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# Trends and variability study of medicinal plants in Himachal Pradesh

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## ABSTRACT

This paper is mainly focussed on the status of extraction and nature of existing trade of medicinal plants in the state. The extracted species were classified on the basis of habitat, habit, economic part used and their present status. To study the trends in extraction of medicinal plants linear growth rates were estimated. To examine the variability the instability indices were calculated. On the basis of habitat only medicinal plants under cultivation showed a positive and significant growth (29.01%/annum) during periods P-I while during P-II upper hill subtropical (28.74%/annum) and cold desert (24.71%/annum) showed significant negative growth. The entire plants showed a negative and significant growth of 21.4 per cent per annum in P-I and seeds in P-II showed negative and significant growth of (45.00%/annum). But in overall bark entire plants and rhizomes showed negative significant growth rates. The Barah flowers showed positive and significant growth of 18.34 per cent per annum. The roots yielded maximum average volume and maximum revenue. The linear growth of medicinal plants based on their present status indicated that only commonly available medicinal plants showed a significant declining growth rate of 10.67 per cent per annum and 9.26 per cent per annum in P-II and in overall. The paper also highlights various lacunae in trade of medicinal plants in the state.

**Keywords:** Medicinal plants; existing trade; extraction status; linear growth rate; instability indices

## INTRODUCTION

India is bestowed with a gift of over 45000 plant species (approx 20% of global spp) of which 35000 species of both higher and lower plant groups are of medicinal values. Apart from their usage in traditional system of medicines like Ayurveda, Siddha and Unani we cannot neglect their prominent use in drugs, fragrances and flavours as this kind of value addition has brought them into economic prominence. Besides their therapeutic significance they are integral element of biodiversity ie about 85 per cent of known and recorded

medicinal plant diversity of the country is captured in forests and wild habitats (Anon 2006). It is also being realized that 82 per cent of high consumption botanicals (>100 MT per annum) in trade originate from wild sources (Ved and Goraya 2008).

Medicinal and aromatic plants are critical to rural economy of Himachal Pradesh. Out of the 100 most important medicinal plant species traded in the country 24 are found in the state. The state exports annually 2500 tons of medicinal plants and their parts. The legal annual trade in medicinal plants in the state is worth about Rs 10 crores at current market prices. The state government earns about Rs 40 lakh per annum from export permits for medicinal plants. The Himachal Pradesh Forestry Sector Medicinal Plants Policy, 2006 for instance aims at furthering the basic objectives of meeting the minor forest produce requirements of the state's rural and tribal populations in accordance with the National Forest Policy, 1988. Moreover in 2003 the state government authorized Gram Panchayats to issue permits for transporting 37 types of medicinal plants extracted within their territorial jurisdictions (Kapta 2006).

Keeping in mind the increasing importance of medicinal plants the present study was taken up with the vision to bring out the trends and variability in the extraction status during 1994-2012. The existing system of medicinal plant trade in the state was examined.

## METHODOLOGY

Secondary data were collected from the records of the HP State Forest Department for a period of eighteen years (1994-95 to 2011-12). The secondary data collected included quantity of medicinal plants collected/produced/traded and export permit fee levied by the forest department.

**Linear growth rate:** For evaluating the trends in production/extraction and nominal and real prices of medicinal plants linear growth rates (LGR) were estimated using the following equation:

$$Y = a + bt$$

where

Y= Quantity extracted/produced/prices of medicinal plants
t= Time variable in year (1, 2, ….. 18)
a= Constant
b= Rate of change

The linear growth rate was calculated as:

$$\text{Linear growth rate} = \frac{b}{\bar{Y}} \times 100$$

where
b = Regression coefficient

$\bar{Y}$ = Mean value of the quantity extracted/produced/prices for the medicinal plants

SE (linear growth rate) = $\frac{100}{\bar{Y}} \times$ SE (b)

where

$\bar{Y}$= Mean value of the quantity extracted/ produced/prices for the medicinal plants

SE(b)= Standard error of b

**Instability index:** The instability in extraction/production of medicinal plants was measured in relative terms by Cuddy-Della Valle index which was used by a number of researchers as a measure of variability in time series data. The simple coefficient of variation overestimates the level of variability in time series data whereas Cuddy-Della Valle corrects the coefficient of variation (Wasim 2011).

Instability index was estimated as:

$$\text{Instability index} = CV \times \sqrt{1 - r^2}$$

where

CV= Coefficient of variation (in per cent)

$r^2$= Coefficient of determination from a time-trend regression

## RESULTS and DISCUSSION

### Classification of medicinal plants

The medicinal plants are demanded all around the world for use by pharmaceutical houses. Himachal Pradesh a hilly state with varying degrees of agro-climatic zones ranging from subtropical to extreme cold deserts is a home for large number of medicinal herbs. There is hardly any representative of medicinal herbs that is not found in the state of which except marine origin. Out of a total of about 3500 species available in the state about 500 are of medicinal importance. In the view of socio-economic scenario of the country the state provides vast varieties of medicinal plants species such as Atis (*Aconitum heterophylum*), Chora (*Angelica glauca*), Safed Musli (*Chlorophytum borivilanum*), Daruharidra (*Berberis aristata*), Pashanbhed (*Bergenia ciliata*), Salampanja (*Dactylorhiza hatagirea*), Singlimingli (*Dioscorea deltoidea*), Kapoor Kachri (*Hedychium acuminata*), Rewandchini (*Rheum australe*), Chiraita (*Swertia chiraita*), Rakhal (*Taxus baccata*), Banafsha (*Viola* Spp) and Sugandhbala (*Valeriana jatamansi*). However majority of the medicinal plants are produced naturally and cultivation takes place only to a very limited extent. Natural production takes place in forests, wastelands and cold deserts. At present there are about 61 medicinal plants which are being extracted from the various habitats in the state.

The extracted medicinal plants were classified based on their habitat, growth habit, economic part used and present status and are presented in Table 1. On the basis of habitat medicinal herbs are

Table 1. Classification of extracted medicinal plants

| Classification Criterion | Category |
|---|---|
| Habitat | Alpine, cold desert, cultivation, wasteland, upper hill subtropical, temperate, temperate to alpine, lower hill subtropical |
| Habit | Climber, fern, herb, licken, shrub, tree, mushroom |
| Part used | Bark, entire plants, flowers, leaves, thallus, rhizomes, roots, wood, stem |
| Present status | Endangered, commonly found |

classified into eight habitat types, on growth habit into six types, on part used into nine categories and on present status into two categories.

**Trends and variability in the extraction of medicinal plants based on their habitat**

The results presented in Table 2 and Fig1 show that the maximum average volume (10657.79 q) was extracted from the temperate zone plants like Dhoop, Diascorea, Horse chestnut, Taxus, Bach, Bankakdi, Thuth, Banafsha, Berberis, Bhutkesi, Chiraita, Diascorea, Guchhi, Chukri, Mushakbala, Chora and Salamishri indicating higher pressure on temperate zone and minimum quantity (311.82 q) was extracted from cold desert plants like *Ephedra and* Talishpatra.

A linear growth rate (LGR) estimated to study the growth pattern of the medicinal plants extracted according to their habitat revealed that none of the habitat showed any significant growth during 1994-2012. However medicinal plants under cultivation like Parshoshan showed a significant growth of 29.01 per cent per annum during 1994-95 to 2002-03 (P-1). Plants such as Kakarsinghi, marigold, Chamber and Kapoorkachri from upper hill subtropical habitat and plants from cold desert habitat showed significant negative growth of 28.74 and 24.71 per cent/annum respectively during 2002-03 to 2011-12 (P-11). The variability in medicinal plants extracted from different habitats increased from period one (P-I) to period two (P-II) except in the extraction of medicinal plants from temperate and cold desert zones. This showed that extraction from these two habitats remained more or less same over the period. In overall the maximum variability in extraction of medicinal plants was reported in upper hill subtropical habitat (1.50) followed by cultivated habitat (1.29) whereas minimum variability was recorded in the extraction of medicinal plants from temperate to alpine (0.55) and temperate region (0.56).

**Trends and variability in the extraction of medicinal plants based on their growing habit**

It is revealed from Table 3 and Fig 2 that maximum average volume of raw herbs was extracted from shrubs (6993.39 q) like Artemissia and Berberis followed by herbs (4390.57 q) like Bach, Banafsha, Bicchubuti, Bitterpatta, Chiraita, Chora, Chukri, Dhoop, Dorighas, Gurbarch, Kalazira, Kapoorkachri, Kuth, Kutki, Kauri Patish, marigold, Mehandi, Mithi Patis, Nagchattri, Ninani etc and trees (697.39 q) like Kakarsinghi, Taxus, Chilgoza, Rhododendron etc. The contribution of climbers (61.8 q) like Dioscorea and wild mushrooms like Gucchie (125.92 q) extracted was low.

Analysis of the data on medicinal plants extracted in the state based on their growing habits was carried out and the results revealed that medicinal plants under trees category showed a significant negative growth of 19.39 per cent per annum during P-I. The medicinal plants under herbs category also showed a negative and significant growth of 9.53 per cent/annum during P-II. But in the overall time period herbs and trees showed a significant negative growth of 7.62 and 18.80 per cent/ annum respectively. The relative variability in medicinal plants extracted on the basis of habit increased from P-I to P-II in case of climbers, herbs and trees but decreased in case of shrubs and mushrooms. In the overall period the maximum variability was reported in climbers (1.69) followed by shrubs (0.90) and minimum in herbs (0.23) and trees (0.80).

**Trends and variability in the extraction of medicinal plants based on their part used**

The classification of medicinal plants extracted on the basis of their economic part used (Table 4, Fig 3) showed that predominantly those medicinal plants were extracted whose roots are used by the pharmacies followed by leaves, entire plants and bark. It was found that the maximum average volume (11335.31 q) was extracted from roots of medicinal plants like Bankakri, Berberis roots, Kakarsinghi, Kutki and Kuth followed by leaves (896.88 q) of plants like Artemissia, Gudburch, Kashmiripatta, Kauri Patties, Mehandi, Pathan Bel, Talish Patra, Thuth plant etc and bark (479.83 q) of plants like Bhojpatra, Birch, Patish, Patrala, Rakhal etc. A small quantity of plant thallus (36.78 q) like wild mushrooms, Gucchie and from wood (70.94 q) of Sathjalori.

The analysis of extraction trends based on medicinal part used revealed that entire plants showed a significant negative growth of 21.45 per cent per annum during period-I while woods of Sathjalori showed a significant negative growth (45.00 %/ annum) during period-II. But in the overall time period bark and entire plants of plants like Banafsha, Brahmi, Chiraita, Dungtuli, Guchhi, Mousegrass and rhizomes of plants

Table 2. Growth rate and instability indices of medicinal plants based on their habitat in Himachal Pradesh during 1994-2012

| Zone | Average volume extracted (q) | Linear growth rate (%/annum) | | | Instability indices | | |
|---|---|---|---|---|---|---|---|
| | | Period-I | Period-II | Overall | Period-I | Period-II | Overall |
| Temperate | 10657.79 | -1.52 (9.36) | -2.72 (5.30) | -2.23 (2.65) | 0.68 | 0.38 | 0.56 |
| Temperate to alpine | 211.17 | -2.75 (7.12) | 0.37 (8.52) | -0.97 (2.57) | 0.52 | 0.62 | 0.55 |
| Lower hill subtropical | 686.75 | 6.38 (6.92) | -17.35 (9.64) | -3.60 (2.98) | 0.50 | 0.70 | 0.64 |
| Upper hill subtropical | 386.94 | 20.09 (14.84) | -28.74** (15.05) | -8.00 (7.00) | 1.08 | 1.09 | 1.50 |
| Cultivation | 478.5 | 29.01** (13.47) | -11.95 (16.86) | -0.87 (6.03) | 0.98 | 1.22 | 1.29 |
| Cold deserts | 311.82 | 5.92 (10.07) | -24.71* (7.66) | -2.29 (3.65) | 0.73 | 0.55 | 0.78 |

Period-I=1994-95 to 2002-03, Period-II= 2002-03 to 2011-12

Figures in parentheses are the standard errors of the linear growth rates

*, **Significant at 5 and 10 per cent level of significance respectively

Table 3. Growth rate and instability indices of medicinal plants based on their growth habit in Himachal Pradesh during 1994-2012

| Growth habit | Average volume extracted (q) | Linear growth rate (%/annum) | | | Instability indices | | |
|---|---|---|---|---|---|---|---|
| | | Period-I | Period-II | Overall | Period-I | Period-II | Overall |
| Climber | 61.80 | 23.21 (18.50) | -32.20 (26.37) | -2.67 (7.92) | 1.34 | 1.91 | 1.69 |
| Herb | 4390.57 | -3.62 (2.85) | -9.53* (3.59) | -7.62* (-1.10) | 0.21 | 0.26 | 0.23 |
| Shrub | 6993.39 | 2.51 (16.06) | -5.33 (68.49) | -0.15 (4.21) | 1.16 | 0.49 | 0.90 |
| Mushroom | 125.92 | 786.85 (13.01) | -279.12 (252.02) | 1.34 (3.31) | 0.94 | 0.57 | 0.71 |
| Trees | 697.39 | -19.39* (6.21) | -0.02 (0.02) | -18.80* (3.74) | 0.51 | 0.52 | 0.80 |

Period-I= 1994-95 to 2002-03, Period-II= 2002-03to 2011-12

Figures in the parentheses are the standard errors of the linear growth rates

*, **Significant at 5 and 10 per cent level of significance respectively

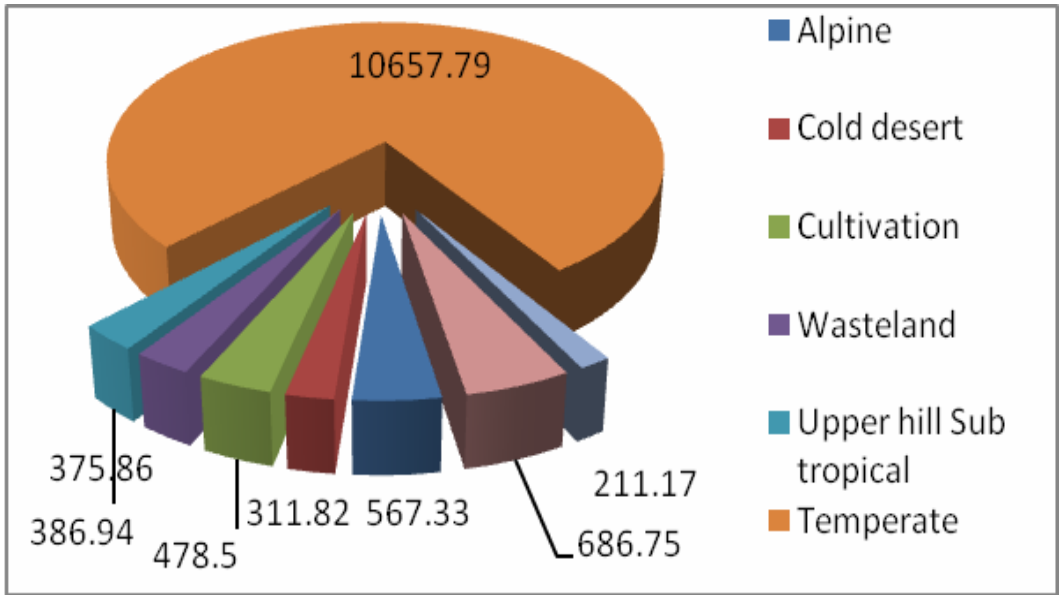


Fig 1. Habitat-wise distribution of extracted medicinal plants in the state during 1994-95 to 2011-12

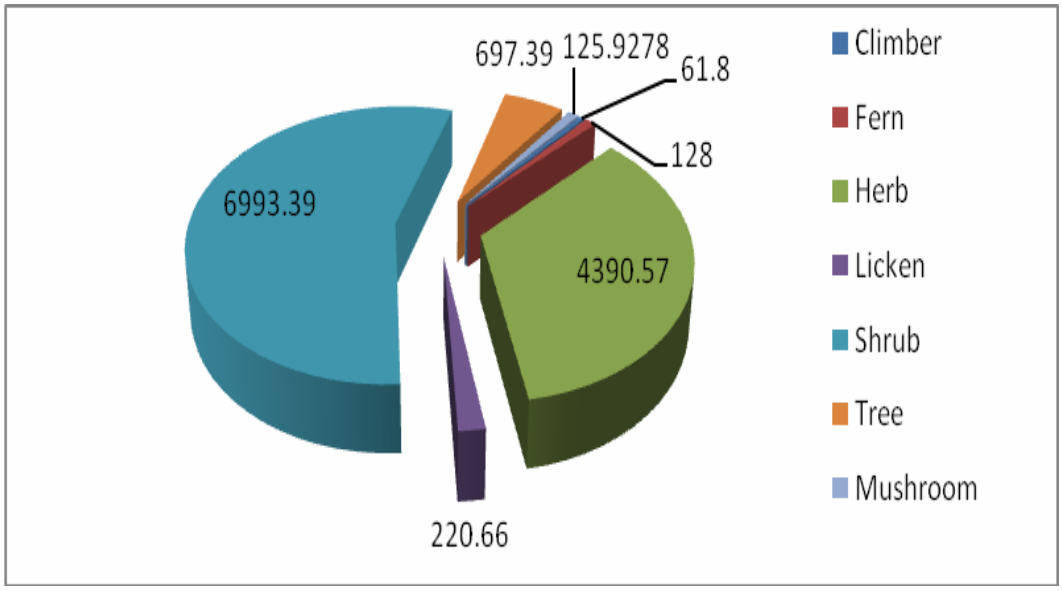


Fig 2. Habit-wise distribution of extracted medicinal plants in the state during 1994-95 to 2011-12

Table 4. Growth rate and instability indices of medicinal plants based on economic part used in Himachal Pradesh during 1994-2012

| Part used | Average volume extracted (q) | Linear growth rate (%/annum) | | | Instability indices | | |
|---|---|---|---|---|---|---|---|
| | | Period-I | Period-II | Overall | Period-I | Period-II | Overall |
| Bark | 479.83 | -0.15 (6.34) | 6.34 (24.55) | -13.43* (3.49) | 0.46 | 1.78 | 0.75 |
| Entire Plant | 271.88 | -21.45** (11.12) | 16.88 (9.17) | -19.44* (5.54) | 0.81 | 0.66 | 1.18 |
| Flowers | 88.89 | 60 (34.63) | 14.53 (14.00) | 18.34* (6.20) | 2.51 | 1.02 | 1.32 |
| Leaves | 896.88 | -15.75 (22.64) | -6.55 (6.94) | -8.44 (7.13) | 1.64 | 0.50 | 1.55 |
| Rhizome | 96.11 | -3.78 (11.81) | -8.95 (21.25) | -10.50* (4.87) | 0.86 | 1.48 | 1.04 |
| Roots | 11335.31 | 0.70 (9.29) | -4.42 (5.39) | -2.48 (2.69) | 0.67 | 0.40 | 0.57 |
| Wood | 70.94 | 13.30 (17.58) | -45.00* (10.95) | -9.58 (7.25) | 1.27 | 1.44 | 1.55 |
| Stem | 170.67 | 7.01 (22.63) | -20.90 (12.29) | 1.36 (5.94) | 1.64 | 0.61 | 1.25 |

Period-I= 1994-95 to 2002-03, Period-II= 2002-03 to 2011-12

Figures in the parentheses are the standard errors of the linear growth rates.

*,** Significant at 5 and 10 per cent level of significance respectively

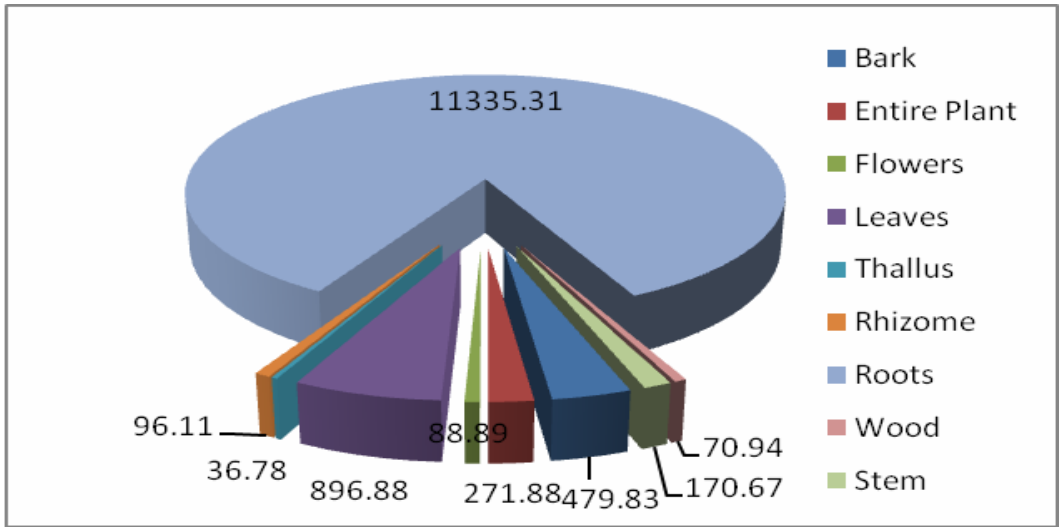


**Fig 3. Distribution of extracted medicinal plants on the basis of economic part in the state during 1994-95 to 2011-12**

like Bach, Kaparkachri, Diascorea etc showed a significant negative growth of 13.43, 19.44 and 10.50 per cent/annum respectively. Medicinal plants such as Barah flowers showed a positive and significant growth of 18.34 per cent per annum. The variability in medicinal plants extracted on the basis of growth habit increased from P-I to P-II in case of bark, rhizomes and wood but decreased in case of entire plant, flowers, leaves, roots and stem. In overall time period the maximum variability was found in wood (1.55) followed by leaves (1.55) and minimum in bark (0.75) and roots (0.57).

## Trends and variability in the extraction of medicinal plants based on their present status

The extracted medicinal plants were also classified according to their present status such as endangered and non-endangered ie commonly available (Table 5, Fig 4). It was found that a many medicinal plants have been classified as endangered. For the sake of simplicity as well as availability of data other categories such as critically endangered near extinct have been kept under broad classification as endangered.

The analysis of volume extracted from medicinal plants based on their present status revealed that average volume extracted (10545.39 q) in case of endangered medicinal plants like Bach, Balapon, Barah flower, Bhutkesi, Bicchubuti, Bitherpatta, Brahmi, Chhalura, Dorighas, Dungtuli, Guchhi, Gudburch, Horse chestnut, Kakarsinghi, Kapoorkachri, Kashmiripatta, marigold, Mehandi, Mousegrass, Muskbala,

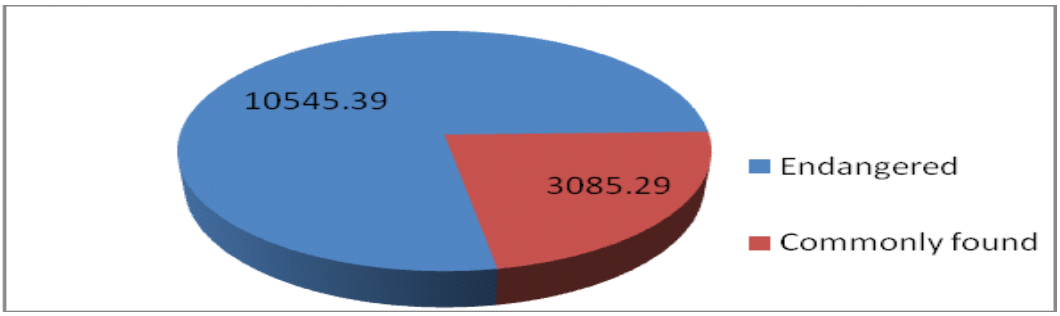


Fig 4. Present status of medicinal plants extracted during 1994-2012

Nagchattri, Patish, Salam Misri, Sath Jalari, seedless deodar cones, Tejpatra, Thuth etc was much higher as compared to non-endangered or commonly available (3085.29 q) plants like Artemissia, Bankakri, Berberis roots, Bhoj Patra, Birch, Chiraita, Chora, Chukri, Dhoop, Diascorea, Ephedra, Kalazira, Kutki, Kuth, Mithi Patis, Neoja, Pathan Bel, Patrala, Rakhal, Smak, T/Patters etc.

The relative variability in medicinal plants extracted on the basis of present status revealed a decrease in variability in medicinal plants extracted on the basis of present status during both the periods in case of endangered as well as commonly found species. In overall the variability was found higher (0.57) in endangered species compared to commonly found species (0.43) (Fig 5). The analysis of linear growth rates of medicinal plants based on their present status revealed that commonly available medicinal plants showed a significant negative growth of 9.26 per cent/ annum in overall period. Moreover a significant negative growth of 10.47 per cent per annum was also found during P-II. In case of endangered medicinal plants no growth was observed since the LGR was not found significant.

**Trade of medicinal plants from Himachal Pradesh**

Most of the herbs collected from the forests in Himachal Pradesh are exported/traded outside the state. The main markets for these herbs are Majith Mandi in Amritsar and Khari-Bawli in New Delhi. The other markets for the medicinal plants are Calcutta, Saharanpur and Mumbai. From these markets produce is either exported or auctioned off to various pharmacies and processing units. But this level of trade could not be estimated due to insufficiency of the required data.

A very high degree of secrecy prevails in the markets particularly in Amritsar and trade is entirely based on the

Table 5. Growth rate and instability indices of medicinal plants based on their present status in Himachal Pradesh during 1994-2012

| Status | Average volume extracted (q) | Linear growth rate (%/annum) | | | Instability indices | | |
|---|---|---|---|---|---|---|---|
| | | Period-I | Period-II | Overall | Period-I | Period-II | Overall |
| Endangered | 10545.39 | -0.139<br>(10.07) | -3.65<br>(4.87) | -0.81<br>(2.65) | 0.41 | 0.35 | 0.57 |
| Commonly found | 3085.29 | 0.73<br>(2.86) | -10.47*<br>(4.08) | -9.26*<br>(1.58) | 0.34 | 0.30 | 0.43 |

Period-I=1994-95 to 2002-03, Period-II= 2002-03 to 2011-12
Figures in the parentheses are the standard errors of the linear growth rates
*,**Significant at 5 and 10 per cent level of significance respectively

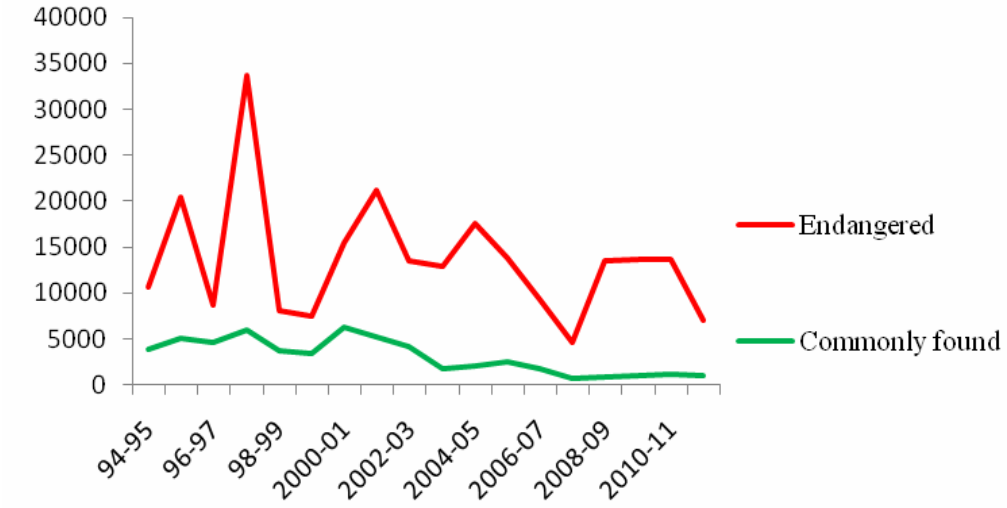


**Fig 5. Growth trends in quantity extracted of medicinal plants based on their present status during 1994-2012**

personal contacts of the traders with the local collectors or commission agents. They do not reveal the information about the source of supply of herbs, buyers and rates of commission. The nature of transaction and illegal dimension are responsible for this secrecy in the market. Traders try to maintain oligopoly by creating barriers to the entry of new traders.

According to Amritsar market traders the quantity coming from Himachal Pradesh is not more than 20-25 per cent of the total produce exported by the state reason being it is easier for the traders to transport the produce to Delhi market and also the bulk buyers purchase the raw material from mainly Khari-Bawli market. On one hand it is easier to export these items from Delhi and on the other the unfavourable tax structure of Punjab government (sales tax and road tax) is responsible for less trading from Amritsar. Though Amritsar market is inaccessible still Amritsar traders act as middlemen between Delhi and Himachal Pradesh traders.

Therefore it is evident from the findings of the study that declining trends in majority of the medicinal plants emphasized the needs to formulate an effective policy for in situ and ex situ conservation of medicinal plants especially which are becoming scarce. Maximum extraction of medicinal plants was taking place from temperate region. There is a need to have a separate policy for the conservation of temperate medicinal plants. Few traders

were involved in trade and a very high degree of secrecy prevailed in medicinal plant markets. There is a need to curtail the level of illegal trade of these plants through regulatory measures.

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