STATUS AND ROLE OF MEDICINAL AND AROMATIC PLANTS (MAPs) IN NEPALESE LIVELIHOOD

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Abstract

Medicinal and aromatic plants (MAPs), a principal sub-component of Non-Timber Forest Products (NTFPs), are undoubtedly an important source of revenue and rural employment. This review paper explores the current ecological and prioritized status of MAPs by the Government and the practical significance of MAPs in bodily health, lucrative employment to the Nepalese population, and revenue opportunities to the government based on 72 published articles from 1995 to 2021. The Department of Plant Resources (DPR) reported that the number of medicinal plant species has increased from 701 in 2007 to 819 in 2016 with 285 endemic plant species from 43 families, and 238 chemically tested MAPs species for medicinal significance. MAPs are highly prevalent within the 1000-2500m elevation gradient in Nepal. GoN has categorized 30 species for economic development, 12 species for cultivation and research, 12 species for protection, and 237 species for collecting royalties. Around 100 Nepalese NTFPs/MAPs are traded, but only 20 species accounts for 80% of the total trade in terms of volume and value. Nepal ranks 42nd with a value of $7.4 million and 62nd with a value of $3.3 million in exports of MAPs and essential oils, respectively, in 2017. About 80% of the Nepalese population relies on traditional medicine for basic health needs. The NTFPs/MAPs Business Promotion Strategy specifies 20 species for product promotion across Nepal. As current data are still lacking on different uses of MAPs in Nepalese society, this comprehensive review will facilitate herbal specialists, policymakers, scientific researchers, botanists, and various key stakeholders to assure better research and increase the export of MAPs that directly improve the socio-economic status of the Nepalese people.

Keywords: COVID-19; Essential oils; Export; Livelihood; Medicinal Plants

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**Introduction**

Medicinal plants are those with therapeutic potential that have been proven successful in one's well-being (World Bank, 2018). Aromatic plants are those that contain or exude volatile compounds such as essential oils. Medicinal and aromatic plants are among the reliable sources of survival and economic opportunity that provide cash income to rural populations (Pérez and Byron, 1999; Olsen and Larsen, 2003; Shackleton and Shackleton, 2004). MAPs are promising raw materials in the pharmaceutical, nutraceutical, and cosmeceutical industries (Marriott, 2000; Pieroni et al., 2004; Barnes and Prasain, 2005).

Medicinal plants are important components of the pharmacopoeia of allopathic treatments, whereas around 28,187 species have been identified in herbal medicine (Wills, 2017). Between 1940 and 2014, 49 percent of biomolecules approved by the United States Food and Drug Administration were natural or derived products (Newman and Cragg, 2016). Approximately 25% of allopathic drugs are currently made from plant-related substances and compounds extracted from plants (Rao et al., 2004). Approximately 15% of plant species have been researched phytochemically, and only 6% have been tested for their pharmacological potency (Seidel, 2020). Thus, there are still many plant-derived chemicals whose medicinal prospects need to be explored (Atanasov et al., 2015; Beutler, 2009; Thomford et al., 2018).

The country ranked 25th in global biodiversity richness and 11th among Asian countries (Ministry of Forests and Environment, 2018b). Nepal's unique topography and varying climates have resulted in floral species count of 11,971, accounting for 3.2% of the world's total flora (MoFSC, 2014). According to the Medicinal and Aromatic Plants Database of Nepal (MAPDON), there are approximately 1,624 medicinal plant species in Nepal, with approximately 100 species traded annually (SAWTEE, 2015). The Department of Plant Resources (DPR) has reported that the number of medicinal plant species has increased from 701 (DPR, 2007) to 819 (DPR, 2016). Till now, 238 MAPs species have been chemically tested for their medicinal properties (Government of Nepal, 2004). Nepal has 285 endemic plant species from 43 families, which have global biological significance (Rajbhandari and Dhungana, 2011). MAPs are more prevalent in forests and grasslands of hilly and mountainous terrain above 2,000m in Nepal (EPI, 2017).

About 85% of MAPs are harvested from the wild, especially in the Far-West and Mid-West of Nepal (GIZ, 2017). Far west Nepal alone accounts for about one-third of Nepal's entire trade volume (Kunwar et al., 2015).
where only one district, Jajarkot contributes US$13,209.4 from MAPs to the national economy (Lamichhane et al., 2021). About 143-161 NTFP species, including MAPs, are collected for commercial purposes (Bhattarai and Ghimire, 2006; Subedi, 2006). However, 60 MAPs species are classified as endangered (Shrestha and Joshi, 1996; Bhattarai et al., 2002). Approximately 50-60% of MAPs harvest goes unrecorded, as they are either consumed in households or sold on local marketplaces without any official procedures (KC, 2014). Around 100 Nepalese NWFPs are traded, but only 20 species account for 80% of the total trade in terms of volume and value (KC, 2014). According to NTFPs studies presented at a seminar on Herbs, Herbal Products, and Spices held in 2005, the forestry sector contributes approximately 15% to the Nepalese GDP, while NTFPs comprise about 5% of GDP (CECI, 2006). As buyers are becoming more interested in organic and natural goods, the market for MAPs continues to grow around the world (Acharya, 2014).

MAPs are among 19 sectors having a high potential for trade promotion listed by the Nepal Trade Integration Strategy (NTIS) (NTIS, 2010). MAPs can be harvested in a short period than timber, which gives them a competitive advantage in the forest as compared to timber (Paudel and Acharya, 2018; Lawrence, 2003). Nepal's NTFP sector has been the subject of much debate and little action. The Master Plan for Forestry Sector (1989-2010) included MAPs as a priority initiative. Despite MAPs being one of the government's priority sectors under the Tenth five-year plan (2002-2007), sufficient attention has not been given to its cultivation (Bhattarai and Ghimire, 2006). The study aimed to present a comprehensive overview of the current ecological and prioritized status of MAPs by GoN to develop and commercialize them, and the general trend of MAPs export from Nepal.

**Methodology**

This paper is based on a thorough analysis of online national and international publications, project papers, websites, booklets, government policy documents, and available published materials. Google Scholar, ResearchGate, Scopus, and PubMed were the primary databases used for acquiring the literature including the keyword ‘MAPs’, ‘NTFPs’ ‘Role’, ‘Livelihood’, ‘COVID-19’, ‘Export’, and ‘Nepal’. Seventy-two articles were identified, which was in agreement with our inclusion and exclusion criteria. The literatures sorted were systematically reviewed multiple times, and information about the status of MAPs and their role in Nepalese livelihood were gathered, compiled, and arranged in a logical sequence. The complete process is explained in figure 1 which is based on the PRISMA flow chart.
Results and Discussion

MAPs distribution in Nepal

In Nepal, MAPs can be found at elevations ranging from 100 to 5,500 m above sea level (Bhattarai and Ghimire, 2006). The total MAPs species richness (Herbs, Shrubs, Climbers, and Trees) is found between the elevation gradient of 1000-2500 m. The MAPs of trees and climbers are found to be optimal at 1000 m; shrubs at 2000 m; and herbaceous at 2500 m (Bhattarai and Ghimire, 2006). MAPs species are distributed in different regions of Nepal (Figure 2). West and Eastern regions have the least MAPs at 2% and 3% respectively while East-center west has the highest at 67%, followed by East-center at 12%.
Tropical and sub-tropical regions have the highest proportion of MAPs, followed by temperate, sub-alpine, and alpine zones. Sub-alpine and alpine medicinal plants are treasured both for their medicinal value and export potential. Medicinal plants and herbs provide sufficient income to fulfill the basic needs of poor and marginalized populations in these areas, as well as revenues to the government. Table 1 shows the distribution of MAPs in Physiographic Zones.

Table 1: Distribution of the Medicinal and Aromatic Plants (MAPs) in Physiographic Zones

| Region                  | % available | MAPs                                                                 |
|-------------------------|-------------|----------------------------------------------------------------------|
| Alpine region above 4000 m | 7           | Ophiocordyceps Sinensis (Yarshagumba), Neopicrorhiza scrophulariflora (Kutki), Nardostachys grandiflora (Jatamansi) |
| Sub-alpine region 3000-4000 m | 18          | Dactylorhiza hatagirea (Panchaule), Taxus wallichina (Lauth Salla), Rheum austral (Padamchal), Swertia chirayita (Chiraito), Podophyllum (Laghuapatra), Paris polyphylla (Satuwa), |
| Temperate region 2000-3000 m | 36          | Swertia chirayita (Chiraito), Aconitum heterophyloides (Nirmasi), Digitalis purpurea (Tilpushpi), Berberis asiatica (Chutro), Valeriana jatamansii (Sugandhawal) |
Sub-tropical region 1000-2000 m  54

Gaultheria fragrantissima (Wintergreen), Zanthoxylum armatum (Timur), Sapindus mukorossi (Ritha), Asparagus racemosus (Kurilo), Cinnamomum tamala (Tejpat), Elaeocarpus sphaericus (Rudraksha), Tinospora sinensis (Gurjo)

Tropical region  below 1000 m  49

Terminalia chebula (Harro), Aegle marmelos (Bel), Terminalia belerica (Barro), Diospyros melanoxylon (Tendu), Azadirachta indica (Neem), Haldina cardifolia (Haldu), Rauwolfia serpentine (Sarpagandha), Phyllanthus emblica (Amala)

Source: (Malla and Shakya, 1995; Subedi, 2006)

Figure 3 shows the relationship between elevation and species diversity/commercial value. As altitude increases, the diversity of MAPs species declines. On the contrary, the commercial value of MAPs species increases with altitude. Despite having low plant diversity, the commercial values of the NTFPs found in Nepal's mountains (highlands) are the highest. For example, the price of Kurilo (Asparagus racemosus) and Sarpagandha (Rauwolfia serpentina) in the Terai regions is less than NRs. 500 per kilogram, whereas the price of Yarsagumba (Ophiocordyceps sinensis), Wild Morel (Mochella esculenta), Jatamansi (Nardostachys grandiflora), Panchaule (Dactylorhiza hatagirea), etc. are many times higher than lowland species (KC, 2014).

Figure 3: General trend of species diversity and commercial importance of NTFPs along the altitudinal gradient in Nepal [Source: (KC, 2014)]
The Government of Nepal (GoN) has established forest policy in 2015 to retain MAPs from exploitation in their natural habitat, as well as to encourage private sectors to domesticate and cultivate MAPs. The goal is to transfer the cultivable MAPs into private land. It has identified (Table 2) 3 major MAPs species of Terai, 16 species of mid-hills, and 11 species of Mountain region that can boost the country's economy.

Table 2: List of MAPs species identified for economic development

| S.N. | Scientific name of the species | Local name of species | Distributional range (m) | Major parts used | Main uses          |
|------|--------------------------------|-----------------------|-------------------------|-----------------|--------------------|
| 1    | Aconitum heterophyllum         | Atis                  | 2400-4100               | Rhizome, Roots  | Medicine          |
| 2    | Aconitum spicatum              | Bisjara               | 3300-4300               | Flower, Leaves  | Medicine, scented oil |
| 3    | Acorus calamus                 | Bojho                 | 200-2300                | Roots           | Medicine          |
| 4    | Asparagus racemosus            | Kurilo                | 150-2100                | Roots, New shoots | Medicine, food |
| 5    | Azadirachta indica             | Neem                  | 100-900                 | Whole plant     | Medicine          |
| 6    | Bergenia ciliate               | Pakhanbed             | 1600-3600               | Rhizome         | Medicine          |
| 7    | Cinnamomum glaucescens         | Suganda kokila        | 200-2500                | Fruit           | Medicine, scented oil |
| 8    | Cinnomumum tamala              | Tejpat                | 450-2100                | Bark, Leaves    | Medicine, spice   |
| 9    | Dactylorhiza hatagirea         | Panchaunle            | 2800-4000               | Rhizome         | Medicine          |
| 10   | Dioscorea deloidea             | Bhyakur               | 450-3100                | Fruit, Roots    | Food              |
| 11   | Gaultheria fragrantissima      | Dhashingre            | 1200-2700               | Leaves          | Scented oil       |
| 12   | Juglans regia                  | Okhar                 | 1200-3000               | Fruit, Bark     | Medicine, food    |
| 13   | Lichen sps.                    | Jhau                  | 2500-3400               | Whole plant     | Medicine          |
| 14   | Morchella esculenta            | Guchi chyau           | 2000-3500               | Whole fungus    | Food              |
| 15   | Nardostachys grandiflora       | Jatamansi             | 3600-5000               | Rhizome         | Medicine, scented oil |
| 16   | Neocirorhiza scrophulariflora  | Kutki                 | 3600-4000               | Rhizome         | Medicine          |
| 17   | Ophiocordyceps sinensis        | Yarsagumba            | 4200-5000               | Whole fungus, larvae | Medicine |
| 18   | Phyllanthus emblica            | Amala                 | 150-1400                | Fruit           | Medicine          |
| 19   | Piper longum                   | Pipla                 | 200-800                 | Fruit           | Spice             |
| 20   | Podophylla hexandrum           | Laghupatra            | 2400-4000               | Roots, Rhizome  | Medicine          |
| 21   | Rauwolfia serpentina           | Sarpagandha           | 100-1200                | Root            | Medicine          |
| 22   | Rheum austral                  | Padamchal             | 3000-4200               | Stem            | Medicine          |
| 23   | Rubia majith                   | Majitho               | 1200-2100               | Stem, Root      | Coloring          |
| 24   | Sapindus mukorssi              | Ritha                 | 1000-1400               | Fruit, Seed, Bark | Detergent        |
| 25   | Swertia chirayita              | Chiraito              | 1500-3000               | Whole plant     | Medicine          |
| 26   | Tagetes minuta                 | Jangali Sayapatri     | 1200-2500               | Whole plant     | Scented oil       |
The GoN has prioritized 12 different MAPs species for cultivation and research (DoF, 2015). Tejpat, Rittha, Timur, Chiraito, and Kurilo are the most important domesticated medicinal species exported from Nepal. Similarly, cultivation of essential oil-producing plants such as Mentha, Chamomile, etc., has begun in Nepal's lower regions. There are still additional plants with enormous earning potential. Some of these species include *Asparagus racemosus* (low altitude), *Cinnamomum glaucescens* (low-mid altitude), and *Dactylorhiza hatagirea* (high altitude) (Table 3).

Table 3: Price of NTFP/Medicinal and Aromatic Plants for cultivation and research

| S.N. | Scientific name of the species | Local name of the species | Price and Current policy arrangement according to Forest Regulation, 2051 |
|------|--------------------------------|--------------------------|---------------------------------------------------------------|
| 1    | *Asparagus racemosus*           | Kurilo                   | Rs 5/kg                                                        |
| 2    | *Cinnamomum glaucescens*        | Sugandha kokila          | Rs 7/kg (Banned without processing)                            |
| 3    | *Dactylorhiza hatagirea*        | Panchaunle               | Rs 1000/kg (Banned without permission for collection, trade) |
| 4    | *Nardostachys grandiflora*      | Jatamansi                | Rs 20/kg (No trade without processing)                         |
| 5    | *Neopicrorhiza scrophulariflora*| Kutki                    | Rs 15/kg (Protected species, banned for collection)            |
| 6    | *Piper longum*                  | Pipla                    | Rs 10/kg                                                       |
| 7    | *Rauvolfia serpentine*          | Sarpagandha              | Rs 20/kg (dry root)                                           |
| 8    | *Swertia chirayita*             | Chiraito                 | Rs 15/kg                                                       |
| 9    | *Taxus wallichina*              | Lauth Salla              | Rs 25/kg                                                       |
| 10   | *Tinospora sinensis*            | Gurjo                    | Rs 2/kg (Collected from wild)                                 |
| 11   | *Valeriana jatamansi*           | Sugandhawal              | Rs 15/kg                                                       |
| 12   | *Zanthoxylum armatum*           | Timur                    | Rs 8/kg                                                        |

Source: (DoF, 2015)

The GoN has amended the Forest Act 1993 in 2009 and categorized the Non-Timber Forest Products (NTFPs) into eight different categories. The GoN has identified 237 NTFPs under eight categories especially for collecting royalty (Figure 4). The highest number of NTFPs falls under the fruit and seeds category at 27% followed by the other category. The least number of NTFPs are represented by gums, resins, and lac at 3%.
Several wild plant species in Nepal have suffered because of overharvesting and habitat destruction. The GoN has also imposed restrictions on the export of 12 NTFPs species under Section 77 of the Forest Act 2019 specifies two provisions (i) Species banned for collection, use, sale, distribution, transportation, and export (ii) Species banned for export outside the country without processing. According to the Nepal Gazette of December 31, 2001, three species (Panchaule, Okhar bokra, and Kutki) have been banned for collection, use, sale and distribution, movement, and export. Similarly, the nine species (Jatamasi, Sarpagandha, Sugandha kokila, Sugandhavala, Jhyau, Talispatra, Lauth Salla, Silajeet, and Yarshagumba) can be processed in the country for export.

Additionally, Nepal is a member of The World Conservation Union (IUCN) and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1974 and 1975 respectively. The following species have been given various IUCN and CITES status.

Table 4: MAPs species protected in Nepal

| S. N. | Scientific Name           | Common Name | Local Name | IUCN Red List Status | CITES Appendix Status |
|-------|---------------------------|-------------|------------|----------------------|-----------------------|
| A.    | Species banned for collection, use, sale, distribution, transportation, and export | Dactylorhiza hatagirea | Salep | Panchaunle | II |
|       | Juglans regia             | Walnut      | Okhar      |                      |                       |
|       | Neopicrorhiza scrophulariflora | Picrorhiza | Kutki      | VU                   | II |
| B.    | Species banned for export outside the country without processing |                      |            |                      |                       |
Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled to avoid utilization incompatible with their survival.

Nepal Herbs and Herbal Products Association (NEHHPA) has prepared the identification manual of 69 commercial MAPs along with pictures. The table below provides detailed information on the distribution, harvesting period, traded parts, and traditional usage of 69 commercial medicinal and aromatic plants (Table 5). Among documented commercial species, the mid-hills have more identified commercial species, whereas the mountain region has the fewest. Ranunculaceae, Combretaceae, Rutaceae, Umbelliferae, Compositae, Berberidaceae, Ericaceae, Orchidaceae, Lauraceae, Liliaceae, Leguminosae and Valerianaceae are the common families of MAPs species found in different regions of Nepal. Fruits, leaves, roots, rhizome as well as the whole plant are used commonly for different purposes such as essential oil, coloring, flavoring, and treatment of diseases mostly like anemia, asthma, diabetes, common cold, and stomach related disease.

Table 5: List of some commercial MAPs of Nepal

| S.N. | Local name of species | Botanical name of species | Family | Distribution (m) | Harvesting time | Parts used | Traditional Uses |
|------|-----------------------|--------------------------|--------|-----------------|-----------------|-----------|------------------|
| 1    | Amala                 | Phyllanthus emblica      | Phyllanthaceae | 150-1600 | Sept-Nov | Fruit | Food Preservative, Digestion, Anemia |
| 2    | Ashuro                | Justicia adhatoda        | Acanthaceae  | 600-1600 | Jul-Oct | Leaves, Flower | Expectorant, Asthma, Bronchitis |
| 3    | Aswagandha            | Withania somnifera       | Solanaceae   | Tropical   | Sept-Oct | Root   | Treatment of Impotency, gout, fever |
| 4    | Atis                  | Delphinium hirtumayi     | Ranunculaceae | 2000-4000 | Oct-Dec | Tuber  | Cough and colds |
| 5    | Bajradanti            | Potentilla fulgens       | Rosaceae    | 1800-3500 | Oct-Dec | Root   | Toothpaste, stomach pain |
| 6    | Barro                 | Terminalia bellirica     | Combretaceae | 3000-1100 | Dec-Mar | Fruit, Seed | Digestion, Gum bleeding, Bronchitis |
| 7    | Bel                   | Aegle marmelos           | Rutaceae    | Up to 1100 | Aug-Sept | Fruit   | Juice, Stomach troubles, diabetes |
| 8    | Bojho                 | Acorus calamus           | Araceae     | 500-2300  | Sept-Feb | Rhizome | Food preservative, cough, and cold, toothache |

Source: (DoF, 2018); VU=vulnerable, ED= endangered.
| No. | Name | Scientific Name | Family | Parts Used | Season | Uses |
|-----|------|-----------------|--------|------------|--------|------|
| 9   | Bhojpatra Bokra | Betula utilis | Betulaceae | Bark | Aug-Nov | Incense, Common cold, Jaundice, Diuretic, Anthelmintic |
| 10  | Bhutkesh | Selinum walluchianum | Umbelliferae | Root | Oct-Nov | Stomach ache, gastric, fever |
| 11  | Bish, Nilo Bish | Aconitum ferox | Ranunculaceae | Rhizome | Oct-Nov | Anti-poisonous |
| 12  | Bishfej | Polypodium vulgare | Polypodiaceae | Modified rhizome | Sept-Oct | Backaches, Stomach troubles |
| 13  | Chamomile Flower | Matricaria chamomilla | Compositae | Flower | March onwards | Essential oil, soaps, cosmetics, tea |
| 14  | Chiraito, Tite | Swertia chirayita | Gentianaceae | Whole plant | Nov-Dec | Anthelmintic, expectorant, antiperiodic, hypoglycemic, laxative |
| 15  | Chiuri | Diplodonema butyracea | Sapotaceae | Fruit, Seed, and Ghee | Jul-Aug | Soap oil, candles, and ghee |
| 16  | Chutto | Berberis asiatica | Berberidaceae | Bark, root | Oct-Dec | Yellow dye, Inflammation of the eye |
| 17  | Dalechuk | Hippophae salicifolia | Elaeagnaceae | Fruit | Sept-Nov | Skin wrinkling, swelling, antibiotics |
| 18  | Dhasingre, Patpate | Gaultheria fragrantissima | Ericaceae | Leaves | October | Food flavoring, relieving pain |
| 19  | Dhayero | Woodfordia fruticosa | Lythraceae | Dried flower | Apr-May | Red dye, Digestion, Nose bleeding |
| 20  | Dhapi | Juniperus indica | Cupressaceae | Leaf, Fruit, and upper part of the petiole | Jul-Aug | Appetite cure, Stomach ache, Piles, Ashma |
| 21  | Gandol, Kaladana | Brachycorythis obcordata | Orchidaceae | Pseudo bulb, Rhizome | Sept-Nov | Expectorant, astringent, energy tonic |
| 22  | Ghodtapre | Centella asiatica | Umbelliferae | Whole plant | Throughout year | Epilepsy, Neural disease, purification of blood, and fever |
| 23  | Githha, Vyakur | Dioscorea bulbifera | Dioscoreaceae | Tuber | Dec-Feb | Source of Diosgenin |
| 24  | Guchi Chyau | Morchella conica | Morchellaceae | Whole part above the ground | May-Jul | Vegetable and tonic |
| 25  | Gurjo, Guduchi | Tinospora sinensis | Menispermacaeae | Stem or petiole | Feb-Apr | Asthma, Cough, Fever, Diabetes, Acidity, skin and urine related disease, leprosy |
| 26  | Harro | Terminalia chebula | Combretaceae | Fruit and seed | Dec-Mar | Leather, garment, dye, and Ayurvedic medicine industries |
| 27  | Jangali sayapatri | Tagetes minuta | Asteraceae | Whole plant | Oct-Nov | Flavoring beverage, medicinal tea, and condiment |
| 28  | Jatamansi | Nardostachys grandiflora | Valerianaceae | Rhizome | Oct-Nov | Stimulant heart and respiratory system, gastric, anemia, urine related disease |
| 29  | Jethimandu | Glycyrrhiza glabra | Leguminosae | Root | Oct-Nov | Common cold, sore throat, vomiting, acidity, gout, joint pain |
| 30  | Jhayau | Parmelia nepalensis | Parmeliaceae | Whole plant | Throughout year | Food poisoning, disturbance in menstrual cycle |
| Page | Name | Scientific Name | Family | Altitude Range (m) | Season | Part Used | Uses |
|------|------|----------------|--------|-------------------|--------|----------|------|
| 31   | Jimbu | Allium hypsistum | Amaryllidaceae | 2500-4000 | Oct-Nov | Whole plant | Spice, altitude sickness |
| 32   | Kachur | Curcuma zedoaria | Zingiberaceae | Up to 1000 | Nov-Dec | Rhizome | Essential oil, common cold, and stomach related disease |
| 33   | Kakarsingi | Pistacia chinensis | Anacardiaceae | 300-1500 | Nov-Dec | Bark of dry fruit | Dysentery, Asthma, against bites of snake and scorpion and killing worms |
| 34   | Kakoil, Ban Lasun | Fritillaria cirrhosa | Liliaceae | 3000-4500 | Sept-Oct | Bulb | Asthma, Bronchitis, and Tuberculosis |
| 35   | Kalo Musli | Curculigo orchioides | Hypoxidaceae | 600-1800 | Sept-Oct | Root and Rhizome | Vomiting, Piles, Jaundice, Asthma, Dysentery, Gonorrhea |
| 36   | Kaulo | Persea odoratissima | Lauraceae | 1000-2100 | Sept-Nov | Bark of the main stem | Manufacturing Incense |
| 37   | Kutki | Neopicrohriza | Scrophulariaceae | 3600-4800 | Nov-Dec | Rhizome and Root | Gastric, Worms, Bile related ailments, Expectorant, Fever and tonic to the heart |
| 38   | Laghupatra | Podophyllum hexandrum | Berberidaceae | 2400-4500 | Oct-Nov | Rhizome and Root | Liver wounds, cancer |
| 39   | Lalgedi, Ratogedi | Abrus precatorius | Leguminosae | Upto 1000 | Sept-Oct | Seed | Energetic, sex stimulant, purifying blood, cough, curing eye disease |
| 40   | Lotu | Taxus wallichiana | Taxaceae | 2300-3400 | Feb-Apr | Leaves | Breast and ovary cancer |
| 41   | Majitho | Rubia manjith | Rubiaceae | 1200-2700 | Oct-Nov | Root and Stem | Heart attack, Ulcer, skin related disease, an antidote to cobra and scorpion bite |
| 42   | Nagbeli | Lycopodium clavatum | Lycopodiaceae | 1200-3500 | Oct-Nov | Dust of Lycopodium (Spores) | Diuretic, Asthma, gout, lungs, and kidney-related disease |
| 43   | Neem | Azadirachta indica | Meliaceae | 100-900 | monsoon | Whole plant | Ideal fertilizer for organic culture |
| 44   | Nimans, Nirbishi, Nilobish | Delphinium demudatum | Ranunculaceae | 2700-4200 | Oct-Nov | Root | Heat production, gastric, acidity, fever, ulcer, and cough |
| 45   | Okhar | Juglans regia | Juglandaceae | 1200-3000 | Nov-Dec | Fruit and Bark of stem | Dye, Detergent, Medicine |
| 46   | Padamchel | Rheum austral | Polygonaceae | 3200-4200 | Nov-May | Rhizome, Petiole of leaf, Leaves | Diarrhea, Gout, and Epilepsy |
| 47   | Pakhunved, Pasanved, Dhunephul | Bergenia ciliata | Saxifragaceae | 1600-3200 | Oct-Nov | Underground stem | Cancer, Dysentery, fever, and kidney disease |
| 48   | Panchaulie, Hatajadi | Dactylorhiza hatagirea | Orchidaceae | 2800-4000 | | Rhizome | Expectorant, astringent, demulcent |
| 49   | Pipla | Piper longum | Piperaceae | 200-1300 | Nov-Jan | Fruit | Condiments, hair tonic, malarial fever, anti-poisonous for snake and wild lizard bites |
| 50   | Ritha | Sapindus mukorossi | Sapindaceae | 600-1400 | Nov onwards | Fruit and seed | Natural soap, medicine for cough, anemia, and epilepsy |
| 51   | Radhakshya | Elaeocarpus sphericus | Elaeocarpaceae | 600-1500 | Dec-Feb | Seed | Digestion, whooping cough, controlling pressure, heart, and mental related disease |
| 52   | Saldhup | Shorea robusta | Dipterocarpaceae | 150-1200 | Oct-Nov | Resin | Diarrhea, urine burns, burn or toothache |
| No. | Name           | Scientific Name                      | Family        | Price Range | Harvest Season | Part Used                     | Uses                                                                 |
|-----|----------------|--------------------------------------|---------------|-------------|----------------|-------------------------------|----------------------------------------------------------------------|
| 53  | Salla Simta    | Tsuga dumosa                         | Pinaceae      | 2300-3300   | Nov-Dec        | Cone                          | Raw material for handicrafts                                          |
| 54  | Sarpagandha, Chandmaruwa | Rauvolfia serpentine                  | Apocynaceae   | 100-800     | Nov-Mar        | Root                          | Veins related disease, sleeplessness, and controlling pressure        |
| 55  | Satavari, Kurilo | Asparagus racemosus                   | Liliaceae     | 300-2200    | Oct-Dec        | Root                          | Energetic and sex stimulant                                          |
| 56  | Satuwa         | Paris polyphylla                      | Liliaceae     | 1900-3100   | Oct-Nov        | Rhizome                       | Kill worms and as tincture iodine in cuts or wounds, alternative for diosgenin |
| 57  | Seto Musli     | Chlorophyllum borivilianum            | Asparagaceae  | 300-1400    | Jan-Mar        | Rhizome                       | Diarrhea, Dysentery, Jaundice and Asthma                              |
| 58  | Sikkai         | Acacia rugata                         | Fabaceae      | 400-800     | Mar-May        | Pods and Seeds                | Stimulant and tonic, insecticides                                    |
| 59  | Siltimur       | Lindera neesiana                      | Lauraceae     | 1500-2700   | Jul-Sept       | Fruit                         | Spice, medicine for gastric and stomach ache                          |
| 60  | Simal ko ful   | Bombax ceiba                          | Bombacaceae   | Up to 1200  | May-Jul        | Cotton like fibrous stuff     | Pillows, cushions, quilts, medicine for Dysentery and stomach related disease |
| 61  | Somlata        | Ephedra gerardiana                    | Ephedraceae   | 2400-4200   | Nov-Dec        | Branches                      | Sinusitis, Asthma, Epilepsy, Diuretic, and Allergy, decrease blood pressure |
| 62  | Sugandh kokila | Cinnamomum glaucescens                | Lauraceae     | 1000-2500   | Oct-Nov        | Fruit                         | Essential oil, stick incense, medicine for cold, worms in stomach, and toothache |
| 63  | Sugandhwal, Samayo | Valeriana jatamansi                | Valerianaceae | 1500-3600   | Nov-Dec        | Rhizome                       | Relief from pain, heal the wound, stimulant, sleepiness, anemia, gastric, digestive and killing germs |
| 64  | Sunpati        | Rhododendron anthopogon              | Ericaceae     | 3300-5100   | Oct-Nov        | Leaves and young petiole       | Respiratory disease like common cold, Asthma, bronchitis              |
| 65  | Tejpat, Dalchini | Cinnamomum tamala                   | Lauraceae     | 450-2000    | Oct-Dec        | Leaves and Bark               | Spice, flavoring, and medicine for digestion, stomachache, dysentery |
| 66  | Timur          | Zanthoxylum armatatum                | Rutaceae      | 1000-2500   | Oct-Dec        | Fruit                         | Headache, toothache, as spice and pesticide                           |
| 67  | Tukiful        | Taraxacum officinale                 | Compositae    | 1000-4000   | Aug-Nov        | Root                          | Potherb, medicine for diuretic, stomachache, and liver-related disease |
| 68  | Tulsi          | Ocimum sanctum                       | Lamiaceae     | 400-1800    | Oct-Nov        | Leaves                        | Common cold, cough, Toothache and Ear pain, purify blood, digestion, decrease blood sugar level |
| 69  | Yarsagumba     | Ophiocordyceps sinensis              | Hypocreaceae  | 4200-5000   | Whole plant    |                               | Energetic, sex stimulant, strengthen memory power, medicine for kidney, heart, and blood-related disease |

Source: Modified from (Gurung and Pyakurel, 2017)
Role of MAPs in Nepalese Livelihood

Traditional medicine in Nepal

A variety of medicinal plants are used to maintain physical, mental, and spiritual health, and to treat specific ailments (Garg et al., 2021). It is believed that Nepali Vaidhyas used Ayurvedic knowledge as early as 879 (IUCN, 2004). Ayurveda is a Hindu holistic healing system that continues to be the key source of medical knowledge and expertise in many South Asian nations, including Nepal (IUCN, 2000). Nepalese have been using herbalism in the Himalayas for centuries, with positive results and a persuasive story (World Bank, 2018). Ayurveda, Traditional Chinese Medicine, Unani, and Tibetan Amchi are some of the traditional systems of medicine that Nepalese practice over a long period (Shengji, 2001). WHO estimated that 80% of the global population relies on herbal medicines for their basic health security (WHO, 2002). Traditional plant-based medicines are used by 70% of India's population (Gadgil, 1998), 80% of Pakistan's population (Ahmad and Ghafoor, 2000), and 80% of Nepal's population (Kunwar et al., 2006). It is estimated that almost 17% of the population lives in cities and has access to modern medicine, while the rest of the population still relies on traditional medicine for their basic healthcare requirements in Nepal (Ambu et al., 2020; Adhikari et al., 2019). In the hilly regions of Nepal, about 215 types of plants are used to cure 139 different types of diseases (Miya et al., 2020).

Globally, approximately 50,000 to 70,000 plant species are used as a traditional and modern medicines (Pyakurel and Baniya, 2011). In the absence of any proven medicines/vaccines for COVID-19 cure, possible antiviral and immune booster herbal medicines, extracts, and formulations may be useful in lowering the global mortality rate associated with COVID-19 (Ak et al., 2020). In the current situation, local people are using medicinal herbs as a treatment option for COVID-19 to boost immunity against viral attacks, as there is no specific treatment for COVID-19. The medicinal herbs such as *Tinospora cordifolia* (Gurjo), *Glycyrrhiza glabra* (Jestimadhu), *Swertia chirayita* (Chiraito), *Ocinum sanctum* (Tulsi), *Zingiber officinale* (Aduwa), *Curcuma longa* (Haledo/Besar), *Allium sativum* (Lasun), *Withania somnifera* (Ashwagandha), *Moringa oleifera* (Sheetal Chini), *Zanthoxylum armatum* (Timur), *Cinnamomum zeylanicum* (Dalchini) and *Phyllanthus emblica* (Amala) are used in Nepal for boosting immunity and treatment purposes (Gyawali et al., 2020).

Socio-economic Benefits

MAPs are a key source of government revenue, contributing substantially to rural livelihoods. MAPs and essential oils rank among Nepal's top export commodities. They are important in terms of employment generation and revenue generation, especially in the poorest regions of Nepal (Kalauni and Joshi, 2018).
Cultivating medicinal plants not only offers a means of livelihood to farmers with limited external inputs but also strengthens the economy (Rajak and Singh, 2017). Growing recognition of natural herbal products, which are non-narcotic, have no side effects, and are easily and affordably accessible to the poor has prompted an increase in demand for medicinal plants in both developed and developing countries (Manoharachary and Nagaraju, 2017). The export and trade of medicinal plants and NTFPs affect the local, national and international economy. People in the hilly region of western Nepal mostly collect MAPs for their livelihood upliftment compared to other regions. Thus, MAPs and essential oils, if developed well, can contribute immensely to the raising of the living standard and socioeconomic status of this region (Sharma and Shrestha, 2011).

The Agro Enterprise Centre (AEC- FNCCI) and the Nepal Herbs and Herbal Products Association (NEHHPA) collaborated to launch the NTFPs/MAPs Business Promotion Strategy. The Strategy's long-term vision is to promote NTFPs/MAPs as a national priority sector for Nepal's economic development, which will be supported by lobbying for a favorable policy environment, encouraging private sector investment in identified areas, and diversifying both national and international markets with the highest level of value addition and processing within the country.

The Strategy specifies 20 species for product promotion across Nepal and envisions collaborative efforts of the business sector, government agencies, and development partners, as well as the active participation of local communities/farmers/collectors in the process (Table 6).

Table 6: Products for promotion Identified by the Strategy

| S.N. | Bio-geographic regions | Political boundaries-Zones/Districts | Species selected/recommended |
|------|------------------------|-------------------------------------|-------------------------------|
| 1.   | Far and mid-western hilly and high regions | Seti: Achham, Bajhang, Bajura, Doti Bheri: Dailekh, Jajarkot, Surkhet Mahakali: Baitadi, Dadeldhura, Darchula | Yarshagumba, Rittha, Lichens |
| 2.   | Western mid-hills (Rapti and Lumbini) | Rapti: Pyuthan, Rolpa, Rukum, Salyan Lumbini: Arghakhanchi, Gulmi, Palpa | Chiuri, Rittha, Lichens, Sugandhawal, Sugandha kokila, Timur |
| 3.   | Kamali region | Dolpa, Humla, Jumla, Kalikot, Mugu | Jatamansi, Kutki, Yarshagumba |
| 4.   | Western Terai and lowlands | Dang, Banke, Bardiya, Kailali, and Kanchanpur | Bael, Chamomile, Mentha, Sarpagandha |
| 5.   | Trans Himalayan region | Manang, Mustang | Dhupi, Jatamansi, Seabuckthorn |
6. Western mid hilly regions (Kali-Gandaki corridor) & Kali-Gandaki corridor: Baglung, Myagdi, Parbat, Kaski, Lamjung, Syangja, Tanahu & Allo, Satuwa, Lokta, Lichens, Dalchini

7. Mid-Terai and lowlands & Chitwan, Parsa, Kapilbastu, Nawalparasi, Rupandehi & Chamonile, Kurilo, Mentha, Lemongrass

8. Western highlands & Gorkha, Dhading, Sindupalchowk, Rasuwa and Dolakha & Dhupi, Lokta, Jatamansi

9. Central mid-hills & Hilly districts of Narayani, Janakpur, and Bagnati zone: Bhaktapur, Kathmandu, Dhading, Lalitpur, Kavrepalanchowk, Rasuwa, Nuwakot, Sindhuli, Makanwanpur, Ramechhap & Lichens, Satuwa, Dhasingre

10. Eastern mid-hills & Dhankuta, Bhojpur, Panchthar, Terhathum, Ilam, Okhaldunga, Khotang, Udayapur & Lichens, Chiraito

11. Eastern Himalayas & Sankhuwasabha, Solukhumbu and Taplejung & Chiraito, Dhupi, Kutki

12. Eastern Terai & Morang, Jhapa, Sunsari, Dolakha, Dhanusa, Sarlahi, Saptari, Mahottari, Bara, Siraha and Rautahat & Mentha, Pipla, Lemongrass

Source: (AEC/NEHHPA, 2012)

The socio-economic benefits pertain mainly to (i) employment generation and (ii) revenue generation

**Employment Generation**

Karnali Zone has been designated as a "Pocket of Excellence" by the GoN for the development of non-timber forest products (NTFPs), especially high-valued medicinal plants (Poudel, 2015). It is particularly crucial in the Himalayan region, where many rural dwellers depend on MAPs for subsistence (Pyakurel and Baniya, 2011). The FNCCI-AEC/NEHHPA (2012) study found that 10-100% of households in high-altitude areas of Nepal are interested in commercial MAP collections. According to NEHHPA, around 50% of local communities are involved in the collection and trade of MAPs or NTFPs. As many as 300,000 families are interested in MAPs collection in 58 districts of Nepal. Another 100,000 families are ready to join the community if suitable conditions are established (SAWTEE, 2015). Women account for more than 50% of those involved in the collection, cleaning, and grading of MAPs (MoCS, 2010). According to a study conducted by the Environmental Resources Institute (ERI), Nepal's forestry sector employs full-time jobs to 1,658,099 people per annum (SAWTEE, 2015). According to Kunwar et al. (2013), janjati and dalit groups received the highest percentage of income from NTFPs in the far-western region. Several studies have shown that MAPs also have a major impact on the local economy (Edward, 1996; Subedi, 1997; Bhattarai, 1997).
Revenue Generation

The following graph demonstrates the export trend of MAPs from 2012-2017. MAPs export value over two decades (1992-2012) increased continuously (MSFP, 2014) and our study shows the increase of export value over 3 fiscal years (2012-2015) but recent two fiscal years (2015/16 and 2016/17) indicates that export value of MAPs is in decreasing trend (Fig 5).

![Graph showing export trend of MAPs from 2012-2017](image)

**Fig. 5: Export trend of MAPs from 2012-2017**

Source: (TEPC, 2017)

According to a WHO study, herbal market demand nearly doubled in Asia during the late 1990s, and the total foreign trade in medicinal plants and their products was US$ 60 billion in 2010 and is projected to cross US$ 5 trillion by 2050 (WHO, 2002). The use of herbal medicine is increasing exponentially worldwide, especially in Asia in the last three decades (Kumar et al., 2014; Huang et al., 2020). Nepal, along with India and China, has been recognized as a major reservoir for the supply of MAPs in Asia (Pyakurel and Oli, 2013). The increase in export value over the last ten years (2005 to 2014) in Nepal suggests increased global demand for MAPs (Ghimire et al., 2016).

Around 90% of MAPs are exported to India in raw form. In 2017, Nepal ranked 42nd among MAPs exporters with a value of $7.4 million. The most exported crude herbs from Nepal are Majitho, Padamchal, Pakhanved, Rittha, Rudrakshya, Kurilo, Satuwa, Tejpat, Yarshagumba, Timur, Chiraito, Jatamansi, Kaulo, and Kutki. Nepal exports 76% of its MAPs production to India and 2.5-3.5% to Vietnam, France, and China (TEPC, 2018). Only about 10% of the total quantity of MAPs obtained is used to manufacture medicinal products or essential oils in factories and small manufacturing units of Nepal (Tiwari et al., 2004). In 2017, Nepal ranked
62nd for essential oil exports with $3.3 million. The most exported essential oils from Nepal are Juniper oil, lemongrass oil, Mint oil, Wintergreen (Dhasingre) oil, Palmarosa oil, Timur oil, Abies oil, Anthopogon (laliguras) oil, Chamomile oil, Citronella oil, French basil oil, and Jatamansi oil. Nepali essential oil is primarily exported to the United States (34%), followed by Europe (37%), and then Asia (24%) (TEPC, 2018).

Limitations of the study
This review briefly describes the role of MAPs in Nepalese livelihood. Due to the lack of recent studies and databases about MAPs, relevant past data are used in this article.

Conclusion
Although Nepal does not have a significant part of global MAPs markets till now, MAPs have been recognized as one of the Himalayan region's prospective high-value resources with huge economic growth potential. Despite having immense potential to introduce a variety of herbal products, the country still lags far behind in the proper utilization of the available resources. The trade policies tailored to the specific regions of Nepal need to be formulated to produce a conducive environment for MAPs marketing. The promotion and domestication of MAPs, proper harvesting techniques, and employment generation through cultivation are crucial in ensuring food safety, alleviating poverty, and upliftment of livelihood. Research and development of medicinal plants should be carried emphasizing improved equipment, modern technology, standardization, and quality assurance of herbal products to generate high revenue. A clear understanding of the access to herbal plants, conservation of natural resources, sustainable exploitation, protection of indigenous knowledge, and information sharing needs to be at the policy level. We recommend public, private, and government-linked sectors contribute to infrastructure development through competitive "field-to-market" incentives and funding.

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Author contribution statements
All the authors were involved in concept development, defining intellectual content, and literature research. V.T. Chhetri, S. Shrestha, and S. Thapa reviewed the literature and prepared a draft manuscript. S. Timilsina edited and reviewed the manuscript for finalization. The published version of the manuscript has been read and approved by all authors. V.T. Chhetri, as a corresponding author, is the guarantor for this article.
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