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DOMESTICATION/CULTIVATION POTENTIAL OF HIGH ALTITUDE MEDICINAL AND AROMATIC PLANTS IN CENTRAL NEPAL

Dhital Narayan Prasad*

High value medicinal and aromatic plants (MAPs) are collected in wild stage in most of Nepal's high altitude areas. The importance of MAPs in those areas is obvious due to their indispensable roles as traditional medicine and income supplement. Yet despite their importance, MAPs are facing severe depletion as little is known about their reproduction biology, habitat requirement and sustainable harvesting technique. Still, the harvesting is ongoing. This study explores, for selected MAP species, the reproduction biology, habitat requirements and local people's practices of harvesting as well as their interest in resource management. The natural habitat of the selected species were visited to observe the habitat type and to collect soil samples. Discussions were held with collectors and other stakeholders on reproduction biology, current harvesting practices, current condition and conservation initiatives for selected species. Local people demonstrate adequate knowledge about high value MAPs such as *Nardostachys grandiflora*, *Valeriana jatamasi*, *Aconitum gammiei*, *Rheum australe*, *Picrorhiza scrofulariflora* and *Dactylorhiza hatagirea*. Cultivation of these species has a high potential provided the product is marketable. Cultivation in community forests through community forests user groups seems to be an appropriate mechanism.

Introduction

Non Timber Forest Products (NTFPs), especially medicinal and aromatic plants (MAPs), are collected from their wild stage in most of the high altitude areas in Nepal. The harvesting of MAPs constitutes an integral part of local livelihoods, contributing from 3 to 44% (average 12%) of annual household income (Olsen & Larsen, 2003). In high altitude areas, income generation activities are limited due to weak infrastructure and limited arable land, which has serious consequences upon the living standard of the people. Medicinal plant collection and trade, therefore, constitutes a much-needed supplement to other income generating activities. Furthermore, medicinal plant collection has the advantage of taking place in agricultural slack periods, requiring no education, and being a traditional activity that has taken place for centuries in the area.

* Forest Management Planning Analyst, Saskatchewan Ministry of Environment, Prince Albert, Saskatchewan, Canada (narayan.dhital@gmail.com)

Although the importance of medicinal and aromatic plants in Nepal's high altitude areas is obvious, the issue of sustainability begs attention. Furthermore, very little is known about the reproduction biology, habitat requirements and domestication/ cultivation potential of MAPs. Although some discussions are going on regarding domestication/ cultivation of high altitude MAPs, the appropriate mechanism is still to be recognized. According to Darwin's theory of evolution, once they are cultivated, crop characteristics are modified knowingly or unknowingly due to alterations in the methods of reproduction and other biophysical differences from their natural occurrence. Darwin called this domestication (Brown, 2010). However, the extent of the difference in cultivated products from natural ones requires further study.

This study focuses on exploring the potential intervention areas and techniques to promote the production and management of high value MAPs (categorically, *Nardostachys grandiflora*, *Valeriana jatamasi*, *Aconitum gammiei*, *Rheum australe*, *Picrorhiza scrofulariflora* and *Dactylorhiza hatagirea*), with the intention of providing recommendations to improve the livelihood of local communities.

Methodology

This study was carried out in Ganesh Himal region of Rasuwa district, located in north west of Kathmandu. The altitude of the area where samples were taken is over 3500m above mean sea level (amsl). Average annual rainfall in the area is about 2000mm, with year round sunny days. There is no rain in October-November and April-May. The temperature of the studied species' habitat is <10°C most of the time and below 0°C in the winter.

The study was conducted in two tiers; firstly, the sites in Rasuwa district were visited where the selected MAPs are naturally available. Discussions were held with collectors about reproduction biology, habitat requirement and their knowledge on management and cultivation/domestication of the selected species. Current harvesting practices and trends were also discussed based on a checklist. Sample specimens of the plants and soil samples were collected. Sampled soil was tested in a lab in Kathmandu, the capital of the Nepal, for pH, organic matter and other micronutrients (Table 1).

Table - 1. Determination of pH, organic matter, N, B, Zn, P, K

SN	Sample	Altitude (masl) sample collected	pH	Organic matter %	N %	Mg/Kg			
						B	Zn	P	K
1	Sugandhawal	2528	6.00	11.2	0.59	0.71	0.48	160.0	0.007
2	Padamchal	3700	5.1	11.3	0.54	0.26	1.44	<2.5	<0.001
3	Nirmasi	3700	5.9	10.0	1.28	-	-	5.0	0.03
4	Jatamasi	3750	5.2	11.3	0.42	-	0.4	42.5	<0.001
5	Panch Aunle	3760	4.9	10.6	0.62	0.26	0.48	42.5	<0.001
	Method used	GPS	pH meter	Volumetric	min	Curcu	DPTA	Colour metric	AAS

Note: Results are valid only for submitted samples

In the second tier, expert consultation was carried out in Kathmandu. Experts were selected from different organizations involved in the domestication/cultivation of MAPs and their management in the country. The perceptions of different actors were triangulated and synthesized.

Results

This section summarizes the information gathered from the collectors, local communities and experts on six selected medicinal and aromatic plants and the potential for their domestication/ cultivation. Following the results, existing policies and practices and potential interventions required to promote the sustainable growth and use of these high value resources are discussed.

Management Practice of MAPs in the Study Area

The studied MAPs are natural resources and have not been cultivated in private or community lands so far. The ownership of these resources lies with the government. The MAPs are regulated by the district forest office (DFO), a district based government line agency responsible for the management of government land, particularly forest. The DFO issues permits for the collection of resources from natural areas and also issues transportation permits after inspecting the collected amount and charging a royalty. But, collectors mentioned that they never go to the DFO for getting a permit rather they collect the MAPs at their will and transport their produce to *Trishuli* (a local market hub) where *Kaji* (a local entrepreneur) holds most of the MAPs channelled from the region. *Kaji* has created a monopolistic market in which collectors do not have bargaining power to get a better price for their products. At the same time, the

government is also losing its revenue. Rather some middlemen and intermediaries are making the most out of it.

Interests and Perceptions of Collectors Towards Cultivation of MAPs

Collectors expressed a strong interest of cultivating MAPs on their private and community lands. However, they pointed out their need for skills and knowledge regarding how to do this. Collectors also identified areas for external support. They are: sharing the technology, providing cultivation training to farmers, establishment of demonstration plots, demonstration of success before going for mass cultivation, supply of seeds/propagules, and some working capital to the farmers and communities to start the business. Specifically, collectors requested the lifting of bans in the collection and transportation of two of the studied MAPs, *Kutki* and *Panchaule*.

The results related to the species-wise potential of domestication/cultivation of six selected MAPs is provided below:

1. Padamchal

Latin Name: *Rheum australe*

Local Name: *Chungbarin/Dangjyu*

There are two types of Padamchal found in the study area. Dangjyu, having a small rhizome, is found inside the forest at relatively lower altitudes (3750m). The other with large rhizomes is called *Chungbarin* and is found in open grassland at higher altitudes. In this study, soil analysis was done for *Dangjyu* only. The collectors mentioned that the reproduction biology is not different for *Dangjyu* and *Chungbarin*. Thus only one variety of Padamchal (i.e., *Dangiyu*) is considered in this study.

Reproduction biology: Padamchal reproduces vegetatively, mostly from rhizomes but collectors have also recorded germination from seed. Flowers come in July-August and remain for approximately two months. Rhizomes are generally collected in September-October. This is a deciduous annual plant and its leaves are shed in August-September.

Habitat requirement: Padamchal prefers the moist climate found at northeastern aspect, mostly under canopy cover. According to collectors, it is found from 3500m up to the snowline. The author recorded this species at 3750m at northeast aspect under the canopy of *Abies pindrow* in Ganesh Himal area of Rasuwa district. The plant found inside the forest at lower altitude (*Dangjyu*) is a shade bearer

while that found at high altitude open areas and grasslands (*Chungbarin*) is a light demander. *Dangjyu* is found in solitary condition under the canopy. *Chungbarin* is found associated with Bikh (*Aconitum spp*) and sometimes with Kutki (*Picrorrhiza scrofulariflora*) in high altitude swamps and plains. Soil test report suggests that Padamchal prefers acidic soil (pH 5.1) with high organic matter content (see Table 1).

Current management practice: The stem and rhizome of this plant is mostly used. Collectors collect this plant in the autumn by digging out the whole rhizome. Padamchal can be collected in a two years interval. Collectors harvest this resource rotationally over two to three years. Collectors mentioned that they have noticed neither severe depletion nor significant increase in the resource in natural areas over the past few years. Collectors transport Padamchal to Trishuli (the local market hub) where Kaji holds most of the MAPs channelled from the region. At Trishuli the market price of Padamchal (both varieties) is 80 Nepalese Rupees/dharni (2.4kg) of dry rhizome.

Domestication and Cultivation Potential

- ***Knowledge of reproduction:*** According to collectors, the rhizome of Padamchal sprouts in April-May, flowers in July-August and fruits in September-October. When collectors harvest the rhizome in September-October, they leave the rest of the plant including remnants of rhizome in the forest, which again sprouts the next April-May. They also mentioned the possibility of germinating seed in April-May but they have not observed this with the objective of reproduction potential. Thus collectors have a good knowledge of the species' reproduction biology.
- ***Local uses:*** Padamchal is used as a source of vitamin, tea from rhizome, pickle from new shoots, and medicine for snakebite and healing broken bones.

2. Jatamasi

Latin name: *Nardostachys grandiflora*
Local name: *Lope*

Reproduction biology: Jatamasi reproduces from rhizomes and branches from its nodes. Collectors mentioned that Jatamasi may also be germinated from seed but they have not observed seedlings in the study area. However, Herb Processing and Production Company Limited (HPPCL) has experimented with Jatamasi germination from seed (C. P. Mishra, personal

communication). Rhizomes sprout in November-December but come out only in March-April. Flowers blossom in July-August. Life span of the flower is about two months, which gives fruits in September-October. September and October are also the months for harvesting rhizomes. Jatamasi is a deciduous plant that sheds its leaves in November-December. Collectors in the study area are harvesting in a three-year rotation but they mentioned that yields are better every five-six years.

Habitat requirement: It is reported that Jatamasi is found at between 3500-4500masl. The author observed the plant at 3750m in the plain of a hillock south of Ganesh Himal. Collectors mentioned that Jatamasi is found in all aspect in gravelly and sandy soils under the shade of Sunpati (*Rhododendron anthopogon*) and mosses (Jhyau). It is not found in naked areas. Jatamasi needs acidic soil (pH 5.2) with a high organic matter content (11.2%), and prefers shade.

Current management practice: Collectors harvest Jatamasi rhizomes and stems. After extracting oil from the rhizome, mart (remnant) is used for making incense. The rhizome is collected in autumn (mostly, before *Dashain*, a national festival). But, the collectors mentioned that the later the collection (e.g. in November-December), the better is the regeneration as immature harvesting reduces the regeneration potential. Whole rhizome is dug out while harvesting. Collectors mentioned that they have observed better regeneration in places where some parts of rhizome is left and even better if remnants are covered with soil. The current harvest interval is two-three years. Collectors observed that the resource is depleting. Most of the Jatamasi from the area goes to *Kaji* (Trishuli) where the dry rhizome fetches 120 Nepalese Rupees/kg. The export of this species in its raw form is banned.

Domestication and Cultivation Potential

- ***Knowledge of reproduction:*** According to collectors, although Jatamasi sprouts in *Mangsir* (November-December), shoots come out only in *Chaitra* (March-April). It flowers in *Shrawan* (July-August), fruits in *Ashoj* (September-October) and rhizomes are harvested in Ashoj (September-October). The rhizome can be segregated into 15-20 slips. HPPCL plants these slips (or seeds) in a nursery in *Falgun* (February-March) and the planting stock is ready for plantation in *Shrawan* (July-August). HPPCL has successfully cultivated Jatamasi in high altitude

areas under the government's Remote Area Development Committee (RADC) and Special Region Development Programme (SRDP). While collecting seed, they cover the whole pod with a plastic bag not to let the seeds fall down on the ground (C. P. Mishra, personal communciation).

- ***Yield:*** In natural areas, a person can collect 10 kg/day if the resource is in good condition. Collectors mentioned that they normally collect between 2-3 kg/day.
- ***Local uses:*** Jatamasi is used to cure throat pain, common cold, and clean the inner body, besides it is worn as a garland. Its also used to make incense; and its aroma keeps snakes away from homes.

3. Sugandhawal

Latin name: *Valeriana jatamasi*
Local name: *Longpe*

Reproduction biology: Sugandhawal sprouts from rhizome in early spring when winter is over. Collectors were not aware of this MAP germinating from seed. Flower blossoms in February-March together with white Rhododendron. Life of the flower is about a month. This is a deciduous annual plant and leafs are shed in November-December. Collectors collect the rhizome in September-October with a three or four year interval.

Habitat requirement: Sugandhawal is found in temperate climates up to 2800m altitude. The author observed this MAP on a private land, the dyke of a corn field, in the northern aspect at an altitude of 2650m in central Nepal. Collectors mentioned that it is found in all aspects in such climate, but it is more abundant in northern aspects because it requires low light. It prefers loamy and soft soil. The soil test report shows that this MAP prefers slightly acidic (pH 6.0) soil with high organic matter content (11.2%). Temperature is up to 20^0C in summer and sometimes chilling in winter. Annual rainfall in its habitat is 2000 mm and rainfall is distributed over eight months. There is no rain in April-May and October-November. It is normally found associated with palatable grasses and other medicinal and aromatic plants (MAPs) such as *Chiraito* (*Swertia chiaraita*) and *Majitho* (*Rubea manjith*).

Current management practice: Sugandhawal is found in national forests, community forests and private lands thereby ownership remains with government, communities and families respectively. The most useful part of the plant is its rhizome, which is collected in June-July by digging out the whole plant. The interval of collection is three-four years. Collectors observed that this resource

is depleting. Main market is Kaji (in Trishuli) where 80-95 Nepalese Rupees/dharni (2.4 kg) of dry rhizome is fetched.

Domestication and cultivation potential

- ***Knowledge of reproduction:*** Sugandhawal sprouts in Falgun (February-March) and flowers in February-May. Rhizomes are harvested in June-July.
- ***Local uses:*** Sugandhawal is used as a medicine for healing burns, for making fire during the traditional Jhakri (Amchi) treatment system, and for making incense.

4. Nirmasi

Latin name: *Aconitum gammiei*
Local name: *Bongmar*

Collectors observed three varieties of Nirmasi (black, red and white) in the study area. Collectors prefer the black and red varieties (though they did not specify why), however the market value is similar for all the varieties. In this study, Nirmasi will hereafter be treated as one variety because of knowledge unavailability on all three varieties. The specimen of black Nirmasi was collected. Nirmasi has very small seed grains.

Reproduction biology: Nirmasi is propagated from rhizome as well as from seed. Like other high altitude species, it sprouts in March-April and flowers in July-September. Flowers remain on the plant for two months, and seeds ripen by November. Collectors harvest the rhizomes in September-October before the seeds mature, thereby reducing the regeneration potential from seed as well as from rhizome due to early harvest. This is a deciduous annual plant species and its leaves are shed in November-December. Currently the rhizome collection interval is five to six years.

Habitat requirement: Nirmasi is found above 3500m altitude. This species was observed at 3750m at northern aspect of the area, together with Padamchal under the canopy of *Abies pindrow* in the rocky slopes. Collectors mentioned it is found in all aspects but its yield is better in northern aspect. Like other high altitude MAPs, Nirmasi prefers high organic matter contents (10 %) and acidic soil (pH 5.9). This plant needs little light and is better under the canopy of trees and water holes. It is found together with Padamchal. Its main associate is Padamchal but it is also found with other species of *Aconitum*. The constituents of its associate Bikh (*Aconitum spp*), which is poisonous, is known to contaminate Nirmasi. There are records of animal and human deaths in the study area after the consumption of Nirmasi contaminated with Bikh.

Current management practice: Collectors harvest the rhizome and stem of Nirmasi. The rhizome is collected in autumn. The rhizome collection interval is five to six years. Collectors observed that the resource is depleting over the years. Collectors get 1200–1300 Nepalese Rupees/kg of dry rhizome in Trishuli. Interestingly, Nirmasi is collected and transported hidden inside the pack of Padamchal because of its high royalty rate and precious market value. Collectors cook the rhizome in sand believing that this helps to increase the weight of the rhizome.

Domestication and Cultivation Potential

- ***Knowledge of reproduction:*** Nirmasi sprouts (from rhizome) or germinates (from seed) in March-April and flowers in July-September. Fruits ripen in October-November and the rhizomes are collected in September-October.
- ***Local uses:*** Nirmasi is used as medicine for fever, food poisoning, common cold, burns, etc.

5. Panchaunle

Latin Name: *Dactylorhiza hatagirea*
Local Name: *Wangpolhakpa*

Reproduction biology: Panchaunle reproduces vegetatively from rhizome. Its seeds may germinate but collectors have not noticed this. When new rhizomes start sprouting in late autumn (November-December), the plant and old rhizome start dying. Collectors prefer collecting new rather than old rhizomes. Flowers come out in June-August and remain on the plants for approximately two months. Fruit ripen in September-October, and at this time the rhizomes are generally collected. A deciduous plant, its leaves are shed in November-December when new rhizomes start sprouting. The rhizome collection interval, as mentioned by collectors, is nine to ten years.

Habitat requirement: Panchaunle is found in all aspects above 3500m amsl. The author reported this species at an altitude of 3750m at a plain on top of a mountain. It was mixed together with Sunpati (*Rhododendron anthopogon*) and Jatamasi (*Nardostachys grandiflora*). In late December, new rhizomes were already sprouted and old rhizomes and plants were dying. According to collectors, it is found from 3500m up to the snowline. The soil test report (Table 1) suggests that Panchaunle prefers acidic soil (pH 4.9) with high organic matter contents (10.6%). This is a light demanding species and its main associates are Sunpati (*Rhododendron anthopogon*), Jatamasi (*Nardostachys grandiflora*), Bikh (*Aconitum species*), etc. It prefers open areas of grassland above the tree line.

Current management practice: Stem and rhizome are the useful parts of the plant. Collectors harvest this plant in autumn by digging out the whole rhizome. Collectors harvest this resource in a rotation of eight to nine years. Collectors mentioned that they are observing a severe depletion of the resource over the years, resulting in this long rotation. Collectors get 1000 Nepalese Rupees/dharni (2.4kg) for the dry rhizome in Trishuli.

Domestication and Cultivation Potential

- ***Knowledge of reproduction:*** According to collectors, the rhizome of Panchaunle sprouts in March-April, flowers in July-August and fruits in October-November. The rhizome is harvested in October-November. When collectors harvest the rhizome, they leave the rest of the plant including remnants of the rhizome in the forest, which again sprouts the next March-April. There is possibility of germination by seed in April-May but the collectors themselves have not observed this with the objective of reproduction potential.
- ***Local uses:*** Panchaunle is used as a vitamin supplement, for skin disease, burns, etc.

6. Kutki

Latin name: *Picrorhiza scrophulaliiflora*

Reproduction biology: Kutki reproduces vegetatively from its rhizome. Seeds may also germinate but collectors have not noticed this. Flowers come out in July–August and remains on the plants for approximately two months. Collectors mentioned that they have not observed fruits. This is a deciduous annual plant and its leaves are shed in November- December. The rhizome, in the form of a tendril, is collected in March–April. The harvest rotation is four to five years.

Habitat requirement: Collectors mentioned that this species is found above 4000m in southeast aspects on sunny plains. According to them, this species prefers moist soil. The author did not encounter this species during the field trip because of heavy snowfall in the area. This is a light demanding species although sometimes it is found in areas where there is no sun. Its main associates are Sunpati (*Rhododendron anthopogon*) and Padamchal (*Rheum australe*).

Current management practice: Collectors harvest the rhizome in spring by cutting its tendrils. They are harvesting Kutki rhizomes in a two-three year rotation. Collectors mentioned that

they are observing depletion of this resource in natural areas. Kutki is banned for collection and transportation in Nepal. However, collectors mentioned that it is being collected and transported illegally. Market price of Kutki is 120 Nepalese Rupees/kg of dry rhizomes in Trishuli.

Domestication and Cultivation Potential

- ***Knowledge of reproduction:*** According to collectors, the rhizome of Kutki sprouts in March-April, flowers in July–August and fruits in September-October. The rhizome is harvested in March–April by cutting its tendrils. If the rhizome is cut in March-April and planted, it sprouts again. Seeds may germinate in April–May but collectors clarified that they have not observed this with the objective of reproduction potential.
- ***Local uses:*** Kutki is used as a medicine for Amoeba, Giardia, fever, food poisoning, and burns, etc.

Discussion

High value MAPs Domestication/Cultivation: Major Drivers for Success

All the species covered in this study propagate from rhizomes. Panchaule, Nirmasi, Jatamasi and Padamchal also propagate from seed. Collectors are knowledgeable about these MAPs' reproduction biology. Local people are interested to cultivate the studied MAPs on their private as well as community lands, because the existing marketing channels and market prices make them economically attractive. Use of these MAPs in traditional medicines means their cultivation has high potential.

High value MAPs Domestication/Cultivation: Major Issues Identified

Interactions with collectors and a series of consultations with experts highlighted a number of issues related to domestication/cultivation of high value MAPs in Nepal. The harvesting time frame of MAPs is longer than that of agricultural crops (Amujoyegbe, Agbedahunsi, & Amujoyegbe, 2012). All the studied species have a rotation of at least two to three years whereas rotation of agricultural crops is shorter. In some cases, more than one agricultural crop is produced in a year. Under such circumstances, farmers do not want to take a risk to wait two to three years to harvest a single MAP crop. Per unit

production cost of MAPs is also higher and cannot compete with agricultural crops. An account provided by HPPCL (C. P. Mishra, personal communication) shows a production cost of 17-25,000 Nepalese Rupees per hectare of Jatamasi cultivation in addition to land rent. As access to sites where MAPs can be cultivated or collected naturally is poor, the production cost increases.

People with skills in the cultivation of MAPs do not live in the area where these species can be cultivated. Therefore, there is problem of proper supervision in cultivated areas by knowledgeable persons. Construction of processing plants in the areas where the MAPs are available could save up to 98% of the transportation cost eventually reducing the production cost. Lack of such facilities limits the chances of local value addition.

Some MAPs (e.g., Kutki and Panchaule) are banned for collection and transportation. Other MAPs such as Jatamasi are banned for export in their raw form. These bans are limiting collector's ability to supplement their income through harvesting these products. The government is also losing its royalty. However, collectors confirmed that the illegal collection and trade of these products is ongoing. Only middlemen and traders are benefitting from such bans in the collection and transportation of MAPs.

Major Risk Factors in MAPs Domestication/Cultivation

The study reveals that the domestication/cultivation of the above-mentioned MAPs will involve several risks. Government policy is a major risk for the cultivation of MAPs in private and community lands. So far, there is no national policy on the issue of MAP domestication/cultivation. The practice of banning the collection and transportation of some species without any concrete study and reason causes a reduction in collector's income and motivation. People started suspecting the government when it reviewed its community forestry policy and imposed a tax on the products harvested from community forests. Market is another major risk in the domestication/cultivation of MAPs.

The market of MAP is monopolistic controlled by the big traders based in Terai and Kathmandu. When supply is sufficient, the market price comes down significantly which causes severe loss of income by collectors.

There is extreme competition in marketing of MAPs at different levels. However, the main competition is among collectors as they

supply at a low price due to a lack of working capital. They agree on supplying products at a low price if they get an advance for their products in difficult times (e.g., during festivals such as Dashain and Tihar). Thus, the collectors are losing a major part of their income to middlemen and traders.

Adulteration is another risk factor in the sub-sector. Due to adulteration of products by some middlemen and collectors, genuine product collectors are not getting a justifiable price. There is a possibility of adulteration in both natural and cultivated products. Due to overharvesting and adulteration, the quality of the products deteriorates and the cultivators and collectors get less for their products. A difference in quality of ingredients in natural and cultivated products also warrants a closer look.

Major Considerations for the Domestication/Cultivation of MAPs

Three main attributes of domestication/cultivation of MAPs, namely land tenure, institutional support and incentives such as working capital, propagules and technical support, are required. A clear mechanism for handling conflicts needs to be established. Species to be domesticated/cultivated should be selected based on the suitability of habitat requirements. Locally available and preferred species are recommended. In the study area, local communities are involved in community forestry activities. They also manage a fund where they collect the money from selling forest products. That fund could be used to initiate the domestication/cultivation of high value MAPs. A demonstration plot would be a starting point for MAP cultivation. Newly introduced technologies should be simple so that the farmers can adopt the technology easily.

Another important consideration is the quality and volume of the products. Suppliers should be assured for regular supply of the quality products. Assistance to the farmers and collectors for alternative market channels is necessary to break the market monopoly. A market price information system should be developed and disseminated widely.

MAPs Cultivation/Domestication Mechanism

Asia Network for Sustainable Agricultural Bio-resources (ANSAB) has successfully experimented with Chiraito (*Swertia chirata*) cultivation. It facilitated a community forestry process resulting in a handover of forest area up to the snow line as a community forest.

After the area was handed over to the community, ANSAB assisted the community to establish a Chiraito nursery and to plant Chiraito in community lands. Cultivation of Chiraito supplemented the income of those involved by up to seven fold (R. P. Acharya, personal communication).

The Centre for International Studies and Cooperation (CECI), a Canada based NGO, also works with community forest user groups (CFUG) to promote the cultivation/ domestication of MAPs. For the purposes of better monitoring and smooth implementation of these activities, it forms district coordination committees and village coordination committees. The chairmen of the district development committee (DDC) and DFO, and district agriculture development officers (DADO) and district livestock officers (DLO), chair the district coordination committees. NGOs and federation of community forest users group (FECOFUN) are members. For village coordination committees, the village development committee (VDC) chairman works as chairman and respected members of societies and field level representatives of the line agencies are members. The main responsibility of the coordination committees at different tiers is to monitor activities on a half yearly basis.

CECI identified Chiraito, Sugandhawal, Timur (*Xanthoxylum armatum*), Ganalu (*Angelica glauca*), and Satuwa as the priority species through pair wise ranking in a Participatory Rural Appraisal (PRA) exercise in six CFUGs in Baitadi district (CECI, 2004). These areas are located in an altitude between 1400m and 2200m. CECI also assisted the establishment of demo plots for these species in community forests. Villagers have already started replicating their successes in their community forests and private lands.

CECI works with FECOFUN as its local partner for the capacity building and institutional strengthening of community forest user groups (CFUGs). It carries out scientific research with the support of the DFO. It also provides technical expertise to incorporate a non-timber forest products (NTFP) promotion component in community forest operational plans (CFOPs). It also provides 30,000 Nepalese Rupees working capital for each FUG involved in the NTFP programme. It encourages community forest user groups to collect propagules from forests. If the propagules (including seeds) are available in the market, CECI supplies it to farmers. CFUGs mobilize this fund as a loan without interest to promote NTFP cultivation within their private lands. DFOs help CFUGs in site and species selection. CECI also influences the central government for formulation of NTFP policy, and organises NTFP producer CFUGs

into cooperatives to increase their bargaining capacity for gaining a better price for their products (C. L. Chaudhary, personal communication). CECI observed that CFUGs are enthusiastic to incorporate NTFPs in their community forest operational plans (CFOPs). They are also interested to cultivate MAPs on their farmland. In one year alone, 97 farmers started domesticating NTFPs in Baitadi district (C. L. Chaudhary, personal communication).

Working through CFUGs to domesticate/cultivate MAPs is also found to be an appropriate mechanism by HPPCL. The Herb Processing and Production Company Limited also considers the leasehold forestry programme to be a potential mechanism to cultivate MAPs, as land rent is free for leasehold forest groups (C. P. Mishra, personal communication).

There should, however, be a mechanism for distinguishing the product. The quality differs according to the sources, i.e. cultivated or sourced naturally.

Potential Intervention Areas to Strengthen the Sub-Sector

Community forest users groups are the main actors in the domestication/cultivation of the high value medicinal and aromatic plants, either at a family level or as an organized group. Building their capacity and raising their awareness on MAPs and NTFPs could be an entry point of the programme. Investment in research such as developing domestication/cultivation techniques for preferred species, analyzing cost and benefit of MAPs vs. agriculture products, and providing training to local farmers and collectors on sustainable cultivation and harvesting of natural products could strengthen the sub-sector.

Establishing a market price information system (MPIS) and disseminating it to the farmers and collectors could save them from being underpaid for their products. The MPIS can disseminate information to mobile phones, which most of the families possess. Creating a network of collectors and cultivators in the form of cooperatives at local and regional levels, and connecting them with larger business networks such as Federation of Nepal Chambers of Commerce and Industry (FNCCI), could increase their bargaining power at the same time providing learning opportunities to run businesses. This may also help to bring the MAP/NTFP sub-sector into the commercial mainstream. At the same time, such cooperatives may also lend much-needed working capital to their members with minimum borrowing cost.

Conclusion

All six species covered in this study are highly valued as traditional medicine and as local income supplements. The main collectors of these medicinal and aromatic plants possess important knowledge on reproduction biology and habitat of the species. As local farmers are not trained, some of the species have been over harvested consequently depleting the resource base and increasing the harvest interval.

Government's procedure regarding MAP transaction is complicated. Some of the species are banned for collection and transportation. Certain policies are unclear and royalty determination is also unrealistic. All these issues are leading to the illegal collection and transportation of high value MAPs from the study area. Although a distinct marketing channel exists, collectors are underpaid for their products due to the monopolistic structure of the market.

Local people are interested in the domestication/cultivation of MAPs. Existing market channels, local income generation potential and availability of reproduction technology give the MAPs a high potential for domestication/cultivation on private as well as community lands. Local farmers, however, need support on domestication/cultivation technologies, propagules, and working capital. Moreover, studies on differentiating constituents of cultivated and natural products, smoothening transaction procedures, diversifying market opportunities, and on onsite value addition should follow the cultivation/domestication endeavour. Indeed, the MAP subsector has the potential to be a strong alternative strategy for the livelihoods of local people living in Nepal's mountainous areas. Experience shows that cultivating MAPs in community forest through CFUG is an appropriate MAPs cultivation mechanism.

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