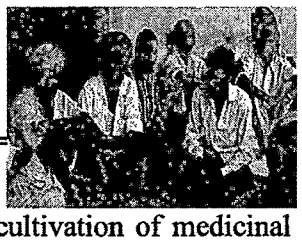
FARMER'S SURVEY



Survey was carried out for assessing the interest of cultivation of medicinal plants and marketing as a livelihood for farmers in the Gujarat State. The study was also undertaken for assessing the awareness of farmer's rights: Plant Breeder's Rights, Plant Variety Protection, Intellectual property rights and implications of World Trade Organization among the farmers of Gujarat State.

Study area

The work was carried out in different villages and districts of Gujarat State. Around 450 farmers were surveyed within a period of two years. The work emphasized on the collection of quantitative and qualitative information with an aim to meet the set of objectives. In order to get a complete picture of the existing scenario, agricultural colleges, institutes working in the field, Local Non Government Organization's (NGO), progressive farmers, literature review was done and primary data were collected from traditional farmers, people in the trade and cultivation of medicinal plants.

Objective of the present study

1. To assess the interest of cultivation of medicinal plants
2. To assess the perception and awareness of farmer's rights
   (Plant Breeder's Rights (PBR), Plant Variety Protection (PVP) and Intellectual property rights (IPR) and implications of World Trade Organization (WTO)
3. Problems and reasons associated with cultivation of medicinal plants

Methodology

First of all, a list of farmers was generated with the help of personal meets, local Non government agencies (NGOs), Government bodies and parent institution (GSFC). The scrutinized list of progressive farmers generated for "Best Progressive farmer of Gujarat for the year 2001" by GSFC and GSFC Science Foundation was also helpful in preparing the list of farmers.

A questionnaire (Annexure-3) was devised in local language and circulated among the Gujarat farmers (Fig.-1). The questionnaire was divided into six different segments (Table-1).

Table-1: Different sections covered in the Farmer's Survey

Sr. No.	Topics asked in Questionnaire
1	The personal section, which included personal details of farmer's name, age, gender, complete address and contact number and qualification
2	Second segment included details on agro-practices followed by the respondents. This segments also included type of cultivation they are undertaking presently, type of fertilizers they are using and the source of irrigation
3	Third segment rest on the awareness of important issues likes WTO, IPR, PVP, PBR and medicinal plants
4	Fourth segment accounted for marketing of the produce
5	Fifth segment accounted for the reasons for not undertaking cultivation of medicinal plants by the farmers
6	Lastly but not the last, views and interest of farmers for cultivation of medicinal plants

The questionnaire was distributed through personal meets, seminars, conferences and with the help of GSFC Marketing Depots situated in all the districts of Gujarat. Around 450 farmers were surveyed within a period of two years. The farmers furnished an enthusiastic and splendid response towards the questionnaire. Total 300 farmers responded back with the filled in questionnaire and rest answered during personal interactions.

Fig-1

A. Personals meet with the farmers

B. Questionnaire surveyed among the farmers of Kutch area

Photoplate - 1

Results and Discussion

The depiction in the map of Gujarat (Figure-2) shows the percentage of farmers responded from different districts of Gujarat. The major respondents were from the various talukas of Vadodara district (21.71%), Kutch (15.71%) and Kheda (9.71%) and comparatively, low responses from different talukas of district Panchmahal (0.46%), Gandhinagar (0.61%) and Mehsana (1.14%), while rest of farmers belonging to other districts range in the – 5.14% to 1.53% of subjects.

The questionnaire was statistically analyzed. A perusal of the various findings of this study led to a number of important conclusions -

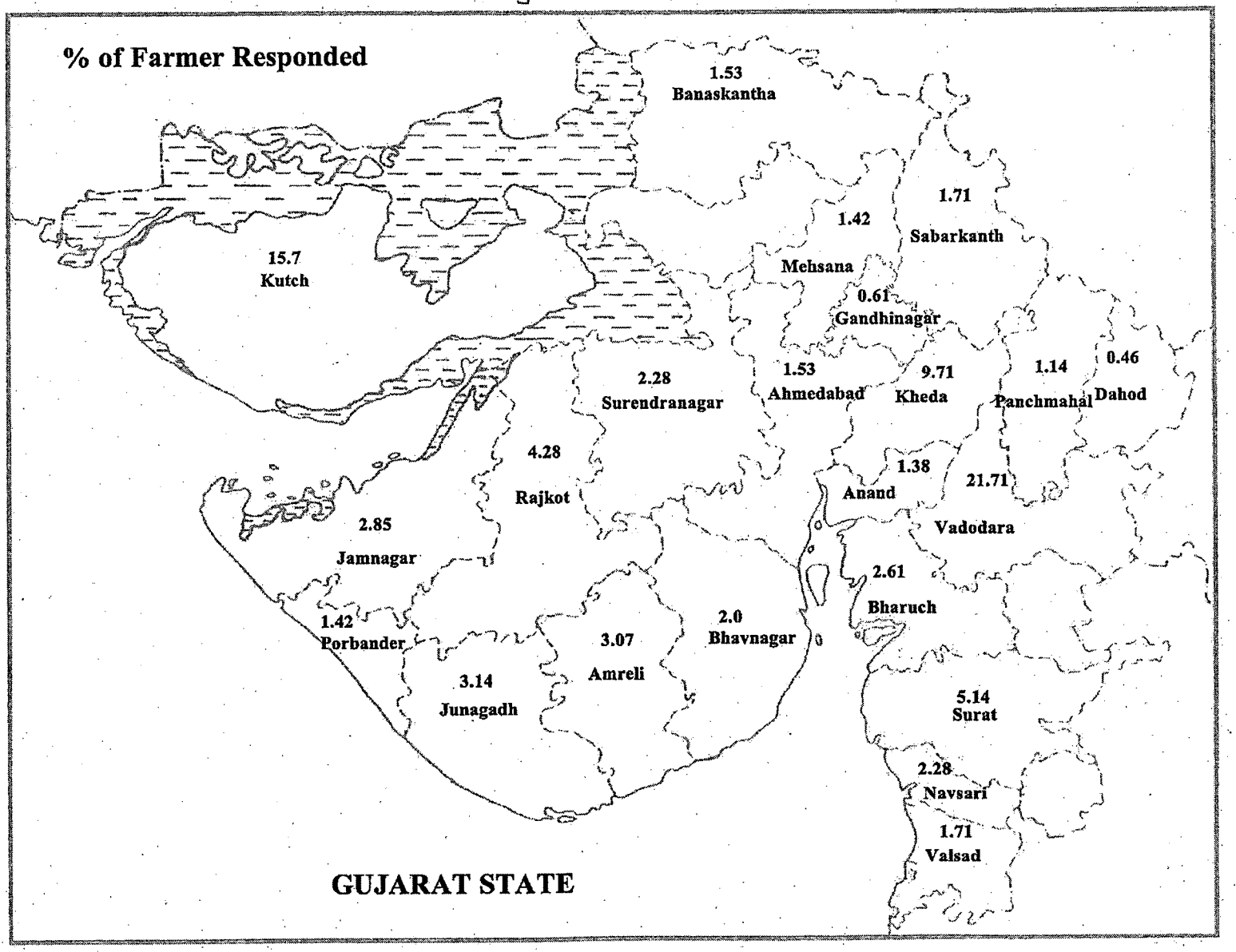
1. **Personal Segments:**

1.1 Age: The age range of farmers surveyed was very broad. The youngest farmer was 18 years old whereas the eldest was 82 years old (Figure - 1.1). The farmers aged between 18-35 constituted 35% of the sample, those aged between 36-50 represented 29%, and those between 51-65 made up 21%, whereas those between 66-80 formed 9% and those above 80 were only 6% of the population.

1.2 Gender: 85% of the male responded the survey form while only 15% of female responded (Figure - 1.2). The views regarding the decision of cultivation of crop when asked verbally, females responded by mentioning that it is male domination field and marketing is done by males so males takes decision regarding the type of cultivation for crop to be taken-up.

1.3 Qualification: On the basis of their qualification, the farmers were divided into six groups. Post graduate farmers were 6% of the group, graduates made upto 21%,

Figure : 2


% of Farmer Responded
1.53
Banaskantha
1.71
Sabarkanth
1.42
Mehsana
15.7
Kutch
0.61
Gandhinagar
2.28
Surendranagar
1.53
Ahmedabad
9.71
Kheda
1.14
Panchmahal
0.46
Dahod
4.28
Rajkot
1.38
Anand
21.71
Vadodara
2.85
Jamnagar
2.61
Bharuch
1.42
Porbander
3.07
Amreli
2.0
Bhavnagar
3.14
Junagadh
5.14
Surat
2.28
Navsari
1.71
Valsad
GUJARAT STATE

Photoplate – 1.1

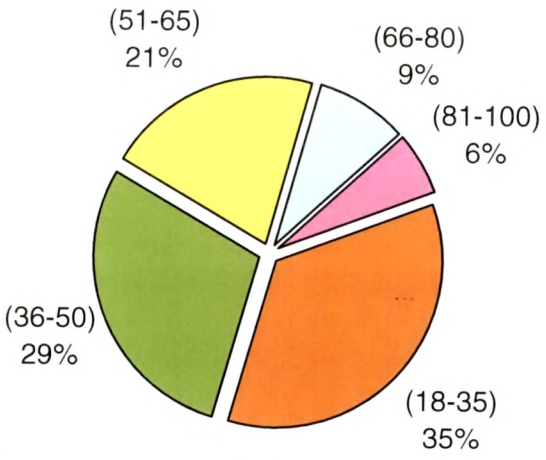


Figure- 1.1 Distribution of responding farmers in different age group for cultivation of Medicinal Plants

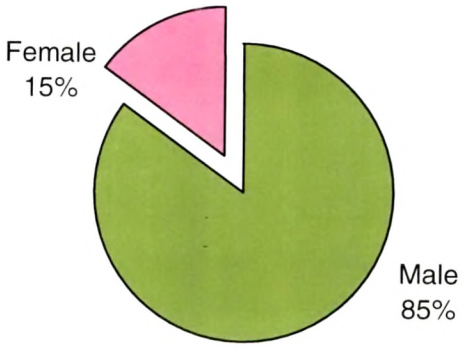


Figure - 1.2 Gender wise distributions of respondents

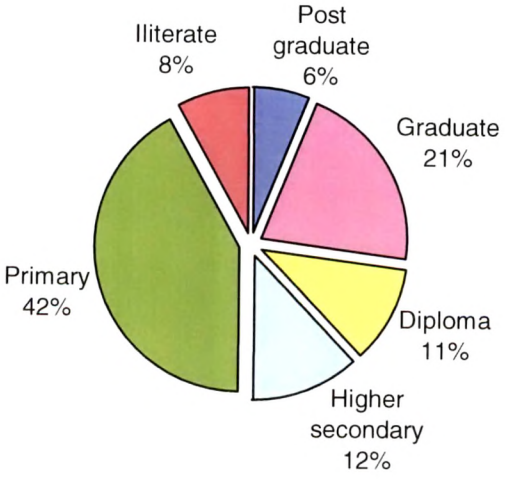


Figure - 1.3 Qualification based distribution % of farmers who responded to the Questionnaire

agricultural diploma holders were 11%, S.S.C. pass were 12%, primary school educated were 42% and illiterate category constituted 8% of the lot (Figure - 1.3).

2. Agro-practices

2.1 Combinations of fertilizers used by Gujarat Farmers

Fertilizers are known to increase growth of plant. Experiments conducted with tree species have shown several times increase in height and biomass of plants due to increasing doses of N, P and K (Singh et al, 1995; Singh and Banerjee, 1999). Compost (FYM) is known to contain high amount of available nutrients and host of microorganisms, which are helpful in decomposing organic matter and improving soil properties. Further compost has been found to be largely instrumental in increasing growth and biomass production of tree species in coal and copper mine overburdens (Williams et al, 1994; Singh et al, 1995).

The survey analysis showed maximum use of chemical fertilizer and farmyard manure mix (51%) by the farmers of Gujarat in their fields. The use of exclusively farmyard manure in the fields has been increased in current years due to the awareness on harmful effects of chemical fertilizers. FYM is known to contain high amount of available nutrients and host of microorganisms, which are helpful in decomposing organic matter and improving soil properties. Further compost has been found to be largely instrumental in increasing growth and biomass production of tree species in coal and copper mine overburdens (Williams et al, 1994; Singh et al, 1995). It is observed that (15%) of Gujarat farmers have started using solely the farmyard manure in the fields for the better health of the fields as well for better returns on long-term basis. High economic returns are earned for the produce generated organically. While still 18% of

farmers use chemical fertilizer to get high yields quickly, irrespective of its harmful effects. Around 4% farmers use the organic fertilizers made from leaves, insects, cow dung, or cow urine to name few. Very few farmers (1%) use the combination of chemical and other fertilizers. There are group of farmers (17%) who tries out variety of combinations using FYM and green manure. Around 6% of farmers used the combinations of chemical, FYM and green manure in their field (Figure - 2.1).

2.2 Type of irrigation method used by farmers of Gujarat

The farmers of Gujarat follow basic four forms of irrigation. These are flood and furrow irrigation method, drip irrigation, sprinkler and monsoon based. Farmers also use various combinations for irrigation of their fields. The most preferred method is the Flood irrigation method. The maximum (51%) of the surveyed farmers responded for the use of flood irrigation method exclusively. While the use of both flood irrigation method and dependence on monsoon rainfall ranked second (25%). Due to uncertainty of rainfall, the farmers of Gujarat have preferred to use drip irrigation and rely on monsoon. Around 12% of farmers have shifted towards the drip irrigation and depend on monsoon rains to irrigate their fields. While still 6% farmers depend still totally on monsoon rainfall. While very low percentage 0.4-1.9% responded for sprinkler system and various combinations either alone or combined any two or other methods. (Figure - 2.2)

Photoplate – 1.2

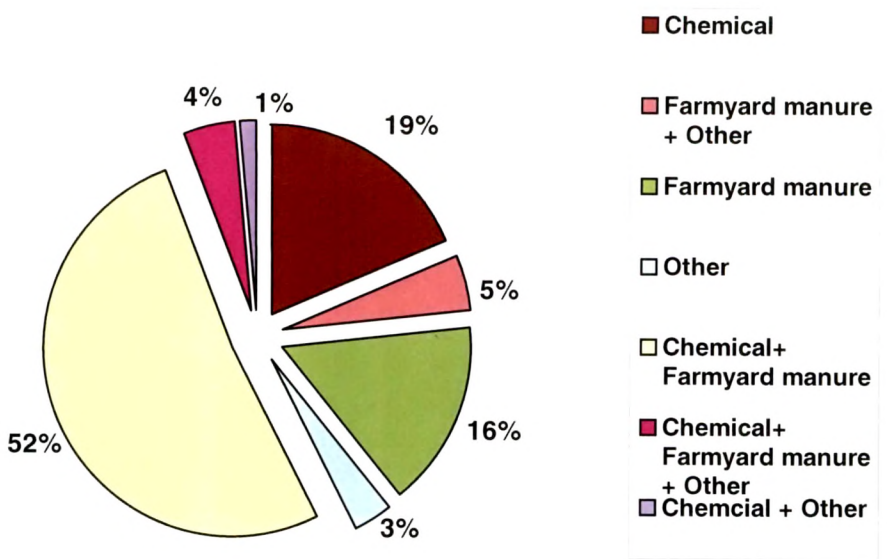


Figure-2.1 The types and combination of fertilizer used by the respondents

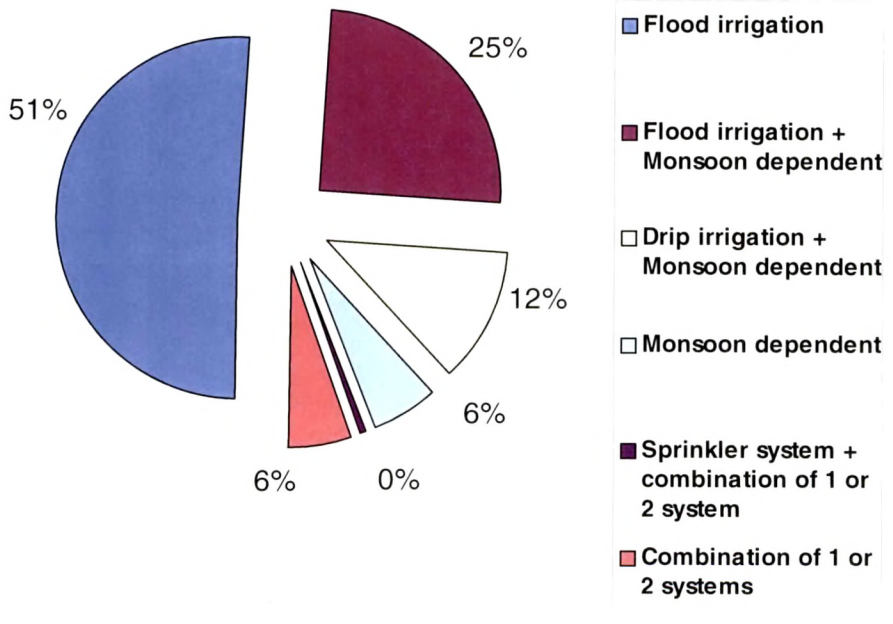


Figure - 2.2 The types and combination of irrigation used by the respondents

3. Awareness

3.1 Awareness regarding World Trade Organization:

The WTO agreement on agriculture was signed as a part of the Uruguay Round Agreement in April 1994. The Uruguay Round of Multilateral trade negotiations took place during the period 1986- 1993. The WTO agreement on agriculture had a 10-year implementation period from 1995 to 2004 for developing countries. The future of the farming of minor forest produce and medicinal plant produce of India are at present depended on outcome of WTO talk (At Geneva). Trade diplomats at Geneva are framing the principles based on which global farm trade will be opened. The agreement on agriculture will be based on three pillars of trade opening talks:

1) Lowering the Imports Duties
2) Cutting Domestic farm support
3) Phasing out Export subsidies.

The agreement came into force with effect from 1st January 2005 but the suitable agreement of the WTO is to make sure the adequate safe-guard to protect the livelihood concern of its 650 million farmers besides food securities of the poor.

The surveyed farmers observed a negative response on the implication of WTO in agriculture. Hardly 20% of farmers had heard about the WTO (Visv Vepar Bazaar) and out of 20% only few respondents had some idea about the implications of WTO on agriculture (Figure - 3.1). Rest of the respondents had no idea and was ignorant of the issues.

Photoplate - 1.3a

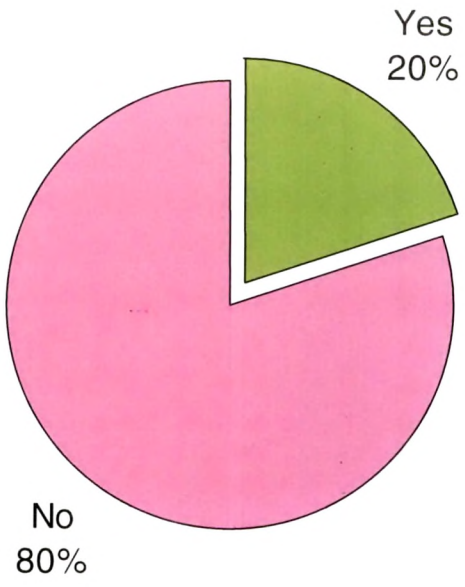


Figure- 3.1 Awareness on WTO among the farmers of Gujarat

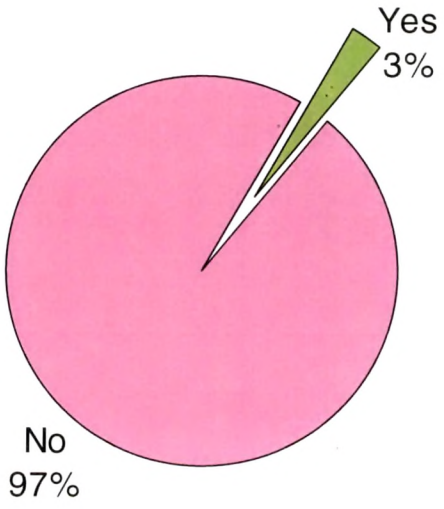


Figure- 3.2 Awareness on Intellectual Property Rights among the farmer community

3.2 Awareness for Intellectual Property Rights:

Intellectual Property Rights (IPR) can protect the traditional Indian agriculture. A lot has been said over the consequences of IPR in agriculture, and in areas where knowledge is said to have been traditionally handed down the generations. However, a proper IPR regime can help protect not only the foreign inventors, but also the domestic players. Examples of turmeric, basmati rice, cotton, neem, darjileen tea etc are the present status.

A passive answer was observed when the awareness of the intellectual property rights in agriculture was asked to the farmers. Hardly 3% of farmers had heard about the IPR (Figure - 3.2). These respondents were aware of the neem and basmati rice incidence. They were aware through newspaper and as well through initiative taken by the local NGO for publishing the reports of neem and basmati in their newsletters. Rests of the respondents had no idea and were not concerned of the issues.

3.3 Awareness for Plant Variety Protection:

The Protection of Plant Varieties and Farmers' Right Bill, 2001 has been brought with the good intention of protecting the tillers of the soil. It came out proposing the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders, to encourage the development of new plant varieties.

Regarding this awareness a very few farmers responded positively (Figure - 3.3). Barely 4% of the farmers had heard about the Plant Variety Protection and when asked what they meant by it, none or the respondents replied. When

prompted they that new seed produced can fetch them more money but how, they were not aware of it. Rests of the 96% respondents had no ideas.

3.4 Awareness for Plant Breeder's Rights:

It is necessary to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. Further, for accelerating agricultural development in the country, it is necessary to protect plant breeders' rights to stimulate investment for research and development, both in the public and private sector for the development of new plant varieties. This would facilitate the growth of the seed industry in the country and ensure the availability of high quality seeds and plant material to the farmers.

Among the farmers surveyed, a very few respondent (5%) were aware of Plant Breeder's Rights (Figure - 3.4). Farmers linked to the agricultural departments or farmer's association were aware but with limited information. Rests of the 95% respondents had no information on the rights.

3.5 Interest in Cultivation of Medicinal Plants:

It was observed that out of total respondents (350), 220 respondents were interested in cultivation of medicinal plants along with the conventional crops (Figure - 3.5).

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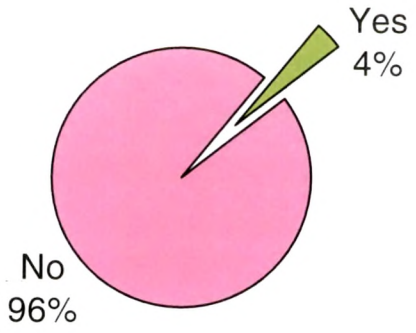


Figure- 3.3 Awareness of Plant Variety Rights among the farmers of Gujarat

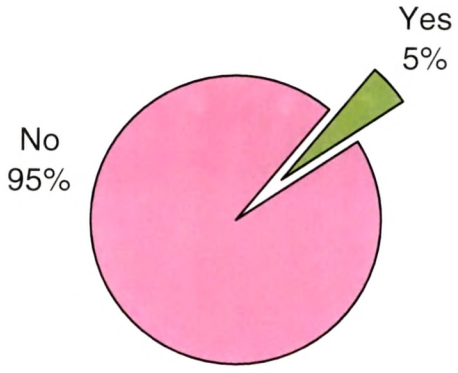


Figure- 3.4 Awareness of Plant Breeder's Rights among the farmers of Gujarat

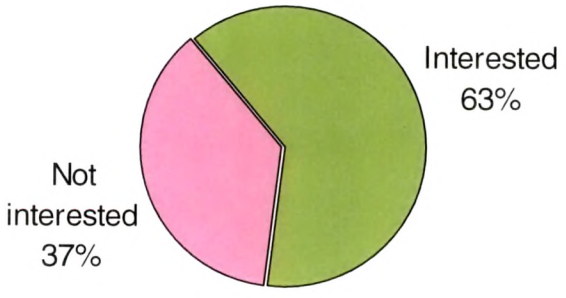


Figure- 3.5 Interest among the farmers for Cultivation of Medicinal Plants

3.6 Based on the qualification, the awareness of WTO, IPR, PBR, PVP and interest in cultivation of medicinal plants was carried out (Figure – 3.6).

3.6.1 WTO Awareness: Out of total Postgraduate (n=21), 90% (n=19) were aware of the term and its implications. While out of total Graduate and Diploma holders only 22% and 36% respectively were aware of the term WTO. While only 3% of the illiterate, 6% of the primary passed and 16% of the higher secondary passed also had heard about WTO through media.

3.6.2 IPR awareness: Based on the qualification and the awareness on IPR, following conclusion was observed. Out of the Postgraduate respondent 19%, Graduate 4%, Diploma 5%, higher secondary 3% and Primary passed 1% were aware of IPR. The illiterate respondents were not aware of the term IPR.

3.6.3 PVP awareness: Based on the qualification and the awareness on PVP, following conclusion was observed. Among the Postgraduate respondent, Graduate, Diploma, higher secondary 24%, 6%, 10%, 3% respectively were really aware of PVP. With the trend less educated (Primary passed and illiterate) had no knowledge about PVP.

3.6.4 PBR awareness: Based on the qualification and the awareness of PBR, following conclusion was observed. Among the Postgraduate respondent, Graduate, Diploma, higher secondary and primary educated 33%, 5%, 13%, 2% and 0.6% were aware of IPR. The illiterate respondents were not aware of the term PBR.

3.6.5 Interest in cultivation of medicinal plants: Based on the qualification, it was observed that maximum interested respondents were well educated. Out of total

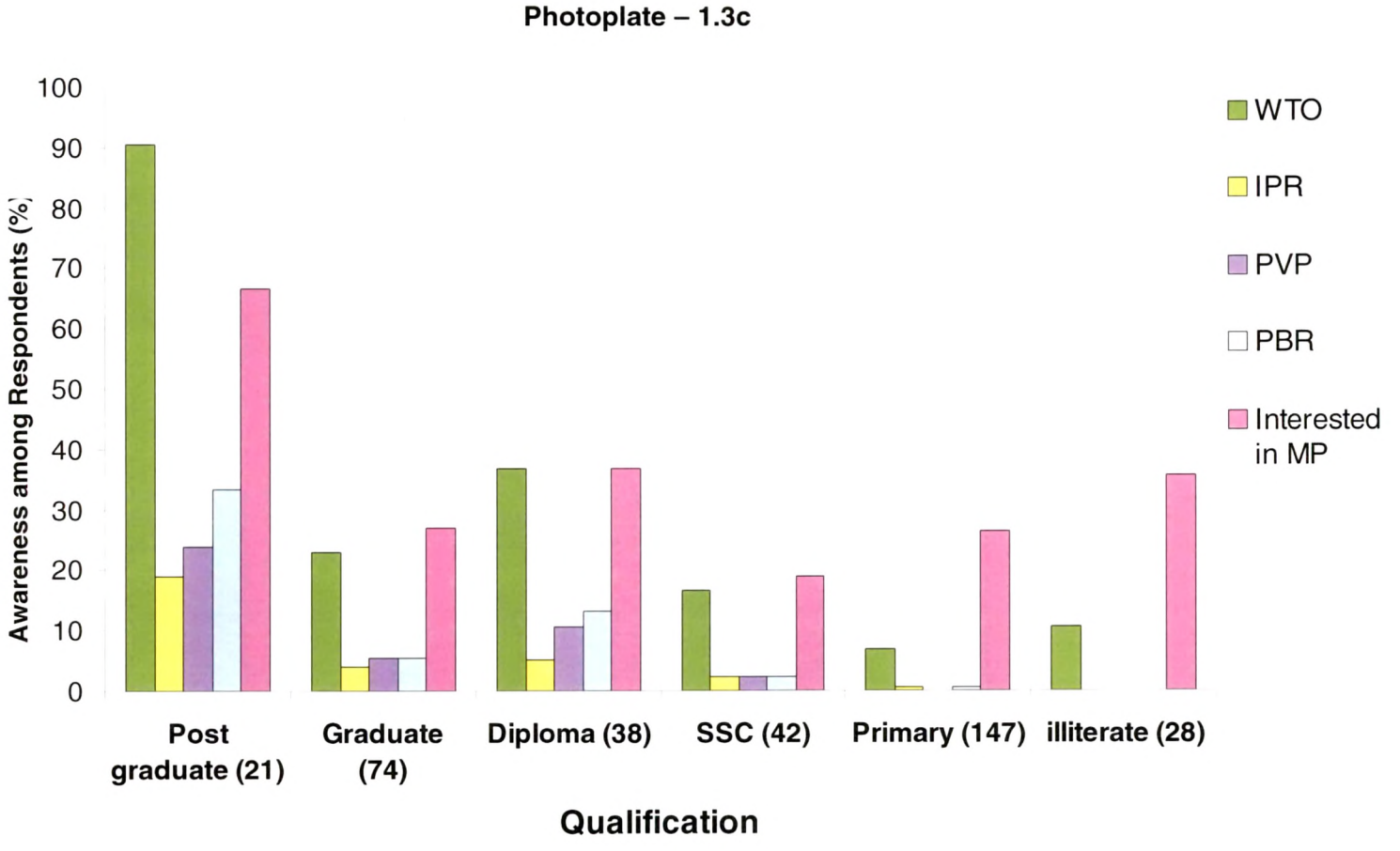
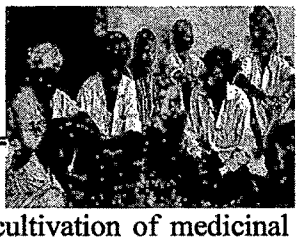


Figure- 3.6 Relationship between Respondent's qualification and awareness on modern developments in Agriculture



Postgraduate respondents 76% were interested in the cultivation of medicinal plants. It was also a surprise to observe that illiterate as well as primary educated respondents were also equally keen in cultivation of medicinal plants. Survey analysis accounted 70% of illiterate and 64% of primary educated respondents interested for cultivation of medicinal plants. While Graduate and Diploma holders elucidated the interest almost 59% and 52% respectively for cultivation of medicinal plants.

Further according to the age, it was observed that the respondents between age of 18-35, 36-50 and 66-80 were extremely interested in cultivation of medicinal plants. Almost 82% of the youngsters, 69% of middle age and 80% of elderly farmers showed keen interest for cultivation of medicinal plants. While least interest was found from the respondents in the age group 51-65 (27%) and 81-100 (14%).

4. Marketing

Marketing is an important issue besetting for the cultivars and the development of the plant based industry in developing countries. The marketability of the product is a crucial factor in determining the success or failure of these enterprises. Market information relates to generating information about markets, means of accessing the markets, market environment and competition. Information is needed on the demand, supply, end uses of the products, distribution channels, product promotion, prices, marketing environment and institutions related to marketing.

4.1 Selling produce in different forms:

The farmers dealing with medicinal plants sell their produce in different forms. They sell as planting materials, raw/unprocessed form or in extracts. It was observed that 17% of the farmers sell their produce as planting material Safed moosli, Coleus. Among these farmers 82% sell raw or unprocessed form of their produce from medicinal plants (Figure - 4.1). For value addition and high returns, this group has the produce powdered for sale. Only 0.4% of the farmers carry out the extraction of the harvest or have set up the extraction units and then market the extracts.

4.2 Marketing the produce:

It was observed that farmers practicing cultivation of the medicinal plants sell their produce to the agents who in turn market it to the wholesale dealers. The wholesale dealer or the big trader either sell it to the manufactures of the medicinal drugs or other products or sometimes to the retailers in raw/unprocessed form. The medicinal plant cultivators also sell their produce as the planting material to other cultivators.

According to the survey analysis it was observed that the 71% of the farmers sell medicinal plant produce to agents. Around 19% of the respondents sell their produce to the dealers. Only 2% farmers sell directly to the pharmaceutical company. Rest of the group (8%) sell their produce in unprocessed form as planting material to other farmers, or to the retailers and/or to the local ayurvedic practitioners (Figure - 4.2).

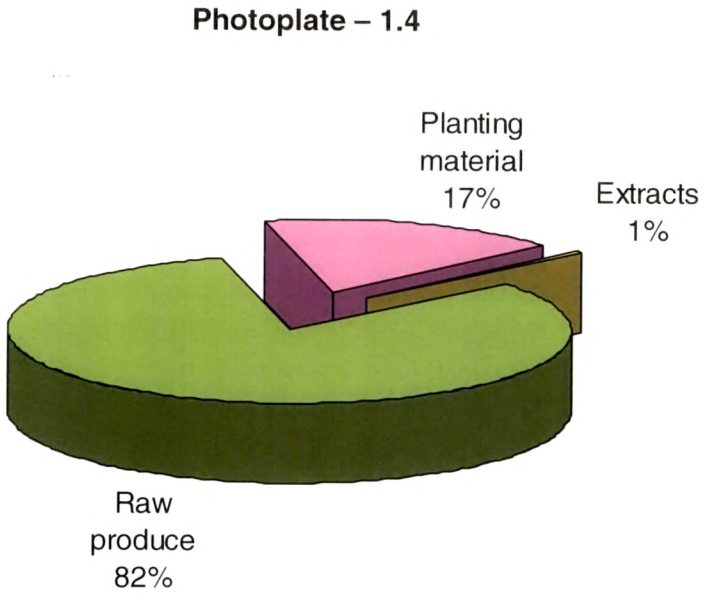


Figure - 4.1 The produce form being marketed by the farmers

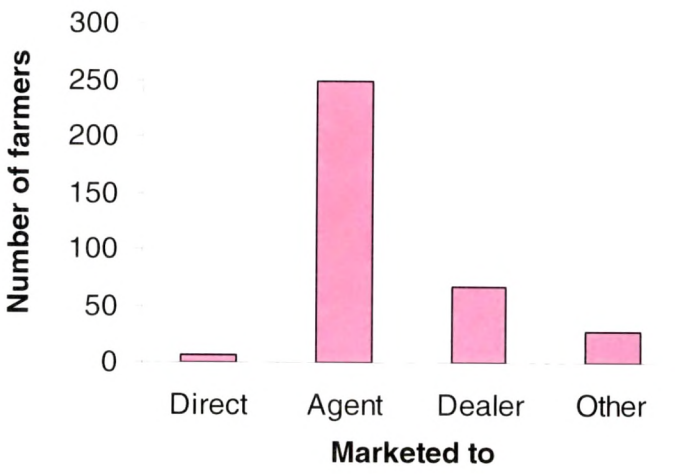


Figure- 4.2 Marketing practice followed by the farmers

5. Cultivation of Medicinal Plants

It was observed that among the surveyed respondents (350), only 105 respondents (30%) were cultivating the medicinal plants along with the conventional crops. Reasons for not cultivating the medicinal plants were studied and broadly categorized into seven classes. The farmers' responses revealed multiple reasons (Figure-5).

5.1 Lacked knowledge about the plant and cultivation practices:

Systematic cultivation of medicinal plants needs specific cultural and agronomic practices. The selection of the plant for cultivation on particular soil also plays a significant role. Many a times, cultivation of high valued medicinal plant may have succeeded in different states, but the same plant can be a failure in the other State due to lack of same agroclimatic and soil conditions. So proper selection of plant is essential based on soil and other conditions for undertaking a cultivation of medicinal plants.

The farmers who had evinced interest in cultivation of medicinal plants required extensive knowledge about the concept. They wanted to know the monetary gains, details of standard agronomic practices, quality parameters, grading standards etc. It was found that 85% of the respondents lacked the knowledge for cultivation of medicinal plants. While 73% of the farmers needed detailed knowledge of the medicinal plants including life cycle, soil specification, fertilizer requirement, irrigation, diseases found, remedy, etc.

5.2 Difficulties in cultivation:

The farmers who practice cultivation of medicinal plants faced several. It was observed that 45% of the farmers faced several difficulties either in germination of seeds, early mortality, low output, losses due to diseases and many more problems in cultivation. There were cases observed where plant selection was not suitable leading to difficulties in cultivation with monetary and time losses.

5.3 Required reliable planting material and the source:

The farmers interested in cultivation of medicinal plants were not aware of the source as well as quality of the planting material from where they can procure the right seeds or planting material. About 59% of the farmers had problems for the reliable source of the planting materials.

5.4 Marketing problems:

The demand of high valued medicinal plants is tremendous in the World over as mentioned earlier. This led to the systematic cultivation of medicinal plants by the farmers. However, for marketing of the produce, farmers face a daunting problem. So marketing is the major issue that needs the utmost priority. Farmers lacked the experience and the knowledge of assured markets for selling their produce. It was observed that maximum number of farmers (80%) experienced marketing problems.

5.5 Economic unviability:

Almost 6% of the respondent farmers found cultivation of medicinal plants as economically unviable.

5.6 Lack of interest in cultivation of medicinal plants:

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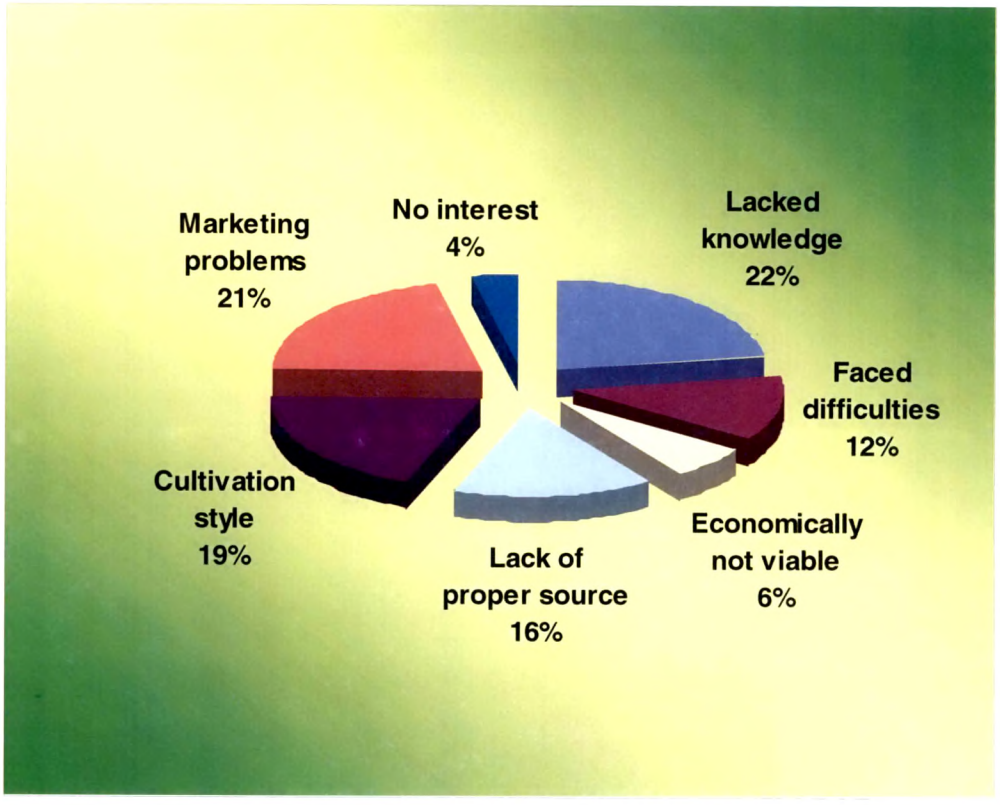


Figure - 5 Reasons for not cultivating Medicinal Plants

A group of farmers comprising 14% showed no interest in cultivation of medicinal plants. They were quite satisfied with their conventional crop cultivation. They found it very risky business.

5.7 Buyback schemes:

Farmers showed willingness for assured buy-back schemes. It was observed that 82% of farmers were ready to initiate the cultivation of medicinal plants on trial basis along with traditional crops.

6. **Experience and views**

6.1 Elucidate Interest:

Farmers showed great interest in cultivation of many medicinal plants according to their land and water availability. Farmers were interested in following medicinal plants for cultivation (Table-2).

Table-2: List of medicinal plants for which farmers showed interest for cultivation

Sr. No.	Botanical Name	Vernacular Name
1	*Adhatoda vasica*	Ardusi
2	*Aloe vera*	Kuvarpatto
3	*Andrographis paniculata*	Kalmegh
4	*Asparagus racemosus*	Shatavari
5	*Bacopa monnieri*	Brahmi
6	*Cassia angustifolia*	Sonamukhi
7	*Catharanthus roseus*	Barmasi
8	*Chlorophytum borivialianum*	Safed moosli
9	*Cinnamomum camphora*	Taj
10	*Commiphora wightii*	Guggal
11	*Convolvulus microphyllus*	Shankpushpi

12	*Emblica officinalis*	Amla
13	*Glychrrhiza glabra*	Jhetimadh
14	*Moringa oleifera*	Sargava
15	*Mucuna pruiens*	Kaucha
16	*Piper longum*	Lindi piper
17	*Plantago ovata*	Isabgul
18	*Rauvolfia serpentina*	Sarpangandha
19	*Swertia chirata*	Kariyatu
20	*Emblica ribes*	Vavding
21	*Withania somnifera*	Ashwagandha
22	*Zingiber officinalis*	Ginger

6.2 Lack faith in commercial units:

Farmers faced misleading information on plants, - which would fetch them quick and more profit. Many farmers had suffered a great loss even in buy-back schemes laid by the industries or agents. False promises were given by the industries/agent and they even dishonored their buyback agreements at the time of harvest on the pretext of quality of plant produce being not upto the mark. This lead to the monetary and time loss to the farmers as they had to sell the produce at a low price.

6.3 Lack in testing centers:

It was observed that the big drug manufacturers and export agents preferred tested medicinal plants and stressed on its certification for the required chemical constituents and their levels in the medicinal plants. There are very few centers in the state, though most progressive, for accurate testing of quality of the extracts. Further, the clear measures and requirement of the produce has not been

clear. This leads to the problems at time of trading the produce. In this plight, in monetary terms farmers are the major sufferers.

Recommendations

Following are the suggestions that has emerged for ensuring successful cultivation of medicinal plants in Gujarat State-

Reliable planting material:

- Cultivation of medicinal plants is a bit difficult owing to the fact that there is a lack of standard agronomic practices for most species and unavailability of sources of quality planting materials and technical guidance.
- Farmers should visits farms where medicinal plants are being cultivated before undertaking any cultivation of medicinal plants.
- Government institutions like Agricultural Universities, Botany Departments, Forest Departments and even NGOs should establish well-developed nurseries for distribution of the quality planting material. This would ensure that the farmers can collect the quality and assured planting material for their cultivation.
- High yielding variations within species need to be generated, propagated and disseminated to farmers.

Technical guidance:

- Government institutions as well as NGOs working for medicinal plants should arrange programmes for propagation, cultivation and marketing of medicinal plants for a range of farming skills and awareness at a nominal charge.
- Proper technical training need to be arranged for those who are interested in cultivation of medicinal plants. Technical know-how in terms of write-up/brochure on plant cultivation should be distributed to the target group.

- Post harvest technology must standardize and passed on to the farmers for better economic returns.
- The relevant information on the market, agronomic schedules, production costs and literature related to the medicinal plants should be available to the farmers through various media and extension programmes. This information should be used to educate the field workers of the organization who can further train the target group.
- It has been observed that most of the farmers engaged in the cultivation of medicinal plants are financially sound and have good educational background, which has helped them to keep themselves updated with the information and cultivation of medicinal plants. On the other hand, the target group is financially weak with poor educational background. Thus some extension programmes should be organized to educate and to motivate the marginal farmers about the cultivation of medicinal plants.

Government initiatives and schemes:

- It may not be possible for the poor farmers to bear the initial expenses for cultivation of medicinal plants, as it is relatively higher than the cultivation of traditional crops. The schemes and subsidies offered by the Government must be availed by the target farmers.
- The names of the medicinal plants species being cultivated should be registered with local government authority as there is a legal need to distinguish the cultivated crop with those growing in the forest to get transit pass (TP) from the Forest Department. This may also help the cultivators in getting the subsidies and loans.

Market:

- The medicinal plant market is prone to price fluctuations. The price of a particular species may certainly go down in case of surplus and overproduction. For example in case of Kaucha (*Mucuna pruiens*), before three years, there was an over-production of this species in Gujarat. This led to a drop in the price to 8-9 Rs/kg instead of earlier 30 Rs/kg approximately. Schemes should be introduced which would ensure a minimum price of medicinal plants for higher profitability than the traditional crops.
- It is recommended that proper market support need be provided to farmers, specially, in the initial phase, as it may be difficult for them to market their produce and get desired returns.

Market intelligence:

- Sustainable agro-practices in medicinal plants can be undertaken on the basis of market intelligence. A credible intelligence gathering mechanism has to be created and prices of planting material of different grades of produce should be made available through media-electronic (internet) and print (local newspapers and market bulletins). Total demand and present supply within and outside the state are to be specially made available to prospective farmers and buyers.

Dissemination of Market formation system:

- The corporate vision for rural marketing can use optimum media mix (print and electronic media) for medicinal plant based on literacy and infrastructure on regional basis. Market information, once available through market intelligence systems, can also be disseminated through both the media. For

example, in India the major means for spreading of market information to remote farmers include: All India Radio with almost 100% coverage of the country, national television channels with 95% coverage and the business sections of various local newspapers (Gera et al, 2003). These days, internet play an important role in dissemination of market information. The website not only allows instant updation, but allows to download the information at block or even at village level for further dissemination at local levels.

Marketing:

- It is the biggest problem for the cultivation of medicinal plants. If the produce is sold individually by the farmers then it is possible in long run that they do not receive the desired returns, if milk cooperative society like "Medicinal Plant Cooperative" is formed, may end up on some desirable returns. So such cooperatives should be initiated and brought into the State.
- Some organization can be set up which can ensure contract farming for better returns.

Organic Produce:

- Medicinal plants raised without using any inorganic fertilizers fetch more price in the market. Therefore chemical fertilizers should be avoided and green manure and biofertilizers should be used. Medicinal plants, because of their pharmaceutical and cosmoceutical use, need to be grown without the use of any chemical inputs. WTO protocol also stresses that only that plant material could be exported that carries the tag of 'organically grown'.

- Trials at organic cultivation of commercial crops have been made and need to be initiated for medicinal plants too. Organic cultivation of medicinal plants has to be a community response and undertaken by every grower.
- Organic cultivation of medicinal plants in the State should be initiated via grower cooperatives on larger scale

Buyback schemes:

- Introduction of buyback schemes and similar measure to boost farmers' confidence and ensure the proper price for the harvest is recommended. Buy back guarantee, such as, that provided by National Remedies Industry to Karnataka farmers to grow Kalmegh (*Andrographis paniculata*) must be extended to other threatened but very important medicinal plant species through Government intervention.
- Buyers should be contacted in advance to get reasonable price for their desired produce.

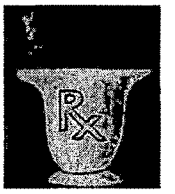
Work required:

- The information generated on various medicinal plants developed by the agriculture universities should be available easily to the farmers.
- More studies are required for possibility of inter-cropping of medicinal plants with other traditional crops and plantations.
- The possibility of developing linkages of Micro-finance with the medicinal plant cultivation should also be explored.
- Ensure high quality scientific and technical backup to the medicinal plant cultivators both in the fields of cultivation and marketing.

- Quality control practices for cultivation, harvest and value addition need to be implemented for international markets.
- Need to promote regional certification and testing facilities to set standards for raw drugs.
- Cultivation of high priority medicinal plant species outside the forest areas is considered as one of the ways to off-load some of the pressure from the fast depleting wild resources and to provide good alternative cropping options to the farming community.

Such studies on medicinal plant valuation signify its economic importance and biodiversity. A local or area based study taking into account its features, ecological function should be an essential preferred approach for the future.

PHARMACEUTICAL SURVEY



A market survey was carried out to assess the present and future requirement as well as the promotion of Medicinal Plants for the Ayurvedic and Pharmaceutical companies. The study also reviewed implications for implementation of World Trade Organization agreement in 2005.

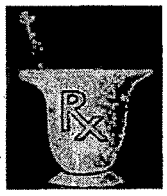
Study area

The Ayurvedic and Pharmaceutical companies established in the Gujarat state were contacted for their tentative requirements and productions. Various distributors, dealers, agents dealing with medicinal plants were also approached for their perceptions in the medicinal plant trade.

Objective of the present study

The techno-economy status of medicinal plants for their future availability, use and demand in the state was evaluated. Moreover, strategies for large-scale cultivation of important and most sought after medicinal plants of the state were reviewed with reference to the following points.

1. List of medicinal plant required by the pharmacies
2. Source of medicinal plant species
3. Annual consumption and requirement of the medicinal plants by the pharmacies.
4. Organoleptic consumption of the medicinal plants
5. Market related information
6. Assessment of the problems faced by the ayurvedic/pharmacies
7. Assessment of the awareness and perception of implementation of WTO norms and patent rights



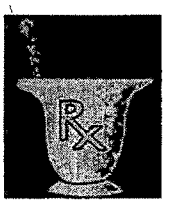
Methodology

The study accentuated on the collection of quantitative and qualitative information. In order to get a complete picture of the existing scenario, various ayurvedic and pharmacies were visited. Based on extensive literature survey, primary data was collected from the authorized persons of the pharmacies dealing with directly or indirectly with medicinal plants.

First, a list of pharmacies established in the state was collected with the help of various sources like district telephone directories, ayurvedic distributors, agents, pharmacies and literature survey. The table shows the details of licensed and functional pharmacies in the state.

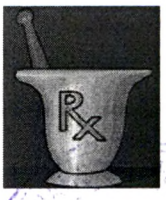
Table-1: List of licensed and functional pharmacies of Gujarat state

Sr. No.	District	No. of licensed Pharmacies	No. of Functional Pharmacies
1	Ahmedabad	165	105
2	Amreli	9	5
3	Banaskantha	9	5
4	Bharuch	14	10
5	Bhavnagar	39	25
6	Dangs	1	1
7	Gandhinagar	3	1
8	Jamnagar	27	19
9	Junagadh	25	10
10	Kheda	25	16
11	Kutch	5	5
12	Mehsana	37	20
13	Panchmahals	7	4
14	Rajkot	73	34
15	Sabarkantha	12	8
16	Surat	31	6
17	Surendranagar	9	5
18	Vadodara	69	29
19	Valsad	45	22
	Total	**605**	**330**



The Department of Food and Drugs Control Administration, Gandhinagar had issued licenses for 605 Ayurvedic pharmaceutical industries (1998) in the state (Singh and Parabia, 2003). The majority of Ayurvedic pharmacies are found in major cities like Ahmedabad (165), Rajkot (73), Vadodara (69), Valsad (45), Bhavnagar (39), Mehsana (37) and Surat (31). The collection of primary data and secondary data for any market survey is the paramount importance to assist management in making decision. The present work was emphasized on the collection of quantitative and qualitative information with the help of a personal meet. The questionnaire was drafted to collect the data regarding medicinal plants used, part used, quantity consumption, place and agency for procurement, plants under cultivation, plants in short supply, plants/drugs exported including views on implementation of WTO agreements.

The forwarding letter with the questionnaire form was dispatched to all the pharmacy owners. The devised format for information is in Annexure-4.



Results and Discussions

Initially there was a very poor response from pharmacy owners to furnish any information. Even after repeated reminders, very few pharmacies responded and provided the information regarding the annual consumption of medicinal plants. Many of the pharmacies were not aware of the correct botanical name of the plants used and had confusion even with local name too. They also complained of lack of time to render required data. Therefore, the questionnaire was revised and list of botanical and local name of the medicinal plants in the format was added to simplify for ease in data filling.

The questionnaire was statistically analyzed. A perusal of the various findings for this study led to a number of important conclusions.

Surveyed pharmacies: The techno-economy survey was carried out during 2003-2005 for pharmacies from various districts located in different agroclimatic zones of Gujarat. The pharmacies were either big, small, seasonal, single-drug manufacturing or multi-drug manufacturing units. During the literature survey, it was found that only 330 ayurvedic pharmacies were in operation, out of 605 licensed pharmacies in Gujarat (Singh, 2003). In the study period of three years, 101 pharmacies from 15 different districts of various agroclimatic zones in Gujarat were surveyed. After continuous efforts and several reminders through letters and telephonic calls and personal visit, very few pharmacies responded and furnished the information regarding the annual consumption of medicinal plants. Initially many of the pharmacies denied to provide any information. Few of the pharmacies were closed down and few were shifted to other locality. Out of functional pharmacies, 26 companies (8%) did not respond even after several reminders and persuasions. After

great efforts, 75 pharmacies (comprising 22%) out of 330 functional units were able to supply necessary details which were collected and statistically analyzed (Fig.-1)

1. Medicinal plants consumption

The information regarding consumption of medicinal plant raw material and its procurement from the respondents was very difficult. The pharmacies were found stubborn, very hesitant and reluctant to reveal the information in the name of **TRADE SECRETS.** Based on the supplied data it was observed that 316 medicinal plant species are used presently to produce different Ayurvedic formulations by the state pharmacies.

1.1 Life forms: The plants were classified according to their life forms such as herbs, shrubs, climbers and trees. Out of 316 medicinal plant species, 131 species are herbs (41%), 43 species are climbers (14%), 41 species are shrubs (13%) and 101 species are trees (32%) (Fig.-2).

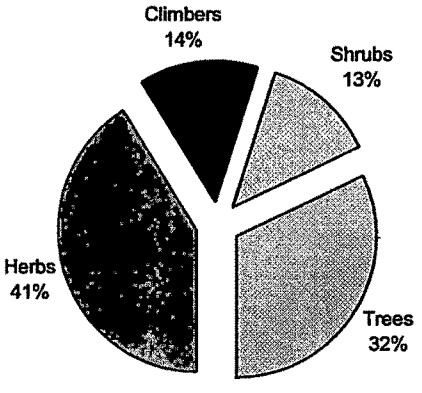
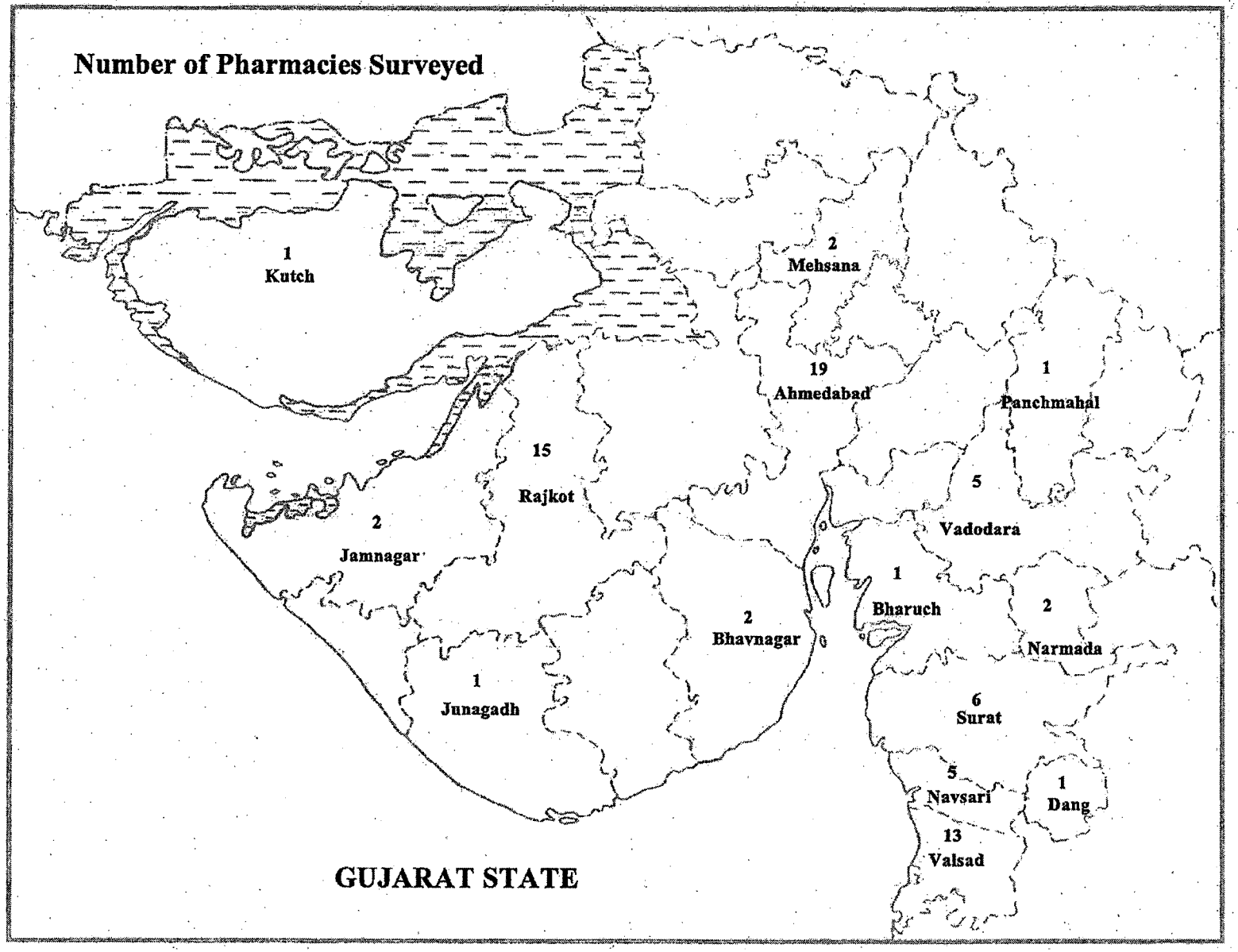
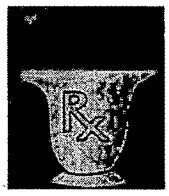


Figure-2: Classification of medicinal plants (as life forms) used by state pharmacies

Figure : 1

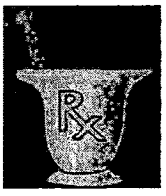

Number of Pharmacies Surveyed
1
Kutch
2
Mehsana
19
Ahmedabad
1
Panchmahal
15
Rajkot
5
Vadodara
2
Jamnagar
1
Bharuch
2
Narmada
2
Bhavnagar
1
Junagadh
6
Surat
5
Navsari
1
Dang
13
Valsad
GUJARAT STATE



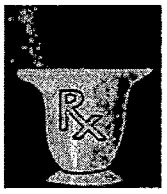
The list of herbs, shrubs, climbers and trees used by the state pharmacies was generated (Tables –2 to 5). Adhikari et al (2003) listed 197 medicinal plants in Uttaranchal State, out of which major parts used in various ailments are bark (118 species), leaves (78 species), Fruits (65 species), root (42 species) and seed (30 species).

Table - 2: List of Herbs (familywise) used by the State Pharmacies:

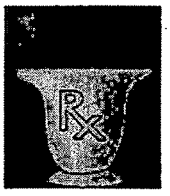
Sr. No.	Botanical Name	Vernacular Name	Sanskrit Name	Part used
	Acanthaceae			
1	*Andrographis paniculatas*	Kalmegh	Bhuinimba	Panchang
2	*Barleria prionitis*	Kantasheriyo	Vajradanti	Panchang
3	*Blepharis edulis*	Utigan beej		Seeds
4	*Hygrophila auriculata*	Aekharo	Kolistha	Panchang
5	*Peristrophe bicalyculata*	Anghedi		Panchang
	Agavaceae			
6	*Agave americana*	Ketki	Kantala	Leaf pulp, Roots
	Amaranthaceae			
7	*Achyranthes aspera*	Ahgedo	Apamarga	Panchang
8	*Amaranthus lividus*	Tandaljo	Alpa marisha	Panchang
	Amaryllidaceae			
9	*Curculigo orchioides*	Kali musli	Hemapuspi	Roots
	Apiaceae			
10	*Anethum graveolens*	Suva	Ahichhatra	Fruits
11	*Apium graveolens*	Ajamo	Yamani	Seeds
12	*Carum carvi*	Shahjiru	Sushavi	Seeds
13	*Carum copticum*	Ajmod	Yavanika	Leaves, Seeds
14	*Carum roxburghii*	Bodi ajmod		Seeds
15	*Centella asiatica*	Kar Brahmi	Mandukparni	Panchang
16	*Corriandrum sativum*	Kothmir	Kustumbari	Fruits
17	*Cuminum cyminum*	Jiru	Ajali	Fruits
18	*Daucus carota*	Gajar	Shikhamualam	Roots
19	*Ferula narthrex*	Hing	Hingu	Gum
20	*Foeniculum vulgare*	Variyali	Madhurika	Fruits
	Apocynaceae			
21	*Catharanthus roseus*	Barmasi	Sangkhaphuli	Leaves, Flowers
	Araceae			



22	*Acorus calamus*	Safed bach	Vacha	Rhizome
23	*Amorphallus campanulatus*	Suran	Arsaghna	Stem
	Asclepiadaceae			
24	*Pergularia daemia*	Nagalandu dheli	Uttamarani	Panchang
	Asteraceae			
25	*Anacylus pyrethrum*	Akalkaro	Akarakarabhah	Panchang
26	*Asteracantha longiifolia*	Akhro		Fruits
27	*Cichorium intybus*	Chikory	Kasani	Seeds
28	*Eclipta alba*	Bhangaro dhodo	Bhrangarajah	Panchang
29	*Eclipta prostrata*	Bhangaro kado	Kesharaja	Panchang
30	*Helianthus annus*	Surajmukhi	Adityabhakta	Flowers
31	*Inula racemosa*	Puskarmool	Pauskaram	Roots
32	*Pluchea lanceolata*	Rasna	Raasna	Roots
33	*Sphaeranthus indicus*	Gorakhmundi	Mundirika	Fruits
34	*Spilanthes acmella*	Marethi	Akarkara	Stem
35	*Taraxacum officinale*	Dulal burau	Dugdhapheni	Panchang
36	*Tridax procumbens*	Pardesi bhangaro		Panchang
37	*Veronia anthelmintica*	Kalijiri	Aranyajiraka	Fruits
	Caesalpiniaceae			
38	*Cassia absus*	Chimed	Kulatthika	Panchang
39	*Cassia auriculata*	Aval	Avarttaki	Panchang
40	*Cassia tora*	Kuvadio	Dadamari	Seeds
	Cannabinaceae			
41	*Cannabis sativa*	Bhang	Vijaya	Seeds
	Convolvulaceae			
42	*Convolvulus microphyllus*	Shankhavali	Gugguluh	Panchang
43	*Evolvulus alsinoides*	Kali shankhavali	Vishnukanta	Panchang
44	*Merremia tridentata*	Bhinigario	Prasarini	Panchang
	Cruciferae			
45	*Lepidium sativum*	Asariyo	Ashalika	Seeds
46	*Raphanus sativus*	Mulo	Moolaka	Seeds
	Cyperaceae			
47	*Cyperus rotundus*	Nagarmoth	Mustaka	Roots
	Euphorbiaceae			
48	*Eulopia campestris*	Salampanjo		Roots
49	*Euphorbia hirta*	Lal dudhi	Raktavinduchada	Stem
50	*Phyllantus fraternus*	Bhoi amli	Adhyanda	Panchang
	Fabaceae			
51	*Alhagi pseudalhagi*	Javaso	Adhikantaka	Panchang



52	*Desmodium gangeticum*	Salvan	Shalaparni	Roots
53	*Glycyrrhiza glabra*	Jethi madh	Madhiuka	Roots
54	*Indigofera tinctoria*	Gali indigo	Neela	Leaves
55	*Phaseolus trilobus*	Moongparni		Panchang
56	*Psoralea coryfolia*	Bawachi	Bakuchi	Seeds
57	*Tephrosia purpurea*	Sharpankho	Sarapunkhah	Panchang
58	*Trigonella foenum-graceum*	Methi	Methika	Seeds
59	*Uraria picta*	Pilvan	Prasniparni	Roots
	Fumariaceae			
60	*Fumaria indica*	Pittapapado	Khsetta parpati	Panchang
	Gentianaceae			
61	*Enicostema littorale*	Mamejavo	Nagajihva	Panchang
	Iridaceae			
62	*Crocus sativus*	Keshar	Kesharaja	Stigma
	Lamiaceae			
63	*Leucas cephalotes*	Kubo	Chatraka	Panchang
64	*Mentha arvensis*	Fudino		Panchang
65	*Ocimum basilicum*	Damro	Ajaka	Leaves
66	*Ocimum canum*	Van tulsi	Gramya	Fruits, Leaves
67	*Ocimum gratissimum*	Ram tulsi	Vriddhatulsi	Panchang
68	*Ocimum sanctum*	Tulsi	Krishna tulsi	Panchang
69	*Origanum majorana*	Maruva		Panchang
	Liliaceae			
70	*Allium cepa*	Kanda	Palandu	Stem bulb
71	*Allium sativum*	Lasan	Lasuna	Stem bulb
72	*Aloe vera*	Kuvar pato	Ghrita- kumari	Leaf pulp
73	*Chlorophytum **borivilianum***	Safed moosli		Roots
74	*Chlorophytum tuberosum*	Moosli		Roots
75	*Colchium luteum*	Suranjan		Roots
76	*Fritillaria roylei*	Kakoli		Roots
77	*Lilium polyphylum*	Kshirkakoli	Ksirakakoli	Bulbs
78	*Polygonatum cirrhifolium*	Meda	Meda	Roots
79	*Polygonum verticillatum*	Mahameda	Mahameda	Roots
80	*Linum usitatissimum*	Alsi	Atasi	Seeds, Flowers
	Malvaceae			
81	*Abelmoschus moschatus*	Muskdana	Latakasturika	Seeds
82	*Sida cordifolia*	Bala dana	Badiyalaka	Roots
83	*Sida spinosa*	Mahabala	Mahabala	Panchang
84	*Sida veronicaefolia*	Nagbala	Bhumibala	Panchang
85	*Urena lobata*	Vagadau bhindo	Vanabhenda	Roots
	Mimosaceae			

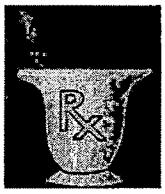


86	*Mimosa pudica*	Lajamni	Lajja	Panchang
	Nymphaeaceae			
87	*Nelumbo nucifera*	Kamal	Ambhoja	Seeds, Flowers
88	*Nymphaea stellata*	Nil kamal	Asilotpala	Flowers
	Orchidaceae			
89	*Malaxis acuminata*	Jivak	Jivakah	Stem
90	*Malaxis muscifera*	Rushbhak	Rsabhakah	Stem
	Oxalidaceae			
91	*Oxalis corniculata*	Amrul sak	Amilika	Panchang
	Papaveraceae			
92	*Argemone mexicana*	Darudi	Srigatakantaka	Panchang
93	*Papaver somniferum*	Khaskhas	Khakasa	Seeds
	Papilionaceae			
94	*Teramnus labialis*	Mash parni		Panchang
	Pedaliaceae			
95	*Pedalium murex*	Ubhu Gokharu	Gokshuru	Panchang
96	*Sesamum indicum*	Tal	Pitratarpana	Seeds
	Piperaceae			
97	*Piper longum*	Lindi piper	Pippali	Fruits, Roots
	Plantaginaceae			
98	*Plantago ovata*	Isaphgul	Snigdhabijah	Seed husk
	Plumbaginaceae			
99	*Plumbago zeylanica*	Chitrak	Citrakah	Roots
	Poaceae			
100	*Cymbopogan martinii*	Rosaghas	Bhustrina	Panchang
101	*Cynodon dactylon*	Dharo	Granthi	Panchang
102	*Desmostachya bipinata*	Darabh	Darbh	Roots
103	*Hordeum vulgare*	Jav	Yavah	Seeds
104	*Vetiveria zizanioides*	Valo, khas	Usirah	Roots
	Ranunculaceae			
105	*Aconitum heterophyllum*	Ativish	Ativisa	Roots
106	*Nigella sativa*	Kalonji	Upakuncika	Seeds
	Rubiaceae			
107	*Rubia cordifolia*	Majistha	Majistha	Roots, Stem
	Scrophulariacea			
108	*Centrartherum anthelminticum*	Kalijiri		Fruits
109	*Bacopa monnieri*	Brahmi	Nira-brahmi	Panchang
110	*Picrorhiza kurroa*	Kadu-kutaki	Katvi	Roots
	Solanaceae			
111	*Datura innoxia*	Dhaturo	Umatta-vrikshaka	Seeds

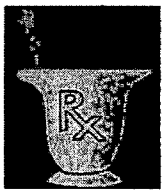
112	*Hyoscyanus niger*	Khursaniajamo	Parasikaya	Seeds
113	*Solanum indicum*	Ubhi bhoiringani	Akranta	Panchang
114	*Solanum nigrum*	Kakamasi	Kakmaci	Fruits
115	*Solanum suranttense*	Bethi bhoiringni	Kantakari	Panchang
116	*Withania coagulence*	Kaknaj		Roots
117	*Withania somnifera*	Ashwagandha	Ashvagandha	Roots
	Trapaceae			
118	*Trapa bispinosa*	Singoda	Jalakantaka	Fruits
	Valerianaceae			
119	*Valeriana jatamansi*	Tagargantha	Tagarah	Rhizome
120	*Nardostachya jatamansi*	Jatamansi	Jatamasni	Roots
	Verbenaceae			
121	*Phyla nodiflora*	Ratveliyo	Agnijvala	Leaves
	Zingiberaceae			
122	*Alpinia galanga*	Kulinjan	Barakulanjan	Roots
123	*Amomum subulatum*	Elcho	Sthulaila	Seeds
124	*Curcuma amada*	Amba haldar	Amrardrakam	Rhizome
125	*Curcuma longum*	Haldar	Karpura-haridra	Rhizome
126	*Curcuma zedoria*	Kachuro	Sati	Rhizome
127	*Elletaria cardamomum*	Elaichi	Trutih	Seeds
128	*Hedychium spicatum*	Kapur kachali	Sathi	Rhizome
129	*Zingiber officinale*	Aadu, Shunth	Ardrakam	Rhizome
	Zygophyllaceae			
130	*Fagonia cretica*	Dhamaso	Dusparsha	Panchang
131	*Tribulus terrestris*	Gokharu	Bahukantaka	Panchang

Table-3: List of Climbers (familywise) used by the State Pharmacies

Sr. No.	Botanical Name	Vernacular Name	Sanskrit Name	Part Used
	Apocynaceae			
1	*Ichnocarpus frutescens*	Kali dudhi	Ulpalasariba	Roots
	Araceae			
2	*Scindapsus officinalis*	Gajpiper	Gajapippali	Fruits
	Aristolochiaceae			
3	*Aristolochia bracteolate*	Kidamari	Pattra-banga	Fruits
	Asclepiadaceae			
4	*Gymnema sylvestre*	Madhunashini	Sarpadarushtrika	Leaves
5	*Hemidesmus indicus*	Dudh vel	Sugandhi	Roots
6	*Leptadenia reticulata*	Dodi	Jivanti	Panchang
7	*Sarcostema acidum*	Som vel	Somavalli	Panchang



8	*Tylophora indica*	Damni vel	Lataksiri	Leaves
	Caesalpiniaceae			
9	*Caesalpinia crista*	Kachka	Kuberakshi	Seeds
	Celastraceae			
10	*Celastrus paniculata*	Malkagni	Jyotismati	Seeds
	Convolvulaceae			
11	*Argyreia speciosa*	Samudrashosh	Vridha-darakka	Panchang
12	*Ipomoea digitata*	Kshirvidarikand	Bhilaykand	Tuber
13	*Operculina turpetum*	Nashotar	Ardhachandra	Stem, Roots
	Cucurbitaceae			
14	*Citrullus colocynthis*	Indrayanmool	Indravaruni	Roots
15	*Coccinia indica*	Kadva ghiloda		Leaves
16	*Cucumis sativus*	Kakdi	Sakur	Seeds
17	*Luffa echinata*	Kukardvel	Akhuvishaka	Fruits
18	*Momardica charantia*	Karela	Sushavi	Fruits
19	*Trichosanthes cucumerina*	Patol patra	Jvaranashana	Panchang
20	*Trichosanthes dioica*	Kadu-Patol	Patola	Panchang
21	*Trichosanthes tricuspidata*	Kakanasha	Kaknasa	Fruits
	Dioscoreaceae			
22	*Dioscorea bulbifera*	Varahikand	Amrita	Roots
	Euphorbiaceae			
23	*Tragia involucrate*	Barhanta	Duralabha	Roots, Leaves
	Fabaceae			
24	*Abrus precatorius*	Chanothi	Gunja	Leaves, Seeds
25	*Clitoria ternatea*	Garni	Aparajita	Seeds
26	*Mucuna prurita*	Kaucha	Kapikacchuh	Seeds
27	*Puereria tuberosa*	Vidarikand	Vidarika	Tuber
	Liliaceae			
28	*Asparagus racemosus*	Shatavar	Shatavari	Roots
29	*Gloriosa superba*	Vachnag	Sukra pushpika	Roots
30	*Smilax zeylanica*	Chopchini	Vana madhusnahi	Rhizome
	Menispermaceae			
31	*Cyclea peltata*	Patha	Patha	Roots
32	*Tinospora cordifolia*	Gado	Amritavalli	Panchang
	Mimosaceae			
33	*Acacia concinna*	Shikakai		Fruits
	Nyctaginaceae			
34	*Boerhaavia diffusa*	Satodi	Punarnava	Roots
	Piperaceae			
35	*Piper betel*	Nagarvel	Nagavalli	Leaves
36	*Piper chaba*	Chavak		Panchang
37	*Piper nigrum*	Kalimari	Maricha	Fruits
	Ranunculaceae			
38	*Clematis triloba*	Morvel	Laghukarni	Panchang
	Rhamnaceae			



39	*Ventilago denticulata*	Asai, Asvel	Raktavalli	Bark
	Saxifragaceae			
40	*Bergenia ligulata*	Pashanbhed	Pashanabheda	Bark
	Violaceae			
41	*Viola odorato*	Banfasa	Banaphaspha	Panchang
	Vitaceae			
42	*Cissus quandrangularis*	Hadsankal	Amara	Stem
43	*Vitis vinifera*	Kali draksh	Draksa	Fruits

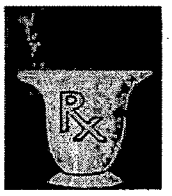
Table-4: List of Shrubs (familywise) used by the State Pharmacies

Sr. No.	Botanical Name	Vernacular Name	Sanskrit Name	Part Used
	Acanthaceae			
1	*Adhatoda vasica*	Ardusi	Vasa	Panchang
2	*Barleria sepiaria*	Kanta		Panchang
	Apocynaceae			
3	*Holarrhena antidysenterica*	Indrajav	Kutaja	Bark, Seeds
4	*Nerium indicum*	Kanera	Asvamaraka	Roots
5	*Rauvolfia serpentina*	Sarapgandha	Sarpagandha	Roots
6	*Thevetia nerifolia*	Pile kaner	Ashvaha	Roots, Fruits
	Asclepiadaceae			
7	*Calotropis gigantean*	Akado	Arka	Roots, Leaves
8	*Calotropis procera*	Akado	Alarka	Roots, Leaves
	Asteraceae			
9	*Saussurea lappa*	Kath, Uplet	Kusttah	Panchang
	Berberidaceae			
10	*Berberis aristata*	Daru-haldi		Bark
	Burseraceae			
11	*Commiphora myrrha*	Hirabol	Rasagandhah	Gum
12	*Commiphora wightii*	Guggul	Bhavabhishtha	Gum-resin
	Caesalpiniaceae			
13	*Cassia angustifolia*	Sonamukhi	Bhumiari	Leaves
14	*Cassia occidentalis*	Kasundro	Kasamardah	Leaves, Seeds
	Capparidaceae			
15	*Capparis sepiaria*	Kanthar	Kakdani	Fruits
	Euphorbiaceae			
16	*Baliospermum montanum*	Dantimool	Danti	Roots
17	*Euphorbia nerifolia*	Thor	Snoohi	Panchang
18	*Jatropha curcas*	Safed Arando	Dravanti	Fruits
19	*Ricinus communis*	Diveli	Amanda	Roots, Leaves

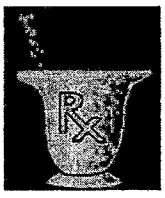
	Lamiaceae			
20	*Anisomeles malabarica*	Runchhalo	Vaikunthah	Panchang
	Lythraceae			
21	*Lawsonia inermis*	Mehndi	Madayantika	Leaves, Seeds
22	*Woodfordia furticosa*	Dhavdi	Dhataki	Flowers
	Malvaceae			
23	*Abutilon indicum*	Khapat	Atibala	Seeds
24	*Hibiscus rosa-sinesis*	Jasud	Rudhrapushpa	Flowers
	Myrsinaceae			
25	*Embelia ribes*	Vavding	Vidang	Fruits
	Oleaceae			
26	*Jasminum auriculatum*	Jui, Champa	Yuthika	Panchang
27	*Nyctanthes arbortristis*	Parijat	Atyaha	Flowers
	Puniacaceae			
28	*Punica granatum*	Dadam	Dadima	Fruits, bark
	Rhamnaceae			
29	*Ziziphus mauritiana*	Bor	Badarah	Roots
	Rosaceae			
30	*Rosa centifolia*	Gulab	Satapatri	Flowers
	Rubiaceae			
31	*Gardenia resinifera*	Dikamari	Suriya	Fruits
32	*Ixora coccinea*	Rukmini	Paranti	Roots, Leaves
33	*Xeromphis spinosa*	Mindhal	Madanah	Fruits
	Rutaceae			
34	*Citrus medica*	Bijoru	Matulungah	Fruits
	Salvadoraceae			
35	*Salvadora persica*	Khara pilu	Brihat pilu	Bark, Leaves, Seeds
	Sterculiaceae			
36	*Abroma augusta*	Ulat kambal	Pivari	Roots
37	*Helicteres isora*	Mardasingi	Mrigashringa	Fruits
	Verbenaceae			
38	*Callicarpa macrophylla*	Priyanguful	Priyangu	Flowers
39	*Clerodendrum phlomodies*	Arni	Agnimantha	Roots, Leaves
40	*Clerodendrum serratum*	Bharangimool	Bharangi	Roots
41	*Vitex negundo*	Nagod	Nirgundi	Leaves

Table-5: List of Trees (familywise) used by the State Pharmacies:

Sr. No.	Botanical name	Vernacular name	Sanskrit name	Part used

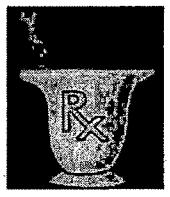


	Alangiaceae			
1	*Alangium salvifolium*	Ankol	Ankolah	Roots, Seeds
	Anacardiaceae			
2	*Buchanania lanzan*	Charoli	Piyala	Fruits
3	*Mangifera indica*	Aambo	Amrah	Fruits
4	*Pistacia integerrima*	Kakadashingi	Karkatasrngi	Galls
5	*Pistacia lentiscus*	Rumimastaki		Resins
6	*Semecarpus anacardium*	Bhilamo	Bhallatakah	Fruits
	Annonaceae			
7	*Annona squamosa*	Sitafal	Shubha	Seeds, Leaves
	Apocynaceae			
8	*Alstonia scholaris*	Sataparni	Saptaparna	Bark, Leaves
9	*Wrightia tinctoria*	Kadi kutij	Svetakutajah	Bark, Seeds Leaves
10	*Wrightia tomentosa*	Dudhlo		Bark
	Arecaceae			
11	*Cocus nucifera*	Nariyeli	Narikela	Fruits
12	*Phoenix dactylifera*	Khajur	Pinda kharjura	Fruits
	Bambusaceae			
13	*Bambusa arundinacea*	Katris bans	Vansa	Stem pulp
	Bignoniaceae			
14	*Dolichandrone falcata*	Mattarsingi		Bark
15	*Oroxylum indicum*	Tetu	Syonakah	Bark, Roots
16	*Stereospermum personatum*	Patala	Patala	Roots, bark
17	*Tecomella undulata*	Ragat Rohido	Chalachhada	Bark
	Bixaceae			
18	*Bixa orellana*	Sinduri	Sinduri	Roots, Bark, Seeds
	Bombacaceae			
19	*Adansonia digitata*	Gorakh amli	Gorakh-chinch	Fruits
20	*Bombax ceiba*	Simlo	Rakta shalmali	Gum
	Burseraceae			
21	*Boswelia serrata*	Kadayo	Shakkaki	Bark
	Caesalpiniaceae			
22	*Bauhina racemosa*	Asitro	Svetakanchan	Bark
23	*Bauhina variegata*	Kachnar	Kancnarah	Bark
24	*Cassia fistula*	Garmalo	Argvadhah	Leaves, Fruits
25	*Saraca indica*	Ashok	Asokah	Bark
26	*Tamarindus indicus*	Khati Amli	Tintrini	Fruits
	Capparidaceae			
27	*Crateava nurvala*	Varun chal	Varuna	Bark, Fruits

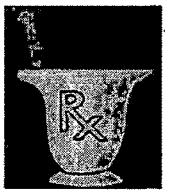


	Caricaceae			
28	*Carica papaya*	Papaiya	Brahmairandah	Seeds
	Cluiaceae			
29	*Garcinia indica*	Kokam	Amlavetasa	Fruits
30	*Garcinia morella*	Revanchini	Kamkustha	Stem
31	*Garcinia pendulata*	Amalvetas		Fruits
	Combretaceae			
32	*Anogeissus latifolia*	Dhavdo	Virataru	Roots, fruits, bark
33	*Terminalia arjuna*	Arjun	Arjunah	Bark
34	*Terminalia bellerica*	Baheda	Aksah	Fruits
35	*Terminalia chebula*	Harade	Haritaki	Fruits
	Dipterocarpaceae			
36	*Shorea robusta*	Sal, Ralgum	Salah	Oleo-gum resin
	Ebenaceae			
37	*Diosypros malabarica*	Timru	Tumvuru	Fruits
	Elaeocarpaceae			
38	*Elaeocarpus ganitrus*	Rudraksha	Rudraksah	Fruits
	Euphorbiaceae			
39	*Croton tiglium*	Jamalgota	Jayapala	Fruits
40	*Emblica officinalis*	Ambla	Dhatri-phala	Fruits
41	*Mallotus philippensis*	Kapilo	Rechanaka	Fruits
42	*Putranjiva roxburghii*	Putranjivi	Putranjiva	Leaves, Fruits
	Fabaceae			
43	*Butea monosperma*	Keshudo	Kinsuka	Roots, Flowers
44	*Dalbergia latifolia*	Sisum	Shisham	Roots, Bark
45	*Pongamia pinnata*	Karanj	Karanjah	Seeds
46	*Pterocarpus santalinus*	Lal chandan	Rakta chandana	Stem (Heart wood)
	Fagaceae			
47	*Quercus infectoria*	Mayufal		Galls
	Flacourtiaceae			
48	*Casearia esculenta*	Saptarangi		Bark
	Gentianaceae			
49	*Swertia chirata*	Kariyatu	Katakah	Panchang
	Guttiferae			
50	*Meusa ferrea*	Nagkeshar	Nagpuspah	Flowers
	Juglandaceae			
51	*Juglans regia*	Akharot	Aksotah	Fruits
	Lauraceae			
52	*Cinnamomum camphora*	Kapur		Deposition of

				cells
53	*Cinnamomum tamala*	Tamal Patra	Tamalapatram	Bark, leaves
54	*Cinnamomum zeylanicum*	Taj	Tvak	Leaves
	Lecythidaceae			
55	*Careya arborea*	Vakumbha	Kumbhi	Bark
	Loganiaceae			
56	*Strychnos nuxvomica*	Zerkuchala	Karaskarah	Seeds, Bark
57	*Strychnos potatorum*	Nirmal	Ambuprasadana	Seeds
	Malvaceae			
58	*Thespesia populnea*	Paraspiplo	Gardha bhanda	Bark
	Meliaceae			
59	*Azadiracta indica*	Limdo	Mahanimba	Panchang
60	*Melia azedarach*	Bakam limado	Brihannimba	Bark
	Mimosaceae			
61	*Acacia catechu*	Kher	Khadirah	Bark, Stem
62	*Acacia nilotica*	Baval	Babbula	Bark, Gum
63	*Albizzia lebbeck*	Siris	Sirish	Bark
	Moraceae			
64	*Artocarpus integrifolia*	Fanas	Panasa	Roots, Seeds, Fruits, Leaves
65	*Ficus benghalensis*	Vad	Vata	Roots, bark
66	*Ficus hispida*	Jangli anjir chal	Kakadumbura	Fruits, Bark
67	*Ficus racemosa*	Umbar chhal	Udumbara	Bark
68	*Ficus religiosa*	Pipalo	Pippala	Bark
69	*Ficus tsiela*	Pipal		Bark
70	*Streblus asper*	Harero	Sakhotah	Roots
	Moringaceae			
71	*Moringa concanensis*	Kadvo sargavo	Madhusigru	Fruits, Bark
72	*Moringa oleifera*	Mitho sargavo	Sigruh	Fruits, Bark
	Myricaceae			
73	*Myrica nagi*	Kaifal		Bark
	Myristicaceae			
74	*Myristica fragrans*	Jaifal	Jatiphala	Fruits, Flowers
	Myrtaceae			
75	*Eucalyptus spp.*	Nilgiri	Nilaniryasa	Leaves
76	*Eugenia caryophyllata*	Laving	Lavangam	Flower bud
77	*Eugenia jaambolana*	Jambu	Nilaprala	Seeds
	Oxalidaceae			
78	*Averrhoa carambola*	Kamrakh	Karmarangah	Fruits
	Palmaceae			



79	*Areca catechu*	Sopari	Gubak	Seeds
	Pinaceae			
80	*Cedrus deodara*	Devdar	Devadaru	Bark
	Poaceae			
81	*Saccharum officinarum*	Sheradi	Ikshu	Stem
	Rosaceae			
82	*Prunus cerasoides*	Padam kast	Padmakah	Stem
	Rubiaceae			
83	*Cinchona officinalis*	Cinchona	Sinkona	Bark
84	*Haldinia cordifolia*	Kadami	Dharakadamph	Roots, Bark
	Rutaceae			
85	*Aegle marmelos*	Bili	Bilva	Roots, Fruits, Bark
86	*Citrus acidus*	Limbu		Fruits
87	*Citrus aurantifolia*	Santra		Fruits
88	*Feronia limonia*	Kotha	Kapitha	Fruits
89	*Murraya koenigii*	Kadipatto	Surabhinimba	Leaves
	Santalaceae			
90	*Santalum album*	Chandan	Chandana	Stem (Heart wood)
	Sapindaceae			
91	*Sapindus laurifolius*	Aritha	Arishta	Fruits
	Sapotaceae			
92	*Madhuca indica*	Mahudo	Madhuka	Fruits, Flowers
93	*Mimusops elengi*	Bakul	Bakula	Bark
	Simaroubaceae			
94	*Ailanthus excelsa*	Aduso	Aralu	Bark
	Sterculiaceae			
95	*Sterculia urens*	Kadaya		Gum
	Symplocaceae			
96	*Symplocos racemosa*	Lodra	Rodhra	Bark
	Thymeleacae			
97	*Aquilaria agallocha*	Kala agar	Aguruh	Resinous wood
	Tiliaceae			
98	*Grewia tenax*	Falsa	Dharmana	Fruits
	Ulmaceae			
99	*Trema orientalis*	Gol, Vanjli	Jivani	Roots
	Verbenaceae			
100	*Gmelina arborea*	Sewan	Gambhari	Stem, Roots, Bark
101	*Tectona grandis*	Sag	Sakkah	Fruits, Bark



According to the database of FRLHT, there are 386 families and 2,200 genera in which medicinal plants are recorded. The top ten families with larger share of medicinal plants of India are Fabaceae, Asteraceae, Lamiaceae, Euphorbiaceae, Rubiaceae, Poaceae, Acanthaceae, Apiaceae, Rosaceae and Convolvulaceae.

According to our survey in Gujarat state the dominant families with larger share of medicinal plants are reported in Fabaceae, Asteraceae, Liliaceae, Euphorbiaceae, Apiaceae, Caesalpiniaceae, Apocynaceae, Lamiaceae, Cucurbitaceae, Asclepiadaceae, Malvaceae and Zingiberaceae respectively. The families with larger number of species used by pharmaceuticals for drug preparation is shown in Fig.-3

1.2 Indigenous and imported plants: Each life form was further classified based on natural population / cultivated and their availability in local market or being imported. Out of 316 medicinal plant species, 252 species (79%) are indigenous and 64 species (21%) are imported from elsewhere (Fig.4). Indigenous species are locally available in the state. Out of total 252 indigenous plant species of Gujarat, 198 species (78%) are available from the forest and 54 species (22%) are cultivated in the state (Fig.5). Earlier survey reported 270 medicinal plant are utilized by the pharmacies (Singh and Parabia, 2003). Out of 270 indigenous plants, 201species (74%) are collected from the wild and 69 speceis (26%) are brought from other states.

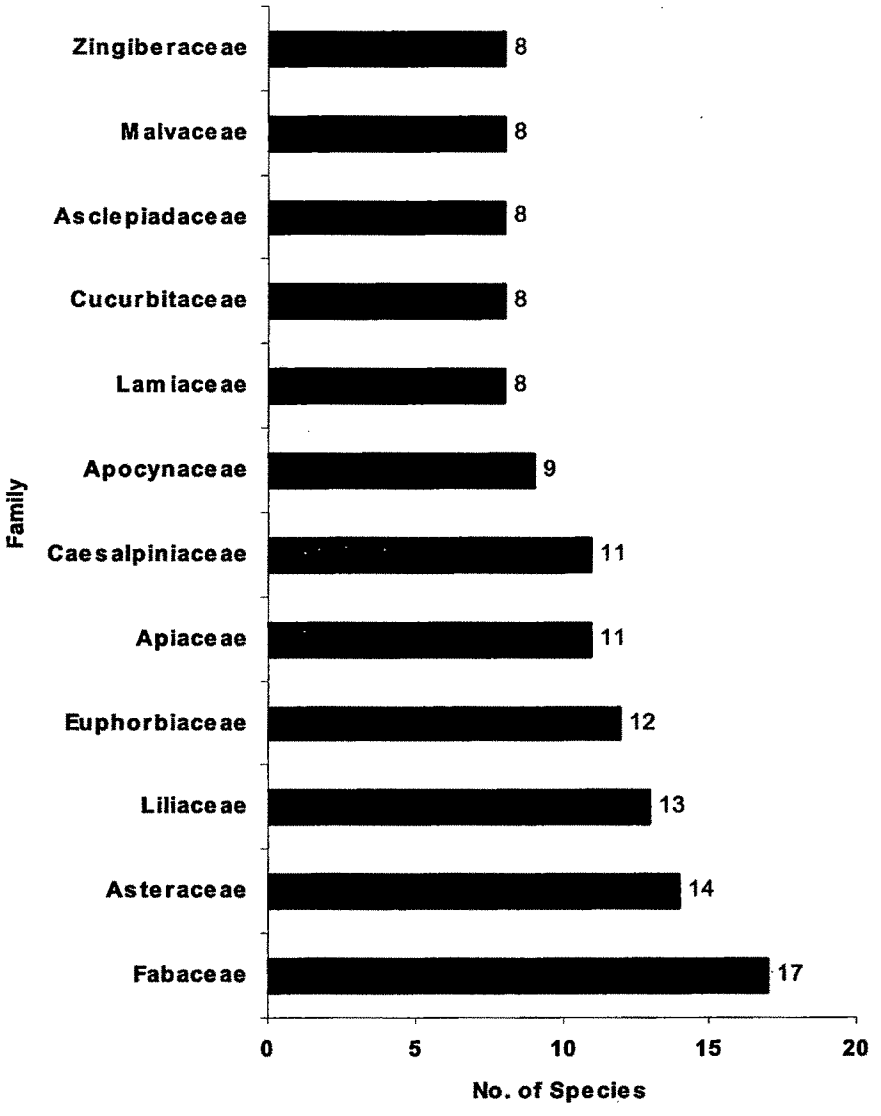


Figure-3: Dominant families with larger share of medicinal plants

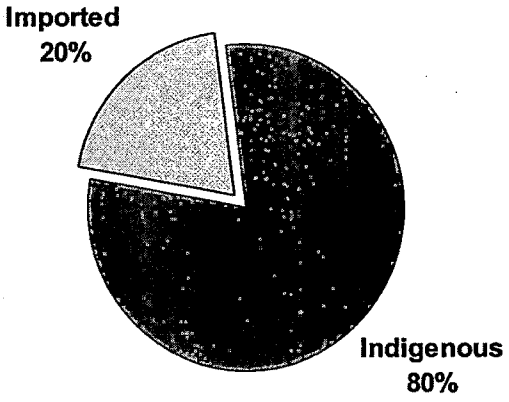


Figure-4: Classification of medicinal plants (as indigenous or imported) used by state pharmacies

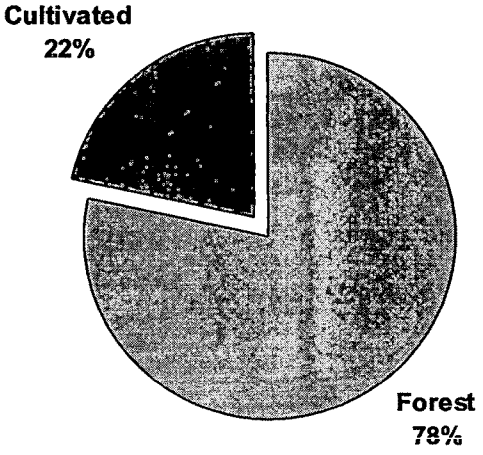


Figure-5: Classification of medicinal plants (as cultivated or growing in forest) used by state pharmacies

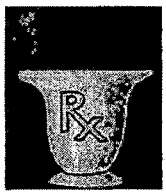
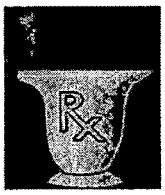


Table- 6: List of medicinal plants cultivated in the state

Sr. No.	Botanical Name	Vernacular Name	Sanskrit Name	Part used
Climbers				
1	*Cucumis sativus*	Kakdi	Sakur	Seeds
2	*Momardica charantia*	Karela	Sushavi	Fruits
3	*Piper betel*	Nagarvel	Nagavalli	Leaves
4	*Piper chaba*	Chavak		Panchang
5	*Trichosanthes dioica*	Kadu-Patol	Patola	Panchang
6	*Vitis vinifera*	Kali draksh	Draksa	Fruits
Herbs				
7	*Agave americana*	Ketki	Kantala	Leaf pulp, Roots
8	*Allium cepa*	Kanda	Palandu	Stem bulb
9	*Allium sativum*	Lasan	Lasuna	Stem bulb
10	*Aloe vera*	Kuvar pato	Ghrita- kumari	Leaf pulp
11	*Alpinia galanga*	Kulinjan	Barakulanjan	Roots
12	*Amorphallus campanulatus*	Suran	Arsaghna	Stem
13	*Anethum graveolens*	Suva	Ahichhatra	Fruits
14	*Apium graveolens*	Ajamo	Yamani	Seeds
15	*Carum carvi*	Shahjiru	Sushavi	Seeds
16	*Carum copticum*	Ajmod	Yavanika	Leaves, Seeds
17	*Catharanthus roseus*	Barmasi	Sangkhaphuli	Leaves, Flowers
18	*Centrartherum anthelminticum*	Kalijiri		Fruits
19	*Corriandrum sativum*	Kothmir	Kustumbari	Fruits
20	*Cuminum cyminum*	Jiru	Ajali	Fruits
21	*Curcuma amada*	Amba haldar	Amrardrakam	Rhizome
22	*Curcuma longum*	Haldar	Karpura-haridra	Rhizome
23	*Curcuma zedoria*	Kachuro	Sati	Rhizome
24	*Cymbopogan martinii*	Rosaghas	Bhustrina	Panchang
25	*Daucus carota*	Gajar	Shikha mualam	Roots
26	*Foeniculum vulgare*	Variyali	Madhurika	Fruits
27	*Hordeum vulgare*	Jav	Yavah	Seeds
28	*Lepidium sativum*	Asariyo	Ashalika	Seeds
29	*Mentha arvensis*	Fudino		Panchang
30	*Ocimum sanctum*	Tulsi	Krishna tulsi	Panchang
31	*Piper longum*	Lindi piper	Pippali	Fruits, Roots
32	*Plantago ovata*	Isaphgul	Snigdhabijah	Seed husk

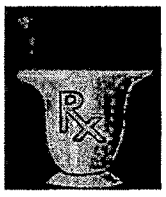


33	*Psoralea coryfolia*	Bawachi	Bakuchi	Seeds
34	*Raphanus sativus*	Mulo	Moolaka	Seeds
35	*Sesamum indicum*	Tal	Pitratarpana	Seeds
36	*Trapa bispinosa*	Singoda	Jalakantaka	Fruits
37	*Trigonella foenum-graceum*	Methi	Methika	Seeds
38	*Zingiber officinale*	Aadu, Shunth	Ardrakam	Rhizome
Shrubs				
39	*Abroma augusta*	Ulat kambal	Pivari	Roots
40	*Cassia angustifolia*	Sonamukhi	Bhumiari	Leaves
41	*Citrus medica*	Bijoru	Matulungah	Fruits
42	*Hibiscus rosa-sinesis*	Jasud	Rudhrapushpa	Flowers
43	*Nerium indicum*	Kanera	Asvamaraka	Roots
44	*Punica granatum*	Dadam	Dadima	Fruits, bark
45	*Rauvolfia serpentina*	Sarapgandha	Sarpagandha	Roots
46	*Ricinus communis*	Diveli	Amanda	Roots, Leaves
Trees				
47	*Carica papaya*	Papaiya	Brahmairandah	Seeds
48	*Cinchona officinalis*	Cinchona	Sinkona	Bark
49	*Citrus acidus*	Limbu		Fruits
50	*Eucalyptus spp.*	Nilgiri	Nilaniryasa	Leaves
51	*Grewia tenax*	Falsa	Dharmana	Fruits
52	*Mangifera indica*	Aambo	Amrah	Fruits
53	*Saccharum officinarum*	Sheradi	Ikshu	Stem
54	*Saraca indica*	Ashok	Asokah	Bark

2. Organoleptic consumption

Owing to the presence of active principle in different parts of the plant, various plant parts are used for specific formulations of the drugs. The plant parts used by the pharmacies were categorized as leaves, roots, fruits, stem, flowers, seed, wood, bark, whole plant and exudate. It was observed that major part of medicinal plant utilized is the roots. The other parts utilized in the descending order are fruits, bark, seeds, leaves, stems, flowers and exudates.

The survey analysis revealed that the consumption of fruits of 64 species, seeds of 110 species, roots and underground parts of 68 species, bark of 47



species, leaves of 33 species, stem and wood of 17 species, flowers of 15 species, exudates of 12 species by the pharmacies (Fig.-6). The whole plant (leaves, stem, fruits, roots and flowers) of 60 species was noted to be used by the pharmacies for

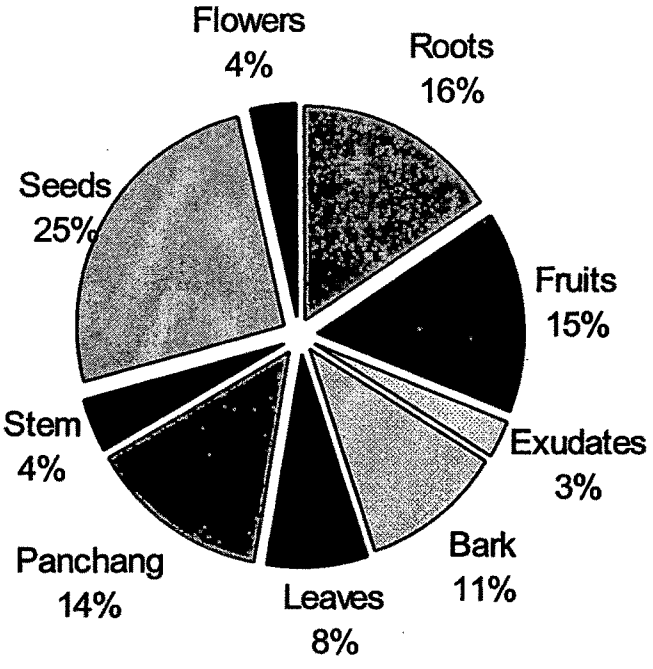
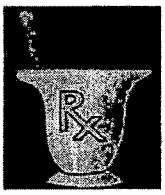


Figure- 6: Different categories of plant parts used by the pharmacies

their formulations. The percentage component of each medicinal plant part in the total bulk of herbal drug clearly indicated that there is heavy pressure on medicinal plant wealth of Gujarat State as most of the plants are harvested from natural populations (forest). Singh and Parabia (2003) reported 45 whole plant species, 65 root and underground species, 24 leaves species, 94 fruits and seeds species, 36 stem and root bark species, 19 stem and wood species, 16 flowers species and 11 species of exudates are used by the Gujarat pharmacies.

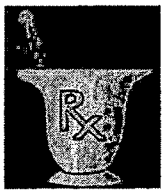


3. Quantity consumed

The information on the annual consumption of raw materials by different state pharmacies was gathered and compiled for individual medicinal plant species. The total consumption of medicinal plant or its part(s), used by the pharmacies was calculated on annual basis. Thus, an estimation of raw materials annually used the Ayurvedic and Pharmaceutical companies in the Gujarat state was established.

Table -7: Annual consumption of medicinal plant roots used by the state pharmacies

Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Climbers			
1	*Asparagus racemosus*	Shatavar	157.89
2	*Boerhaavia diffusa*	Satodi	42.27
3	*Citrullus colocynthis*	Indrayanmool	12.20
4	*Cyclea peltata*	Patha	0.96
5	*Dioscorea bulbifera*	Varahikand	4.73
6	*Gloriosa superba*	Vachnag	4.53
7	*Hemidesmus indicus*	Dudh vel	27.57
8	*Ichnocarpus frutescens*	Kali dudhi	0.001
9	*Ipomoea digitata*	Kshirvidarikand	5.36
10	*Operculina turpetum*	Nashotar	12.41
11	*Puereria tuberosa*	Vidarikand	32.99
12	*Tragia involucrate*	Barhanta	0.001
Herbs			
13	*Aconitum heterophyllum*	Ativish	32.29
14	*Agave americana*	Ketki	0.06
15	*Alpinia galanga*	Kulinjan	4.51
16	*Chlorophytum borivialianum*	Safed moosli	4.56
17	*Chlorophytum tuberosum*	Moosli	6.30
18	*Colchium luteum*	Suranjan	0.01



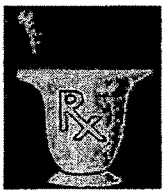
19	*Curculigo orchioides*	Kali musli	10.34
20	*Cyperus rotundus*	Nagarmoth	34.97
21	*Daucus carota*	Gajar	13.95
22	*Desmodium gangeticum*	Salvan	4.66
23	*Desmostachya bipinata*	Darabh	0.30
24	*Eulopia campestris*	Salampanjo	0.07
25	*Fritillaria roylei*	Kakoli	2.95
26	*Glycyrrhiza glabra*	Jethi madh	79.16
27	*Inula racemosa*	Puskarmool	11.70
28	*Nardostachya jatamansi*	Jatamansi	17.68
29	*Picrorhiza kurroa*	Kadu-kutaki	14.95
30	*Piper longum*	Lindi piper	46.16
31	*Pluchea lanceolata*	Rasna	25.83
32	*Plumbago zeylanica*	Chitrak	39.00
33	*Polygonatum cirrhifolium*	Meda	0.91
34	*Polygonum verticillatum*	Mahameda	0.38
35	*Rubia cordifolia*	Majistha	42.25
36	*Sida cordifolia*	Bala dana	19.59
37	*Uraria picta*	Pilvan	3.34
38	*Urena lobata*	Vagadau bhindo	0.001
39	*Vetiveria zizanioides*	Valo, khas	12.60
40	*Withania coagulence*	Kaknaj	0.02
41	*Withania somnifera*	Ashwagandha	287.16
Shrubs			
42	*Abroma augusta*	Ulat kambal	1.41
43	*Baliospermum montanum*	Dantimool	1.97
44	*Calotropis gigantean*	Akado	0.14
45	*Calotropis procera*	Akado	0.03
46	*Clerodendrum phlomodies*	Arni	3.11
47	*Clerodendrum serratum*	Bharangimool	34.63
48	*Ixora coccinea*	Rukmini	0.001
49	*Nerium indicum*	Kanera	0.06
50	*Rauvolfia serpentina*	Sarapgandha	15.51
51	*Ricinus communis*	Diveli	6.80
52	*Saussurea lappa*	Kath, Uplet	4.48
53	*Thevetia nerifolia*	Pile kaner	0.001
54	*Ziziphus mauritiana*	Bor	0.07
Trees			
55	*Aegle marmelos*	Bili	38.05

56	*Alangium salvifolium*	Ankol	1.27
57	*Anogeissus latifolia*	Dhavdo	82.71
58	*Artocarpus integrifolia*	Fanas	1.69
59	*Bixa orellana*	Sinduri	0.01
60	*Butea monosperma*	Keshudo	2.57
61	*Dalbergia latifolia*	Sisum	1.57
62	*Ficus benghalensis*	Vad	1.32
63	*Gmelina arborea*	Sewan	10.72
64	*Haldinia cordifolia*	Kadami	0.04
65	*Oroxylum indicum*	Tetu	1.70
66	*Stereospermum personatum*	Patala	3.80
67	*Streblus asper*	Harero	0.001
68	*Trema orientalis*	Gol, Vanjli	0.0003
Total			**1230.276**

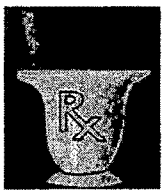
Singh and Parabia (2003) carried out pharmaceutical survey in Gujarat state. They reported 901 (metric tonne) annual consumption of drug obtained from root/underground organs from 65 medicinal plants.

Table- 8: Annual consumption of plant bark used by the state pharmacies

Sr. No.	**Botanical Name**	**Vernacular Name**	**Metric Tonnes**
Climbers			
1	*Bergenia ligulata*	Pashanbhed	13.00
2	*Ventilago denticulata*	Asai, Asvel	0.0002
Shrubs			
3	*Berberis aristata*	Daru-haldi	36.22
4	*Holarrhena antidysenterica*	Indrajav	28.46
5	*Punica granatum*	Dadam	8.99
6	*Salvadora persica*	Khara pilu	1.00
Trees			
7	*Acacia catechu*	Kher	29.59
8	*Acacia nilotica*	Baval	14.48
9	*Aegle marmelos*	Bili	38.05



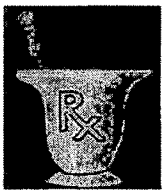
10	*Ailanthus excelsa*	Aduso	0.62
11	*Albizzia lebbeck*	Siris	0.60
12	*Alstonia scholaris*	Sataparni	0.11
13	*Anogeissus latifolia*	Dhavdo	82.71
14	*Bauhina racemosa*	Asitro	0.23
15	*Bauhina variegata*	Kachnar	6.75
16	*Bixa orellana*	Sinduri	0.01
17	*Boswelia serrata*	Kadayo	0.01
18	*Careya arborea*	Vakumbha	0.11
19	*Casearia esculenta*	Saptarangi	1.84
20	*Cedrus deodara*	Devdar	10.41
21	*Cinchona officinalis*	Cinchona	2.42
22	*Cinnamomum tamala*	Tamal Patra	10.78
23	*Crateava nurvala*	Varun chal	5.93
24	*Dalbergia latifolia*	Sisum	1.57
25	*Dolichandrone falcata*	Mattarsingi	0.21
26	*Ficus hispida*	Jangli anjir chal	0.21
27	*Ficus racemosa*	Umbar chhal	18.32
28	*Ficus religiosa*	Pipalo	0.61
29	*Ficus tsiela*	Pipal	0.90
30	*Gmelina arborea*	Sewan	10.72
31	*Haldinia cordifolia*	Kadami	0.04
32	*Melia azedarach*	Bakam limado	1.19
33	*Mimusops elengi*	Bakul	0.84
34	*Moringa concanensis*	Kadvo sargavo	1.35
35	*Moringa oleifera*	Mitho sargavo	2.86
36	*Myrica nagi*	Kaifal	2.03
37	*Oroxylum indicum*	Tetu	1.70
38	*Saraca indica*	Ashok	54.35
39	*Stereospermum personatum*	Patala	3.80
40	*Strychnos nuxvomica*	Zerkuchala	1.95
41	*Symplocos racemosa*	Lodra	16.63
42	*Tecomella undulata*	Ragat Rohido	3.27
43	*Tectona grandis*	Sag	0.70
44	*Terminalia arjuna*	Arjun	50.69
45	*Thespesia populnea*	Paraspiplo	0.82
46	*Wrightia tinctoria*	Kadi kutij	0.41
47	*Wrightia tomentosa*	Dudhlo	0.03
Total			**454.5202**



Singh and Parabia (2003) reported 263 (metric tonne) annual consumption of drug obtained from bark from 36 medicinal plants.

Table-9: Annual consumption of plant leaves used by the state pharmacies

Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Climbers			
1	*Abrus precatorius*	Chanothi	4.36
2	*Coccinia indica*	Kadva ghiloda	0.001
3	*Gymnema sylvestre*	Madhunashini	8.28
4	*Piper betel*	Nagarvel	0.01
5	*Tragia involucrate*	Barhanta	0.001
6	*Tylophora indica*	Damni vel	2.93
Herbs			
7	*Agave americana*	Ketki	0.06
8	*Aloe vera*	Kuvar pato	84.31
9	*Carum copticum*	Ajmod	0.36
10	*Catharanthus roseus*	Barmasi	0.01
11	*Indigofera tinctoria*	Gali indigo	5.20
12	*Ocimum basilicum*	Damro	0.05
13	*Ocimum canum*	Van tulsi	0.001
14	*Phyla nodiflora*	Ratveliyo	0.003
Shrubs			
15	*Calotropis gigantean*	Akado	0.14
16	*Calotropis procera*	Akado	0.03
17	*Cassia angustifolia*	Sonamukhi	111.84
18	*Cassia occidentalis*	Kasundro	3.59
19	*Clerodendrum phlomodies*	Arni	3.11
20	*Ixora coccinea*	Rukmini	0.001
21	*Lawsonia inermis*	Mehndi	6.14
22	*Ricinus communis*	Diveli	6.80
23	*Salvadora persica*	Khara pilu	1.00
24	*Vitex negundo*	Nagod	6.21
Trees			
25	*Alstonia scholaris*	Sataparni	0.11
26	*Annona squamosa*	Sitafal	0.53
27	*Cassia fistula*	Garmalo	5.82

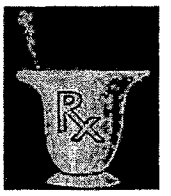


28	*Cinnamomum tamala*	Tamal Patra	10.78
29	*Cinnamomum zeylanicum*	Taj	0.36
30	*Eucalyptus spp.*	Nilgiri	36.75
31	*Murraya koenigii*	Kadipatto	0.001
32	*Putranjiva roxburghii*	Putranjivi	3.00
33	*Wrightia tinctoria*	Kadi kutij	0.41
Total			**302.198**

Singh and Parabia (2003) reported 302 (metric tonne) annual consumption of drug obtained from leaf from 24 medicinal plants.

Table-10: Annual consumption of medicinal plant seeds used by the state pharmacies

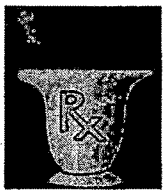
Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Climbers			
1	*Abrus precatorius.*	Chanothi	4.36
2	*Caesalpinia crista*	Kachka	0.04
3	*Celastrus paniculata*	Malkagni	6.63
4	*Clitoria ternatea*	Garni	0.05
5	*Cucumis sativus*	Kakdi	0.12
6	*Mucuna prurita*	Kaucha	103.79
Herbs			
7	*Abelmoschus moschatus*	Muskdana	1.00
8	*Amomum subulatum*	Elcho	1.11
9	*Apium graveolens*	Ajamo	6.24
10	*Blepharis edulis*	Utigan beej	0.01
11	*Cannabis sativa*	Bhang	0.12
12	*Carum carvi*	Shahjiru	0.92
13	*Carum copticum*	Ajmod	0.36
14	*Carum roxburghii*	Bodi ajmod	0.80
15	*Cassia tora*	Kuvadio	1.49
16	*Cichorium intybus*	Chikory	8.70
17	*Datura innoxia*	Dhaturo	28.39
18	*Elletaria cardamomum*	Elaichi	8.00



19	*Hordeum vulgare*	Jav	0.08
20	*Hyoscyanus niger*	Khursaniajamo	9.42
21	*Lepidium sativum*	Asariyo	0.68
22	*Linum usitatissimum*	Alsi	0.01
23	*Nelumbo nucifera*	Kamal	1.71
24	*Nigella sativa*	Kalonji	2.18
25	*Papaver somniferum*	Khaskhas	0.44
26	*Plantago ovata*	Isaphgul	101.30
27	*Psoralea coryfolia*	Bawachi	18.96
28	*Raphanus sativus*	Mulo	3.65
29	*Sesamum indicum*	Tal	41.40
30	*Trigonella foenum-graceum*	Methi	6.98
Shrubs			
31	*Abutilon indicum*	Khapat	5.86
32	*Cassia occidentalis*	Kasundro	3.59
33	*Holarrhena antidysenterica*	Indrajav	28.46
34	*Lawsonia inermis*	Mehndi	6.14
35	*Salvadora persica*	Khara pilu	1.00
Trees			
36	*Alangium salvifolium*	Ankol	1.27
37	*Annona squamosa*	Sitafal	0.53
38	*Areca catechu*	Sopari	0.41
39	*Artocarpus integrifolia*	Fanas	1.69
40	*Bixa orellana*	Sinduri	0.01
41	*Carica papaya*	Papaiya	3.10
42	*Eugenia jaambolana*	Jambu	17.67
43	*Pongamia pinnata*	Karanj	8.75
44	*Strychnos nuxvomica*	Zerkuchala	1.95
45	*Strychnos potatorum*	Nirmal	0.004
46	*Wrightia tinctoria*	Kadi kutij	0.41
Total			**439.784**

Table-11: Annual consumption of plant based stem used by the state pharmacies

Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Climbers			
1	*Cissus quandrangularis*	Hadsankal	1.03

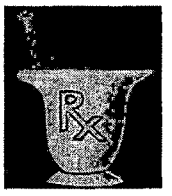


2	*Operculina turpetum*	Nashotar	12.41
Herbs			
3	*Allium cepa*	Kanda	0.75
4	*Allium sativum*	Lasan	3.09
5	*Amorphallus campanulatus*	Suran	1.03
6	*Euphorbia hirta*	Lal dudhi	0.003
7	*Lilium polyphylum*	Kshirkakoli	0.21
8	*Malaxis acuminata*	Jivak	0.04
9	*Malaxis muscifera*	Rushbhak	0.03
10	*Rubia cordifolia*	Majistha	42.25
11	*Spilanthes acmella*	Marethi	13.20
Trees			
12	*Acacia catechu*	Kher	29.59
13	*Bambusa arundinacea*	Katris bans	5.09
14	*Garcinia morella*	Revanchini	0.07
15	*Gmelina arborea*	Sewan	10.72
16	*Prunus cerasoides*	Padam kast	0.95
17	*Saccharum officinarum*	Sheradi	4.65
Total			**125.33**

Singh and Parabia (2003) reported 300 (metric tonne) annual consumption of drug obtained from stem and wood from 19 medicinal plants.

Table-12: Annual consumption of whole plant (Panchang) by state pharmacies

Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Climbers			
1	*Argyreia speciosa*	Samudrashosh	3.62
2	*Clematis triloba*	Morvel	0.31
3	*Leptadenia reticulata*	Dodi	65.83
4	*Piper chaba*	Chavak	10.65
5	*Sarcostema acidum*	Som vel	7.37
6	*Tinospora cordifolia*	Gado	262.47
7	*Trichosanthes cucumerina*	Patol patra	2.98
8	*Trichosanthes dioica*	Kadu-Patol	1.44



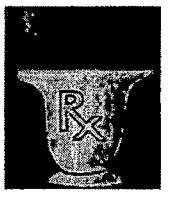
9	*Viola odorato*	Banfasa	1.52
Herbs			
10	*Achyranthes aspera*	Ahgedo	11.55
11	*Alhagi pseudalhagi*	Javaso	4.43
12	*Amaranthus lividus*	Tandaljo	0.03
13	*Anacylus pyrethrum*	Akalkaro	10.11
14	*Andrographis paniculatas*	Kalmegh	25.94
15	*Argemone mexicana*	Darudi	4.27
16	*Bacopa monnieri*	Brahmi	20.48
17	*Barleria prionitis*	Kantasheriyo	2.00
18	*Cassia absus*	Chimed	0.25
19	*Cassia auriculata*	Aval	1.21
20	*Centella asiatica*	Kar Brahmi	15.48
21	*Convolvulus microphyllus*	Shankhavali	26.93
22	*Cymbopogan martinii*	Rosaghas	0.04
23	*Cynodon dactylon*	Dharo	0.21
24	*Eclipta alba*	Bhangaro dhodo	58.58
25	*Eclipta prostrata*	Bhangaro kado	25.26
26	*Enicostema littorale*	Mamejavo	75.40
27	*Evolvulus alsinoides*	Kali shankhavali	3.88
28	*Fagonia cretica*	Dhamaso	3.55
29	*Fumaria indica*	Pittapapado	7.24
30	*Hygrophila auriculata*	Aekharo	0.53
31	*Leucas cephalotes*	Kubo	0.01
32	*Mentha arvensis*	Fudino	103.21
33	*Merremia tridentata*	Bhinigario	0.36
34	*Mimosa pudica*	Lajamni	0.52
35	*Ocimum gratissimum*	Ram tulsi	0.001
36	*Ocimum sanctum*	Tulsi	58.54
37	*Origanum majorana*	Maruva	0.07
38	*Oxalis corniculata*	Amrul sak	0.001
39	*Pedalium murex*	Ubhu Gokharu	0.51
40	*Pergularia daemia*	Nagalandu dheli	0.001
41	*Peristrophe bicalyculata*	Anghedi	0.07
42	*Phaseolus trilobus*	Moongparni	0.32
43	*Phyllantus fraternus*	Bhoi amli	23.51
44	*Sida spinosa*	Mahabala	0.01
45	*Sida veronicaefolia*	Nagbala	0.21
46	*Solanum indicum*	Ubhi bhoiringani	0.07
47	*Solanum suranttense*	Bethi bhoiringni	28.77

48	*Taraxacum officinale*	Dulal burau	0.00
49	*Tephrosia purpurea*	Sharpankho	39.25
50	*Teramnus labialis*	Mash parni	1.62
51	*Tribulus terrestris*	Gokharu	95.82
52	*Tridax procumbens*	Pardesi bhangaro	0.01
Shrubs			
53	*Adhatoda vasica*	Ardusi	122.92
54	*Anisomeles malabarica*	Runchhalo	0.001
55	*Barleria sepiaria*	Kanta	0.06
56	*Euphorbia nerifolia*	Thor	1.00
57	*Jasminum auriculatum*	Jui, Champa	1.01
58	*Saussurea lappa*	Kath, Uplet	4.48
Trees			
59	*Azadiracta indica*	Limdo	162.43
60	*Swertia chirata*	Kariyatu	23.20
Total			**1321.544**

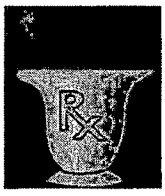
Singh and Parabia (2003) reported 789 (metric tonne) annual consumption of drug obtained from whole plants from 45 medicinal plants.

Table-13: Annual consumption of medicinal plant fruits by the state pharmacies for formulations

Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Climbers			
1	*Acacia concinna*	Shikakai	1.00
2	*Aristolochia bracteolate*	Kidamari	3.50
3	*Luffa echinata*	Kukardvel	0.001
4	*Momardica charantia*	Karela	10.31
5	*Piper nigrum*	Kalimari	61.30
6	*Scindapsus officinalis*	Gajpiper	2.15
7	*Trichosanthes tricuspidata*	Kakanasha	0.001
8	*Vitis vinifera*	Kali draksh	6.54
Herbs			



9	*Anethum graveolens*	Suva	12.00
10	*Asteracantha longiifolia*	Akhro	0.70
11	*Centrartherum anthelminticum*	Kalijiri	0.002
12	*Corriandrum sativum*	Kothmir	8.85
13	*Cuminum cyminum*	Jiru	16.02
14	*Foeniculum vulgare*	Variyali	3.95
15	*Ocimum canum*	Van tulsi	0.001
16	*Piper longum*	Lindi piper	46.16
17	*Solanum nigrum*	Kakamasi	0.42
18	*Sphaeranthus indicus*	Gorakhmundi	7.51
19	*Trapa bispinosa*	Singoda	0.01
20	*Veronia anthelmintica*	Kalijiri	4.57
Shrubs			
21	*Capparis sepiaria*	Kanthar	0.99
22	*Citrus medica*	Bijoru	0.05
23	*Embelia ribes*	Vavding	25.27
24	*Gardenia resinifera*	Dikamari	1.04
25	*Helicteres isora*	Mardasingi	18.54
26	*Jatropha curcas*	Safed Arando	1.31
27	*Punica granatum*	Dadam	8.99
28	*Thevetia nerifolia*	Pile kaner	0.001
29	*Xeromphis spinosa*	Mindhal	0.01
Trees			
30	*Adansonia digitata*	Gorakh amli	0.41
31	*Aegle marmelos*	Bili	38.05
32	*Anogeissus latifolia*	Dhavdo	82.71
33	*Artocarpus integrifolia*	Fanas	1.69
34	*Averrhoa carambola*	Kamrakh	0.001
35	*Buchanania lanzan*	Charoli	2.06
36	*Cassia fistula*	Garmalo	5.82
37	*Citrus acidus*	Limbu	15.46
38	*Citrus aurantifolia*	Santra	0.61
39	*Cocus nucifera*	Nariyeli	29.12
40	*Crateava nurvala*	Varun chal	5.93
41	*Croton tiglium*	Jamalgota	0.80
42	*Diosypros malabarica*	Timru	0.01
43	*Elaeocarpus ganitrus*	Rudraksha	0.21
44	*Emblica officinalis*	Ambla	375.85
45	*Feronia limonia*	Kotha	0.04

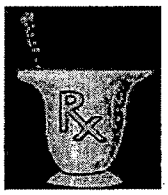


46	*Ficus hispida*	Jangli anjir chal	0.21
47	*Garcinia indica*	Kokam	8.09
48	*Garcinia pendulata*	Amalvetas	1.84
49	*Grewia tenax*	Falsa	0.07
50	*Juglans regia*	Akharot	0.56
51	*Madhuca indica*	Mahudo	0.03
52	*Mallotus philippensis*	Kapilo	3.66
53	*Mangifera indica*	Aambo	0.67
54	*Moringa concanensis*	Kadvo sargavo	1.35
55	*Moringa oleifera*	Mitho sargavo	2.86
56	*Myristica fragrans*	Jaifal	5.68
57	*Phoenix dactylifera*	Khajur	0.03
58	*Putranjiva roxburghii*	Putranjivi	3.00
59	*Sapindus laurifolius*	Aritha	12.16
60	*Semecarpus anacardium*	Bhilamo	1.12
61	*Tamarindus indicus*	Khati Amli	1.94
62	*Tectona grandis*	Sag	0.70
63	*Terminalia bellerica*	Baheda	99.22
64	*Terminalia chebula*	Harade	214.70
Total			**1157.857**

Singh and Parabia (2003) reported 1051 (metric tonne) annual consumption of drug obtained from fruits and seeds 94 medicinal plants.

Table-14: Annual consumption of medicinal plant as flowers by the state pharmacies

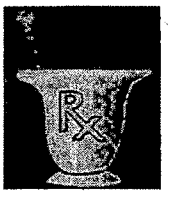
Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Herbs			
1	*Catharanthus roseus*	Barmasi	0.01
2	*Crocus sativus*	Keshar	0.02
3	*Helianthus annus*	Surajmukhi	0.30
4	*Linum usitatissimum*	Alsi	0.01
5	*Nelumbo nucifera*	Kamal	1.71
6	*Nymphaea stellata*	Nil kamal	0.20
Shrubs			



7	*Callicarpa macrophylla*	Priyanguful	0.02
8	*Hibiscus rosa-sinesis*	Jasud	1.63
9	*Nyctanthes arbortristis*	Parijat	0.001
10	*Rosa centifolia*	Gulab	0.25
11	*Woodfordia furticosa*	Dhavdi	11.60
Trees			
12	*Eugenia caryophyllata*	Laving	0.5
13	*Madhuca indica*	Mahudo	0.03
14	*Meusa ferrea*	Nagkeshar	13.22
15	*Myristica fragrans*	Jaifal	0.568
Total			**30.069**

Table-15: Annual consumption of plant exudate by the state pharmacies for drug preparations

Sr. No.	Botanical Name	Vernacular Name	Metric Tonnes
Herbs			
1	*Ferula narthrex*	Hing	3.13
Shrubs			
2	*Commiphora myrrha*	Hirabol	28.37
3	*Commiphora wightii*	Guggul	69.21
Trees			
4	*Acacia nilotica*	Baval	14.48
5	*Aquilaria agallocha*	Kala agar	1.46
6	*Bombax ceiba*	Simlo	3.84
7	*Cinnamomum camphora*	Kapur	4.96
8	*Pistacia integerrima*	Kakadashingi	8.84
9	*Pistacia lentiscus*	Rumimastaki	0.25
10	*Quercus infectoria*	Mayufal	1.37
11	*Shorea robusta*	Sal, Ralgum	38.00
12	*Sterculia urens*	Kada	19.20
Total			**193.11**

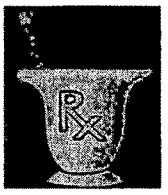


4. Place and agency for procurement

The respondents did not furnish information about the method and source of the procurement of raw materials. The general response received was that the raw material and extract form was procured from the markets in Ahmedabad, Mumbai, Delhi, Chennai, Unjha, Amristsar, Sojitra, Surat, Neemuch, Gandevi, Dehradun and local markets. Further, many of the pharmacies were found to be the associated company or set up. Thus, individual pharmacy owner provided data of only one of the associated pharmacy group. Same type of survey was also carried out in Western Rajasthan by Kumar et al, (2005). They revealed enormous differences in selling rates in the various markets for the same species. Same comparison of selling rates of herbals in Delhi has been reported earlier (Anonymous, 2003). Kumar et al, (2005) revealed that knowing the sale price was possible but its purchase price was never revealed. Disscussion with various traders revealed that the difference between procurment and sale price of herbals could range from 15-25%.

5. Plants cultivation by the pharmacy

The pharmacies were not much honed for backward intervention for herbal cultivation. Very few pharmacies had their own cultivation for some selected species. For the sake of generating goodwill among the consumers, or to utilize their surplus land, they seemed to undertake cultivation of medicinal plants. Few pharmacies had also undertaken contract farming for selected species. Most of the pharmacies procured required raw materials in powder or extract forms. Based on the survey the highly consumed cultivated plants identified are - *Plantago ovata,*



Aloe vera, Zingiber officinale, Piper longum, Cassia angustifolia, Eucalyptus spp, Mentha viridis, Curcuma longa, Ocimum sanctum and *Sesamum indicum.*

6. Plants in short supply

The respondents seemed to procure their requirements easily from the local markets, or else where for which they restricted to furnish the source. It was noted that they carried out their production even with the help of the substitutes. Few respondents short-listed the medicinal plants, which they found in short supply. According to Planning Commission and National Medicinal Plants Board, Government of India, the medicinal plants in short supply and quantity and prioritized species for research and development in India are mentioned in the Table-16.

Table-16: Plants in short supply in India and Gujarat

Sr. No.	Botanical Name	Vernacular Name	Species in short supply (India)[a]	Species in short supply (Gujarat)[b]
1	*Acacia catechu* (L. f.) Willd.	Khair	√	
2	*Aconitum ferox* Wall.	Vatsnabh	-	
3	*Aconitum heterophyllum* Wall.	Atees	√*	√
4	*Aegle marmelos* (L.) Correa	Bel	-*	
5	*Alpinia galanga* (L.) Willd.	Kulanjan	√	
6	*Andrographis paniculata* (Burm. f.) Wall.	Kalmegh	-*	
7	*Aquilaria agallocha* Roxb.			√
8	*Aquillaria malaccensis* Lamk.	Agaru	√	
9	*Artemisia maritima* L.	Kunja	√	√
10	*Asparagus racemosus* Willd.	Shatavari	-*	
11	*Bacopa monnieri* (L.) Penn.	Brahmi	-*	
12	*Baliospermum montanum* Willd.			√
13	*Berberis aristata* L.			√
14	*Berberis aristata* DC.	Kingora	-*	√
15	*Cassia angustifolia* Vahl	Senna	-*	
16	*Cedrus deodara* (Roxb. Ex D. Don) G. Don			√
17	*Chlorophytum tuberosum* Bak.	Safed musli	-*	

18	*Coleus barbatus* Benth.	Patharchur	-*	
19	*Commiphora myrrha*			√
20	*Commiphora wightii* (Arn.) Bhandari	Guggul	√*	√
21	*Convolvulus arvensis.*			√
22	*Crocus sativus* L.	Kesar	-*	
23	*Curculigo orchioides* Gaerten.	Kali musli	√	√
24	*Curcuma zedoaria* (Christ) Rosc.	Kachora	√	√
25	*Dioscorea bulbifera* L.			√
26	*Embelia ribes* Burm. f.	Jheum	-*	√
27	*Garcinia indica* Choisy	Kokam	-*	
28	*Gloriosa superba* L.	Kalihari	-*	
29	*Glycyrrhiza glabra* L.	Mulethi	-*	
30	*Gymnema sylestre* (Retz.) R. Br.	Gudmar	-*	
31	*Hemidesmus indicus* (L.) Br.	Anantmul	√	√
32	*Inula racemosa* Hook. f.			√
33	*Leptadenia reticulata*			√
34	*Mallotus philippensis* Muell. -Arg.	Kamela	√	√
35	*Mesua ferrea* L.			√
36	*Myrica esculenta* Ham. ex Don	Kaphal	√	√
37	*Myristica fragrans* Hoult.	Jaiphal	√	√
38	*Nardostachys jatamansi* (Don) DC.	Jatamansi	√*	√
39	*Nelumbo nucifera* Gaertn.	Kamalphool	√	√
40	*Ocimum sanctum* L.	Tulsi	-*	
41	*Phyllanthus amarus* Schum & Thonn	Bhui amla	-*	
42	*Phyllanthus emblica* L.	Amla	-*	
43	*Picrorhiza kurroa* Benth.	Katuki	√*	√
44	*Piper cubeba* L. f.	Kabab chini	√*	√
45	*Piper longum* L.	Pippal	-*	√
46	*Piper nigrum* L.			√
47	*Pistacia chinensis* Bunge	Kakadshingi	√	√
48	*Plantago major* L.	Isabgol	-*	
49	*Plumbago zeylanica* L.			√
50	*Pterocarpus santalinum* L.f.			√
51	*Rauvolfia serpentina* (L.) Benth. ex Kurz.	Sarpagandha	-*	
52	*Rubia cordifolia* L.			√
53	*Santalum album* L.	Chandan	-*	
54	*Saraca asoca* (Roxb.) De Wilde	Ashok	√*	√
55	*Saussurea costus* (Falc.) Lipsch.	Kut	√*	
56	*Saussurea lappa* C. B. Clarke			√
57	*Sida cordifolia* L.			√
58	*Smilex* sp	Chopchini	√	√
59	*Solanum indicum* L.			√

60	*Salanum nigrum* L.	Makoy	-*	
61	*Swertia chirayita* (Roxb. ex Flem.) Karsten.	Chirata	√*	√
62	*Tecoma undulata*			√
63	*Tinospora cordifolia* (L.) Merr.	Giloe	-*	
64	*Valeriana jatamansi* Jones	Tagar	√	
65	*Vetiveria zinzanioides* (L.)Nash			√
66	*Wagatia spicata*			√
67	*Withania somnifera* (L.) Dunal	Ashwagandha	-*	
68	*Wrightia tinctoria* Br.	Indrajava	√	√

[a] Medicinal plants in short supply and quantity required according to the Planning Commission, Government of India

[b] Present survey analysis

* Prioritized species of medicinal plants for research and development according to the National Medicinal Plants Board, Government of India

\- Not known

7. Imported plant species

Most of the respondents had the views that the medicinal plants, which were not available from Gujarat, could be availed from the local markets or through the extractors (Table-17).

Table-17: List of medicinal plant imported (cultivated and wild source) procured by Gujarat pharmacies from the other states

Sr.No.	Botanical Name	Vernacular Name	Type	Part Used
Cultivated				
1	*Aconitum heterophyllum*	Ativish	Herbs	Roots
2	*Acorus calamus*	Safed bach	Herbs	Rhizome
3	*Amomum subulatum*	Elcho	Herbs	Seeds
4	*Anacylus pyrethrum*	Akalkaro	Herbs	Panchang
5	*Areca catechu*	Sopari	Tree	Seeds
6	*Berberis aristata*	Daru-haldi	Shrubs	Bark
7	*Callicarpa macrophylla*	Priyanguful	Shrubs	Flowers
8	*Cannabis sativa*	Bhang	Herbs	Seeds

9	*Carum roxburghii*	Bodi ajmod	Herbs	Seeds
10	*Cinnamomum zeylanicum*	Taj	Tree	Leaves
11	*Colchium luteum*	Suranjan	Herbs	Roots
12	*Crocus sativus*	Keshar	Herbs	Stigma
13	*Croton tiglium*	Jamalgota	Tree	Fruits
14	*Elletaria cardamomum*	Elaichi	Herbs	Seeds
15	*Eugenia caryophyllata*	Laving	Tree	Flower bud
16	*Eulopia campestris*	Salampanjo	Herbs	Roots
17	*Ferula narthrex*	Hing	Herbs	Gum
18	*Fritillaria roylei*	Kakoli	Herbs	Roots
19	*Garcinia pendulata*	Amalvetas	Tree	Fruits
20	*Glycyrrhiza glabra*	Jethi madh	Herbs	Roots
21	*Hedychium spicatum*	Kapur kachali	Herbs	Rhizome
22	*Hyoscyanus niger*	Khursaniajamo	Herbs	Seeds
23	*Inula racemosa*	Puskarmool	Herbs	Roots
24	*Jasminum auriculatum*	Jui, Champa	Shrubs	Panchang
25	*Lilium polyphylum*	Kshirkakoli	Herbs	Bulbs
26	*Malaxis acuminata*	Jivak	Herbs	Stem
27	*Malaxis muscifera*	Rushbhak	Herbs	Stem
28	*Myristica fragrans*	Jaifal	Tree	Fruits, Flowers
29	*Nigella sativa*	Kalonji	Herbs	Seeds
30	*Papaver somniferum*	Khaskhas	Herbs	Seeds
31	*Picrorhiza kurroa*	Kadu-kutaki	Herbs	Roots
32	*Piper nigrum*	Kalimari	Climbers	Fruits
33	*Pluchea lanceolata*	Rasna	Herbs	Roots
34	*Polygonatum cirrhifolium*	Meda	Herbs	Roots
35	*Polygonum verticillatum*	Mahameda	Herbs	Roots
36	*Rosa centifolia*	Gulab	Shrubs	Flowers
37	*Saussurea lappa*	Kath, Uplet	Shrubs	Panchang
38	*Scindapsus officinalis*	Gajpiper	Climbers	Fruits
39	*Swertia chirata*	Kariyatu	Tree	Panchang
40	*Valeriana jatamansi*	Tagargantha	Herbs	Rhizome
41	*Viola odorato*	Banfasa	Climbers	Panchang
42	*Withania coagulence*	Kaknaj	Herbs	Roots
Wild Source				
43	*Aquilaria agallocha*	Kala agar	Tree	Resinous wood
44	*Bergenia ligulata*	Pashanbhed	Climbers	Bark
45	*Cedrus deodara*	Devdar	Tree	Bark
46	*Cinnamomum camphora*	Kapur	Tree	Deposition of cells

47	*Cinnamomum tamala*	Tamal Patra	Tree	Bark, leaves
48	*Commiphora myrrha*	Hirabol	Shrubs	Gum
49	*Elaeocarpus ganitrus*	Rudraksha	Tree	Fruits
50	*Garcinia indica*	Kokam	Tree	Fruits
51	*Garcinia morella*	Revanchini	Tree	Stem
52	*Juglans regia*	Akharot	Tree	Fruits
53	*Meusa ferrea*	Nagkeshar	Tree	Flowers
54	*Myrica nagi*	Kaifal	Tree	Bark
55	*Nardostachya jatamansi*	Jatamansi	Herbs	Roots
56	*Pistacia integerrima*	Kakadashingi	Tree	Galls
57	*Pistacia lentiscus*	Rumimastaki	Tree	Resins
58	*Prunus cerasoides*	Padam kast	Tree	Stem
59	*Pterocarpus santalinus*	Lal chandan	Tree	Stem (Heart wood)
60	*Rubia cordifolia*	Majistha	Herbs	Roots, Stem
61	*Shorea robusta*	Sal, Ralgum	Tree	Oleo-gum resin
62	*Smilax zeylanica*	Chopchini	Climbers	Rhizome
63	*Strychnos nuxvomica*	Zerkuchala	Tree	Seeds, Bark
64	*Symplocos racemosa*	Lodra	Tree	Bark

Respondents were not keen for disclosing the raw materials being procured through import from other states but they readily furnished the details about the drug, which they exported to other countries. Singh and Parabia (2003) reported 25 species (217 Metric tonne) being imported from the wild and 44 species (271 Metric tonne) from the cultivated. According to their survey *Shorea ro*busta, *Nardostachys jatamansi* and *Aconitum heterophyllum* are largely imported from the wild source and *Piper nigrum* and *Glychrrhiza glabra* are largely imported from the cultivated source in the state.

8. Export potential

Annual export trends in medicinal plants and Ayurvedic products of India over past four financial years from 1999-2003 (Fig.-7) shows rise in manufacturing of ayurvedic products (Prahalathan, 2004). Kumar et al, (2005) reported 12 species

which are dominantly traded and exported. Rawat and Garg (2005) listed few medicinal plants, which carry substantial export potential. They are *Plantago ovata, Vinca rosea, Aloe vera, Garcinia cambogia, Gymnema sylestre, Ocimum sanctum, Picrorhiza kurroa, Phyllanthus nirula* and *Holarrhena antidysenterica.* Some of these are in demand as crude drgs, drug produce or for their active principle. Out of the listed medicinal plants for export, few are already found wild in Gujarat and rests are cultivated. They also have listed 22 medicinal plants, which are exported from India.

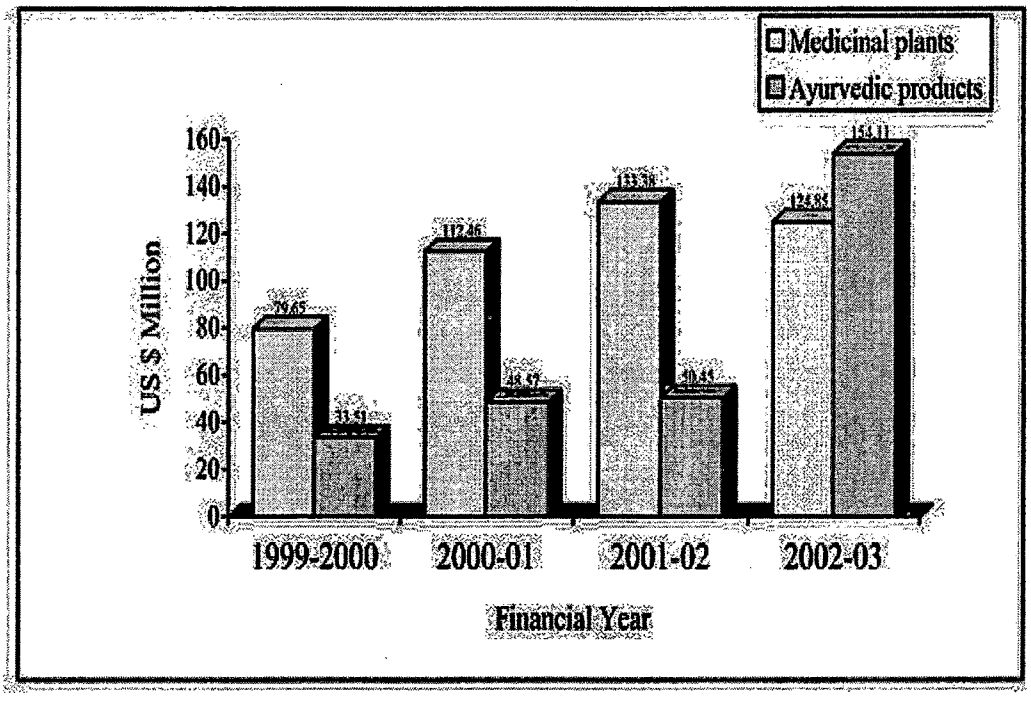


Figure- 7: Annual exports trends in medicinal plants and Ayurvedic products of India over past four financial years

9. Highly consumed medicinal plants in Gujarat pharmacies

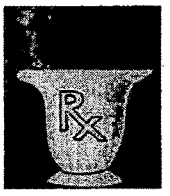
Herbs: *Aconitum heterophyllum, Aloe vera, Bacopa monnieri, Centella asiatica, Cichorium intybus, Convolvulus microphyllus, Curcuma longa, Cyperus rotundus,*

Datura innoxia, Eclipta alba, Enicostema littorale, Glycyrrhiza glabra, Hysocynus niger, Mentha arvensis, Nardostachys jatamansi, Ocimum sanctum, Pistacia integerrima, Plantago ovata, Plumbago zeylanica, Psoralea coryfolia, Rubia cordifolia, Sesamum indicum, Solanum surattense, Spillanthus acmella, Tephrosia purpurea, Tribulus terrestris, Withania somnifera and *Zingiber officinale.*

Shrubs: *Adhatoda vasica, Berberis aristata, Cassia angustifolia, Clerodendrum serratum, Commiphora myrrha, Commiphora wightii, Embelia ribes, Helicteres isora, Holarrhena anti-dysenterica, Punica granatum, Rauvolfia serpentina* and *Woodfordia fruticosa.*

Trees: *Acacia catechu, Acacia nilotica, Aegle marmelos, Anogeissus latifolia, Azadirachta indica, Cinnamomum tamala, Cocos nucifera, Emblica officinalis, Eucalyptus sps., Eugenia caryophyllata, Eugenia jaambolana, Ficus racemosa, Gmelina arborea, Mallotus philippensis, Mesua ferea, Myristica fragrens, Pongamia pinnata, Pterocarpus santalinus, Saccharum officinarum, Santalum album, Saraca indica, Shorea robusta, Sterculia urens, Swertia chirata, Symplocos racemosa, Terminalia arjuna, Terminalia bellirica* and *Terminalia chebula.*

Climbers: *Asparagus racemosus, Bergenia ligulata, Boehaavia diffusa, Citrullus colocynthis, Gymnema sylvestre, Hemidesmus indicus, Leptadenia reticulata, Mucuna prurita, Operculina turpethum, Piper chaba, Piper longum, Piper nigrum, Pueraria tuberosa, Sarcostemma acidum, Tinospora cordifolia* and *Trichosanthes cucumerina.*



The survey of the purchase and sale price of different herbals has been also carried out by Kumar et al, (2005) in four districts of arid western Rajasthan made by visting traders and have listed 131 ethnomedicinal plants in their work. Earlier Kumar and Parven (2000) have reported 65 taxa as household remedies, 34 as traditional system of Ayurveda and 17 as commercialized remedies.

10. WTO implementation

With reference to their views on WTO agreements and its implementation including implications seemed to be a very difficult question to the pharmacies. Many of them were not even aware of it, few did have some information but still were waiting for agreement to be an order. Few pharmacies had kept the issue into consideration and have started into ways of its implementation. Very few pharmacies have started following GLP and GMP practices.

11. Ayurvedic preparations

The details on plant parts used in the ayurvedic preparations were gathered from the industries. Earlier Kapoor and Mitra (1976) had listed 1674 pharmaceutical preparations from 542 medicinal plants in their survey of 160 leading pharmaceutical companies of India and listed medicinal plants of higher order used in ayurvedic preparations. Intensely used medicinal plants were compiled based on the formulations prepared by pharmacies (Table- 18). While Rawat and Garg, (2005) have listed the occurrence of medicinal plants in 1,145 important herbal formulations in India.

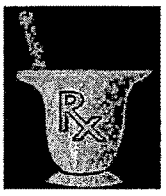


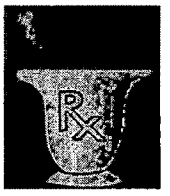
Table-18: Medicinal plants of intense use in Ayurvedic preparations

Sr. No.	Botanical Name	Medicinal Plant	Used in no.of formulations.	
			Kapoor and Mitra (1976)	Rawat and Garg (2005)
1	*Acorus calamus* Linn.	Vacha	51	-
2	*Adhatoda vasica* Nees.	Vasaka	110	110
3	*Aegle marmelos* Correa.	Bael	60	-
4	*Boerhavia diffusa* Linn.	Punarnava	52	52
5	*Cyperus rotundus* Linn.	Musta	102	102
6	*Saraca asoca* Roxb.	Ashoka	55	
7	*Glycyrrhiza glabra* Linn.	Yastimadhu	141	141
8	*Hemidesmus indicus*	Sariva	55	
9	*Holarrhena antidysenterica* Wall.	Kutaja	59	59
10	*Piper longum* Linn.	Pippali	133	135
11	*Emblica officinalis* Gaertn	Amla	209	219
12	*Terminalia bellirica* Roxb.	Baheda		
14	*Terminalia chebula* Retz.	Harde		
15	*Tinospora cordifolia* Miers.	Gulancha	88	88
16	*Tribulus terrestris* Linn.	Gokharu	65	65
17	*Berberis aristata*	Daruharida	-	65
18	*Withania somnifera* Dunal.	Ashwagandha	109	109

12. Problems encountered by Ayurvedic companies

i. The price at which the raw materials are available to the pharmacies is very high. This results in increasing the cost of production of formulations.

ii. Some pharmacies even face quality problems as they lack in-depth awareness on processing techniques. For example: the fruits of *Terminalia chebula* where seven varieties originating from different parts of India have been attributed with different types of therapeutic properties (Pandey and Chunekar, 1995). This is likely to be due to effect of physical, agroecological conditions and



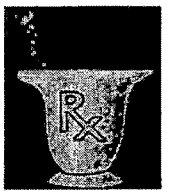
locality factors on the therapeutic properties and compositions of physiologically active consitituents of crude drug.

iii. Many a times, adulteration of raw material is found which hinders the quality of the drug.

iv. Small companies suffer a lot due to non-availability of standards to check their products.

v. Identification of plants is also a serious problem. The problems get more compounded as many plants have the same name. The identity of the botanical source of the components of some plant is still unknown or highly debated. The common example is Murva, Ashtavarga, Granthiparni, Gajpippali and many more. The source of Pashanbheda may be *Bergenia ciliata* or *Didymocarpus pediciallatus*, source 'sariva' may be *Hemidesmus indicus, Cryptolepis buchananiii* and *Decalepis hamiltonii* is also debated.

vi. Collection, drying and storage process and practices also need to be developed systematically. Therapeutic quality of a crude drug also depends on the age of the plant source and the vegetative stage when the required part of the plant is collected. For example fruits of Harde (*Terminalia chebula*) should be harvested at a stage when they attain full size but are still unripe, fruits of Bili (*Aegle marmelos*) need to be harvested when raw, mature stem of Galo (*Tinospora cordifolia*) should be harvested when the plant is leafless while kutaja (*Holarrhena antidysenterica*) shows maximum alkaloid content at the full bloom stage (Dutta et al, 1950). Further post harvest processing is very important to maintain the therapeutic efficacy of the raw material. Proper care



needs to be taken during cutting, chipping, and removal of moisture and storage.

vii. Multinational companies get a better edge due to good quality of packaging, proper preservation and complete sterilization method adopted by them during preparations.

viii. Lack of captive cultivation by industries limits their capacities to respond to sudden market changes. According to a study (Majumdar, 2001) manufacturers require Market Information System (MIS) to provide for information regarding identifying the species, new uses of herbs and alkaloid analysis. The information so provided in an organized manner and at accessible location can motivate more manufacturers to go for captive cultivation.

13. Recommendations

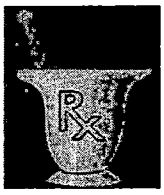
The market study has shown that the under-development of many aspects of the market has significant negative implications for biodiversity and positive implications for consumer welfare, market players, and state expenditure. The development of the market is therefore critical in promoting widespread welfare and in limiting the costs (direct and indirect) which society bears because of under developed market. Suggestions are based largely in terms of the opportunities and constraints facing the market. Apart from the problems encountered by the ayurvedic companies be solved, there are development requires actions at two key levels. Firstly, coordinated support for the indigenous medicine industry needs to be developed amongst

policy makers in all levels of government, in business and in NGOs. A supportive, consistent and positive policy and regulatory environment needs to be developed for the indigenous medicine industry. It is important for policy makers to view planning for the development of the herbal sector in holistic manner. It should be borne in mind that conservation strategies for medicinal plants are as important as cultivation strategies. Policies to regulate prices and wild harvest of plants from wild are as important as cultivation initiatives.

Secondly, development actions are required within the market itself. However, little significant market development will occur within a positive policy environment and a coherent strategy for industry transformation. The system of scientific, systematic and sustainable harvesting, drying and grading of species should be established at each level.

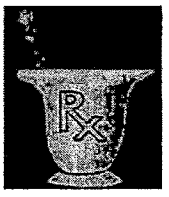
Further

a) Harvesting of Resources from the Wild: The principle of harvest from the wild being followed as at present seems to be making wild collections 'somehow', 'anyhow'and 'before others'. The indiscriminate harvesting practice has led many a high value medicinal plant species to the risk of extinction. Whereas the need for harvest from the wild, being linked to livelihood security of rural populations is recognized, the wild populations can still be conserved:
    i. by developing and disseminating sustainable harvest methods through field agencies and research institutes
    ii. by effectively regulating the wild harvests of high risk species through formulating comprehensive participatory resource management plans, harvesting guidelines and enabling legislation.



b) Augmentation of the Wild Medicinal Plant Resources: The indiscriminately exploited forest areas, especially near habitations, known to harbour good populations of medicinal plants in the past need to be rehabilitated. This can be achieved by adapting the forest management practices to the benefit of these species and/ or by augmenting wild populations of medicinal plant species through planting. This rehabilitation can, however, take place only if the local communities find a stake in this activity and become responsible partners in this programme. One of the ways to create such a stake for the community is through developing these depleted forests as Medicinal Plant Propagation Areas (MPPAs) under the State Participatory Forest Management (PFM) Regulations with all the harvest proceeds going to the participating community. PRIs as instruments of local self-government and the State Forest Department as the primary facilitating agency need to play a key responsible role in this programme. The programme can provide worth while income generation opportunity especially to the rural communities. Programme to develop scientific management practices in favour of medicinal plants and to augment wild populations of medicinal plants in responsible partnership with the local communities through PRIs in accordance with PFM guidelines should be initiated.

c) Market Information System: There is no mechanism in the State to inform the growers about the price or the demand of different species of medicinal plants in different markets. This is mainly because there is no nodal agency in the State to own this activity. Lack of this information hampers the effective positioning of the State on herbal map of the country and is also viewed as one



of the causes for slow picking up of cultivation in the State. The State should designate a nodal agency for gathering trade-related information in consultation with Private Sector on medicinal plants and making it available to the resource user groups.

d) Organize gatherers and producers: The trade in medicinal plants is highly exploitative. The collectors and producers of medicinal plants get only a negligible share in this multi-crore rupees business. One of the reasons for these low returns is that the gatherers of medicinal plants are poor rural households with little bargaining power. Often the medicinal plants harvesting by rural poor households end up towards repayment of the loan installments. With a little bargaining power, better returns could be obtained. Viable models of community organization for trade and enterprise development in respect of medicinal plants would be developed.

e) Pricing of Wild Harvest: Another issue linked to harvest from the wild is that of pricing of the produce for commercial purposes. At present, medicinal plants sourced from the wild command a market price largely based on the labour involved in such collections plus a token royalty charged by the State Forest Department. The conservation costs (protection, augmentation and management), the environmental costs (quotient of damage to ecology during harvesting) and the community benefits (opportunity cost of retaining the particularlanduse) are not reflected while arriving at royalty or price of this raw material. The low prices at which the raw material from the wild is available, is one sure deterrent to picking up of cultivation of medicinal plants in the State. A system to rationalize royalty rates reflecting the conservation,

environmental and community benefit values should be worked out in consultation with various stakeholders to get fair remuneration to the State and its people.

f) Trade and Enterprise: Trade practices related to medicinal plants have been traditionally complex and secretive with a chain of commission agents involved from the harvesting stage to the final destination of every plant/raw drug. In the process, the gatherers and producers of this resource receive only incidental charges for collection from the wild or subsistence prices for cultivated material. The non-availability of remunerative buy-back arrangements also affects the confidence of growers into going in for cultivation of medicinal plants. These trade practices are affecting the quality (as quantity being the principle, adulteration of the material takes place) and cultivation (being non-remunerative) of medicinal plants on one hand and development of value addition enterprise on the other. The Policy should be created to improve the situation so that medicinal plant related trade and enterprise starts making significant contribution to the economy of the State especially of the rural areas.

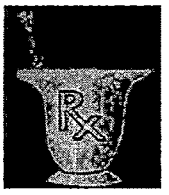
g) Regulatory framework for cultivation: Most of the traded medicinal plant species of the State being accessed from the wild – and, therefore, forming 'forestproduce' - it becomes very difficult for even the genuine growers to prove that a particular consignment of medicinal plants is of cultivation origin. Therefore, even the cultivated material could attract provisions of the Forest Produce (Transit) Rules, 1961 and the growers end up paying royalty/ permit fee to the state for trade of cultivated material. In the absence of any

regulatory mechanism, it is difficult even for the regulatory authorities to certify the source of the material and monitor the yield.

h) Establishment of models for viable public-private-community partnerships: Trade and enterprise of medicinal plants/ products is, however, intimately linked to remunerative returns to the producers. One of the ways it can become remunerative is to ensure buy back arrangements with the users of this produce. It can happen only if the user group is assured of getting agreed quantities year after year. Experience shows that working in isolation in the field are neither good for the managers neither of the resource, nor for collectors and producers of the resource. Public-private-community partnership in this effort, including effective involvement of the three. The State should establish models for viable public-private-community partnerships for cultivation, value addition and marketing of medicinal plant based enterprise.

i) Formation and Monitoring of nodal agency: Effective formation of nodal agency and its implementation is necessary. This nodal agency also requires constant monitoring. It would be worth while to set up an interdisciplinary Task Force for monitoring at the macro level. This Task Force, comprising of elected representatives from all levels, representatives of concerned agencies, civil society organizations, and subject matter experts, will also guide drawing the development plan of the sector.

j) Quality Certification and Fair Trade Practices: Medicinal plants need to pass through stringent quality checks to enable their export. The cultivated material needs to be certified by some accredited agency. The trade of the material also



needs to follow fair trade practices. Mechanism for quality certification and fair trade practices should be put in place.

k) Facilitating in situ Consumption and Buy-back Arrangements: The lack of remunerative buy-back arrangements is a major hurdle in promoting cultivation. The State has a large number of herbal-based pharmaceutical units. The State should put in place mechanisms for ensuring that the herbal based pharmaceuticals in the State meet their raw drug requirements from the available raw material in the State.

l) Linkages with Neighbouring States: To avoid the undue socio-economic exploitative mechanisms and to check the illegal trade practices in the medicinal plants, there is need to establish a coordination mechanism by means of periodical review meetings in the areas of policy, conservation, cultivation, trade and marketing practices amongst the neighbouring states like Madhya Pradesh and Maharashtra and North-Eastern States having a potential medicinal plants resource and its virtual trade.

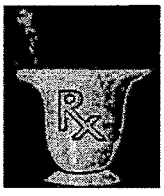
m) Establishment of Medicinal Plant Education Parks: A well designed medicinal plant education park exhibiting live specimens of medicinal plants as per important themes of traditional and local value along with appropriate signage is a potential tool to educate people about various aspects related to medicinal plants. Medicinal plant educational parks with attached nurseries should be established in the State.

n) Promotion of home/ community herbal gardens: Availability of plants at hand is one of the ways to promote the use of plants for health care purposes. People can be educated about the use of plants for their primary health care

needs and motivated to grow a mosaic of medicinal plants in their homesteads. Similar gardens can be established for the community also for use by the local herbal healers. These herbal gardens can help in re-establishing the fast vanishing bond between the local communities on one hand and their environment on the other. The State should initiate a programme to promote local use of ecosystem specific medicinal plants via home and community herbal gardens for health security in rural and urban areas.

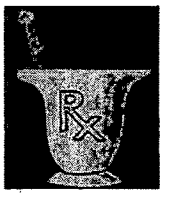
o) Bio-prospecting: The vast storehouse of accumulated knowledge about healing properties of plants lying with the folk healers is also facing a threat of permanent loss. People need to be reminded of their rich medico-cultural heritage and motivated to revive this heritage for their primary health care needs and passing on the associated knowledge trove to the next generations. One of the ways to promote the continuation of these traditions is by way of home/ community herbal gardens. Incentives should be given to the traditional herbal healers for preparation of herbal formulations, and attempts should be made to organize them. In order to promote the tradition to next generation, the available herbal formulations should be renewed by standardizing their efficacy, and to establish a Social Capital Trust for herbal practitioners.

p) Orienting the Research on Medicinal Plants: Major research on medicinal plants in the State as on now is on cultivation of exotics species or a handful of native species in high commercial trade. There is little research on cultivation of ecologically sensitive and red listed native medicinal plant species. Similarly, there is no apparent research agenda related to addressing the in situ management of medicinal plants. The research agenda of the scientific



institutions working on medicinal plants shall, therefore, need to be modified. This would mean committing major proportion of the budget for medicinal plants for research on plants indigenous to the state as against the present trend of major budgetary resource allocation in favour of exotics. The State should sponsored research on medicinal plants in concentration with in situ management, cultivation, harvesting, value addition, quality certification and marketing of native medicinal plant species. Studies on valuation of medicinal plants signify its economic importance and biodiversity. A local or area based study taking into account its features of species and genera and its ecological function should be preferred approach.

q) The studies based on valuation of drugs and pharmaceutical is a need of hour. Very few studies based on it are carried out. Kumar, (2004) had critiqued emerging policy issues on valuation of plant diversity for pharmaceutical uses from the works done in last 15 years (1985-2000). As careful analysis of these studies provides an indication of the direction in which the valuation of medicinal plant is progressing. Studies of Farnsworth and Soejarto (1985), Principe (1991) and Mendelsohn and Ballick (1995) are based on economic estimates. While Farnsworth and Soejarto (1985) calculated the value of medicinal plants expected to disappear by 2000 in the US. They estimated the total value of medicinal plants in the US for the year 1973 and 1980. On the basis of the active ingredients of those plants present in the drugs consumed by people in the US. While studies of Aylward (1993), Artuso (1999), Pearce and Puroshothaman (1992) are based on estimation of net economic value. Bhakat and Pandit (2003) carried out the inventroy of medicinal plants in a



rural landscape of Chilkigarh village in West Bengal. They ascertained medicinal values of plants in consultation with Chopra et al (1956,1968), Kirtikar and Basu (1935), Pakrashi and Mukhopadhyay (2001), Saini (2000), Sanyal and Namhata (1995), Sur et al (1992) and Zaidi (1994-95).