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Holistic Understanding for  
Justified Research and Action  
(Hujra)

## Research and Development relating to Medicinal Plants

(Collection, review, analysis and future guidelines for IPRP)



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## PREFACE

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This report has been prepared as a result of partnership between IPRP (Innovations for Poverty Reduction Project) and HUIRA (Holistic Understanding for Justified Research and Action). IPRP is Swiss Agency for Development and Cooperation (SDC) funded project mandated to the Swiss Interco-operation (IC) for implementation in the selected areas of Malakand Division. IPRP conceptualized the study and provided all financial support for execution. This report is the outcome of a series of activities including a national level consultative workshop on “Linking medicinal plants research and policy to poverty reduction and conservation” and review of the relevant literature.

The overall goal of IPRP is “Innovative and market oriented diversification in the management of natural resources contributes to better living conditions of the rural communities in poverty pockets of remote and rain fed areas in the NWFP”. The IPRP partnership is based on mutual understanding with HUIRA regarding the assignment to be undertaken. This assignment is in line with the vision and mission of HUIRA and would further strengthen its organizational capability, besides helping IPRP and its future interventions in research and development relating to medicinal and aromatic plants. The outcome will be of immense importance for the project focused and directed plan for the development and sustainable use of the natural resources for poverty reduction of marginalized and disadvantaged segments of the population. Besides, it will also prove instrumental in the endeavors of the partner organization towards their vision and mission.

The activities are intended to prepare research and development action plan for poverty reduction through efficient and innovative uses of medicinal and aromatic plants. The region of focus is Malakand lying in Hindukush Mountain range of Northern Pakistan. The expected outcome is to provide a guideline for research program of IPRP on medicinal and aromatic plants, a research action plan on medicinal plants of commercial importance with concrete recommendations for future use of IPRP and provision of list of relevant partner institutions in research and development.

Mr. Momin Khan assisted the coordinator as Research Associate in the collection of literature and compilation of review. Mr. Muzakkir Ahmad and Mr. Saleem Ahmad of HUIRA assisted in the documentation process. The inputs provided by Mr. Khalid Hussain CTA, IPRP and Syed Iqmail Hussain Shah Regional Project Manager Mountain Area Conservancy Project in preparation of this report are duly acknowledged.

**Dr. Inam-ur-Rahim**  
**Project Coordinator**

## LIST OF ABBREVIATIONS

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AKRSP	Aga Khan Rural Support Programme
AKU	Aga Khan University
CBO	Community Based Organization
DNA	De-oxy Ribo Nucleic Acid
ERP	Environmental Rehabilitation Project
EVM	Ethno Veterinary Medicines
HEJ	Haroon Ibrahim Jamal Institute of Chemistry Karachi
HUJRA	Holistic Understanding for Justified Research and Action
IPRP	Innovation for Poverty Reduction Project
IUCN	International Union for Conservation of Nature
KIDP	Kalam Integrated Development Project
MACP	Mountain Area Conservancy Project
MAP	Medicinal and Aromatic Plants
NARC	National Agriculture Research Council
NGO	Non-Governmental Organization
NIAB	Nuclear Institute of Agriculture and Biotechnology
NIBGE	Nuclear Institute of Bio-Tecnology and Genetic Engineering
NIFA	Nuclear Institute for Food and Agriculture
NIH	National Institute for Health
NWFP	North West Frontier Province
PATA	Provincially Administered Tribal Areas
PCSIR	Pakistan Council for Scientific and Industrial Research
PFI	Pakistan Forest Institute
PMNH	Pakistan Museum of Natural History
RCC	Regional Coordination Cell
SDC/IC	Swiss Development for Cooperation/Inter Cooperation
WHO	World Health Organization
WTO	World Trade Organization
WWF	World Wide Fund for Nature

## EXECUTIVE SUMMARY

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This report has been prepared as a result of partnership between SDC funded IPRP (Innovations for Poverty Reduction Project) and HUIRA (Holistic Understanding for Justified Research and Action). It is the outcome of a series of activities including a consultative workshop and review of the relevant literature. The activities are intended to prepare research and development action plan for poverty reduction through efficient and innovative uses of medicinal and aromatic plants. The region of focus is Malakand lying in Hindukush Mountain range of Northern Pakistan. The objectives included collection and review of existing researches on medicinal plants and identify relevant stakeholders, holding consultative workshop with the identified stakeholders to develop a research and development action plan for IPRP and identify potential partners in medicinal herbs research and development for future collaboration with IPRP to materialize the developed action plan.

The available research documents related to research and development of medicinal plants were collected from different institutions and libraries, individual researchers, academics and organizations. Secondary data was collected from various institutions throughout the country including but not restricted to Universities, Post-graduate Colleges, Research Institutions (Pakistan Forest Institute, National Agriculture Research Center, PCSIR), Pharmaceutical Industries and Media. Interviews were held with relevant researchers to identify potential participants and speakers for the consultative workshop including experts in Chemistry, Tib, Ecology, Conservation and Development, Pharmacology and Marketing of herbals in the country. The collected literature was reviewed and submitted to potential speakers at the occasion of consultative workshop, and for comprehensive inclusion in the final research and development action plan. Experts from all relevant disciplines to medicinal and aromatic plants were invited in a workshop. The key institutions represented by relevant scientists and directors included HEJ, IUCN Pakistan, Malakand University, Peshawar University, Hamdard University Karachi, Qarshi Industries Hattar, Forest Department NWFP, Wildlife Department NWFP, Pakistan Forest Institute Peshawar, Government College University Lahore, University of Agriculture Faisalabad, Agricultural University Peshawar, WWF Pakistan, SDC/IC Pakistan, Livestock and Dairy Development Department NWFP, NARC Islamabad, PASTIC Islamabad, Pakistan Museum of Natural History Islamabad, Mountain Area Conservancy Project, Arid Zone Research Institute Quetta and local NGO,s apart from different famous Hakims, researchers in Medicinal and Aromatic plants and local politicians. Their suggestion contributing to research and development action plan through pre-planned presentations and strategic group work were obtained. The proceedings of the workshop were developed that included the recommendations to be included in the research and development action plan.

The review indicated that during the past 4 decades local researches and development programs have mostly remained fragmented and limited efforts if any, have been made through integrated and participatory approach. The bulk of the documents regarding research are in education institutions through students in the respective disciplines. Current research system and processes are not based on people issues; hence, the research output is not locally adaptable. Available research facilities are personal benefit oriented rather than societal orientation. Researchers are frustrated and discouraged due

to bureaucratic hurdles/ procedures. Researchers and research institutions are mostly ignorant of national and people needs, local farming system and land uses and social context is insufficiently known. Advisory/guiding support system to locate users for applying the research results is not available. There is lack of skill to effectively coordinate the development initiative in the available social system and mostly technician are dealing with the social sector. Landowners are not directly dependent on habitat in most situations and they are rarely inclined to work with non-owner users in equitable manner, which are the actual exploiter of the resources available at the habitat. Awareness about valuable MAP is limited; hence these are either freely grazed or harvested for feed. Awareness about value addition and utilization of MAP is limited at both local and regional level. No effective research on harvest stage condition for high level of drug constituents and no phyto-chemical screening! (Source, genus, species) not effectively carried out. There is a lack of skill of management of habitat at both farmer and professional level. Statistics regarding habitat production capacity, levels of production, consumption/usage is not available. Traditional healers (*Hakim*) have the tradition of hiding their recipes and only transfer their knowledge to one obedient subject; hence no documentation and experience sharing, and recipes are neither shared nor standardized. There is no national recognition of Hikmat, despite the fact that there is international realization of "Return to nature". Local *Hakims* have not been given the required skill enhancement training. Management prescription for sustainable yield has not so far been worked out. Statistical data on productive capacity of the habitat, and consumption and usage of the output at local and region/country level is still lacking. Qualitative and quantitative inventory is lacking. Habitat level interaction and species associative effect have not so far been documented even for key species. Different people have developed different hypotheses for example *Morchella* association with different species is claimed, but no valid information about the habitat and associative effects are available. Impact of introduced/exotic species on the plant community structure has not so far evaluated. Grazing impact on MAP available in the wilderness not understood and formula for yield regulations not established. Conservation status of MAP not known to draw updated red list for effective management and biological threshold level of different species not understood. Key plant resources available in wilderness are depleted and when farmers are mobilized for non-profitable cultivation of MAP, there is over-harvesting of species from the wild. Link between policyholder and field research is missing and limited number of species cultivated at local level. Limited, if any information on genetic mapping of the indigenous medicinal plants is available. There are insufficient facilities for genetic characterization of medicinal plants and standardization of in-vitro culture techniques. In addition there is lack of trained manpower and facilities for application of recombination-DNA-technology to propagate the desired characteristics in medicinal and aromatic plants.

Under prevailing circumstances, the collector receives minimal from MAP trade and the consumer has to pay very high price. Collectors also lack skills to identify and differentiate MAP and they have no access to proper pre and post harvest techniques. Local researchers have limited capacity to identify species with medicinal value, while community understand the plant in local terminology but not utility. Drug Monograph in local languages containing detailed description of Hikmat medicines is missing. Researches are not responsive to real situation and at the most there are isolated studies by individuals. List of priority species neither prepared nor shared with the industry and *Hakims* that can form the base for effective link between collectors and industry.

Communal involvement in general in development planning is nominal. Adulteration is common in the commercial samples and many other plant species are mixed to increase the volume and cheat the buyer. Collector is not properly aware about the collection and sale of MAP, while lack of collector level association/organization predisposes them to exploitation. Hence they in turn degrade and exploit the habitat. There is lack of timely payment and fair price. Community is not aware of the exportable species value and there is no information sharing system and poor linkages among collectors' producers and end users. No projection of supplies and demand position of MAP. The non-local users/processors not informed about the availability and distribution of available plants, while collectors are not aware of the industrial or market demands. Post harvest processing not standardized and extended and crude product rather than value added products are marketed. Pre and post harvest processing skill are outdated and there is no information available on active ingredient level in wild as well as cultivated MAP species. Comparative qualities and level of active ingredients with standard processing procedures from the wild or cultivated sites has not been established.

Among the emerging local level opportunities the recently established Malakand University has two campuses, one at Chakdara in Lower Dir and the other at Shiringal at Upper Dir Districts. It has a Pharmacy Department at Chakdara Campus and a research center at Sheringal, where 83-acre land is available for the cultivation of the Medicinal and Aromatic plants (MAP).

The need is to coordinate the efforts through initiating joint applied ventures contributing to poverty reduction at national level in general and MAP producing region in particular. And wherein, different institutions can contribute according to their capacity and identify limiting elements for efficient trans-disciplinary coordinated research system to arrange needed support. For applied research contributable to poverty reduction, the need would be to involve the entire chain from cultivation, conservation, production and processing to marketing. There is a need to built capacity of the community for effective management of the habitat and promote complementary association among resource owners and non-owner users related to the habitat, through initiating dialogues. This is needed before intervening the habitat for research and development purposes.

A local quarterly newsletter can link local collector, processor, research and industry and serve as a tool for information sharing. Botanical names needs to be properly written with Hikmat and local names and periodically extended through newsletter. This will also promote local use of traditional medicines and can facilitate documentation of local herbal wealth. There is a need for area prioritization in each ecological zone for different land uses and participatory area selection for management. In every zone the need is to prioritize species, develop model species management plan at valley level in different ecological zones, establish small socially fenced areas to prevent extinction of key species and develop species management plan at valley level. There is a need to build capacity and develop skills of the local community and relevant development partners to implement management plan. Skill development of collectors is needed for collection and post collection processing. Research is needed on determining chemical constituents and phyto-chemical screening of local species. This can lead to selection of most appropriate habitat for different key species. A training system is also required for improving the utility of *Hakims* and their proper follow up.

Local researchers and community activists can be trained in proper species identification, proper collection and management of the habitat. Valley wise list of key available species can be prepared in association with communities and provided to different herbal industries, which will in turn select and provide the information to the community about quantity required by the industry.

The presence of a resourceful and effective coordinating system is mandatory to facilitate and coordinate implementation of development proposals. The system is needed to be capable of linking financial support, local government, relevant federal ministries, industry, research institutions and research personals. In the coordinating system, a team of taxonomists, phyto-chemists, pharmacologists and nutritionists can work jointly for suitable resource identification and development. It can also document the indigenous knowledge and consolidate already available information, data and reports on MAP.

Local people traditionally provide herbal medicines to treat different ailments of human and livestock. This knowledge needs proper documentation and validation. The hierarchy of desired processes includes collection of information, identification of plant resource, determination of efficacy, determination of active constituent, establishment of safety and finally crude drug development for local use. Promoting research and development of Ethno Veterinary Medicines can reduce the bill of regularly spent on deworming and cure of metabolic diseases. The coordinating system can subsequently work on standardization of the consolidated data and its validation and can facilitate the dissemination of information on research and development of MAP through a newsletter and can develop monographs. The process can facilitate to link the researchers, collector, producer and end-users.

For the purpose a Regional Coordination Cell (RCC) may be established in a local institution like Malakand University. It is expected that after five years RCC will continue coordinated researches and will be able to obtain funds for research from other facilitating agencies. The need would be to look into, how the research theme contributes to the objectives of poverty reduction and conservation. The establishment of RCC may make the research process that can contribute to poverty reduction smooth. Resource Center located at HUIRA can provide the literature and documentation support to selected students and may communicate community's priorities for research to RCC and extend research findings to communities. RCC may devise a five-year tentative research action plan on different relevant themes and may recommend at least five research students per year for research stipend and expenses for MSc, MPhil and PhD studies. The proposed activities may include facilitation of research on determining chemical constituents & Phyto-Chemical screening of local MAP species, development and validation of indigenous knowledge about Ethno-Veterinary Medicines and Human Health Practices in different zones, promotion of genetically superior MAP and develop genome library for indigenous MAP, linkages among community, industry, research and development institutions and publication of local quarterly newsletter.

Medicinal plants are valued for human and animal disorders and 80% of the local population still depends on these for their health problem. Traditional knowledge regarding herbal cure for human, livestock and poultry is particularly with women that is available in fragmented form. Such knowledge is not documented and is rapidly disappearing. Such information is needed to be collected about dosage, formulation, correct plant identification, diseases indications, routes of drug administration and

efficacy etc. To document indigenous knowledge about MAP and promote its utility, students from different education institutions may facilitate the process through different level surveys. These institutions can facilitate to document the role of traditional recipes in health management, enlist MAP valley/region wise, share with other relevant research and development institutions through RCC and herbal industry, and publish MAP list and utility in locally understandable language. Local CBOs and Hamdard University may jointly organise local exhibitions for MAP display and invite industries, hakims to attend. Three exhibitions in three model valleys may be organized in three consecutive years. Hamdard University can be supported for developing protocols for priority MAP species and monograph in Urdu & English containing cheap recipes containing the local plants. HUIRA can extend the process to communities and local healers and disseminate tested indigenous knowledge at different levels.

Stable MAP business requires sustainable returns of the profit and sustainable production with limited yearly production fluctuation. Collection from wild resources always poses inconsistent production. Currently collection does not match with the productive capacity of the habitat. Species of high demand are over-harvested and low demand under-harvested. Collectors are competing for early harvesting and some time pre-fruiting collection, if they will wait till the maturity, other will get the chance to harvest. They mostly uproot the plant even if only flowers or leaves are needed. Studies to assess economic feasibility of different cultivable medicinal and aromatic plants are mandatory to stabilize MAP trade. MAPs have normally a long maturity period from 3-4 years for leaves/fruits and 6-8 years for rhizome production. This will need experimentation through periodic blocks for long duration plants. Additionally promoting contract farming with different herbal companies like that practiced by tobacco companies can promote cultivation. The prerequisite for all these would require standardization of techniques for cultivation of medicinal and aromatic plants, reducing profit margin through regular provision of market information and linking MAP cultivation with tourism. To assess economic feasibility of cultivable medicinal and aromatic plants and promote their cultivation Malakand University at its Shiringal Campus already has a program to carry out cultivation trails of economically feasible plants. Local CBOs can complement the activity by supporting and monitoring subsequent demonstration plots in the vicinity of selected model valleys. WWF Pakistan, Hamdard University Karachi, Qarshi Industries, PFI Peshawar, University of Malakand and Pakistan Museum of Natural History already have experience in cultivation of medicinal plants and their expertise can be utilized for the purpose of promoting cultivation at farmer level. IPRP can devise strategy in partnership of local CBOs to promote contract farming through facilitating association and links of communities with herbal industry, promote local level micro-entrepreneurship and devise appropriate market information system. HUIRA may facilitate regular provision of market information and conservation status to the relevant communities and research institutions. After initial 5 years experimentation at test plots and research stations, IPRP may facilitate cultivation at different regions on commercial scale during subsequent 5 years. With conservation related programs like IUCN, WWF, PFI and Forest department HUIRA may promote cultivation of threatened species in the natural habitat of model valleys and continue it subsequently in partnership with Malakand University and Agriculture Research Station after project termination.

Different training and skill development programs for collection and post collection processing and value addition at model valleys can be arranged through local CBO's and HUIRA may facilitate, update, and modify the training and capacity building process per need. HEJ, Aga Khan University, Pharmacy department of various Universities, PCSIR Laboratories and Hamdard University can develop, update and modify the training module. It may include some basic training and subsequent refresher course. To promote complementary association among landowners of the MAP habitat and non-owner users,

entrepreneurs and defusing market exploitation, HUIRA in association with the Union Council and local CBOs can assess facilitation needs, and devise strategy to promote social complementation and conflict management. Subsequently it can organize collectors through networking and associations. This is needed before intervening in to the habitat for research and development and may follow associative sale on fair price with ensured timetable for payment to the collector. Local CBOs can facilitate collectors for associative sale and promote awareness at community level about WTO. HEJ, PCSIR and Chemistry /Pharmacy Departments of different Universities can work to test the traded samples and devise mechanisms to improve the quality of traded samples.

There is a need to develop qualitative and quantitative inventory and facilitate research on associative effects at habitat level. Purchase from wild collection needs to be watched through community activists and relevant institutions in the name of cultivated production using the tool of motivation and community mobilization. In collaboration with Forest and Wildlife department, MACP and WWF, IPRP may coordinate to make the inventory of MAP in model valleys and can prioritize different MAP in different zones for different land uses and allocation for model MAP management plans. HUIRA and IPRP in partnership of MACP may facilitate studies on associative effect of MAP, researching grazing impact on MAP to prescribe for appropriate stocking and experimentation through periodic blocks for long duration wild MAPs. Studies on associative effects may also include assessment of alien species impact on local plants. Such studies may lead to determine harvest quota, monitor harvest and sale and select species wise sites for modeling and developing species management plan. IPRP and Local CBOs can select areas for model management plan, PFI and Malakand University may develop model management plan and determine harvest quota. After 3 years, local economy may be linked with the conserved habitat and local CBO/community can take the responsibility to manage and monitor. IPRP, HUIRA and local CBOs may survey local market for wild and cultivated plant, compare with habitat harvest capacity, and do lobbying for appropriate legislation and institutional mechanisms at different levels.

A large variety of non-traditional marketable herbal resources can be promoted for herbal teas, food supplements, flavor enhancement, anti-oxidants, functional food supplements and cosmaceuticals. Testing and promoting these as micro-enterprise at local level can provide jobs to many at local level. This requires no clinical trials, regularization or exports problems and is a simple good manufacturing practice with huge national and international market. To promote such innovative approaches in herbal micro-enterprise at local level HEJ to take the lead role facilitated by Chemistry department of Peshawar University, and PCSIR at regional and CBOs at local level. The initial exploration of innovations and its preliminary testing can be facilitated by HEJ and Chemistry Department Peshawar University. This can be refined further at local level by HUIRA and local CBOs. Apart from soft term lending facilitation by Bank of Khyber and Zari Taraqiati Bank, collector's savings IPRP can provide technical and monetary support for local micro-MAP enterprise promotion. The activity may include exploration and promotion of non-traditional marketable herbal resources for herbal teas, food supplements, flavor enhancers, anti-oxidants, functional food supplements and cosmaceuticals and develop corresponding technologies. After preliminary testing locally adaptable entrepreneurship for extraction of essential oils, value added crude extracts, enriched extracts & semi-purified constituents can be promoted with due technical support from HEJ and Chemistry Department.

Cropping in general and cash crops in particular, are encroaching the habitat of MAP to fulfill the demand of multiplying population. Overgrazing and uncontrolled grazing of the wild habitat are common. Deforestation, crop encroachment, afforestation and introduction of alien species are contributing to changes in plant community structure. There is inadequate research on geographic and ecological zones & inventory of medicinal and aromatic plants with reference to assess hotspots quantitatively & life cycle studies. In the face rapidly modifying community structure and prevent species extinction, there is a need to establish aromatic plant gardens on communal areas particularly focusing areas with tourism attraction a dialogue can be initiated among relevant stake holders including Tehsil Council and Malakand University, wherein a strategy can be evolved that can lead to allocate areas for botanical gardens. IPRP can bear the plantation and fertilization costs for initial 3 years, and subsequently the custodian institutions can look after the management of gardens and can sustain the activity by linking it with tourism. Forest Department may allocate reserve scrublands under its custodianship for the medicinal plants protected areas. IPRP and Wildlife Department can facilitate its establishment through motivation of the local communities and Local CBOs, Forest Department and Tehsil Council can look after the protected areas and sustain the activity.

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## INTRODUCTION

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Plants provide a variety of resources that contribute to the fundamental needs of food, clothing and shelter. Among plants of economic importance Medicinal and Aromatic plants have played a vital role in alleviating human sufferings (Baquar, 2001). Plants are utilized as therapeutic agents since time immemorial in both organized (Ayurveda, Unani) and unorganized (folk, tribal, native) form (Girach *et al* 2003). The healing properties of many herbal medicines have been recognized in many ancient cultures. Early herbalists believed that the plant part resembling any part of the human body was considered useful for the ailment of those parts and there is no part of the body without its corresponding herb, a hypothesis known as the “Doctrine of Signature” (Baquar, 2001). Bhiksu Atreya, a Professor of the University of Taxila and his student named Jivaka were the well-known persons with an intimate knowledge of the characteristics of medicinal plants (Singh *et al* 2003).

Mountain people rely on forest-based activities like hunting, herb gathering, foraging and to some extent on cropping. In these areas different indigenous systems of medicine exist since centuries and cater the needs of nearly 70% human population and livestock (Singh *et al* 2003). Through experience complementary interrelations have been evolved leading to better understanding of nature at local level and therefore, enhanced the chances of human survival in harsh mountain environment (McCorkle, 1992). This primitive way of life is fast disappearing. The relentless exploitation during the transition from traditions to modern and subsistence to market orientation disturbed the ecological balance and adversely affected their economic life along with the resource base. The result was that slowly the mountain people lost control over their economic destiny (Singh *et al* 2003). The reasons for the degrading exploitation of natural resources are however, not so simple, some rooted deeply in development pattern, rapidly increasing population, extreme fragmentation of land holdings and slow growth of job opportunities (Repetto and Gillis 1990), and other in lack of effective institutional mechanisms.

The natural resources how so ever large are bound to diminish hence need effective strategy for sustainable utilization. The need is to bring these plants under plough to meet the rising demand of the resultant product (Singh *et al* 2003). Cultivation of Medicinal and Aromatic plants is constrained due to lack of suitable technology, which has led to low yield and poor quality. Consequently, medicinal herbs are predominantly harvested in sufficient quantities from the wild in an unregulated manner (Shabbir *et al* 2003). There are many astonishing things to learn from the collector of these herbs. Spreading and preservation of this traditional knowledge has become important for human existence. In modern medicines, plants occupy a significant place as raw material for some important drugs, although synthetic drugs and biotechnology have brought about a revolution in controlling different diseases (Hansel, 1975). Also there is a growing tendency all over the world, to shift from synthetic to natural based products including medicinal and aromatic plants. It is the time to consider neglected and little known medicinal and aromatic plants at global as well as regional level. Conservation and sustainable utilization of Medicinal and Aromatic plants must involve a long term, integrated, scientifically oriented action program.

Being an important integral part of the development intervention in botanics can play a crucial role in mitigating the degradative exploitation and increasing poverty. The in-situ and ex-situ cultivation of medicinal and aromatic herbs can play an important role in local economy. Moreover, farm products could be certified as to source, identity and quality (Shabbir *et al* 2003). Increasing awareness about the potentials of available plants may encourage many innovative and progressive growers and entrepreneurs to take up their cultivation and propagation as a commercial enterprise. Apart from health care, this enterprise may provide

means of livelihood to scores of people. Less than 5% of the plants have so far been analyzed as potential medicine and still there is a great scope of research in this field. There is a need to develop strong linkages between growers, collectors, health experts and pharmaceutical industries for developing scientific basis on which these systems of medicine are working (Kotain, 1990). The current value of global trade of the medicinal plant products has been put over US\$ 75 billion per year and is growing at the rate of 12.5% annually. Of the total value of trade, about 20 billion US\$ accounts for over the counter (OTC) drugs, over US\$ 25 billion for prescription drugs and remaining US\$ 30 billion for the nutritional supplements. Bulk of the raw material (90%) is produced in developing countries (Asia, Africa and Latin America) and 60% is imported/ processed and used in the developed countries. About 90% of the marketed material is collected from the wild resources (Sharma, 2003). New areas have also been explored in the traditional uses of plants e.g., their use as contraceptives (Panda, 2003) and anti-aging agents. "Office to Alternative Medicine" has been established in USA to provide support to alternative medicines and assess their possible integration with modern medicines (Sharma, 2003).

Pakistan is mainly a dry country and only 16% of Pakistan (including Azad Kashmir) is sub-humid, mainly including the northern mountain regions, well suited to dense and diverse plant population in wilderness (Abeed Ullah Jan, 1993). However, being marginal in the development process the mountain regions are facing severe poverty, and population explosion that compels the communities for degradative exploitation of available natural resources. Among the mountain regions, through providing wide variation in climate, soil, altitude and latitude, nature has bestowed on Malakand region a very rich botanical wealth and a large diversity of plants. To avert the process of degradative exploitation of natural resource base and increasing poverty in the regions, the need would be to evolve a research and development action plan for Medicinal and Aromatic plants that apart from enterprise development should include the pertinent aspects of preservation, maintenance, exploitation, conservation and sustainable utilization. A holistic and systematic approach envisaging interaction between social, economic and ecological systems will be a more desirable one (Sharma, 2003).

### **1.1 Hypothesis**

1. Promoting medicinal plants conservation, cultivation, processing and marketing can effectively contribute to poverty reduction through value addition and micro-enterprise promotion and can reduce the threat to bio-diversity;
2. Revival of the traditional medication system can save the resources of the poor spent on purchasing expensive allopathic medicines and can contribute to poverty reduction;
3. Exploring research and development options may provide broader outlines that will need sharing with the community. This will provide space for local adjustment and modification in accordance with zonal variation. Selection and prioritization by the concerned communities, particularly the relevant social segment and gender/age group can lead to development of a workable zone wise research and development action plan;
4. Wild medicinal plants do not exist in isolation, but as a part of complex habitat used for timber, grazing and tourism. Integrated approach will create enabling environment for applying best-suited treatment to the assigned habitat and will facilitate sustainable production. In existing situation the need will be to assign priority to several land uses in participatory and integrated manner; and
5. Solely focusing on marketing will accelerate habitat degradation, hence raising awareness in complementary manner among local people for the use of traditional medicines for both human and livestock need focus.

### **1.2 Objectives**

1. Collection and review of existing researches on medicinal plants and identify relevant stake holders;
2. Hold consultative workshop with the identified stakeholders to develop a research and development action plan for IPRP; and

3. Identify potential partners in medicinal herbs research and development for future collaboration with IPRP to materialize the developed action plan.

## METHODOLOGY

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### **2.1 Collection of research data**

The available research documents were collected from different institutions and libraries related to research and development of medicinal plants, individual researchers, academics and organizations. Secondary data from various institutions throughout the country including but not restricted to Universities, Post-graduate Colleges, Research Institutions (Pakistan Forest Institute, National Agriculture Research Center, PCSIR), Pharmaceutical Industries and Media through Research Assistants hired for the purpose.

### **2.2 Interviews with the researchers**

Interviews were held with relevant researchers to identify potential participants and speakers for the proposed consultative workshop including experts in Chemistry, Tib, Ecology, Conservation and Development, Pharmacology and Marketing of herbals in the country

### **2.3 Review of literature**

The collected literature was reviewed and submitted to potential speakers at the occasion of consultative workshop, and for comprehensive inclusion in the final research and development action plan

### **2.4 Internal workshop**

Internal workshop was held to review the progress of work and devise strategy for the external consultative workshop

### **2.5 Consultative workshop**

Experts from all relevant disciplines to medicinal and aromatic plants were invited in a workshop. Their suggestion contributing to research and development action plan through pre-planned presentations and strategic group work were obtained. The proceedings of the workshop were developed that included the recommendations to be included in the research and development action plan

### **2.6 Development of research action plan**

The recommendations of the workshop were organized in the form of research and development action plan for IPRP

## REVIEW OF LOCAL RESEARCH AND DEVELOPMENT IN BOTANICS

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Local research and development in medicinal, aromatic and economic plants during the past 4 decades has mostly remained fragmented and limited efforts if any, have been made through integrated and participatory approach. The bulk of the documents regarding research are in education institutions through students in the respective disciplines. These include Pakistan Forest Institute (PFI) Peshawar, Botany, Chemistry and Pharmacy departments of different Universities. Apart from education institutions, development and conservation related projects and programs like Environmental Rehabilitation Project (ERP), Swiss Development Cooperation/Inter Co-operation (SDC/IC), World-Wide Fund for Nature (WWF), International Union for Conservation of Nature (IUCN) assisted Mountain Area Conservancy Project (MACP), National Agricultural Research Council (NARC), Pakistan Agricultural Research Council (PARC) and different laboratories of Pakistan Council for Scientific and Industrial Research (PCSIR), have carried out bulk of applied work toward development and promotion of research with different rates of successes. Husein Ebrahim Jamal Research Institute (HEJ) is a center of excellence in Chemistry with international reputation and is promoting research and development in its own sphere.

During the past half century natural production of medicinal and aromatic plants (MAP) found in different ecological regions were surveyed and published in the form of a booklet containing around 350 plants with natural distribution, ecological occurrence and its brief medicinal uses. Subsequently hilly and plains areas were surveyed and natural production of different medicinal plant were estimated. In addition, key ecological zones for different medicinal plants were identified and results published at different interval.

For Ex-Situ cultivation/propagation of important MAP, trials were made in the experimentally established farms in hilly as well as plain areas. Until date medicinal plants branch has published 150 scientific booklets and research papers. At a two and a half-Acre land of experimental medicinal plants farm at Pakistan Forest Institute (PFI) Peshawar main campus, experiments are conducted on indigenous as well as exotic medicinal plants. A living medicinal plants museum has also been established that contains approximately 200 medicinal plants of different kind. In addition there is a drug museum and medicinal plants herbarium where approximately 2000 samples of different local plants are available. At Medicinal Plant Branch of PFI, Peshawar research work on the local medicinal plants has been conducted mainly through postgraduate students (Annexure 1):

Being a training and education institution, it will continue to undertake research activities through students. There is however a need to link these researches to the field problems including those relating to conservation and development of MAP. Medicinal plants branch PFI, Peshawar can collaborate in the following areas for the promotion of research and development of medicinal and aromatic plants:

1. Qualitative and quantitative survey of medicinal and aromatic plants resource of Malakand Division, at regular intervals to regularize sustainable production and increase export potential;
2. Drug market survey to determine the supply and demand position of various crude drugs and aromatic raw material to find their potential for industrial utilization and local consumption;
3. Pilot scale cultivation of indigenous and economic plants of commercial value for the traders. Pharmaceutical and aromatic industry of Pakistan through community participations as income generation activities at low and high hills;

4. Regeneration of important medicinal and aromatic plants in natural habitats for their conservation and sustainable uses; and
5. Establishment of a seed bank of medicinal and aromatic plants for their ex-situ conservation and future improvement as well as for distribution to growers.

**Malakand University**, a recently established University has two campuses, one at Chakdara in Lower Dir and the other at Shiringal at Upper Dir Districts. It has a Pharmacy Department at Chakdara Campus and a research center at Sheringal, where 83-acre land is available for the cultivation of the MAP. Recently Higher Education Commission (HEC) has given to the University, 3 crore rupees for research on plant genetic resources including MAP. HEJ will provide technical support for establishing the center. At Shiringal Campus, the plan is to establish a forestry institute and a center of Bio-technological research. Land, logistics and technical human resources in the form of on-job scientists, equipments and students will be available. Moreover, at the two campuses situated in the two different ecological zones of Malakand region can provide research plots for on-farm trails of MAP. Being situated in the area of focus of IPRP Malakand University can have a crucial role in complementary research partnership with IPRP and HUIRA for standardizing cultivation prior to extension and pharmacological research. **Jahanzeb Government College** attached to Malakand University also has a post Graduate Botany Department that can be involved in ecological research. Being attached to the University of Malakand, research plots for different experiments can be established in different colleges of Malakand region in the vicinity of model IPRP valleys.

**Chemistry, Pharmacy and Botany departments in the University of Peshawar**, are doing research in their respective disciplines through students. Department of Botany in **Islamia College** University of Peshawar has carried out student research in identical manner on the plants given at annexure-3 with medicinal or economic value. The thesis compiled as a result of these researches usually remains inside the faculties and rarely published. With the exception of some research-oriented individuals, most of the academic staff remains limited to the teaching of prescribed courses obligatory under the curriculum. The University is seldom involved in applied researches facilitated by different project. Effective academic research system integrated with the real system and appropriate research funding is lacking. According to the available literature, Botany department has conducted research on the plants given at annexure-2 mainly focusing on their ecological distribution and pharmacognosy. Recently sufficient funds have been or in the process to be made available to different universities. University of Peshawar can provide facilities for applied research on botanicals in relevant areas during initial phase of implementing research and development action plan. Subsequently coordinated applied research activities at Malakand and Peshawar Universities can be facilitated. **Quaid-i-Azam University Islamabad**, Department of Biological Sciences has similarly carried out research on the distribution of medicinal plants in Margalla hills and National park Islamabad. The plants given at annexure-4 have been reported during the research.

**Aga Khan University Karachi** is conducting pharmaceutical research on therapeutic uses of the following medicinal plants: *Plantago ovata* (ispaghula), *Nigella sativa* (Kalonji), *Carum copticum*, *Cichorium intybus*, *Zingiber officinale* (ginger) and *Withania somnifera* (Indian Gensing). Currently different plant sources are evaluated for their Antihypertensives, Cardiotonic, Spasmogenic, Laxative, Antiasthmatic, Antispasmodic, antidiarrhoeal, Uterotonic, Antiinflammatory, Antifungal, Antioxidants, Analgesic, Antidiabetics and Prokinetic effects. The university is conducting research in collaboration with Karachi University, HEJ Institute of Chemistry, Bahawudin Zakria University Multan, Islamia University Multan, Peshawar University, and Blochistan University, Quetta. **Hamdard University Karachi** is doing research in the areas of Ethno-botany, ethno-pharmacology, ethno-medicines, pre-Clinical Toxicity and Clinical Pharmacology. They are publishing research articles in quarterly Journals (Medicus) containing research papers on different aspects of medicinal and aromatic plants for more than 4-decades. In addition they have also published different monographs on Unani Herbal drugs

independently or in partnership with other institutions. Apart from possibility of partnership to develop drug monographs of locally available medicinal and aromatic plants, partnership can be established with Aga Khan University and Hamdard University for promoting research in Ethnopharmacology, Pharmacogony and pre-clinical studies on animal models. Hamdard University can work to promote contract farming in Malakand region. Aga Khan University and Hamdard University can facilitate for arranging training courses for local *Hakims* and other stakeholders in the disciplines of Ethnobotany, Ethnopharmacology and Pharmacogony. It shall however, require support from relevant institutions and other partners in field.

Researchers at **University of Agriculture Faisalabad** have conducted research on Anthelmintic, Antiulcerogenic and Antidiabetic activities of different indigenous plants, apart from investigating indigenous foods/meals/vegetables and drinks for their effects on diabetic patients. Some work has also been done on the plants for antioxidant, antibacterial, anticoccidial and antihepatotoxic activities. Plants showing most promising antidiabetic activity included Puthkanda (Aerial parts), Satona (Leaves) and Kowanch (Seeds). Results of Anthelmintic Studies indicated that Karanjwa (Seeds), Shahterah (Aerial parts), Kalonji (Seeds), Hermal (Seeds) and Qust-e-Shireen (Roots) are plants having potential to be used as anthelmintics. Antiulcerogenic Studies indicated that *Ocimum basilicum* (Niazbo) leaves have best potentials. Similarly, there is a scope to promote research in partnership with the University on local Ethno Veterinary plants with potentials for treating Mastitis, parasitic problems, and respiratory diseases, diseases of urinary tract, uterine prolapse, and silent heat. University of Veterinary and Animal Sciences, Lahore is another important institution that can be involved in Ethno-Veterinary pharmacological research.

### **3.1 National level research and conservation related institutions:**

National Level research and conservation related institutions include NARC, PARC, Pakistan Museum of Natural History (PMNH) Islamabad, Pakistan Science Foundation (PSF), National Institute of Health (NIH) and PCSIR Laboratories. NARC and NIH are working at policy level at their respective level, while PSF is basically a funding agency for supporting scientific research including research on Medicinal and Aromatic plants. It has done some work on ecological research in partnership with PMNH. Apart from establishing a national herbarium, **PMNH** is working on the conservation and documenting ecological distribution of natural indigenous flora. The data available at the institution revealed the ecological distribution of the Medicinal and Aromatic plants given at annexure-5:

The **HEJ** is a renowned chemistry excellence center and over 1000 research papers on the chemistry of Pakistani medicinal plants have been published in leading international journals of the world. (Choudhry *et al*, 2000). HEJ is providing M.Phil and Ph.D level research and training facilities to students. It has abundant state-of the art, world-class instrumental and laboratory facilities, plentiful financial resources and support. HEJ has conducive research environment with full-access to the relevant literature and a well-established chemical and pharmacological screening laboratories. It has appropriate pilot plant facility for industrial scale process optimization, capability of value addition, space, infrastructure and reasonably competent manpower. HEJ has worked on the marketing of the medicinal plants of Malakand Division given at annexure-6: The HEJ is willing to help in the establishment of the following small units in the Malakand region (Choudhry *et al* (2000).

1. Cleaning, drying, grading and packing units;
2. Units for the manufacturing of mother tinctures of herbal/homeopathic medicines;
3. Units for the manufacturing of standardized extracts of medicinal plants;
4. Units for the extraction of essential oils (fragrances) from fresh aromatic plants; and
5. Marketing and transportation units.

At NARC a National Herbarium and Genebank is established. Research is conducted on germplasm 'Plant breeding' line identification and in-situ and ex-situ conservation of medicinal plants. From July 2002 to June 2003, germplasm of Medicinal Plants was collected from Punjab, Balochistan, NWFP and Azad Kashmir. A total of 618 accessions belonging to more than fifty species including Tukham-e-Balongo, Kali zeeri, Sonf, Ajwain, Ispbaghol, Dhania, Ajwain kharasani, Soya, Kasni, Kolangi, Chamomile, Metharay, Tulsi, Chaskoo, Anot katara, lajwanti, Arind, Ghata, saffaran, Black cumin and Melathi were collected. The material collected has been processed, documented and preserved in the Genebank of Plant Genetic Resources Programme. In addition to local collections, the germplasm of *Plantago ovata* (30 accessions), *Hyoscyamus niger* (8 accessions) and *Ricinus communis* (20 accessions) were imported from USA. It has carried out work on evaluation of local (under natural Habitat) and exotic germplasm of *Plantago ovata* (Ispbagol), at Bahawalpur with basic statistics for its 47 accessions. NARC has worked on germplasm and development of production technology with morphological & agronomic traits in various accessions of Castor (*Ricinus communis*), morphological & genetic diversity in Niazbo (*Ocimum basilicum*) with summary of statistics for qualitative & quantitative traits in *Ocimum basilicum*, screening and evaluation of Kolangi (*Nigella sativa*), germplasm and seedborne fungi in *Cyamopsis tetragonoloba* (Guar), and germplasm and effects of fungicide on seed germination and seedling vigor and areas of collection of *Cyamopsis tetragonoloba* (Gaur).

NARC has also worked on the germplasm, screening and evaluation of *Foeniculum vulgare* (Sonf), and germplasm with characterization & evaluation data of (*Foeniculum vulgare*). It has also worked on germplasm, screening and characterization of *Anethum graveolens* (Soya, Dill), *Folnum graceum* (Mathi), *Linum usitatissimum* (Alsi), *Lallementia royleana* (Tukham-e-Balongo), Characterization and Evaluation of *Carum copticum* (Desi Ajwain) Germplasm, Screening of Germplasm of *Coriander sativum* (Coriander or Dhania), and collected evaluation Data of *Coriandrum sativum* (Dhania). NARC has worked on development of production and post harvest technology of *Matricaria chamomilla* (Gul-e-Baboona). Work included establishing soil requirements, propagation techniques, irrigation, chemical weed control, manure and fertilizer requirements, harvesting and drying, distillation, and standardizing flower and oil yield. NARC has also established germplasm evaluation/demonstration plot at farmer's level. It included yield trials of *Plantago ovata* at three locations in Dunyapur (one) and Hasilpur (two), demonstration of *Nigella sativa*, demonstration of Tukham-e-Balongo (*Lallamantia royleana*). In addition, NARC is also facilitating analysis of plant Species for active constituents.

NARC has established a herbal garden containing plant like *Ginkgo biloba* (Ginko), four species of *Mentha*, (*M. piperata*, *M. piperata-X*, *M. arvensis*, *M. longifolia*), *Crocus sativa* (Zaffron), *Viola odorata* (Banafsha), *Ocimum sanctum* (Tulsi), *Ocimum basilicum* (Niazbo), *Oenothera biennis* (Evening Primrose), *Helianthus tuberosus* (Jerusalem artichoke), *Cymbopogon flexuosus* (Lemon grass), *Glycyrrhiza glabra* (Malathi), *Cassia absus* (Chasku), *Catharanthus roseus* (Periwinkle), etc. have been planted in Herbal Garden. NARC is also working on promotion of *Crocus sativus* (Zafron) and *Viola odorata* (Banfsha), *Adiantum capillus-veneris*, *Cannabis sativa*, *Punica granatum*: Marwat and Shinwari (1996), Shinwari *et al* (1996).

**NIH (National Institute of Health) Islamabad** has coordinated the formulation of a draft policy titled "Traditional Medicines Policy and Regulation" and is at review stage in collaboration with World Health Organization and is in final stage. World Health Organisation (WHO) has framed the following guidelines in formulating national level policies.

1. To adapt, adopt and implement where appropriate, WHO traditional medicine strategy as a basis for national traditional medicines programs or work plans;
2. Where appropriate, to draft and implement national policies and regulations on traditional, complementary and alternative medicines in support of the proper use of traditional medicines, and its integration in to the national health care systems, depending on the circumstances in their own countries;

3. To recognise the role of certain traditional practitioners, as one of the important resources in primary health care services particularly in low income countries, and in accordance with the local circumstances;
4. To set up or expand and strengthen existing natural drug safety monitoring systems to monitor herbal medicines;
5. To provide due support for systematic research on traditional remedies;
6. To take measures to protect and preserve traditional medical knowledge and medicinal plant resources for sustainable development of traditional medicines, including the intellectual property rights of traditional medicine practitioners, as provided for, under national legislation consistent with international obligations;
7. To ensure, where appropriate and in accordance with national circumstances, provision of training and, if necessary, training of traditional medicine practitioners, and of a system for the qualification, accreditation of licencing of traditional medicine practitioners; and
8. To promote sound use of traditional medicines, and complementary and alternative medicine by consumers and providers.

The **Natural Drugs Division of PCSIR Laboratories Complex, Peshawar** (now upgraded to Medicinal Botanic Center) was established in 1958. The objectives were to explore the natural drugs resources of Pakistan. The Center consists of five main sections, chemistry, pharmacology, botany, environmental research and analytical chemistry. The aim of the Chemistry Section is to evolve processes for the exploitation of medicinal plants of known therapeutic value, isolate active principles of medicinal plants, synthesize new drugs and undertake analysis of pharmaceuticals. The botany section is engaged in research on taxonomic identification of plants and pharmacognostic studies conducting survey of useful plants of Pakistan. The pharmacology section is engaged in the screening of medicinal plants for their proper evaluation. Environmental research section is engaged in the process, developed for the treatment of industrial effluents. Besides this, it carries out research in the field of air, water and noise pollutions.

The aims and objectives of the Medicinal Botanic Centre are to carry out botanical and chemical survey of medicinal plants for various uses. It carries out studies on the isolation techniques, sets up quality control standards in order to standardize the indigenous herbal pharmaceutical industry, and develops new processes and products based on indigenous raw materials. The objectives of the Centre include experimental cultivation of medicinal and aromatic plants in appropriate ecological zones in order to get qualitative improvement. It aims to improve the quality of herbs (increase in yield of crops and the active constituents) by genetic and plant breeding methods in order to introduce high yielding plants in the country. The Centre provides Adhoc and advisory services in management, cultivation and development of indigenous and exotic aromatic and medicinal plants as well as authentication and verification of plant materials having industrial utilization. It provides advisory services in large and small-scale extraction and processing of the important classes of natural products, phytochemical and biological screening of natural products in crude and pure state, and standardization and value addition of herbal products.

PCSIR Peshawar has undertaken taxonomic studies on trees, shrubs and climbers of Pakistan, introduction and cultivation of plants of medical importance, screening of plants for anticancer activity, production of Opium Alkaloids, preparation of Glycyrrhizic acid and ammonium glycyrrhizinate from licorice. It is preparing Silymarin from *Silybum marianum* and Calcium Sennodides A & B from *Cassia angustifolia*, biochemical synthesis of Ephedrine hydrochloride, odourless garlic powder, Aloe extracts concentrate, and Aloe vera based skin care ointment. The Medicinal Botanic Centre also extracts oil from seabuck thorn seeds. More than 600 research papers have been published in journals of national and international repute. These papers are results of the research on the natural drug resources of Pakistan and provide background information on their exploitation. The Centre has published bulletins on Alkaloidal Drugs research (1970), exploitation of the natural drug resources of West Pakistan, Part-I (1970), exploitation of the Natural Drug Resources of Pakistan, *Matricaria chamomilla* for Flowers and

Blue oil (1984), *Silybum marianum* for Silymarin and Edible oil (1984). It has published monographs with the titles of “Screening of Medicinal Plants for Anticancer Activity and Isolation of Pure compounds from Active Plants (1982)” and “Standardization of Herbal Durgs, (1982)”. The Centre has also published books titled “Compendium of Medicinal Plants (1978)” and “Guide for Pharmacy Assistant (2000)”.

### 3.2 Conservation and development related NGO's and projects

After mid seventies many conservation, development and support programs were initiated like Range Management Project, Watershed Management Project, Social Forestry Project, ERP, Kalam Integrated Development Project (KIDP), Buner Development Project, Provincially Administered Tribal Area (PATA) Project, and Aga Khan Rural Support Program (AKRSP). WWF (Ethno-Botany) Biodiversity Conservation and MACP projects followed these. SDC/IC documented indigenous folk knowledge, social system of herbal medication and marketing system of medicinal and aromatic plants. ERP worked on documenting indigenous knowledge about medicinal plants and ecological distribution and regeneration in the areas protected for tree plantation in Swat, Buner and Chitral. They have reported the availability of Medicinal Plants in Malakand region given at annexure-7:

In relation to medicinal and aromatic plants, **WWF** have set the following objectives for their work:

1. To build capacity of the local grower for cultivation of medicinal plants through training, on farm technology transfer & sustainable harvesting of medicinal herbs, training workshops, establishing medicinal plants nurseries at different levels;
2. To minimize collection & post harvesting losses of medicinal herbs through training and demonstration;
3. Awareness – plants conservation in general & medicinal herbs in particular through environmental education activities in school, workshop for teachers, and establishment of nature clubs, international biodiversity day celebration, environmental day celebration and motivation of the local community; and
4. To accomplish the developmental and conservation activities the project has signed MoU with Qarshi Industries and developed terms of partnership with Al Khidmat Falahi Tanzeem Sulathar for the purchase of *Adiantum cepillus-vanaris* by Qarshi Industries from Sulathar community.

Constraints that effect progress toward conservation and development included non-serious attitude of the community, severe cold climate and snowfall, seasonal migration of the community, unavailability of seed (*Crocus sativus*), inaccessibility of the Project area and unexpected weather. Expected development targets included extension of the medicinal plant cultivation to Mankial, Gath & Sakhra etc, raise nursery of MAP in each plot area, training for collection & growers, sowing the collected seeds along with other species in Sulathar & Miadam nurseries, facilitating contract between Miadam development council & Qarshi Industries for growing medicinal plants, facilitating marketing of *Taxus wallichiana*, *Ulmus wallichii*, *Valeriana jatamaensi*, *Sassurea lappa*, *conitum heteriogtkym*, *Dioscorea detoidae*, during their season of maturity from the communities, Organizing teacher, training workshop regarding environmental education, organize and conduct phyio sociological survey of the area, collecting base line data regarding the prevailing forest protection practice in Sulathar, establishment of community protected area in Sulatanr, facilitating MoU between Qarshi and green hill development society, Mandal Dag, documenting indigenous knowledge regarding medicinal herbs in the area and establishing more nurseries at household level in Sulathar, Charam and Mandal Dag local cities apart from facilitating marketing of the cultivated *Crocus sativus* in the nurseries.

The experience shows that in the valley, *Crocus sativa* grows from October to April, wherein the soil remains barren and unproductive. The cultivation of medicinal plants, especially *Crocus*

*sativa* can become an integrated part of the cropping system. This would change the status of the valley from mono crop to bi-crop area. In the Project area *Matricaria chamomilla* has excellent yield. It can be cultivated in barren area of the valley. WWF in partnership with Qarshi Industries leased land, developed nurseries and encouraged cultivation of MAP. Cultivation of the following plants has promising potentials to compete with staple crops: *Mucana pruriens*, *Withania somnifera*, *Ocimum basilicum*, *Centranthum anthelminticum*, *Mimosa pudica*, *Cardiospermum helicacabum*, *Lallementia royleana*, *Sida cordifolia*, *Ginkgo biloba*. Medicinal and Aromatic plants reported by WWF to be available in Swat District are given at annexure-8:

In relation to MAP, MACP is working for entrepreneurship development and reduction of middleman exploitative role. It is providing training to the local communities in collection, drying, packing, storing, identification of appropriate harvest stage and part to be harvested. MACP is also working on identification of level of constituents. Trainings in extract preparation to the local communities has been planned. In-situ cultivated plots in different valleys of Swat and Chitral have been established to explore optimal cultivation requirements, and relative economics with other crops in order to promote commercial cultivation of key species. MACP is also working on exploring optimal harvest quota for different valleys in Tirichmir and Qashqar conservancies encompassing parts of Chitral, Dir and Swat districts. MACP has also established collaboration with WWF in cultivation trails and environmental education. MACP has reported the plants (Annexure-9) that can economically compete with some crops.

### 3.3 Recommendations of the workshops on medicinal and aromatic plants

The proceedings of the workshop on “Wild Plant Resources of Northern Pakistan” held on May 11 and 12, 1998 identified the following gaps in knowledge of MAP:

1. Many species of medicinal or economic importance are not known;
2. Medicinal properties of species are not fully understood;
3. Conservation needs are not appreciated (Protected Areas, Deferred grazing, Seed dispersal);
4. Propagation techniques are not properly known (Cultivation, harvesting, storage);
5. Marketing potential and market trends are not properly known; and
6. Comparative economics and cultivation of medicinal plants against agriculture crops and livestock rearing not determined.

Following are the recommendations to address the gaps:

1. Fill in the gaps in knowledge about medicinal and economic plants; and
2. Preserve traditional knowledge and build upon it for conservation.

Following are the suggestions for improvement of In-situ cultivation and propagation of MAP:

1. The law of supply and demand governs MAP production and therefore only those plants may be cultivated which have a constant demand in the market and can provide a reasonable cash return to the communities;
2. Scarce plants requiring long period of growth and specific ecological conditions at higher elevations may be conserved and regenerated in their natural habitat;
3. Pharmaceuticals interested in the cultivation of specific plants should initiate pilot-scale cultivation with their own research and development facilities; and
4. Procedures may be evolved to streamline marketing of medicinal plants. Unstable market and fluctuation in prices are the main causes of low commercial scale production. Policy on acceptance of produce and support price is necessary.

Conclusion and recommendation for sustainable medicinal plant development include:

1. The endangered plants need conservation in natural habitat to ensure sustenance;
2. Trading and collection sub-centers may be established in the foothill towns of Chitral, Swat and Northern Areas to stabilize the market. Marketing of crude drugs must be streamlined in

a manner that the collectors and traders do not suffer losses due to fluctuation in the market prices;

3. Social organization and village cooperative societies should be mobilized to exploit the resource through manpower available in the hamlets;
4. Training to the collectors on cultivation, processing and post-harvest treatment of crude drugs;
5. Research facilities for development of MAP need improvement;
6. Suggestions for processing of MAP during and after collection;
7. The MAP collected from different places should be standardized for their contents before sale to the market. This will not only provide a better quality to the consumer but will also help in earning foreign exchange;
8. Collection/drying/grading/packing units should be established in plant habitat by the pharmaceutical industries to ensure sustained supply of quality raw drugs;
9. The storage conditions in the godowns need improvement; and
10. Training to the collectors, cultivators and drug dealers on post-harvest treatment of crude drug at PFI to maintain purity and quality of herbal drugs for marketing.

Some major problem and suggestions for improved marketing include:

1. Trade in crude drugs is monopolized by few wholesale dealers (middleman) in most of the markets and the rest of the shopkeepers are small trader, generally depending on wholesale dealers for their supplies;
2. Due to high fluctuation in the market rates, it is difficult to ascertain the actual rate of a particular crude drug;
3. The margin of profit of the traders is very large. The loser is the producer/cultivator who cannot get reasonable price for the raw material. This practice may be discouraged to benefit the producers for increased production of crude herbal drugs and to ensure their availability at reasonable rates for the consumer; and
4. The quality of crude drug is not up to the mark as the material is stored in unhygienic manner and often infested with insect and fungus. The godowns, where the herbal drugs are stored are generally dark and ventilation is extremely poor. This results in the deterioration of crude drugs and ultimately leads to financial loss to the traders.

Summary of solutions for income generation from trade and cultivation of MAP for local communities include:

1. Regular training program, workshops;
2. Seasonal purchase depots like those of tobacco;
3. Loans to growers, dealers, hakims etc. should be provided (for equipments of cultivation etc.);
4. Government should support local medicine, stop import of medicine, which can be prepared in country;
5. Permit system should be regulated i.e. permits should be free and easily available.
6. Seeds, cuttings etc, of various MAP should be provided on subsidized rates to the growers; and
7. Trial plots at various places should be initiated.

Constraints to maintain and improve biodiversity of medicinal and economic plants in Northern Himalayan region include:

1. Heavy grazing by local and nomads;
2. Unscientific exploitation and smuggling;
3. Lack of public awareness;
4. Lack of transportation facilities and market information;
5. Lack of conservation;
6. Lack of incentives;

7. Little interest by Forest Department;
8. Lack of coordination;
9. Lack of identification; and
10. Lack of phonological information.

Recommendation for sustainably improving biodiversity of medicinal and economic plants in Northern Himalayan region include:

1. Lease out plant growing areas to processors to ensure regular supply to the industry;
2. Providing incentive to farmers for cultivation of medicinal plants;
3. Providing concessions to the industry involved in processing of medicinal plant;
4. A centre of Excellence be created for the promotion of research and education;
5. Creation of a national expert committee to examine the various aspects like conservation, cultivation, processing, difficulties, extraction, drying, storing, transport, quality, market supply and export, to develop future plan of action;
6. Growing MAP with trees and demonstration form;
7. Publicity programs for the finished products and raw material of crude drugs;
8. Quantitative surveys for the assessment of the plants;
9. Liberalizing trade policy by eliminating duties etc;
10. Basic research and education system for MAP and training to the communities in conservation, collection, drying, provision of quality material, garbling and storing;
11. Set up living plants museum and herbarium in Gilgit, Muzafarabad, Abbottabad and Swat;
12. Commence more workshops, seminars in the MAP growing areas; and
13. In-situ conservation of medicinal plants.

### 3.4 Research areas needing attention

Medicinal plants are also used for flavours and fragrances in various industries such as bakery, confectionery, alcoholic beverages, foods, soft drinks and pharmaceuticals. Added to the appetizers, biscuits, bread, butter, cakes, cheese, forcemeat, dessert, drinks, egg dishes, fish dishes, meat, puddings, salads, sances, seasonings, soups, teas, vegetables, and vinegars. Flavour of food makes the food palatable, added in pastes, powders of dentrifices, mouthwashes, and gargles, breath fresheners and denture cleaners. There is also need to develop better institutional research & development support & public polices for the development of essential oil industry (Bhattachar Jee, 2000)

Essential oil bearing plants of Pakistan are given at Annexure-10. Malik *et al* (1971) reported oil-producing plants of Baluchestan forest, Galis, Kaghan & Siran forest, Azad Kashmir, Swat, Chitral & Dir forest & cultivated oil producing plants of Pakistan given at annexure-11:

There is a wide variety of essential oil-bearing flora, and some of the plants can be exploited on a small commercial scale. The plants such as, *Skimmia laureola*, *Valeriana wallichii*, *Artemisia spp*; *Elsholtzia patrini*, *Origanum vulgare*, *Saussurea lappa*, *Angelica glauca* etc, occurring in the northwestern coniferous forests, offer source of seasonal sustained supply of material. The plants could be used in small portable stills to be set-up in the vicinity of forests. The oil thus extracted could be used either in pharmaceutical industry or in the preparation of perfumes, or both, at reasonable economic justification. The conventional distillation is operated through the steamstill. A simpler still can be devised, so that it is easily handled by labour without any closer supervision. Some grasses, i.e. *Cymbopogon martini*, (*'motia' grass*) are rich sources of essential oil, and can be adapted in cultivation. It is impresse upon that some planning should be done to establish oil industry. A variety of plants containing fair quality of oil, in different regions of the country are available. Some of these platns have acclimatized under controlled cropping at farms.

Cultivable MAP in Azad Kashmir include *Allium cepa*, *Allium sativum*, *Beta vulgaris*, *Capsicum annum*, *Capsicum fastigatum*, *Capsicum frutescens*, *Coriandrum sativum*, *Curcuma longa*, *Foeniculum vulgare*, *Mentha arvensis*, *Mentha piperita*, *Prunus amygdalus*, *Prunus persica*,

*Punica granatum*, *Vitis vinifera*, *Zizyphus mauritiana* Hussain (1991-92). Shah (1976-77) reported the following list of cultivated medicinal plants at Botany Department, Peshawar University. *Aloe barbedensis*, *Artemisia kuramensis*, *Bryophyllum calycinum*, *Carum copticum*, *Cassia angustifolia*, *Cassia fistula*, *Catharanthus roseus*, *Citrus aurantifolia*, *Datura innoxia*, *Ephedra intermedia*, *Ephedra nebrodensis*, *Glycyrrhiza glabra*, *Hyoscyamus niger*, *Linum usitatissimum*, *Papaver somniferum*, *Punica granatum*, *Rosmarinus officinalis*, *Verbascum thapsus*, *Vitis venifera*, *Zizyphus manuritiana*. Cultivable Medicinal Plants at PCSIR Laboratories, Peshawar include *Aloe barbandenis*, *Anethum graveolens*, *Carum copticum*, *Catharanthus roseus*, *Citrus medica*, *Cymbopogon citratus*, *Datura fastuosa*, *Foeniculum vulgare*, *Glycyrrhiza glabra*, *Hyoscyamus niger*, *Trigonella foenumgracum*, *Mentha spicata*, *Pyrethrum cinerarifolium*. Cultivable Medicinal Plants at PFI, Peshawar include *Acorus calamus*, *Calchicum luteum*, *Cardiospermum halicacabum*, *Carum copticum*, *Chenopodium ambrosoides*, *Cymbopogon citratus*, *Datura fastuosa*, *Dioscorea deltoidea*, *Ephedra nebrodensis*, *Foeniculum vulgare*, *Glycyrrhize glabra*, *Hygrophilia spinosa*, *Nigella sativa*, *Ocimum americanum*, *Ocimum basilicum*, *Papaver samniferum*, *Plantago ovata*, *Ricinus communis*, *Zingiber officinale*. Other reported cultivable medicinal plants at PFI included *Apium graveolens*, *Cardiospermum helicacabum*, *Carum copticum*, *Catharanthus roseus*, *Cuminum cyminum*, *Cymbopogon citratus*, *Foeniculum vulgare*, *Hygrophila spinosa*, *Lallemantia royleana*, *Lawsonia alba*, *Linum usitatissimum*, *Matricaria chamomilla*, *Mentha arvensis*, *Nigella sativa*, *Ocimum basilicum*, *Pimpinella anisum*, *Plantago ovata*, *Psoralea corylifolia* (Khan 1984)

According to Khan (1984) medicinal plants should be cultivated on experimental basis before extending it as a crop. Some medicinal plants like *barhi alachi*, *choti alachi*, *lawang*, *darchini* and *kali marach* are imported despite local suitable climate. Different diseases and insects like virus curving, and leaf and root diseases affect medicinal plants. The identification and protection from these diseases is needed. Few traders monopolize sale of the medicinal plants. They buy the plants at their own choice & the farmers suffer from the problem of sale of medicinal plants (Khan, 1985).

Following are the reason/causes hindering to obtain optimum benefits from the market of medicinal and aromatic plants (Choudhry *et al*, 2000):

1. Limited efforts are underway to regenerate endangered medicinal plants;
2. Lack of standard institution to check the quality of raw material. Polluted, sub-standards, mixed and expired material is sent to medicinal companies and Hakeems leading to reduced market rate at national and international level;
3. Herbs are beneficial, when their useful parts contain maximum amount of active constituent, while children, woman, herdman and servant of contractors, untrained in proper collection and processing collect these; and
4. Extraction of chemical constituents is totally neglected for commercial/ trade purpose. Only two plants *Ephedra* and *Artemisia* are traded on commercial scale.

Recommendations of the market survey are:

1. Standard institution for medicinal plant development, sustainable production and conservaton;
2. Standardized farming methods of the high value herbs to insure increase in the income of the farmer in hilly area;
3. Established industries for extraction of chemical constituents in those areas where chemical constituent extracted and used on commercial level to reduce the expenditure on import; and
4. Training of local farmers in modern methods of farming, collection, drying, and storage at village levels through NGOs and CBOs.

## RESEARCH AND DEVELOPMENT RELATED INSTITUTIONS

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The country has not been able to develop a coordinated institutional infrastructure and human resource to add value to the medicinal plant resources and for the sustainable use of floral wealth. Following are some of the institution currently working in this field.

### 4.1 Phyto-Chemistry

1. International Center for Chemical Sciences Research, Institute of Chemistry, University of Karachi;
2. PCSIR Laboratories, Peshawar; and
3. Chemistry and Pharmacology Department of Various Universities

### 4.2 Taxonomy, Collection, Herbarium

1. PFI Peshawar;
2. NARC Islamabad;
3. PMNH Islamabad;
4. Herbarium, University of Karachi;
5. Hamdard University, Karachi and
6. Botany Department of various Universities;

### 4.3 Pharmacology

1. HEJ Research Institute, University of Karachi, Karachi;
2. The Aga Khan Medical University, Karachi;
3. Hamdard University, Karachi;
4. Khyber Medical College, Peshawar;
5. NIH Islamabad;
6. University of Agriculture, Faisalabad;
7. University of Veterinary and Animal Sciences, Lahore;
8. University of Agriculture, Peshawar and
9. Pharmacology and Pharmacognosy Department of various Universities.

### 4.4 Standardization, Quality Control and Safety Assurance

1. Hamdard University, Karachi;
2. Pharmacy Faculty, University of Karachi; and
3. HEJ Research Institute, University of Karachi.

### 4.5 Medicinal Plants Cultivation, Tissue-Culture

1. Hamdard University Karachi;
2. Qarshi Industries, Hattar, Pakistan;
3. PFI Peshawar;
4. University of Malakand;
5. PMNH Islamabad;
6. Hamdard University, Madinatul Hikmah Campus, Karachi and
7. PARC Islamabad;

### 4.6 Propagation

1. University of Malakand;
2. NARC Islamabad;

3. H.E.J Research Institute, University of Karachi;
4. Nuclear Institute of Bio-technology and Genetic Engineering (NIBGE), Faisalabad;
5. Nuclear Institute of Agriculture and Bio-technology (NIAB), Faisalabad and
6. PCSIR Peshawar, Karachi.

#### **4.7 Ethno-Botany, Database**

1. PFI Peshawar;
2. Botany Departments of various Universities and
3. Baitul Hikmah Research Institute, Hamdard University, Karachi.

#### **4.8 Conservation**

1. MACP, Pakistan;
2. WWF, Pakistan;
3. IUCN, Pakistan;
4. SDC/IC, Pakistan;
5. Forest Department NWFP;
6. AKRSP, Pakistan; and
7. Palas Conservation and Development Project (PCDP) Kohistan, NWFP, Pakistan.

The need is to coordinate the efforts through initiating joint applied ventures contributing to poverty reduction at national level in general and producing region in particular. And wherein, different institutions can contribute according to their capacity and identify limiting elements for efficient trans-disciplinary coordinated research system to arrange needed support. For applied research contributable to poverty reduction, the need would be to involve the entire chain from cultivation, conservation, production and processing to marketing.

## CONSULTATIVE WORKSHOP CONCLUSIONS

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### 5.1 Existing situation

1. MAP gathering is an income earning activity for poor and marginal people. Approximately 5000 families and mainly their women and children are involved in collection either for market or local use. From marketing, the collector receives minimal and the consumer has to pay very high price;
2. MAP are valued for human and animal disorders and 80% population still depends on these for their health problem;
3. Malakand region provides 20 % share of the total traded and 40% of the exported MAP share of the country. No organized effort has been carried out to promote trade and cultivation of MAP;
4. MAPs are over-exploited and the habitat is degrading. Collection does not match with the productive capacity of the habitat. Species of high demand are over-harvested and low demand under-harvested;
5. Collector lack skills to identify and differentiate MAP, proper pre and post harvest techniques;
6. There is no national recognition of Hikmat, despite the fact that there is international realization of "Return to nature"
7. Awareness about valuable MAP lacking, hence these are either freely grazed or harvested for feed;
8. Awareness about value addition and utilization of MAP is lacking at both local and regional level;
9. Drug Monograph in local languages containing detailed description of Hikmat medicines missing;
10. Statistics regarding habitat production capacity, levels of production, consumption/usage not available;
11. Researches not responsive to real situation and at the most there are isolated studies by individuals;
12. Traditional knowledge regarding herbal cure for human, livestock and poultry is particularly with women that is available in fragmented form and is rapidly disappearing;
13. Traditional herbalists (Hakims) have the tradition of hiding their recipes and these are not properly documented;
14. Information regarding aromatic plants available however cost effective species are not considered for farming;
15. Researchers not aware about local farming system and land uses and social context is insufficiently known;
16. There is inadequate research on geographic and ecological zones & inventory of medicinal and aromatic plants with reference to assess hotspots quantitatively & life cycle studies;
17. Pharmacological research into active ingredients is in initial stages;
18. Conservation and institutional management of MAP is not fractionated along scientific lines;
19. Post harvest processing and value addition not assisted by research;
20. Agronomic techniques not standardized for species with longer maturity period;
21. Missing link between policyholder and field research;
22. Limited number of species cultivated at local level ( $\pm 20$ ). The key cultivated species include: *Foeniculum vulgare*, *Carum copticum*, *Hyoscyamus niger*, *Pimpinella anisum*, *Bunium persicum*, *Plantago ovata*, *Althaea officinalis*, *Lallemantia royleana* and *Prosalea corylifolia*; and

23. Some species are over-harvested to the extent that these can be declared as threatened species. These include: *Saussurea costus*, *Valeriana jatamansi*, *Polygonatum multiflorum*, *Angelica glauca*, *Podophyllum hexandrum*, *Dioscorea deltoidea*, *Asparagus adscendense*, *Geranium wallichianum*, *Viola odorata*, *Aconitum spp*; *Polygonum amplexicaule*, *Glycyrrhiza glabra*, *Ferula asafoetida*, *Morchella esculenta*, *Morchella conica*, *Ephedra girardiana*, *Jurinea macwcephala* and *Paoenia emodi*.

## 5.2 Gaps in existing researches and development

1. No documentation of MAP at local level. Traditional healers (*Hakim*) only transfer their knowledge to one obedient subject, hence no documentation and experience sharing, and recipes are neither shared nor standardized;
2. Management prescription for sustainable yield has not so far been worked out. Statistical data on productive capacity of the habitat, and consumption and usage of the output at local and region/country level is still lacking;
3. No effective research on harvest stage condition for high level of drug constituents and no phyto-chemical screening! (Source, genus, species) not effectively carried out. There is a lack of skill of management of habitat at both farmer and professional level. *Hakims* not given the required skill enhancement training. Local researchers have limited capacity to properly identify species with medicinal value, while community understand the plant in local terminology but not utility;
4. List of priority species neither prepared nor shared with the industry and *Hakims* that can form the base for effective link between collectors and industry. Communal involvement in general in development planning is nominal;
5. Qualitative and quantitative inventory is lacking. Habitat level interaction and species associative effect have not so far been documented even for key species. Different people have developed different hypotheses for example *Morchella* association with different species is claimed, but no valid information about the habitat and associative effects are available. Impact of introduced/exotic species on the plant community structure has not so far evaluated. Grazing impact on MAP available in the wilderness not understood. Formula for yield regulations not established. Conservation status of MAP not known to draw updated red list for effective management and biological threshold level of different species not understood. Depletion and extinction of key plant resources available in wilderness. A general observation is that, when farmers are mobilized for non-profitable cultivation of MAP, there is over-harvesting of species from the wild. Collectors are competing for early harvesting, if they will wait till the maturity, other will get the chance to harvest. They mostly uproot the plant even if only flowers or leaves are needed. Pre fruiting collection has been proved to be injurious to habitat;
6. Lack of skill to effectively coordinate the development initiative in the available social system. Mostly technician are dealing with the social sector;
7. Cropping in general and cash crops in particular, are encroaching the habitat of MAP to fulfill the demand of multiplying population. Overgrazing and uncontrolled grazing of the wild habitat are common. De-forestation, crop encroachment, aforestation and introduction of alien species are contributing to changes in plant community structure;
8. Traditional approaches are replicated in many situations. Awareness about innovative approaches and ecological/economical significance are lacking;
9. No information on genetic mapping of the indigenous medicinal plants are available. There are insufficient facilities for genetic characterization of medicinal plants and standardization of in-vitro culture techniques. In addition there is lack of trained manpower and facilities for application of recombination-DNA-technology to propagate the desired characteristics in medicinal and aromatic plants;
10. Coordination among different agencies working on MAP is lacking at every level. Current research system and processes are not based on people issues; hence, the research output is

not locally adaptable. Available research facilities are personal benefit oriented rather than societal orientation. Researchers are frustrated and discouraged due to bureaucratic hurdles/procedures. Researchers and research institutions are totally ignorant of national and people needs. Advisory/guiding support system to locate users for applying the research results not available;

11. Quality control is lacking. Adulteration is common in the commercial samples and many other plant species are mixed to increase the volume and cheat the buyer. There is no mechanism for protection of endangered species. There is confusion of tenure. Landowners are not directly dependent on habitat in most situations and they have the non-owner users, who are the actual exploiter of the resources available at the habitat;
12. Collector is not properly aware about the collection and sale of MAP, while lack of collector level association/organization predisposes them to exploitation. Hence they in turn degrade and exploit the habitat. There is lack of timely payment and fair price;
13. Disappearance and lack of documentation of traditional knowledge. Information not available on traditional knowledge about cure through medicinal herbs. Such information are needed to be collected about dosage, formulation, correct plant identification, diseases indications, routes of drug administration and efficacy etc;
14. Community not aware of the exportable species value and there is no information sharing system and poor linkages among collectors producers and end users. No projection of supplies and demand position of MAP. The non local users/processors not informed about the availability and distribution of available plants, while collectors are not aware of the industrial or market demands;
15. No proper research on commercially important species. Limited number of species available for cultivation. Majority of temperate MAP cannot compete with cash crops practices prevailing in the region and long duration temperate MAP species not cultivated. Agronomic techniques for majority of plants not standardized. Tissue culture techniques for wild habitat promotion not yet developed Long duration species of temperate region not cultivated. Farmers not convinced to grow aromatic plants. No seed bank for the supply of good quality seeds. Germplasm for cultivation are not available in the market for most of the species. Most species do not compete favorably with existing crops. No information on genetic mapping of indigenous medicinal plants. There are insufficient facilities for genetic characterization of MAP. Insufficient standardized in-vitro plant culture techniques available;
16. Post harvest processing not standardized and extended and crude product rather than value added products are marketed. Outdated pre and post harvest processing skill and no information available on active ingredient level in wild as well as cultivated MAP species. Comparative qualities and level of active ingredients with standard processing procedures from the wild or cultivated sites not established;
17. Lack of resources for micro-enterprise development at local level;
18. Lack of facilitating mechanism and know-how to establish complementary links with other enterprises like tourism;
19. Lack of information as well as access to information about MAP; and
20. There has been little recognition at local and national level for the use of Ethno Veterinary Medicines.

### **5.3 Options for mitigation**

1. A local newsletter can link local collector, processor, research and industry and serve as a tool for information sharing. Botanical names should be properly written with Hikmat and local names through quarterly newsletter. This will also promote local use of traditional medicines and can facilitate documentation of local herbal wealth;
2. Area prioritization in each ecological zone for different land uses and participatory area selection for management. In every zone prioritize focus species. Developing model species

management plan at valley level in different ecological zones (5 zones i.e., Alpine, moist temperate, dry temperate, sub-tropical and scrub zones) and establishment of small socially fenced areas to prevent extinction of key species. Develop species management plan at valley level. Build capacity of the local community and develop skills of relevant development partners for implementation of management plan;

3. Skill development of collectors for collection and post collection processing. Research on determining chemical constituents and phyto-chemical screening of local species. This can lead to selection of most appropriate habitat for different key species. Training for improving the utility of *Hakims* and their proper follow up. Local researchers and community activists can be trained in proper species identification, proper collection and management of the habitat;
4. Preparation of valley wise list of key available species in association with communities and its provision to different herbal industries, who will in turn select and provide the information to the community about quantity required by the industry;
5. Develop qualitative and quantitative inventory and facilitate research on associative effects at habitat level. Purchase from wild collection needs to be watched through community activists and relevant institutions in the name of cultivated production using the tool of motivation and community mobilization;
6. Built capacity of the community for effective management of the habitat. Promote complementary association among resource owners and non-owner users related to the habitat, through initiating dialogues. This is needed before intervening the habitat for research and development purposes;
7. Grazing can be balanced with optimum MAP production. Researching impact of grazing on MAP key habitat to devise prescription for appropriate stocking. Cultivation of alien species in wilderness may only be allowed in special cases after detailed environmental impact assessment;
8. A large variety of non-traditional marketable herbal resources can be promoted for herbal teas, food supplements, flavor enhancement, anti-oxidants, functional food supplements and cosmeceuticals. Testing and promoting these as micro-enterprise at local level can provide jobs to many at local level. This requires no clinical trails, regularization or exports problems and is a simple good manufacturing practice with huge national and international market. Also Local level non-chemical enterprises can be promoted locally;
9. Identification of genetically superior medicinal plants species, and development of genomic library for indigenous MAP. Inclusion of medicinal plants on the priority agenda in biotechnology institutions in the field of agriculture. Cultivation of medicinal plants aimed at establishing a germplasm i.e., gene pool of medicinal plants. Promotion of research on MAP germplasm and breeding of fine varieties Reservation of germplasm for future cultivation. Experimenting tissue culture for rapid multiplication. Establish seed bank to ensure supply of quality seed. Facilitating, strengthening and up gradation of existing bio-tech research institutes to broaden their focus towards medicinal plants (e.g., NIBGE, NIAB, NIFA);
10. Facilitate development of a regional coordination and information sharing system that can interact with community, industry, research and development institution (HEJ, PCSIR, Universities, development funding agencies etc). The presence of a resourceful and effective coordinating system is mandatory to facilitate and coordinate implementation of development proposals. The system is needed to be capable of linking financial support, local government, federal ministries (Science and Technology, Commerce and Industry), Industry, research institutions and research personals. In the coordinating system, a team of taxonomists, phyto-chemists, pharmacologists and nutritionists can work jointly for suitable resource identification and development. Among the available indigenous research institutions HEJ and PCSIR can effectively contribute to the process, while in various universities botany, chemistry, pharmacy and nutrition can be involved in providing suitable students for research activities. The coordinating system can create a network of local

inhabitants that can promote intermediate scale local enterprise based on simple, indigenously fabricated, appropriate technologies and sustainable use of natural resources. Local level chemical processing enterprise can work for extraction of essential oils; value added crude extracts, enriched extracts and semi-purified chemical constituents. Such indigenous processing technologies are transferable to local entrepreneurs through the proposed coordinating system;

11. Research to explore mechanisms for improving quality of traded plants. Study on tenure and land uses and exploring options for complementary communal options. Facilitate to establish local community ownership & empower collectors. Launch an awareness raising campaign about WTO;
12. IPRP, HUIRA & Local government should facilitate to organize the collectors through networking and associations, and provision of market information. This may follow associative sale on fair price and ensure timely payment to the collector through CBO,s. This will enhance the bargaining ability of collectors and can facilitate negotiation with large-scale buyers;
13. Regional coordination and information sharing system can also document the indigenous knowledge and consolidate already available information, data and reports on MAP. The system can subsequently work on standardization of the consolidated data and its validation. It can facilitate the dissemination of information on research and development of MAP through the proposed quarterly newsletter and can develop a separate monograph. The process of such information sharing can facilitate to link the researchers, collector, producer and end-users;
14. Prepare regional list of prioritized MAP in association of other development partners working in the region, share it with herbal industry and publish in local languages through the quarterly newsletter. Organize local exhibition, where community can display plant wealth and industries/ hakims can attend. This may initiate Hakims/industry to promote demand-oriented production/ cultivation. Education and motivation can promote in-situ medicinal plants propagation;
15. Stable MAP business requires sustainable returns of the profit and sustainable production with limited yearly production fluctuation. Collection from wild resources always poses inconsistent production. Studies to assess economic feasibility of different cultivable medicinal and aromatic plants are mandatory to stabilize MAP trade. MAPs have normally a long maturity period from 3-4 years for leaves/fruits and 6-8 years for rhizome production. This will need experimentation through periodic blocks for long duration plants. Additionally promoting contract farming with different herbal companies like that practiced by tobacco companies can promote cultivation. The prerequisite for all these would require standardization of techniques for cultivation of medicinal and aromatic plants. Reducing profit margin through regular provision of market information and linking MAP cultivation with tourism can promote cultivation. Establishment of local nurseries seed banks and training of farmers. Cultivation of threatened species on priority;
16. Skill development of collector in collection and post collection processing for quality and value added product and research on establishing active constituent level grown in different habitats;
17. Community level micro enterprise promotion through micro credit
18. Establish an aromatic plant garden at Malakand particularly in areas of tourist interest like Madayan and Chitral to be monitored by local CBO,s and link it with tourism. Owners and users equitable benefits sharing through enterprise (Integration of MAP management plan and linking it with tourism, forestry, conservation and habitat management plans in association with the communities. Establishment of protected areas in Malakand region and making it complementary with tourism;
19. Protocols should be developed for priority species. Survey for correct/valid information for documentation and scientific validation of recipes for monographs; and

20. There is a huge space for promoting ethno-veterinary medicines. Livestock provide the space to test the efficacy of a plant for a particular ailment before its use in human. Local people traditionally provide herbal medicines to treat different ailments of livestock. This knowledge needs proper documentation and validation. The hierarchy of desired processes includes collection of information, identification of plant resource, determination of efficacy, determination of active constituent, establishment of safety and finally crude drug development for local use. Disease areas needing special focus include mastitis, parasitic problems, respiratory problems, diseases of the urinary tract and reproductive problems like prolapsed uterus and silent heat. Livestock is the main stay of marginal and landless. Promoting research and development of Ethno Veterinary Medicines can reduce the bill of regularly spent on de-worming and cure of metabolic diseases.

## RESEARCH AND DEVELOPMENT ACTION PLAN

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The action plan developed indicates the suggested activities, potential partners that can facilitate the execution of the proposed activities and suggested strategy to materialize the proposed activities in different areas. The broader outline for the proposed activities is given in the light of consultative workshop, visit to the relevant institutions and review of existing research, development and conservation efforts and can be refined in subsequent consultative meetings with the potential partners for each section of activities. The broader sections of the proposed activities, relevant potential partners and execution strategies are given as under:

### 6.1 Regional Coordination Cell Establishment

Regional Coordination Cell (RCC) establishment and institutionalization need institutionalization at potentially willing institution in Malakand region like Malakand University. It is expected that after five years RCC will continue coordinated researches and will be able to obtain funds for research from other facilitating agencies. The need would be to look into, how the research theme contributes to the objectives of poverty reduction and conservation. The research administration at RCC may facilitate the coordination and supervise the research activities at local level. The establishment of RCC may make the research process that can contribute to poverty reduction smooth. Resource Center located at HUIRA can provide the literature and documentation support to selected students and may communicate community's priorities for research to RCC and extend research findings to communities. RCC may devise a five-year tentative research action plan on different relevant themes and may recommend at least five research students per year for research stipend and expenses for MSc, MPhil and PhD studies. IPRP may provide the field costs and analytical cost on research for five consecutive years. The criterion for selecting research areas may be its potential contribution to poverty reduction.

#### *Proposed activities and implementation strategy*

1. **To facilitate research on determining chemical constituents & Phyto-Chemical screening of local MAP species:** For research on determining chemical constituents & phyto-chemical screening of local MAP species, RCC may coordinate with HEJ Research Institute of Chemistry, University of Karachi and Department of Chemistry, University of Peshawar. The facilities at PCSIR Laboratories in Peshawar and HEJ Institute of Chemistry in Karachi can be used for the determination of Chemical constituents and Department of Chemistry in Peshawar University in particular and Chemistry Departments in other national level Universities can provide the students for conducting the research. Different species of medicinal and aromatic plants having commercial importance and medicinal values, in different model valley of IPRP to be used as prime study areas;
2. **To facilitate research to develop and validate indigenous knowledge about Ethno-Veterinary Medicines and Human Health Practices in different zones:** For Ethno Veterinary Medicines (EVM) research, RCC may coordinate with University of Agriculture, Faisalabad, University of Veterinary and Animal Sciences, Lahore and University of Agriculture, Peshawar. The Aga Khan Medical University, Karachi; Hamdard University, Karachi; Khyber Medical College, Peshawar, National institute of health (NIH), Islamabad may recommend students to the RCC for pharmacological studies on local plants. Different species of medicinal and aromatic plants having medicinal values and traditionally used for human and livestock health in different model valley of IPRP may be used as prime study areas;

3. **To facilitate promotion of genetically superior MAP and develop genome library for indigenous MAP:** Malakand University is establishing a research station and genome library at its Shiringal campus. RCC will recommend to IPRP students working at the campus belonging to different universities for stipends and field/analytical costs funding on themes that can contribute to poverty reduction;
4. **To facilitate linkages among community, industry, research and development institutions:** Linking the research process to community and development institutions and facilitate development of network that can promote local intermediate scale enterprise based on simple, indigenously fabricated, appropriate technology and sustainable natural resource use can be facilitated through HUIRA and
5. **To facilitate publication of local quarterly newsletter:** The proposed newsletter is desired to contain extension and awareness raising material in research, development and conservation of natural resources in general and medicinal and aromatic plants in particular in local and national languages. RCC may arrange scientific publishing material, while HUIRA may facilitate publication of quarterly newsletter. IPRP may facilitate the process during initial five years. HUIRA may subsequently continue the publication.

## 6.2 Indigenous knowledge documentation

### *Proposed activities and implementation strategy*

To document indigenous knowledge about MAP and promote its utility students from Malakand University, Aga Khan University, Hamdard University, Jehanzeb Government College and other education institutions may facilitate the process through different level surveys. These institutions can facilitate to document the role of traditional recipes in health management, enlist MAP valley/region wise, share with other relevant research and development institutions through Regional Coordination Cell and herbal industry, publish MAP list and utility in locally understandable language. Local CBOs and Hamdard University may jointly organise local exhibitions for MAP display and invite industries, hakims to attend, and the cost of exhibition born by IPRP. Three exhibitions in three model valleys may be organized in three consecutive years. Hamdard University can be supported for developing protocols for priority MAP species and monograph in Urdu & English containing cheap recipes containing the local plants. HUIRA can extend the process to communities and local healers and disseminate tested indigenous knowledge at different levels.

## 6.3 Economic feasibility of cultivable medicinal and aromatic plants

### *Proposed activities and implementation strategy*

To assess economic feasibility of cultivable medicinal and aromatic plants and promote their cultivation Malakand University at its Shiringal Campus already has a program to carry out cultivation trials of economically feasible plants. Local CBOs can complement the activity by supporting and monitoring subsequent demonstration plots in the vicinity of selected model valleys. Test plots can initially be established in Malakand University, different Degree Colleges in the vicinity of IPRP model valleys and Agriculture Research Station Mingora for standardizing cultivation techniques for MAP followed by community level test plots. WWF Pakistan, Hamdard University Karachi; Qarshi Industries, Hattar, Pakistan; PFI, Peshawar; University of Malakand and National Museum of Natural History, Islamabad already have experience in cultivation of medicinal plants and their expertise will be utilized for the purpose of promoting cultivation at farmer level. IPRP can devise strategy in partnership of local CBOs to promote contract farming through facilitating association and links of communities with herbal industry, promote local level micro-entrepreneurship and devise appropriate market information system. HUIRA may facilitate regular provision of market information and conservation status to

the relevant communities and research institutions. After initial 5 years experimentation at test plots and research stations, IPRP may facilitate cultivation at different regions on commercial scale during subsequent 5 years. With Conservation related programs like IUCN, WWF, PFI and Forest department HUIRA may promote cultivation of threatened species in the natural habitat of model valleys and may continue it subsequently in partnership with Malakand University and Agriculture Research Station after project termination.

#### **6.4 Sustainable production of wild indigenous medicinal and aromatic plants**

##### ***Proposed activities and implementation strategy***

In collaboration with Forest and Wildlife department, MACP, WWF and IPRP may coordinate to make the inventory of MAP in its model valleys and can prioritize different MAP in different zones for different land uses and allocation for model MAP management plans. HUIRA and IPRP in partnership of MACP may facilitate studies on associative effect of MAP, researching grazing impact on MAP to prescribe for appropriate stocking and experimentation through periodic blocks for long duration wild MAPs. Studies on associative effects may also include assessment of alien species impact on local plants. Such studies may lead to determine harvest quota, monitor harvest and sale and select species wise sites for modeling and developing species management plan. Pakistan Forest Institute (PFI), Forest Department, Malakand University, NWFP Agricultural University and Botany departments, can facilitate to develop the inventory, experiment periodic blocks, and do research on associative and grazing effects. IPRP and Local CBOs can select areas for model management plan, PFI and Malakand University develop model management plan and determine harvest quota. After 3 years, local economy may be linked with the conserved habitat and local CBO/community can take the responsibility to manage and monitor. IPRP, HUIRA and local CBOs may work to survey local market for wild and cultivated plant, compare with habitat harvest capacity, and do lobbying for appropriate legislation and institutional mechanisms at different levels.

#### **6.5 Capacity building program for collectors and processors**

##### ***Proposed activities and implementation strategy***

Different training and skill development programs for collection and post collection processing and value addition at model valleys can be arranged through local CBO's and HUIRA may facilitate, update, and modify the training and capacity building process per need. HEJ, Aga Khan University, Pharmacy department of various Universities, PCSIR Laboratories and Hamdard University can develop, update and modify the training module. It may include some basic training and subsequent refresher course. The training areas may include:

1. Collection, post collection training in MAP & follow up;
2. Capacity building of local Hakims and follow up;
3. Motivation for *in-situ* propagation of key MAP;
4. Capacity building in innovations for herbal enterprise and
5. Build capacity of the community for effective management of the habitat.

#### **6.6 Complementary association among relevant stake holders**

##### ***Proposed activities and implementation strategy***

To promote complementary association among landowners of the MAP habitat and non-owner users, entrepreneurs and defusing market exploitation, HUIRA in association with the Union Council and local CBOs can assess facilitation needs, and devise strategy to promote social complementation and conflict management. Subsequently it can organize collectors through networking and associations. This is needed before intervening in to the habitat for research and development and may follow associative sale on fair price with ensured timetable for payment to

the collector. Local CBOs can facilitate collectors for associative sale and promote awareness at community level about WTO. HEJ, PCSIR and Chemistry /Pharmacy Departments of different Universities can work to test the traded samples and devise mechanisms to improve the quality of traded samples.

## **6.7 Innovative approaches in herbal micro-enterprise**

### ***Proposed activities and implementation strategy***

To promote innovative approaches in herbal micro-enterprise at local level HEJ to take the lead role facilitated by Chemistry department of Peshawar University, and PCSIR at regional and CBOs at local level. The initial exploration of innovations and its preliminary testing by HEJ and Chemistry Department Peshawar University can be refined further at local level by HUIRA and local CBOs. PCSIR can work to develop the relevant technologies. Apart from soft term lending facilitation by Bank of Khyber and Zari Taraqiati Bank, collector's savings IPRP can provide technical and monetary support for local micro-MAP enterprise promotion. The activity may include exploration and promotion of non-traditional marketable herbal resources for herbal teas, food supplements, flavor enhancers, anti-oxidants, functional food supplements and cosmeceuticals and develop corresponding technologies. After preliminary testing locally adaptable entrepreneurship for extraction of essential oils, value added crude extracts, enriched extracts & semi-purified constituents can be promoted and supported by IPRP with due technical support from HEJ and Chemistry Department.

## **6.8 Aromatic plant garden and medicinal and aromatic plants protected areas**

### ***Proposed activities and implementation strategy***

To establish aromatic plant gardens on communal areas particularly focusing areas with tourism attraction initially a dialogue can be initiated between relevant stake holders including Tehsil Council, Jehanzeb Government College and Malakand University, wherein a strategy can be evolved that can lead to allocate areas for botanical gardens. IPRP can bear the plantation and fertilization costs for initial 3 years, and subsequently the custodian institutions can look after the management of gardens and can sustain the activity by linking it with tourism. Forest Department may allocate reserve scrublands under its custodianship for the medicinal plants protected areas. IPRP and Wildlife Department can facilitate its establishment through motivation of the local communities and Local CBOs, Forest Department and Tehsil Council can look after the protected areas and sustain the activity. Wildlife Department, Local CBOs and HUIRA can work collectively to identify area for protection. Wildlife Department may monitor and further promote the protected area and link it with Tourism

### Annexture-1

*Abies pindrow*, *Abies webbiana*, *Acer pentapomicum*, *Acer pictum*, *Aconitum chasmanthum*, *Aconitum heterophyllum*, *Acorus calamus*, *Adhatoda vasica*, *Aegle marmelos*, *Aesculus indica*, *Ammi visnaga*, *Angelica glauca*, *Artemisia absinthium*, *Artemisia brevifolia*, *Artemisia waldest*, *Atropa acuminata*, *Berberis lycium*, *Bergenia ciliata*, *Betula utilis*, *Bombax malabaricum*, *Bunium persicum*, *Calotropis procera*, *Cannabis sativa*, *Carthamus tinctorius*, *Carum copticum*, *Carum bulbocastanum*, *Cedrus deodara*, *Chenopodium ambrosioides*, *Chrysanthemum lincroriaefolium*, *Coriandrum sativum*, *Crataegus songarica*, *Dactylorhiza hatagirea*, *Datura fastuosa*, *Datura metel*, *Datura stramonium*, *Digitalis lanata*, *Digitalis purpurea*, *Dioscorea deltoidea*, *Dodonaea viscosa*, *Elshoizia patrinii*, *Foeniculum vulgare*, *Fraxinus excelsior*, *Geranium wallichianum*, *Hyoscyamus niger*, *Juglan regia*, *Juniperus macropoda*, *Indigofera gerardiana*, *Lavatera kashmiriana*, *Linum usitatissimum*, *Melia azedarach*, *Mentha longifolia*, *Narcissus tazetta*, *Nigella sativa*, *Ocimum americanum*, *Origanum vulgare*, *Paeonia emodi*, *Papaver somniferum*, *Parrotiopsis jacquemontiana*, *Parowskia abrotanoides*, *Pinus excelcia*, *Pinus gerardiana*, *Pinus griffithii*, *Pinus wallichiana*, *Plantago ovata*, *Podophyllum hexandrum*, *Plantago ispagula*, *Plantago psyllum*, *Podophyllum emodi*, *Podophyllum hexandrum*, *Populus alba*, *Populus ciliata*, *Prunus padus*, *Pinus roxburghii*, *Polygonum amplexicaule*, *Punica granatum*, *Pyrethrum chrysanthemum*, *Quercus incana*, *Rheum emodi*, *Salix denticulata*, *Ricinus communis*, *Salvia hydrangea*, *Saussurea costus*, *Senecio jacquemontianum*, *Skimmia laureola*, *Sorbaria tomentosa*, *Taxus wallichiana*, *Thymus linearis*, *Tinospora cordifolia*, *Tinospora miers*, *Vitex-agnus-castus*, *Urtica dioca*, *Valeriana jatamansi*, *Viburnum cotinifolium*, *Viburnum nervosum*, *Viola serpens*, *Zanthoxylum armatum*, *Zizyphus vulgaris*, *Zizyphus oxyphylla*:  
Distribution: Malakand, Himalayas, Kaghan and Siran, PFI Peshawar, Khyber Agency:  
References: Wani *et al* (2002), Zaman and Khan (1970), Vohora & Kumar (1971), Kazmi and Siddiqi (1953), Zaman and Immam (1972), Malik *et al* (1971), Zaman *et al* (1972), Khan and Zaidi (1976) & (1989), Khan (1976), Afridi (2002), Rizwana *et al* (2002)

### Annexture-2

*Abies pindrow*, *Acacia catechu*, *Acacia modesta*, *Acacia nilotica*, *Achillea millefolium*, *Achyranthus aspera*, *Aconitum chasmanthum*, *Aconitum heterophyllum*, *Acorus calamus*, *Adiantum capillus-veneris*, *Adhatoda vasica*, *Adhatoda zylonica*, *Adiantum incisum*, *Ajuga bracteosa*, *Alhagi maurorum*, *Aloe barbedensis*, *Allium cepa*, *Amaranthus viridis*, *Anagalis arvensts*, *Anethum graveolens*, *Anagalis arvensts*, *Aristida adscensciouns*, *Argemone maxicana*, *Arenaria serpyllifolia*, *Arisaema flavum*, *Artemisia kuramensis*, *Artemisia maritima*, *Bauhinia variegata*, *Berberis lyceum*, *Bergenia ciliata*, *Beta vulgaris*, *Buddleja asiatica*, *Bryophyllum calycinum*, *Calotropis procera*, *Cardiospermum helicacabum*, *Celastrus royleanus*, *Colchicum luteum*, *Cannabis sativa*, *Convolvulus arvensis*, *Caralluma tuberculata*, *Carissa opaca*, *Carum copticum*, *Cassia angustifolia*, *Cassia fistula*, *Catharanthus roseus*, *Capsicum frutiscens*, *Capsicum fastigatum*, *Capsicum annum*, *Chenopodium album*, *Chenopodium ambrosioides*, *Cichorium intybus*, *Cissampelos pareira*, *Citrus medica*, *Convolvulus arvensis*, *Cordia latifolia*, *Coriandrum sativum*, *Cuminum cyminum*, *Curcuma longa*, *Cuscuta reflexa*, *Cymbopogon citratus*, *Cynodon dactylon*, *Delbergia sissoo*, *Datura fastuosa*, *Datura innoxia*, *Datura metel*, *Datura stramonium*, *Dioscorea deltoidea*, *Dodonaea viscosa*, *Zanthoxylum armatum*, *Emblica officinalis*, *Ephedra intermedia*, *Ephedra gerardiana*, *Ephedra nebrodensis*, *Eucalyptus camaldulensis*, *Euphorbia dracunculoides*, *Euphorbia helioscopia*, *Euphorbia hirta*, *Faeniculum vulgare*, *Fagonia cretica*, *Ficus carica*, *Ficus palmata*, *Foeniculum vulgare*, *Fumaria indica*, *Geranium nepalense*, *Geranium wallichianum*, *Glycgrrhiza alalosa*, *Glycyrrhiza glabra*, *Gymnosporia royleana*, *Abelomoschus esculentus*, *Hedera nepalensis*, *Heteropogon contortus*, *Hyoscyamus muticus*, *Hyoscyamus niger*, *Hypericum perforatum*, *Myrsine africana*, *Ipomoea pestigridis*, *Iris germanica*, *Jasminium officinale*, *Justicia adhatoda*,

*Juglans regia*, *Lamium album*, *Lantana indica*, *Linum usitatissimum*, *Mallotus phillippensis*, *Malva perviflora*, *Malva neglecta*, *Matricaria chamomilla*, *Maytenus royleanus*, *Melia azedarach*, *Melilotus indica*, *Mentha longifolia*, *Mentha arvensis*, *Mentha sylvestris*, *Marrubium vulgare*, *Micromeria biflora*, *Mirabilis Jalapa*, *Morus alba*, *Musa paradisiaca*, *Myrsine africana*, *Nepeta hindostana*, *Nerium odorum*, *Nerium oleander*, *Nigella Sativa*, *Ocimum americanum*, *Ocimum basilicum*, *Olea ferruginea*, *Viola odorata*, *Origanum vulgare*, *Otostegia limbata*, *Oxalis corniculata*, *Paeonia emodi*, *Paganum harmala*, *Papaver somniferum*, *Phyllanthus emblica*, *Phyla nodiflora*, *Phoenix sylvestris*, *Pinus roxburghii*, *Plantago ispagula*, *Plantago lanceolata*, *Plantago major*, *Plantago ovata*, *Isodon rugosus*, *Podophyllum hexandrum*, *Prunus persica*, *Prunus amygdalus*, *Punica granatum*, *Punica protopunica*, *Pinus roxburghii*, *Pteris cretica*, *Quercus incana*, *Ranunculus muricatus*, *Rawolfia Serpentina*, *Rhazya stricta*, *Ricinus communis*, *Rubus fruticosus*, *Rumex hastatus*, *Salvia moorcroftiana*, *Skimmia laureola*, *Solanum miniatum*, *Solanum surratense*, *Sonchus asper*, *Swertia chirata*, *Taraxacum officinale*, *Taxus baccata*, *Themeda anathera*, *Thymus linearis*, *Trifolium repens*, *Iris germanica*, *Valeriana Jatamansi*, *Verbascum thapsus*, *Verbena officinalis*, *Vicia sativa*, *Viola odorata* *Viola serpens*, *Vitex negundo*, *Urtica dioica*, *Withania coagulans*, *Withania somnifera*, *Zanthoxylum armatum*, *Zingibar officinale*, *Zizyphus jujuba*, *Zizyphus numelaria*, *Zizyphus mauritiana*: Distribution: North Wazirestan Agency, Azad Kashmir, Timergara Dir, Malakand, Buner, Mohmand Agency, Gadoon Area, Ekaghund and Michni Area, Hazara : Naveed-ur-Rehman (1992), Hussain (1991-92), Shah (1991-92), Shah (1992-93), Ali (1987), Dastagir (20001), Afridi (1986), Kifayat-ur-Rehman (1986), Tasbih Ullah (1985), Rashid (1987), Shah (1976-77), Dastagir *et al* (1999), Ghorri (1985)

### **Annexure-3**

*Acacia arabica*, *Acacia modesta*, *Justicia adhatoda*, *Adiantum venestum*, *Ajuga bracteosa*, *Amaranthus viridis*, *Ammi visnaga*, *Artemisia maritima*, *Berberis lyceum*, *Boerhaavia diffusa*, *Calotropis procera*, *Cannabis sativa*, *Carthamus oxycantha*, *Chenopodium ambrosioides*, *Cichorium intybus*, *Citrullus colocynthis*, *Cynodon dactylon*, *Daphne oleoides*, *Datura inoxia*, *Dodonaea viscosa*, *Euphorbia helioscopia*, *Ficus palmata*, *Fumaria indica*, *Juglans regia*, *Mallotus phillippensis*, *Malva sylvestris*, *Melia azedarach*, *Mentha longifolia*, *Micromeria biflora*, *Mirabilis jalapa*, *Nasturtium officinale*, *Nerium oleander*, *Olea ferruginea*, *Onosma hispidum*, *Opuntia monacantha*, *Otostegia limbata*, *Periploca aphylla*, *Pinus roxburghii*, *Plantago ovata*, *Punica granatum*, *Ricinus communis*, *Rubus fruticosus*, *Salvia moorcroftiana*, *Solanum nigrum*, *Tamarix aphylla*, *Tribulus terrestris*, *Verbascum thapsus*, *Verbena officinalis*, *Viola biflora*, *Vitex negundo*, *Withania somnifera*: Distribution: Swat Ranizai Malakand Agency: Iqbal-ul-Din (1998)

### **Annexure-4**

*Acacia catechu*, *Acacia modesta*, *Acacia nelotica*, *Albizia lebbbeck*, *Barleria cristata*, *Berberis lyceum*, *Bombax ceiba*, *Calotropis procera*, *Carissa opaca*, *Cassia fistula*, *Dalbergia sissoo*, *Dendrocalamus strictus*, *Dodonaea viscosa*, *Embelia ribes*, *Euphorbia helioscopia*, *Euphorbia royleana*, *Ficus benghalensis*, *Ficus religiosa*, *Flacoura indica*, *Ficus virgata*, *Hyoscyamus niger*, *Jasminium officinale*, *Jasminum humile*, *Justicia adhatoda*, *Lantana camara*, *Melia azedarach*, *Maytenus royleanus*, *Mellotus philippinensis*, *Mimosa rubicaulis*, *Morus alba*, *Nannorrhops ritchieana*, *Nerium oleander*, *Olea ferruginea*, *Opuntia monacantha*, *Otostegia limabata*, *Phoenix sylvestris*, *Phyllanthus emblica*, *Pyrus pashia*, *Punica granatum*, *Pinus roxburghii*, *Quercus leucotrichophora*, *Ricinus communis*, *Rosa brunonii*, *Rubus fruticosus*, *Vitex negundo*, *Withania somnifera*, *Woodfordia fruticosa*, *Zanthoxylum armatum*, *Zizyphus nummularia*, *Zizyphus mauritiana*: Shinwari and Khan (1998)

### **Annexure-5**

*Acacia nilotica*, *Aconitum heterophyllum*, *Adiantum capillus-veneris*, *Aloe indica*, *Althaea officinalis*, *Allium sativum*, *Anisomeles indica*, *Andrachne cordifolia*, *Apium graveolens*, *Apium maritima*, *Artemisia maritima*, *Berberis lycium*, *Calotropis procera*, *Carthamus tinctorius*,

*Carum bulbocastanum, Carum copticum, Cassia angustifolia, Cassia fistula, Centella asiatica, Citrullus colocynthis, Colchicum luteum, Cordia dichotoma, Coriander sativum, Cucumis melo, Cuscuta reflexa, Datura fastuosa, Dioscorea deltoidea, Eclipta prostrata, Embelia ribes, Ephedra girardiana, Fagonia cretica, Ferula foetida, Ficus carica, Foeniculum vulgare, Fumaria parviflora, Gentiana kurroo, Glycyrrhiza glabra, Grewia asiatica, Heliotropium strigosum, Hyoscyamus niger, Justicia adhatoda, Lawsonia alba, Linum usitatissimum, Mallotus phillippensis, Matricaria chamomilla, Melia azedarach, Mentha longifolia, Mirabilis jalapa, Morus alba, Myrsine Africana, Myrtus communis, Nelumbium speciosum, Nepeta ruderalis, Nymphaea alba, Ocimum basilicum, Onosma echioides, Oxalis corniculata, Paeonia emodi, Peganum harmala, Peucedanum graveolens, Pimpinella stewartii, Pistacia integerrima, Plantago ovata, Portulaca olearacea, Punica granatum, Rhazya stricta, Rheum emodi, Ricinus communis, Rosa damascena, Salvadora persica, Salvia aegyptiaca, Salvia plebeian, Saussurea lappa, Sesamum indicum, Sida cordifolia, Sisymbrium irio, Skimmia laureola, Solanum nigrum, Swertia chirata, Thymus linearis, Tinospora cordifolia, Tribulus terrestris, Valeriana jatamansii, Vitis vinifera, Viola serpens, Withania coagulans, Withania somnifera, Zizyphus jujuba:* Distribution: Medicinal Plant of Pakistan Islamabad, NWFP, Northran Area, Punjab, Sindh: Shah (2004).

#### **Annixture-6**

*Acorus calamus, Allium sativum, Althaea rosea, Apium graveolens, Avena sativa, Berberis lycium, Carum copticum, Cedrus deodar, Capsicum annum, Coriander sativum, Dodonaea viscosa, Ficus Carica, Fumaria indica, Foeniculum vulgare, Inula recemosa, Linum usitatissimum, Mentha piperita, Morus alba, Morus nigra, Origanum vulgare, Paeonia emodi, Pimpinella anisum, Podophyllum hexandrum, Polygonatum verticilatum, Prunus domestica, Punica granatum, Rheum emodi, Rosa damascena, Salvia moorcroftiana, Urtica dioica:* Choudhry *et al* (2000)

#### **Annixture-7**

*Acacia modesta, Achyranthus aspera, Acorus calamus, Adiantum venestum, Ailanthus altissima, Ajuga bracteosa, Allium sativum, Amaranthus viridis, Ammi visnaga, Anethum graveolens, Argyrolobum roseum, Artemisia brevifolia, Astragalus stoloniferous, Berberis lyceum, Bergenia ciliata, Betula utilis, Bauhinia variegata, Butea monosperma, Cichorium intybus, Calotropis procera, Caltha alba, Cannabis sativa, Capparis spinosa, Carelluma edulis, Carrissa spinarum, Carthamus sp., Carum bulbocastanum, Carum carvi, Celtis australis, Chenopodium foliosum, Cichorium intybus, Cissampelos pareira, Codonopsis clematidea, Convolvulus arvensis, Cotoneaster nummularia, Datura stramonium, Debregeasia saeneb, Dephne mucronata, Dodonaea viscosa, Ephedra gerardiana, Epilobium hamatimosi, Euphorbia thomsoniana, Faeniculum vulgare, Ferula narthex, Ficus verigata, Foeniculum vulgare, Fumaria indica, Grewia optiva, Gymnosporia royleana, Hedra nepalensis, Hippophae rhamnoides, Hyoscyamus niger, Inula recemosa, Juglans regia, Juniperus excelsa, Justicia adhatoda, Malva neglecta, Malva perviflora, Melia azedarach, Melilotus philippinensis, Mentha arvensis, Mentha longifolia, Mentha sylvestris, Monotheca buxifolia, Morchella esculenta, Myrsine africana, Nepeta cataria, Nerium odorum, Olea ferruginea, Onosma echioides, Opuntia dellinii, Oxalis corniculata, Paeonia emodi, Papaver somniferum, Peganum harmela, Pistacia khinjak, Plantago lanceolata, Plantago major, Plantago ovata, Plectranthus rugosus, Podophyllum hexandrum, Polygonum aviculare, Portulaca olearacea, Primula sp., Prunus eburnean, Punica granatum, Quercus incana, Rheum emodi, Rhynchosia arenaria, Ricinus communis, Rosa webbiana, Rumex hastatus, Rumex nepalensis, Salvia officinales, Berginia ciliate, Sisymbrium irio, Skimmia laureola, Solanum miniatum, Solanum surratense, Sorcococa saligna, Statica gilesii, Stsymbrium irio, Taraxacum officinale, Teucrium stocksianum, Thymus linearis, Urtica dioca, Verbascum thapsus, Vibernum nervosum, Viola odorata, Viola serpens, Vitex negundo, Xanthium strumarium, Zanthoxylum armatum, Zizyphus oxyphylla, Zizyphus sativa :Distribution: Chital, Swat and Buner: Ahmad and Sher (1997)*

## Annexure-8

*Abelmoschus esculentus*, *Abies pindrow*, *Acacia catechu*, *Acacia modesta*, *Acacia nilotica*, *Achillea millefolium*, *Achyranthus aspera*, *Aconitum violaceum*, *Acorus calamus*, *Adiantum incisum*, *Adiantum nigrum*, *Adiantum venustum*, *Aesculus indica*, *Ailanthus altissima*, *Ajuga bracteosa*, *Ajuga parviflora*, *Allium cepa*, *Allium sativum*, *Alnus nitida*, *Amaranthus caudatus*, *Amaranthus spinosus*, *Amaranthus viridis*, *Ammi visnaga*, *Andrachne cordifolia*, *Anemone rubicola*, *Apluda mutica*, *Arisaema flavum*, *Arisaema jacquemontii*, *Aristida cyanantha*, *Artemisia brevifolia*, *Artemisia scoparia*, *Artemisia vulgaris*, *Asparagus officinalis*, *Asphodalus tenuifolius*, *Astragalus anisacanthus*, *Atropa accuminata*, *Avena sativa*, *Berberis lycium*, *Bergenia ciliata*, *Betula jacquemontii*, *Bistorta amplexicaulis*, *Boerhaavia diffusa*, *Brassica campestris*, *Brassica oleracea*, *Bromus japonicus*, *Bunium persicum*, *Buxus sempervirens*, *Calendula arvensis*, *Calendula officinalis*, *Calotropis procera*, *Caltha alba*, *Capparis decidua*, *Capsella bursa-pastoris*, *Capsicum annuum*, *Capsicum frutescens*, *Caralluma edulis*, *Cassia fistula*, *Cedrella serrata*, *Cedrus deodar*, *Celtis caucasica*, *Chenopodium album*, *Chenopodium botrys*, *Chenopodium murale*, *Cichorium intybus*, *Citrullus colocynthis*, *Clematis govaniana*, *Clematisgrata*, *Colchicum luteum*, *Colocasia esculenta*, *Convolvulus arvensis*, *Conyza canadensis*, *Coriandrum sativum*, *Corydalis govaniana*, *Cotoneaster microphylla*, *Cotoneaster nummularia*, *Crataegus oxycantha*, *Cucumis sativus*, *Cucurbita maxima*, *Cuminum cyminum*, *Cuscuta reflexa*, *Cymbopogon distans*, *Cynodon dactylon*, *Cynoglossum lanceolatum*, *Dactyloctenium aegyptium*, *Dalbergia sissoo*, *Daphne oleoides*, *Datisca canabina*, *Datura innoxia*, *Datura innoxia*, *Delphinium aquilegifolium*, *Delphinium denudatum*, *Dendrocalamus strictus*, *Dicanthium annulatum*, *Dioscorea deltoidea*, *Diospyrus kaki*, *Diospyrus lotus*, *Diplachne fusca*, *Dodonaea viscosa*, *Dryopteris stewartii*, *Ebretia obtusifolia*, *Echinopsgriffithianus*, *Elaeagnus parviflora*, *Ephedra gerardiana*, *Eriophorum comosum*, *Eryngium biebersteinianum*, *Eucalyptus globulus*, *Euphorbia helioscopia*, *Euphorbia prostrata*, *Euphorbia wallichii*, *Ficus carica*, *Ficus racemosa*, *Ficus religiosa*, *Equisetum arvense*, *Flacourtia indica*, *Foeniculum vulgare*, *Fragaria indica*, *Fraxinus zantholoides*, *Fumaria indica*, *Gentiana kurroo*, *Geranium collinum*, *Geranium wallichianum*, *Gymnosporia royleana*, *Hedera nepalensis*, *Heteropogon contortus*, *Hippophae rhamnoides*, *Hyoscyamus niger*, *Hypericum perforatum*, *Iberis amara*, *Imperata cylindrica*, *Ipomoea carica*, *Indigofera heterantha*, *Jasminium humile*, *Juglans regia*, *Justicia adhatoda*, *Lageneria vulgaris*, *Lathyrus aphaca*, *Lathyrus cicera*, *Lathyrus pratensis*, *Lathyrus sativus*, *Launea procumbens*, *Lepidium sativum*, *Lespedeza juncea*, *Limonium gilesii*, *Luffa aegyptiaca*, *Mallotus phillippensis*, *Malus pumila*, *Malva neglecta*, *Malva officinalis*, *Medicago minima*, *Medicago polymorpha*, *Melia azedarach*, *Melilotus alba*, *Melothria heterophylla*, *Mentha longifolia*, *Mentha spicata*, *Mirabilis jalapa*, *Momordica charantia*, *Morchella esculenta*, *Morus alba*, *Morus nigra*, *Myrsine africana*, *Narcissus tazetta*, *Nerium indicum*, *Nicotiana tabacum*, *Olea ferruginea*, *Onopordum acanthium*, *Onosma bracteatum*, *Onychium japonicum*, *Opuntia dellinii*, *Origanum vulgare*, *Oryza sativa*, *Otostegia limbata*, *Oxalis corniculata*, *Paeonia emodi*, *Papaver rhoeas*, *Papaver somniferum*, *Peganum harmala*, *Picea smithiana*, *Pimpinella stewartii*, *Pinus roxburghii*, *Pinus wallichiana*, *Pisum sativum*, *Plantago lanceolata*, *Platanus orientalis*, *Plectranthus rugosus*, *Podophyllum hexandrum*, *Polygonatum verticillatum*, *Polygonum barbatum*, *Populus caspica*, *Portulaca olearacea*, *Potentilla nepalensis*, *Primula denticulata*, *Prunus armeniaca*, *Prunus domestica*, *Prunus persica*, *Pteridium aquilinum*, *Pyrus communis*, *Pyrus pashia*, *Quercus baloot*, *Quercus floribunda*, *Quercus leucotrichophora*, *Ranunculus aquatilis*, *Ranunculus muricatus*, *Raphanus sativus*, *Rheum australe*, *Rhododendron arboreum*, *Ricinus communis*, *Robinia pseudoacacia*, *Roripa nasturtium-aquaticum*, *Rosa moschata*, *Rosa serica*, *Rosa webbiana*, *Rubus ellipticus*, *Rubus fruticosus*, *Rubus ulmifolius*, *Rumex dentatus*, *Rumex hastatus*, *Saccharum bengalense*, *Saccharum spontaneum*, *Salix babylonica*, *Salix tetrasperma*, *Salvia linata*, *Salvia moorcroftiana*, *Salvia plebeia*, *Sarcococca saligna*, *Senecio chrysanthemoides*, *Setaria viridis*, *Silene vulgaris*, *Skimmia laureola*, *Solanum esculentum*, *Solanum melongina*, *Solanum nigrum*, *Solanum surratense*, *Solanum tuberosum*, *Sonchus*

*arvensis*, *Spinacea oleracea*, *Tagetes minuta*, *Taraxacum officinale*, *Taxus buccata*, *Thalictrum foliosum*, *Thymus linearis*, *Tribulus terrestris*, *Trichosanthes cucumerina*, *Trifolium repens*, *Trigonella foenum graecum*, *Triticum aestivum*, *Tylophora hersuta*, *Urtica dioica*, *Valeriana jatamansi*, *Verbascum thapsus*, *Viburnum cotinifolium*, *Viburnum foetens*, *Viola betonicifolia*, *Viola biflora*, *Viola canescens*, *Viola serpens*, *Vitex negundo*, *Vitis Jacquemontii*, *Withania coagulans*, *Withania somnifera*, *Xanthium strumarium*, *Zanthoxylum armatum*, *Zizyphus numularia*, *Zizyphus oxyphylla*, *Zizyphus sativa*: Shinwari et al (2003)

#### **Annexure-9**

*Berberis lycium*, *Paeonia*, *Morchella*, *Podophyllum*, *Matricaria*, *Viola pilosa*, *Aconitum heterophyllum*, *Aconitum chasmantham*, *Dioscorea deltoidea*, *Asparagus*, *Valeriana jatamansi*, *Primula macrophylla*, *Polygonum amplexicaule*, *Polygonatum multiflorum*, *Berginea ciliata*, *Rheum emodi*, *Thymus linearis*, *Ephedra*, *Bonium persicum*, *Colchicum leutum*, *Sassurea costus*: Other medicinal plants reported by MACP having medicinal value include *Aesculus indica*, *Artemisia absinthium*, *Capparis spinosa*, *Daphne mucronata*, *Ficus carica*, *Hippophae rhamnoides*, *Paeonia emodi*, *Podophyllum emodi*, *Rosa alba*, *Swertia cordata*, *Tamarix gallica*, *Taraxacum officinale*, *Valeriana wallichii*, **Distribution:** Malakand Division: MACP (2004)

#### **Annexure-10**

*Abies pindrow*, *Acacia arabica*, *Acacia catechu*, *Acacia decurrens*, *Acacia farnesiana*, *Acacia modesta*, *Achillea millefolium*, *Acorus calamus*, *Alpinia galanga*, *Alpinia malaccensis*, *Amomum aromaticum*, *Anethum graveolens*, *Angelica glauca*, *Anthemis nobilis*, *Anthocephalus cadamba*, *Anthoxanthum odoratum*, *Arohangolica officinalis*, *Artemisia vulgaris*, *Balsamodendron pubescens*, *Balsamodendron roxburghii*, *Bignonia suaveolens*, *Blumea aromatica*, *Blumea balsamifera*, *Blumea malcomii*, *Boswellia glabra*, *Boswellia serrata*, *Boswellia thurifera*, *Calamintha umbrosa*, *Carum carvi*, *Cedrela microcarpa*, *Cedrela toona*, *Cedrus deodara*, *Cestrum aurantiacum*, *Cestrum nocternum*, *Cestrum parqui*, *Chenopodium ambrosioides*, *Cinnamomum camphora*, *Cinnamomum cecicodaphne*, *Cinnamomum obtusifolium*, *Cinnamomum tamala*, *Cinnamomum zeylanicum*, *Citrus aurantifolia*, *Citrus decumana*, *Citrus limon*, *Citrus medica*, *Citrus paradisi*, *Citrus reticulata*, *Citrus sinensis*, *Commiphora mukul*, *Conanga odorata*, *Coriandrum sativum*, *Cymbopogon jawarancusa*, *Cuminum cyminum*, *Cupressus torulosa*, *Curcuma aromatica*, *Curcuma longa*, *Curcuma zedoaria*, *Cupressus macropoda*, *Cymbopogon caesius*, *Cymbopogon caloratus*, *Cymbopogon citratus*, *Cymbopogon confertiflorus*, *Cymbopogon flexuosus*, *Cymbopogon martini*, *Cymbopogon nardus*, *Cyperus longus*, *Cyperus niveus*, *Cyperus rotundus*, *Cyperus scariosus*, *Dalbergia sissoo*, *Daucus carota*, *Decaspermum paniculatum*, *Dendrobium species*, *Dianthus caryophyllus*, *Dipterocarpus turbinatus*, *Eucalyptus citriodora*, *Eucalyptus globulus*, *Eucalyptus terebinthifolius*, *Eugenia jambolana*, *Eulophia species*, *Excoecaria agallocha*, *Foeniculum vulgare*, *Gaultheria fragrantissima*, *Gaultheria procumbens*, *Habenaria species*, *Hemercocallis fulva*, *Hibiscus abelmoschus*, *Humulus lupulus*, *Hyacinthus ciliata*, *Hyacinthus glaucus*, *Hyacinthus orientalis*, *Hyssopus officinalis*, *Inula graveolens*, *Ipomoea bona-nox*, *Ipomoea grandiflora*, *Iris germanica*, *Jasminum grandiflorum*, *Jasminum humile*, *Jasminum officinale*, *Jasminum sambac*, *Juglans regia*, *Lantana camara*, *Lantana odorata*, *Lathyrus odoratus*, *Lavandula latifolia*, *Lavandula officinalis*, *Linum usitatissimum*, *Lonicera confusa*, *Lonicera japonica*, *Lonicera quinquelocularis*, *Lonicera sempervirens*, *Lonicera webbiana*, *Magnolia grandiflora*, *Magnolia pterocarpa*, *Matricaria chamomilla*, *Melaleuca lencadendron*, *Melaleuca minor*, *Mentha arvensis*, *Mentha sylvestris*, *Mentha viridis*, *Michelia champaca*, *Mimusops elengi*, *Murraya koenigii*, *Murraya paniculata*, *Myrica gale*, *Myrica nagi*, *Myristica arratica*, *Myristica clarkeana*, *Myristica longifolia*, *Myrtus communis*, *Narcissus janguilla*, *Narcissus poeticus*, *Narcissus tazetta*, *Nelumbium speciosum*, *Nepeta cataria*, *Nicotiana tabacum*, *Notholirion thomsonianum*, *Nyctanthes arbor-tristis*, *Ocimum basilicum*, *Ocimum carium*, *Ocimum gratissimum*, *Ocimum minimum*, *Ocimum pilosum*, *Ocimum sanctum*, *Ocimum virida*, *Orchis species*, *Origanum marjorana*, *Origanum vulgare*, *Osmorhiza longistylis*, *Pelargonium graveolens*, *Pelargonium*

*roseum, Perilla frutescens, Pimpinella anisum, Pinella officinalis, Pinus excelsa, Pinus roxburghii, Piper betle, Piper longum, Piptacis mutican, Pogostemon patchouli, Populus balsamifera, Populus nigra, Prunus amygdalus, Psidium guajava, Reseda odorata, Rhododendron arboreum, Rhododendron campanulatum, Rhododendron lepidotum, Ricinus communis, Rivea hypocrateriformis, Rosa alba, Rosa centifolia, Rosa damascena, Rosa moschata, Ruta graveolens, Salvia officinalis, Santalum album, Saussurea costus, Schinus molle, Skimmia lanreola, Spartium junceum, Spiraea species, Syringa emodi, Thymus linearis, Trachyspermum copticum, Urena lobata, Valeriana wallichii, Vanilla species, Vetiveria zizanioides, Viburnum foetans, Viburnum grandiflorum, Viburnum nervosum, Viola canescens, Viola odorata, Viola serpens, Vitex agnuscastus, Vitex trifolia, Vitis vinifera, Viurunum cotinifolium, Vulgaris species, Wistaria sinensis, Zanthoxylum armatum, Ziziphora clinopodioides, Ziziphora tenuior : Khan (1959). Pazir Gul (1996), Kazmi (1960) and Zaman (1970) reported that, *Ocimum americanum* is the oil producing plant of Azad Kashmir, Balochistan, NWFP, Punjab and Sindh.*

#### **Annexure-11**

*Abies pindrow, Acacia farnesiana, Acorus calamus, Angelica glauca, Artemisia brevifolia, Carum bulbocastanum, Carum copticum, Cedrus deodara, Chenopodium ambrosioides, Cinnamomum camphora, Coriandrum sativum, Cuminum cyminum, Cymbopogon citratus, Cymbopogon martini, Elaeagnus hortensis, Elsholtzia patrinii, Eucalyptus citriodora, Foeniculum vulgare, Juniperus macropoda, Narcissus tazetta, Ocimum americanum, Oil producing plants, Origanum vulgare, Parowskia abrotanoides, Pinus logifolia, Pinus wallichiana, Pistacia mutica, Psoralea corylifolia, Salvia hydrangea, Saussurea costus, Schinus molle, Senecio jacquemontianus, Skimmia laeola, Thymus linearis, Thymus vulgaris, Valeriana wallichii, Vitis-agnus-castus, Zanthoxylum armatum*

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