fruit, Dodder and Timber    | Nutritional | 1 2 3    |
| Kaoulo              | Perea odoratissima (Nees) Kosterm. | Lauraceae            | Tree          | Bark       | To make Nepalese Bread (Like Ring) | Nutritional | 1 2 3    |
| Kavro               | Ficus lacor Buch-Ham              | Moraceae             | Tree          | Flower     | Pickle                     | Nutritional | 1 2 3    |
| Khole sag           | Nasturtium officinale R. Brit.    | Brassicaceae         | Herb          | Whole part | Vegetable                  | Nutritional | 1 2 3    |
| Kurilo              | Asparagus racemosus Willd.        | Asparagusaceae       | Climber       | Young twig | Root, Vegetable, Medicine   | Nutritional | 1 2 3    |
| Laligurans          | Rhododendron arborum Smith        | Ericaceae            | Tree          | Flower, Fruit | Ornament, Medicine | Medicinal, aesthetic | 1 2 3 |
| Lapsi               | Choeropspondia asiallarii (Roxb.) | Anacardaceae         | Tree          | Fruit      | Make Pickle, As Fruit       | Nutritional | 1 2 3    |
| Hunkholo            | -                                 | -                    | Tree          | Fruit      | As pickle                  | Nutritional | 1 2 3    |
| Nigalo              | Arundinaria falciata              | Poaceae              | Tree          | Young Stem | As vegetable               | Nutritional | 1 2 3    |
| Gophila             | -                                 | -                    | Tree          | Fruit      | As fruit                   | Nutritional | 1 2 3    |
| Ghangur             | -                                 | -                    | Shrub, Climber| Fruit      | As fruit                   | Nutritional | 1 2 3    |
| Jhre Saag           | Ophiglossum vulgatum L.           | Ophiglonsaceae       | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Seuda Saag          | -                                 | -                    | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Khuada Saag         | -                                 | -                    | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Nausitha Saag       | -                                 | -                    | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Naigya              | -                                 | -                    | Climber       | Fruit      | As fruits                  | Nutritional | 1 2 3    |
| Guyeli              | -                                 | -                    | Tree          | Fruit      | As fruit                   | Nutritional | 1 2 3    |
| Kairo               | -                                 | -                    | Tree          | Fruit      | As fruit                   | Nutritional | 1 2 3    |
| Nauri               | -                                 | -                    | Climber       | Fruit      | As fruit                   | Nutritional | 1 2 3    |
| Kubu Saag           | -                                 | -                    | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Azmale Saag         | -                                 | -                    | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Badmale Saag        | -                                 | -                    | Herb          | Leaves, stem | As vegetable               | Nutritional | 1 2 3    |
| Bhadaure niuro      | Dryopteris sps                    | Aspidiaceae          | Herb          | Stem       | As vegetable               | Nutritional | 1 2 3    |
| Ekle niuro          | Dryopteris sps                    | Aspidiaceae          | Herb          | Stem       | As vegetable               | Nutritional | 1 2 3    |
| Tangleide niuro     | Dryopteris sps                    | Aspidiaceae          | Herb          | Stem       | As vegetable               | Nutritional | 1 2 3    |
| Mnlolide niuro      | Dryopteris sps                    | Aspidiaceae          | Herb          | Stem       | As vegetable               | Nutritional | 1 2 3    |

1 = “Ghanpokhara”, 2 = “Ghalegaun” and 3 = “Bhujung”.Italic signifies presence while bold signifies absence of NUS.
test for primary occupation (agriculture and non-agriculture), ethnicity (marginalized and touchable and marginalized and untouchables), and gender (men and women) of the household head.

3. Result and discussion

3.1. Descriptive comparison of characters

3.1.1. Overall cultivation status of research areas

Out of 35 respondents, seven (20%) cultivated finger millet (Eleusine coracana) and five (14%) cultivated barley (Hordeum vulgare) in Ghalegaun. 30 (85%) cultivated finger millet, 18 (51%) cultivated foxtail millet (Setaria italica), 3 (8%) cultivated proso millet (Panicum miliaceum), 14 (40%) cultivated buckwheat (Fagopyrum esculentum) and 26 (74%) cultivated barley in Ghanpokhara. 35 (100%) cultivated finger millet, 26 (74%) cultivated foxtail millet, 3 (8%) cultivated proso millet, 5 (14%) cultivated buckwheat and 23 (66%) cultivated barley in Bhujung. In total, 72 (68%) out of 105 respondents cultivated finger millet, 44 (42%) cultivated foxtail millet, 6 (5%) cultivated proso millet, 19 (18%) cultivated buckwheat and 54 (51%) cultivated barley (Figure 2).

The average total production area was 0.155 ha for finger millet, 0.028 ha for foxtail millet, 0.002 ha for proso millet, 0.014 ha for buckwheat, and 0.033 ha for barley. Similarly, the average total production was 228.08 kg for finger millet, 54.32 kg for foxtail millet, 3.42 kg for proso millet, 19.35 kg for buckwheat, and 44.77 kg for barley (Figure 3). Nepal is experiencing an increased trend of cultivation area, production, and productivity of these crops. The average productivity of finger millet has increased by 6.25% from the year 2011 (1120 kg/ha) to 2019 (1190 kg/ha). Similarly, for buckwheat it has increased by 29% from year 2011 (860 kg/ha) to 2019 (1110 kg/ha) and for barley it has increased by 25% from year 2011 (1000 kg/ha) to 2019 (1250 kg/ha) (MoALD, 2020). Our result has also supported this increasing data trend with the productivity of 1472 kg/ha for finger millet, 1382 kg/ha for buckwheat, and 1357 kg/ha for barley.
3.1.2. Average cultivation area and production quantity of research areas

A survey of research areas found that the average production area was 0.031 ha for finger millet and 0.007 ha for barley in Ghalegaun. 0.131 ha for finger millet, 0.039 ha for foxtail millet, 0.004 ha for proso millet, 0.035 ha for buckwheat, and 0.056 ha for barley in Ghanpokhara. Whereas 0.305 ha for finger millet, 0.045 ha for foxtail millet, 0.003 ha for proso millet, 0.009 ha for buckwheat, and 0.037 ha for barley in Bhujung (Figure 4).

The total average production was found to be 42.2 kg for finger millet and 9.51 kg for barley in Ghalegaun. 180.36 kg of finger millet, 75.6 kg of foxtail millet, 5.96 kg of proso millet, 45.9 kg of buckwheat, and 75.77 kg of barley in Ghanpokhara. Whereas 461.67 kg of finger millet, 87.36 kg of foxtail millet, 4.32 kg of proso millet, 12.14 kg of buckwheat, and 49.05 kg of barley in Bhujung (Figure 5).

3.1.3. Average food sufficiency status of research areas

An average food sufficiency status ranges from 3-6 months to >12 months for different crops in three different research areas (Table 1). A previous study in four mountainous districts of Nepal including Lamjung shows that the food sufficiency of cereals and vegetables is not adequate for even six months (Gauchan et al., 2020). However, people in research areas are using these crops as a source of income too. The value-added products of these crops along with their unit price are listed in (Table 2).

3.2. Descriptive comparison of documented neglected and underutilized species

A list of 92 plant species was documented as neglected and underutilized from the field survey (Table 3). The plant belonging to herbs was 33, shrubs 23, trees 24, climbers 13, and creeper one (Figure 6). Of the 92 plant species, 20 species were used for seed, 17 for stems, four for roots, 35 for fruits, 18 for leaves, one for the tuber, five for twigs, two for pods, seven for whole parts, two for barks, two for flowers and one for underground stem (Figure 7). According to respondents, the source of seeds they used was found to be 95 by their savings, 52 by a neighbor, 90 by agro-vet, 35 by NGO, 20 by government, and 20 by cooperatives (Figure 8).
3.3. Comparison of means of socio-demographic factors for characters

Out of the population interviewed, 52 percent were men and 48 percent were women. The respondents' average age was around 45 years with 66 years of the eldest and 24 years of the youngest (Figure 9).

3.3.1. Effect of education status on NUS cultivation

Kruskal-Wallis test had been used to compare the means of education status of household head as basic, secondary, and higher secondary. Results indicate that all the parameters were statistically significant (Table 4). A household with basic education status has the highest mean for all parameters viz. buckwheat area (56.45), buckwheat production (57.63), finger millet area (63.22), finger millet production (63.05), barley area (58.77), barley production (58.69), foxtail millet area (59.29), foxtail millet production (59.29), proso millet area (52.02), and proso millet production (52.02). It signifies that the people with higher education status have either migrated to the city areas or are not actively involved in agriculture for their livelihood while the people with basic education status are still entirely dependent on agriculture resulting in NUS conservation.

3.3.2. Effect of primary occupation on NUS cultivation

Mann-Whitney U test was used to compare the means for primary occupation of household head as agriculture and non-agriculture. Results indicate that except for proso millet area and proso millet production, all other parameters were statistically significant (Table 4). Agriculture group has the highest mean for buckwheat area (55.62), buckwheat production (55.62), finger millet area (56.45), finger millet production (54.98), barley area (58.94), barley production (59.99), foxtail millet area (59.99), and foxtail millet production (59.99). Non-agriculture has the highest mean for proso millet area (54.98) and proso millet production (54.98). Farmers' primary occupation as agriculture has shown to promote the conservation of NUS. For people with agriculture as a primary occupation, there is no alternative to earn a living. Moreover, people here are still unaware of the proso millet's importance. Only the progressive farmers with a strong link to NGOs and government officials had tried to preserve and promote NUS in these areas. However, LI-BIRD-Nepal is playing a remarkable role in the promotion of foxtail millet in these areas mainly, in Ghanpokhara.

3.3.3. Effect of ethnicity on NUS cultivation

Mann-Whitney U test had been used to compare the means for the ethnicity of household head as marginalized and touchable and marginalized and untouchables. Results indicate that only four parameters namely barley area, barley production, foxtail millet area, and foxtail millet production were significant while all other parameters were found to be insignificant (Table 4). Marginalized and untouchables have the highest mean for buckwheat area (57.63), buckwheat production (57.63), foxtail millet area (74.22), foxtail millet production (74.22), finger millet area (63.84), finger millet production (63.00), barley area (68.75), and barley production (68.75). Likewise, marginalized and touchable has the highest mean for proso millet area (53.54), and proso millet production (53.54). Marginalized and untouchables are more involved in NUS conservation and preservation. They have been using and safeguarding NUS for generations (Padulosi et al., 2013). This scenario can be supported by the poor economic condition of these individuals and agriculture as the only way of life.

3.3.4. Effect of gender on NUS cultivation

Mann-Whitney U test had been used to compare the means for the gender of household head as men and women. Results indicate that none of the parameters were statistically significant (Table 4). Men have the highest mean for buckwheat area (55.27), buckwheat production (55.27), barley area (56.05), barley production (55.97), foxtail millet area (53.52), foxtail millet production (53.52), proso millet area (53.84), and proso millet production (53.84). Likewise, women have the highest mean for finger millet area (56.31) and finger millet production (56.65). Both men and women are actively involved and there is no significant difference between their work performance to maintain and protect NUS. The men respondent in the research area was relatively more acquainted with the crop species than the women respondent. A previous study in Nepal shows that women over the age of 35 was able to depict the usage of 65 percent of all consumable species whereas young men was able to depict just 23 percent (Shrestha and Dhillon 2006).

4. Conclusion

The findings support the significance of socio-demographic factors in characterizing, evaluating, and conserving neglected and underutilized species on-farm. Results indicated that education status and primary occupation of the household head have a great role whereas ethnicity has a certain level of role while gender has no the role to play on-farm conservation of NUS. People with basic education status and agriculture as their core occupation showed a higher influence on conservation. Nepal has a great diversity of crop species that are neglected and underutilized. These very species provide tremendous nutritional, medical, and profitable values. If encouraged, it would significantly contribute to reduce poverty, particularly in rural communities, and to improving of local populations' nutritional and medical status. To promote these NUS in Nepal, it is necessary to establish a research and development program including all possible potential participants such as with government, academics, entrepreneurs, and producers to promote NUS.

| Parameters          | Mann-Whitney U test | Kruskal-Wallis test |
|---------------------|---------------------|---------------------|
|                     | Primary occupation  | Ethnicity            | Gender               |
|                     | U value  Sig.       | Mean value           | U value  Sig.       | Mean value       | H value  Sig.       | Mean value       |
| Finger millet area  | 324.00  0.00        | 64.56                | 538.50  0.11        | 63.84             | 1209.50  0.27      | 56.31             | 35.21  0.00       | 63.22             |
| Finger millet production | 339.50  0.00 | 64.35                | 552.00  0.14        | 63.00             | 1192.50  0.27      | 56.65             | 34.28  0.00       | 63.05             |
| Foxtail millet area | 657.50  0.00        | 59.99                | 372.50  0.00        | 74.22             | 1346.50  0.83      | 53.52             | 18.17  0.00       | 59.29             |
| Foxtail millet production | 657.50  0.00 | 59.99                | 372.50  0.00        | 74.22             | 1346.50  0.83      | 53.52             | 18.17  0.00       | 59.29             |
| Proso millet area   | 1104.50  0.27      | 54.98                | 664.00  0.28        | 53.54             | 1329.00  0.46      | 53.84             | 20.01  0.00       | 52.02             |
| Proso millet production | 1104.50  0.27 | 54.98                | 664.00  0.28        | 53.54             | 1329.00  0.46      | 53.84             | 20.01  0.00       | 52.02             |
| Buckwheat area      | 976.50  0.04        | 55.62                | 638.00  0.32        | 57.63             | 1250.00  0.23      | 55.27             | 8.24   0.01        | 56.45             |
| Buckwheat production | 976.50  0.04      | 55.62                | 638.00  0.32        | 57.63             | 1250.00  0.23      | 55.27             | 8.24   0.01        | 56.45             |
| Barley area         | 727.50  0.00        | 58.94                | 467.50  0.02        | 68.28             | 1207.50  0.25      | 56.05             | 17.81  0.00       | 58.77             |
| Barley production   | 734.50  0.00        | 59.99                | 460.00  0.01        | 68.75             | 1211.50  0.26      | 55.97             | 17.65  0.00       | 58.69             |
Declarations

Author contribution statement

Bipin Neupane, Sadikshya Poudel: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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References

FAO, 2009. Food Insecurity in the World. FAO, Rome, Italy.
Gauchan, D., Joshi, B.K., Sthapit, S., Jarvis, D., 2020. Traditional crops for household food security and factors associated with on-farm diversity in the mountains of Nepal. The Journal of Agriculture and Environment 21, 31–43.
Joshi, B.K., Shrestha, R., Gauchan, D., Shrestha, A., 2019. Neglected, underutilized, and future smart crop species in Nepal. J. Crop Improv. 34 (3), 291–313.
Manandhar, N.P., 2002. Wild Edible Plants of Nepal. Bulletin of Department of Medicinal Plant No. 11.
MoALD, 2020. Statistical Information on Nepalese Agriculture 2016/17. Singha Durbar. Ministry of Agriculture and Development, Agri-Business Promotion and Statistics Division, Kathmandu Nepal.
Padulosi, S., Thompson, J., Rudebjer, P., 2013. Fighting poverty, hunger and malnutrition with neglected and underutilized species. Bioversity International.
Padulosi, S., Mal, B., Bala Ravi, S., Gowda, J., Gowda, K.T.K., Shanthakumar, G., Yenagi, N., Dutta, M., 2009. Food security and climate change: role of plant genetic resources of minor millets. Indian Journal of Plant Genetic Resources 22 (1), 1–16.
Raschke, V., Cheema, B., 2008. Colonisation, the New World Order, and the eradication of traditional food habits in East Africa: historical perspective on the nutrition transition. Publ. Health Nutr. 11 (7), 662–674.
Rojas, W., Valdivia, R., Padulosi, S., Pinto, M., Soto, J.L., Alcocer, E., Guzman, L., Estrada, R., Apaza, V., Bravo, R., 2009. From neglect to limelight: issues, methods and approaches in enhancing sustainable conservation and use of Andean grains in Bolivia and Peru. In: Buerkert, A., Gebauer, J. (Eds.), Agrobiodiversity and Genetic Erosion. Contributions in Honor of Prof. Dr Karl Hammer. Supplement 92 to the Journal of Agricultural and Rural Development in the Tropics and Subtropics. Kassel University Press GmbH, pp. 87–117.
Schmidt, M., Lam, N.T., Hoanh, M.T., Padulosi, S., 2010. Promoting neglected and underutilized tuberous plant species in Vietnam. pp. 183–193. In: Haas, R., Canavari, M., Sree, B., Tong, C., Arurapu, B. (Eds.), Looking East Looking West: Organic and Quality Food Marketing in Asia and Europe. Wageningen Academic Publishers, The Netherlands.
Shrestha, D., 2013. Indigenous vegetables of Nepal for biodiversity and food security. Int. J. Biodivers. Conserv. 5 (3), 98–108.
Shrestha, P.M., Dhillon, S.S., 2006. Diversity and traditional knowledge concerning wild food species in a locally managed forest in Nepal. Agrofor. Syst. 65, 55–63.
WCMC, 1994. In: Groombridge, B. (Ed.), Biodiversity Data Source Book. World Conservation Press, Cambridge, United Kingdom.
Williams, J.T., Haq, N., 2000. Global Research on Underutilized Crops. An Assessment of Current Activity and Proposal for Enhanced Cooperation. International Center for Underutilized Crops, Southampton, UK.