Global Journal of Medical research
Microbiology and Pathology
Volume 13 Issue 2 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4618 & Print ISSN : 0975-5888

# Trade of Threatened Himalayan Medicinal and Aromatic Plants-Socioeconomy, Management and Conservation Issues in Garhwal Himalaya, India

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*GJMR-C Classification :* *NLMC Code: QV 752*


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# Trade of Threatened Himalayan Medicinal and Aromatic Plants-Socioeconomy, Management and Conservation Issues in Garhwal Himalaya, India

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*Abstract* - Collection and trade of medicinal and aromatic plant species (MAPs) is age old practice throughout the world to increase household income. Over harvesting decreased their populations and a number of species became threatened in natural habitat. Survey was conducted on trade of such threatened MAPs from wild in Garhwal Himalaya (Uttarakhand), India. Information's were collected on MAPs trade, channels involved and profit at each level of transaction. Even after ban on commercial exploitation of some MAPs, trade continued through illegal ways. Harvesting starts from July and continue till November. Further, harvesting prior to seed dispersal decreased chance of recruitment of new individual, due to which abundance of these species is decreasing with alarming rate.

Total eighteen species are in active trade from study areas, out of which five are common for all sites. Number of MAPs traded from each site directly influenced by abundance of species in natural habitat. 18% of annual cash income generated from MAPs related activities in these areas. Market demand for *Aconitum heterophyllum, Nardostachys jatamansi* and *Picrorhiza kurrooa* is much higher than supply. Percentage of profit varied at each level from site to site and species. Traders earned maximum percentage of profits whereas collectors also received good profit, due to which they were engaged in illegal trade. Rotational harvesting may be applied for sustainable utilization. Agrotechnology has been developed for few MAPs, but incentive should be given to farmers to initiate cultivation of such species for *ex situ* conservation.

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## I. Introduction

People settled in the high altitude areas of Himalayan regions have limited options to earn money for their daily needs, due to uneconomic nature of cereals production i.e. low returns from agricultural production. Only few varieties of Millets, Buckwheat, Pulses, Amaranths, Barley, etc. are cultivated crops in small quantities in these regions due to small and fragmented land holdings. Animal husbandry is another important income generating source for them. However, integrated agriculture system, animal husbandry, etc. is unable to satisfy the basic minimum subsistence needs of the peoples and poverty is common in these areas. Despite the abundance of natural resources, most of its peoples are marginalized and still live on subsistence level (Singh 2006). In the past four decades, human population in Indian Himalaya has increased up to 2.7 fold (Nandy and Rao 2001), whereas cereal crop production in mountain agriculture become uneconomic and decreasing regularly (Chauhan 2010). Due to the low agricultural production, lack of industrial development, poverty and unemployment, peoples migrate to exploit biodiversity to improve their socioeconomy. MAPs collection provides extra source of income, which compensate low agricultural production. It has been estimated that many village communities derive as much as 10-50% of their household income from the sale of the forest products (Olsen and Helles 1997; Kuniyal et al 2005; Williams et al 2005; Adhikari et al 2007; Christensen and Heilmann-Clausen 2009). Annual cash income in itself proved to be positively correlated with income from wild products (Olsen and Larsen 2003; Pandit and Kumar 2010).

Demand of herbal medicine is increasing throughout the world. Annual turnover of herbal medicine in India is estimated 1,77,000 MT for which 960 plant species are in active trade (Ved and Goraya 2008). Such increased demand creates a pressure on natural population, due to which many species declined in their number and abundance and entered into various degrees of threat (Uniyal et al 2006). On account of high degree of threat CITES has notified 11 Indian MAPs in its schedule for care including *Nardostachys jatamansi, Picrorhiza kurrooa,* etc. To conserve such threatened species, Government of India imposed ban on collection of such MAPs from natural habitats but the ban imposed for conservation purpose; promoted illegal trade. There are many reports in daily newspapers for seizing of banned MAPs, extracted illegally from wild sources, whereas large part of illegal trade escapes.

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The trade of medicinal plants had attracted the attention of scientist as well as development planners on their potential to improve rural livelihoods throughout the world. A number of studies are available regarding medicinal plant trade from different parts of the world including India (Edwards 1993; Olsen 1998; Olsen and Larsen 2003; Williams et al 2005; Kala et al 2006; Uniyal et al 2006; Pandit and Kumar 2010; Heubach et al 2011), whereas pattern of trade especially in threatened high altitude species is rarely available. Olsen and Bhattatarai (2005) reported that local trader can have a negative margin in one year and positive in another. Larsen and Olsen (2007) found that empirical data does not paint a clear picture of unfair harvester exploitation and advocated a need for more stringent price data collection because many studies assumed exploitative nature of middlemen but none of the reference provide suggestion as to what a fair margin is?. Holley and Cherla (1998) emphasized the need to investigate the socioeconomic profiles of the economic agents in a review of medicinal plant sector in India. Trade data and household survey is important in order to effective conservation (Olsen 2005). In view of above, present paper provide information's on role of MAPs in household income to improve socioeconomy of hill peoples, pattern of trade especially in threatened high altitude species along with policy management for conservation of such species.

## II. Material and Methods

### a) Study Sites

The study area falls (between 29°26'-31°28' N and 77°49'-80°6' E) in Uttarakhand, India (Figure 1). Alpine and sub alpine sites covering surrounding areas of Har-Ki-Doon (HKD) and Dayara (DR) in Uttarkashi district, Panwali Kantha (PK) in Tehri district, Madhyamaheshwer (MD) in Rudraprayag district and Joshimath (JM) in Chamoli district are known as potential zone of wild MAPs in western Himalaya. Population in these areas is distributed in villages from lowland (1000 m asl) to high altitude regions (2500 m asl). Peoples of high altitude regions migrate to MAPs producing areas with their cattle's in the temporarily settlements during May to October and exploits MAPs to increase their cash income. MAPs collected in villages of such areas are traded throughout the markets. Therefore, these areas were selected and surveyed for present studies.

### b) Methods

Each of the selected sites was visited frequently during 2008 to 2010 and data were collected. Information's were collected on MAPs trade from all sites and voucher specimen were maintained, authenticated by Dr. P. Prasad of Botanical Survey of India, Dehradun and deposited in same herbarium (BSD 201-238). Based on the trade volume and number of collectors engaged, species that were in active trade in all zones was selected for detail investigation *i.e.* profit at each level of transaction. These species are 1) *Aconitum heterophyllum* Wall. ex Royle, 2) *A. balfourii* (Bruhl) Muk (synonym *A. atrox*), 3) *Nardostachys jatamansi* DC., 4) *Picrorhiza kurrooa* Benth ex Royle, and 5) *Rheum* spp. (*Rheum emodi* and *R. moorcroftianum*). At least two collectors of 50% families from two villages of each study site were interviewed for estimation of annual household income as cash. Data regarding involvement of households, contribution of MAPs related activities in annual income, season and method of collection of MAPs, channels involved in trade, methods of sale, etc. was collected by open ended questionnaire and standardized interviews. Respondents were assured that the data will be used only for research purpose and their identity will not be disclosed. Data on involvement of households engaged and percentage share in annual income through MAPs related activities were collected from these villages, pooled and average values was calculated. Channels involved in trade was identified and treated as proposed by Olsen and Bhattarai (2005). Ten to fifteen collectors, 3-4 middlemen and traders were interviewed from each of the selected zones for data collection and at least 50% of them interviewed in every study year. 'Species area curve method' was applied to collect data in a sigmoid form as suggested by Williams et al (2005).

Income of collectors was estimated on the basis of net income with the sale of selected species minus input cost (time consumed for collection of particular species @Rs. 120 per day as common labor charges in these sites). Profit percentage of all channels was calculated based on the difference in sale price received minus purchase price. Net profit at different level of traders was estimated by deducting expenses during journey *i.e.* loading, transport, expenses on journey and other charges. Selling price was analyzed on the sites of collection and their trade route, as personal observation at least once in every year. Existing market of this region (Wholesale market of Dehradun, Haridwar, Saharanpur and retail market of Badrinath and Rishikesh) was surveyed, because collected MAPs are traded in these markets. Variation in prize of MAPs throughout the study period was pooled and average values was considered for further analysis. To calculate final data on profit percentage of different channels, data of net income at species level at each channels from each sites were pooled separately and average value were calculated as percentage profit.

## III. Results

Collection and trade of MAPs is age-old practice and believed to be 5000 year old. However, number of species traded fluctuated regularly. Before 1994, collection of MAPs in these areas was made by

licensed contractor with payment of royalty to forest department and sale through district level cooperative societies. Later on some of the plants categorized as threatened and their collection was banned from natural habitats. Even after ban, peoples settled in high altitude regions migrate to MAPs growing areas, exploit a number of species and sale them to market in illegal way. Almost 30-40% families (varies with altitude of villages and their option to other source of income) are directly linked to MAPs related activities *i.e.* collection, drying, grading or selling, etc. They generated 18% of total annual cash income through MAPs related activities (Figure 2). There was a stark difference in abundance (availability as well as density) of MAPs from site to site. These differences directly influenced cost of collection and number of species traded along with trade pattern from each site. Collection of MAPs made frequently throughout the summer season although major proportion were extracted from August to November. During the months of August to November, peoples made team to collect MAPs, moved to sites and stayed there for few weeks in natural caves or in tents. Collections were made in a destructive way (as underground part is economic in these perennial species) by uprooting whole plants even before the maturation of seeds. Currently eighteen MAPs species are in trade from study areas. List of important MAPs with their trade name, distribution range, economically useful part with sites of collection is presented in Table 1.

The traders of MAPs employed local agent (local traders), who made contact with collectors. Collectors dig out MAPs from nature, supplied them to local traders (sometime directly to traders if local trader is not present as in DR and PK sites, Fig. 3). Local traders supplied MAPs to traders. Different channel involved in the trade of these species are presented in Figure 3. Local traders were often moneylenders or local merchants of household requirements. The collectors were mostly local inhabitants but sometimes persons hired by the local traders which extracted plants destructively. Collectors dug out material from nature, dried it partially or completely and carried the produce to local trader's house. The produce further moved to other channels accordingly. Sometime MAPs may also bypass through one or more channels as indicated in Figure 3. Volume, market rate and value of collected species, annual demand and deficit are presented in Table 2. Study reveals that volume of collected MAPs varied from site to site depending on availability of species. Total worth of 5 selected species is Rs. 1,17,21,400 annually from this region. Among these species, sale of *P. kurrooa* provided highest income of Rs. 34,98,750. *A. balfourii* was second important income generating species with value of Rs. 33,60,000. Collection of *A. heterophyllum* was much lower in quantity as compared to other species but had high market rate and trade reached up to Rs.13,10,400. Collection of *Rheum* spp. showed lowest income among selected species. Observations revealed that there is a gap between demand and supply of selected species. This gap was much higher in *A. heterophyllum, N. jatamansi* and *P. kurrooa.*

Table 3, show details of profit percentage of channels involved in trade, at each site. Profit analysis of collectors indicates that they got lowest profit of 2.24% in MD with the sale of *A. heterophyllum* and maximum (59.52%) in PK with the sale of *A. balfourii.* Local traders are important channel in trade of MAPs, which purchase material from collectors. They earned lowest profit of 6.66% in JM with the sale of *N. jatamansi* and highest (29.41%) in MD with the sale of *Rheum* spp. Traders obtained maximum profit of 92.80% in PK with the sale of *A. balfourii* and minimum profit 2.70% in HKD with the sale of *Rheum* spp. *A. balfourii* was the species with maximum profit for traders in most of the sites while *Rheum* spp. was the source of minimum profit in four sites. The mode of transportation on roads depends on the volume of the produce and distance to be covered *e.g.* Trucks, Bus or Jeep. The traders then send produce to wholesaler in Dehradun, Haridwar, Saharanpur, Ram Nagar or Delhi market. In case of market, wholesale dealer earned maximum profit of 36.84% with the sale of *Rheum* spp. and profit of 10.0-18.66% with the sale of other MAPs. In retail market, maximum profit was 53.84% for the sale of *Rheum* spp. and minimum profit of 5.66% with the sale of *A. heterophyllum.* Other three species provided almost similar (13.63%-17.97%) profit to retail shopkeepers.

## IV. Discussion

Collection and trade of MAPs is as old as human civilization and an integral part of socioeconomy in rural areas. However, pattern of trade changed from time to time *i.e.* in the form of exchange of food material with the peoples of low altitude areas in ancient time, exchange as money in later stage, collection via licensed contractor and now in illegal way. Poor economy with good profit compelled peoples in illegal harvesting of threatened MAPs. It is also estimated that a total 2200MT of MAPs covering 100 species are traded from Uttarakhand (Ved and Goraya 2008). In general, the income generated through MAPs related activities (only 18%) is a small part, but due to lack of other sources of income it makes important contribution. MAPs collection provides cash business and sometime advance monetary benefits to local economy. Mostly traders paid incentives to collectors as advance money for collection of MAPs at the start of season. Edwards (1993) also reported almost similar pattern for MAPs collection in Nepal. MAPs also act as 'saving' to be cashed in contingencies and thus constitute the larger part of household income in time of need (Olsen 1998).

Large part of population was found linked to MAPs work in Nepal (Larsen and Olsen 2007). Engagement of only 30-40% families in MAPs related activities is lower as compared to other parts of the world, which may be due to changing nature of policy and decrease in abundance of MAPs. Collection of MAPs continued throughout the summer season with destructive harvesting practice is also reported earlier (Rai et al 2000).

Variation in the numbers and volume of MAPs collected from site to site may be due to availability (abundance and density of species) in nature, profit earning and preference in terms of physical labor of particular species. Our observation reveals that few sites are rich whereas others are poor in availability of MAPs. Collection of *A. balfourii* and *P. kurrooa* is easier as compared to *A. heterophyllum, N. jatamansi* and *Rheum* spp. A difference in the relative abundance and diversity of plants sold by street traders and shop traders is also reported in Johannesburg, South Africa (Williams et al 2005). The volume of collected MAPs and deficit reveals that the study areas are under heavy harvesting pressure. Due to manifold increase in market demand, collection period increased from few months to all growing seasons (July-November) against the principle of active constituents and quality. However, collectors have the opinion that collection is difficult during October-November as compared to August- September due to cold and freezing of soil. Only underground parts are useful in these species and plants were uprooted through destructive harvesting system. Almost 66% of total species sourced from wild reported to be harvested destructively (Ved and Goraya 2008). Further, harvesting prior to seed dispersal decreased chance of recruitment of new individual, due to which abundance of these species is decreasing with alarming rate. Occurrence of trade channels and unequal distribution of profit among market channels is also reported for other species and regions (Holley and Cherla 1998; Olsen 1998; Olsen and Bhattarai 2005; Kuniyal et al 2005).

Lack of storage facilities and technology is major factor, which accelerate sale of medicinal plants even when price may not be better. Collectors are sometime compelled to sell produce with minimum profit due to uncertainty in MAPs trade. Availability (abundance) of species at collection sites also fluctuated profit percentage, as abundance is directly related to cost of collection. Shiva (1998) has the opinion that wholesalers have a virtual monopoly on the Jari-buti trade and control the price, paid to the small traders. Sharma (2004) also reported that market price, trade and channels of *Cordyceps* sp. collection are not transparent in Indian subcontinent. The overall study indicates that traders earned maximum percentage of profits. Contrary to exploitation of collectors in MAPs trade, here collectors also got good profit with the sale of MAPs, due to which they take risk of illegal collection. Higher profit obtained by the collectors and traders in DR and PK, as compared to other sites could become possible due to lack of one channel (local traders) in trade chain. The study supports earlier studies (Sharma and Tewari 1996; Gupta 1997) that highest share of profits to collectors can be ensured with less number of middlemen. Retail market showed less profit percentage in most of the species, which may be due to bypass transaction of produce that decreased number of channels.

Collection of medicinal plants raises a number of complex environmental and social issues that must be addressed locally on a case-by case basis (WHO 2003). Income from MAPs is integral part in the socioeconomy of the peoples settled in such areas. Apart from healthcare, medicinal plants are mainly alternative income generating source of underprivileged community (Lacuna-Richman 2002), therefore, strengthening of this sector may benefit and improve the living standard of poor peoples (Kala et al 2006). In case, the root is not harvested at maturity stage, it starts decaying from the core (Rundel and Witter 1994). Therefore, ecologically non-destructive systems of collection may be employed and the ban imposed on collection may be replaced with rotational harvesting system to promote sustainable utilization of biodiversity. Due to socioeconomic importance of biodiversity, Conservation of Biological Diversity (CBD) also agreed on a framework that biodiversity should be utilized for human welfare in a sustainable manner (Kate and Laird 2000). Subedi and Koontz (1999) also supported rotational harvesting for MAPs in Nepal with minimum 20% plant undisturbed. Ghimiri et al (2005) indicates that sustainable commercial harvest of *P. kurrooa* may be feasible while *N. grandiflora* appears very sensitive to harvest. Larsen and Olsen (2007) concluded that the present level of information renders impossible conclusion on weather the resource is degraded or not, status of MAPs was essentially based on participant's perceptions of change in various species parameters such as population size and not equivalents to scientific evidences for the status of any medicinal plants species. In such case careful management is required for sustainable harvesting of high altitude perennial medicinal plants (Ghimiri et al 2008). Further, recently developed cultivation technology of few high altitude MAPs (Nautiyal et al 2001, 2003, 2005; Chauhan and Nautiyal 2005; Chauhan et al 2008) will also be helpful in conservation of these species if technology transferred to interested growers properly. However, farmers need incentive for cultivation of these species.

## V. Conclusions

Illegal MAPs trade continues in Himalayan regions even after imposing ban, to restrict it. Thousands of plants of these species are uprooted

every year through destructive harvesting system. Good profit at each channels encourage peoples to involve in illegal trade. MAPs trade showed their importance in socioeconomy of these regions. Thus without providing optional sources of income generation for local population, complete ban on MAPs collection seems impossible. On the other hand conservation of natural resources is also important issue to restrict biodiversity loss. Furthermore, collection practices should also ensure the long term survival of wild populations and their associated habitats. Management plans for collection should provide a framework for setting sustainable harvest levels and describe appropriate collection practices. In such condition, rotational harvesting after few years interval (only after seed dispersal) may be useful. Cultivation of such species should be promoted, as it is viable option to meet the increasing demand, improvement in socioeconomy and conservation of these species. If MAPs cultivation starts once, illegal collection will automatically discouraged. To meet the challenges in MAPs sector, scientific studies should be conducted for- 1) the impact of illegal collection on natural resource, 2) resource assessment survey for evaluation of the regulation potential, and 3) What is the limit of sustainable harvesting? It should be determined at species level.

## Acknowledgments

Authors are grateful to Prof. A. N. Purohit, FNA (Ex Director) and Prof. A. R. Nautiyal, Director, HAPPRC, for consistent encouragement. Financial support by Deptt. of AYUSH, Ministry of H& FW and DBT, Govt. of India, New Delhi is gratefully acknowledged.

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*Table 1 :* General information on MAPs in trade in Western Himalaya

| S.N. | Plant species | Trade name | Useful part | Distribution range (m asl) | Sites of collection* |
|---|---|---|---|---|---|
| 1. | *Aconitum balfourii* | Mitha Bish | Tubers | 2500-4000 | 1,2,3,4,5 |
| 2. | *Aconitum heterophyllum* | Atis | Tubers | 3000-4500 | 1,2,3,4,5 |
| 3. | *Allium sp.* | Farn | Arial shoots | 2800-4200 | 2,5 |
| 4. | *Angelica glauca* | Choru | Underground | 2500-3800 | 1,2,3,4 |
| 5. | *Arnebia benthami* | Lal Jari | Underground | 3000-4000 | 1,4 |
| 6. | *Dactylorhiza hatagirea* | Salampanja | Tuber | 2800-4000 | 1,2,3 |
| 7. | *Fritillaria roylei* | Kakoli | Tuber | 2800-4000 | 1,3 |
| 8. | *Habaenaria* spp. | Riddhi-Briddhi | Tuber | 2200-3000 | 2,3,5 |
| 9. | *Malaxis muscifera* | Jeevak | Tuber | 2500-3700 | 2,5 |
| 10. | *Morina longifolia* | Dhoop | Whole plant | 2800-3800 | 2,5 |
| 11. | *Nardostachys jatamansi* | Jatamansi | Underground | 3300-5000 | 1,2,3,4,5 |
| 12. | *Picrorhiza kurrooa* | Kutki | Rhizomes | 2800-4500 | 1,2,3,4,5 |
| 13. | *Podophyllum hexandrum* | Bakarchimka | Underground | 2800-3800 | 1,2 |
| 14. | *Polygonatum sp.* | Mahamaida | Underground | 2200-4000 | 1,2,5 |
| 15. | *Polygonum sp.,* | Kanthla | Tuber | 3000-4200 | 3,4,5 |
| 16. | *Rheum* spp. | Archa, Dolu | Underground | 2800-4200 | 1,2,3,4,5 |
| 17. | *Swertia* spp. | Chirata | Whole plant | 2000-3500 | 2,5 |
| 18. | *Thalictrum* spp. | Mamira | Underground | 2800-3700 | 1,5 |

* Site of collection - 1-HKD, 2- DR, 3- PK, 4- MD, 5-JM

*Table 2 :* Quantity (qt.), value (Rs.), demand and deficit of selected MAPs in Western Himalaya

| Sites | Quantity of selected species (qt.) | | | | |
|---|---|---|---|---|---|
| | *A. heterophyllum* | *A. balfourii* | *N. jatamansi* | *P. kurrooa* | *Rheum* spp. |
| HKD | 1.0 | 33 | 18 | 5.5 | 18 |
| DR | 0.45 | 58 | 4.25 | 10 | 6 |
| PK | 1.50 | 25 | 18 | 48 | 18 |
| MD | 1.35 | 32 | 39 | 60 | 13 |
| JM | 0.38 | 12 | 35 | 32 | 32 |
| **Total** | **4.68** | **160.0** | **114.25** | **155.5** | **87.0** |
| Market rate (Rs.)/kg | 2800 | 210.0 | 250.0 | 225.0 | 80 |
| Value (Rs.) | 13,10,400 | 33,60,000 | 28,56,250 | 34,98,750 | 6,96,000 |
| Demand | 24.0 | 189.0 | 317.0 | 470.0 | 91.0 |
| Deficit | 19.32 | 29.0 | 202.75 | 314.5 | 4.0 |

*Table 3 :* Profit percentage of different channels involved in trade of MAPs in Western Himalaya

| Sites | Categories | *A. heterophyllum* | *A. balfourii* | *N. jatamansi* | *P.kurrooa* | *Rheum* spp. |
|---|---|---|---|---|---|---|
| DR | Collector | 20.8 | 54.54 | 33.89 | 36.84 | 12 |
| | Local trader | - | - | - | - | - |
| | Trader | 64.22 | 88.91 | 18.06 | 24.46 | 4.39 |
| HKD | Collector | 8.87 | 45 | 25 | 27.77 | 11.11 |
| | Local trader | 24.07 | 29.31 | 10.71 | 17.39 | 25 |
| | Trader | 42.26 | 72.41 | 19.76 | 19.72 | 2.70 |
| MD | Collector | 2.24 | 34.88 | 15.0 | 31.11 | 13.33 |
| | Local trader | 13.46 | 23.72 | 15.94 | 10.16 | 29.41 |
| | Trader | 53.70 | 77.72 | 17.37 | 24.46 | 13.77 |
| PK | Collector | 11.08 | 59.52 | 39.13 | 43.67 | 25 |
| | Local trader | - | - | - | - | - |
| | Trader | 78.59 | 92.80 | 17.09 | 29.60 | 6.14 |
| JM | Collector | 12 | 42.22 | 33.33 | 37.5 | 20 |
| | Local trader | 15.71 | 15.62 | 6.66 | 36.0 | 25 |
| | Trader | 47.05 | 74.41 | 16.27 | 26.42 | 78.57 |
| Drug Shop | Wholesaler | 10.41 | 18.66 | 10.0 | 12.5 | 36.84 |
| | Retailer | 5.66 | 17.97 | 13.63 | 13.63 | 53.84 |

- Local traders not found in sites

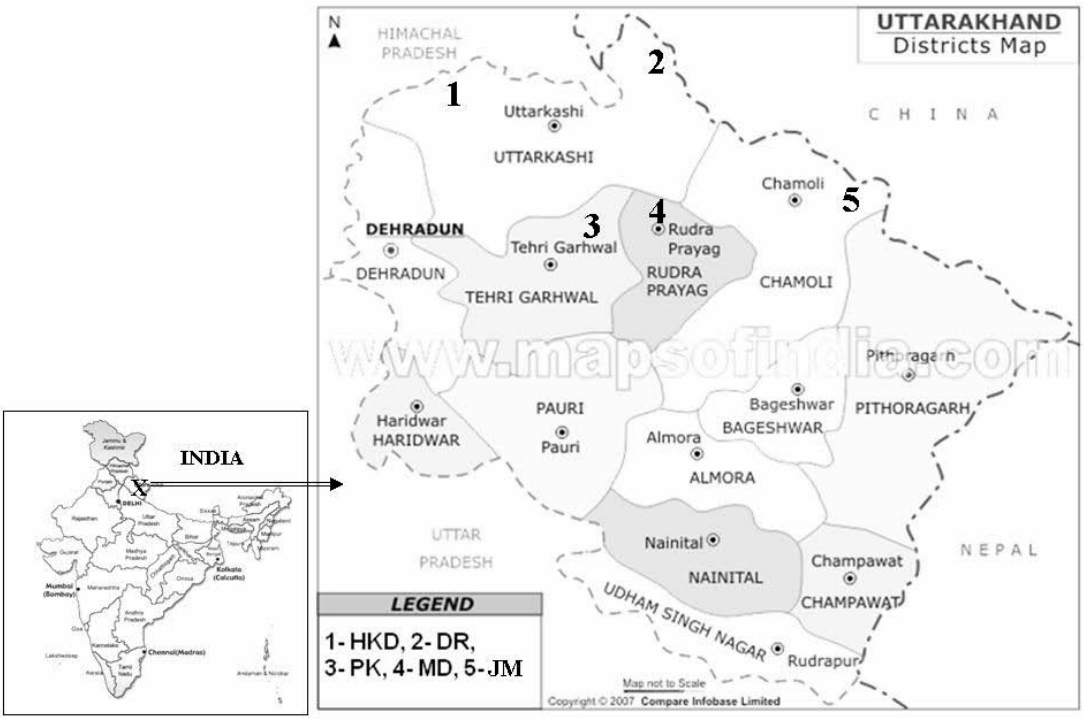


*Figure 1 :* Location map showing study sites in Uttarakhand (India)

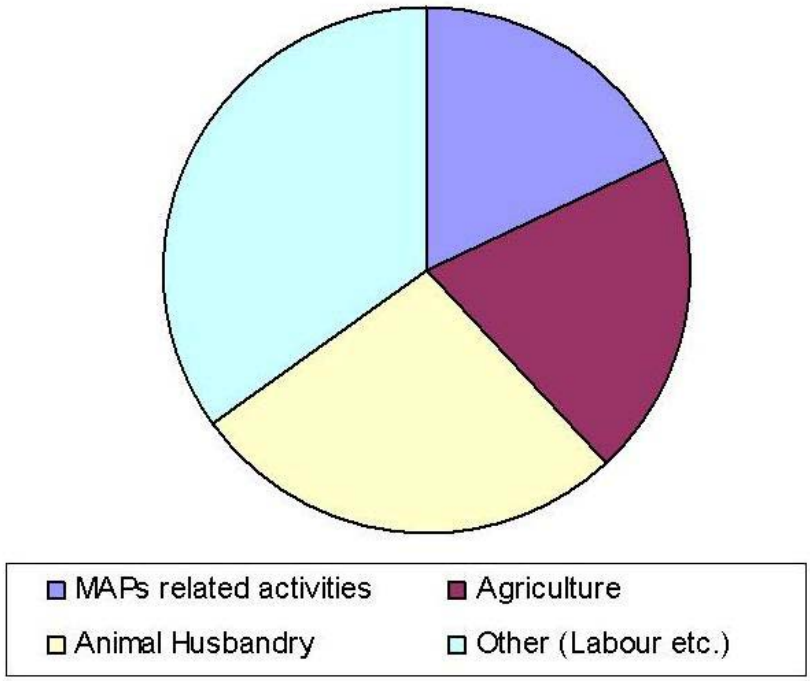


*Figure 2 :* Percentage share of MAPs in household's income in study areas

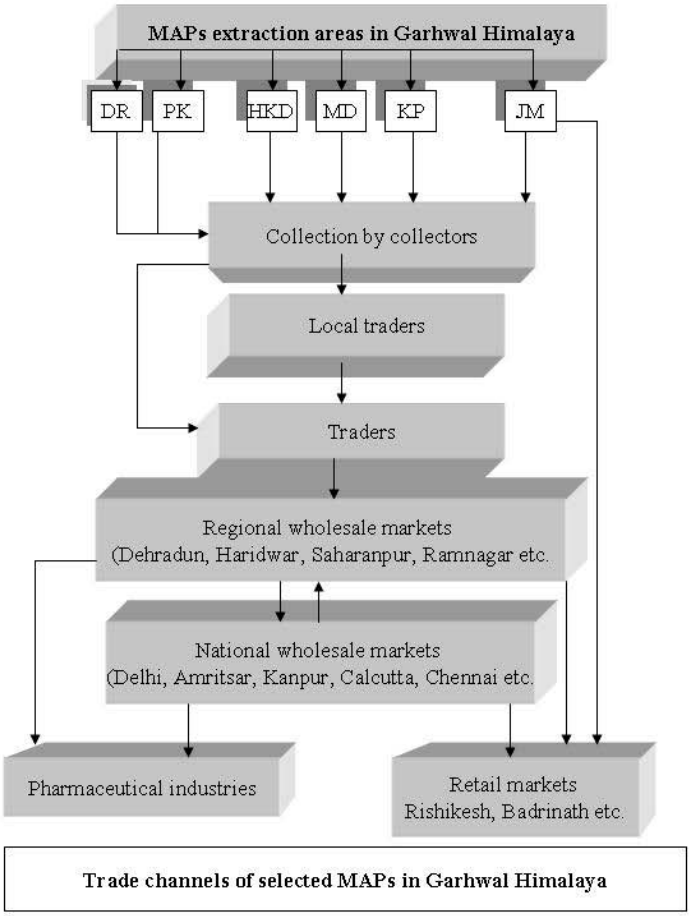


*Figure 3 :* Trade channels of selected MAPs in study areas

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