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Perennial medicinal plants for rainfed farming system in arid region

J. P. Singh*, V.S. Rathore and R.K. Beniwal
Central Arid Zone Research Institute Regional Research Station Bikaner-334004, Rajasthan

Abstract

In arid region, growing interest, awareness and cultivation of medicinal crops are discussed on several fora. The needed attention was not given to indigenous woody species adapted to harsh climatic conditions over the introduced ones. There is need to enhance farmer livelihoods through increased farm income by integrating suitable woody and herbaceous medicinal plant species in existing farming system. The present paper reviews the woody perennials of medicinal importance and possible avenues for integrating them in various ALUS in farming system perspective.

Key Words : *Arid ecosystem, farming system, fodder, medicinal plant, woody perennials*

Introduction

Rise in population, inadequate supplies of drugs in certain parts of the world, high cost and toxic effect of synthetic drugs have created renewed interest in natural drugs. This led to spurt in the use of herbal medicine and consequently the international trade in medicinal plants has recorded a sharp rise (Prathibha *et al.*, 1999). The use of herbals in veterinary sector is also blooming up as dietary supplement or therapeutic use on health and productivity of livestock e.g. adaptogeneic herbs in equines (Dwivedi, 2005) and their use is gaining scientific footing over synthetic drugs in developed countries (Lawson, 1994).

Thar desert is endowed with considerable diversity of medicinal plants and well documented by various researchers (Chopra *et al.*, 1960; Chopra and Abrol, 1964; Gupta *et al.*, 1966; Shekhawat and Anand, 1984; Singh and Pandey, 1998; Pandey *et al.*, 1989; Kumar and Parveen, 2000; Kasera *et al.*, 2002; Sharma and Prajapati, 2002; Singh *et al.*, 2002; Chaudhari *et al.*, 2005; Kumar *et al.*, 2005; Singh and Sharma, 2005). Recently, Awasthi and Dhandar (2003) gave an account of medicinal fruit plants of arid region. Dinesh Kumar (2000), Kumar (2000), Anjaria (2002), Kumar *et al.* (2004), and Dwivedi (2005) dealt veterinary aspect of herbal drugs. In recent past the natural vegetation of Thar Desert witnessed drastic change due to increasing grazing pressure, urbanization, introduction of irrigation etc. All these factors resulted into change in composition of natural vegetation and depletion of important economic plants (Singh *et al.*, 2002) including medicinal plants.

***Corresponding author :**
Sr. Scientist, CAZRI, Bikaner
E mail : jpbkn@yahoo.com

Integration of medicinal species in various Alternate Land Use Systems (ALUS), suitable to specific agro ecological and socio-economic conditions in farming system perspective is key to assure sustained supply of these herbal products. There is an urgent need to design medicinal plant based farming system which can cater diverse needs of farming community along with higher biological productivity, more income and employment generation. The integration of indigenous multipurpose woody perennials viz. fodder cum medicinal species, fruit cum medicinal species, fuel wood cum medicinal species and medicinal cum bio fence species in existing farming system seem to be viable option in this regard. This paper is an attempt to highlight indigenous multipurpose perennial species having medicinal properties along with suitable land use systems for integrating them, as organized information on this aspect is scanty.

Medicinal Plants Cultivation:

In western Rajasthan, some medicinal crops are cultivated commercially, such as Senna (*Cassia angustifolia* Vahl), Isaphgol (*Plantago ovata* Forsk.), Aloe (*Aloe barbadenensis* Mill.), and Ashwgandha (*Withania somnifera* (L.) Dunal) to some extent. The fruit crops having medicinal value viz., Aonla (*Emblica officinalis* Gaertn.), Anar (*Punica granatum* L.), Bael (*Aegle marmelos* (L.) Corr.), Ber (*Ziziphus mauritiana* Lamk.), Gonda (*Cordia dichotoma* Forst. f.), Nimbu (*Citrus aurantifolia* (Chiristm.) Swingle) etc. are also in cultivation in the area. Anar (pomegranate) is placed as one of the premier health fruits in this century and known for its antioxidants properties

(Damania, 2005). The species like Anar, Aonla, Bael, Ber have demand in pharmaceuticals in local market and for export. Bael has approximate Rs. 200-250 million domestic sales in India (Rawat and Garg, 2005). Ber (Jujube) has important place as an important arid fruit crops with medicinal value. Paris and Dilleman (1960) mentioned, "The Jujube also has definite emollient properties for which it was formerly classed as one of the four 'pectoral' fruits for making pectoral cough drops". However, these species have their own limitations during water scarcity, prolonged drought and frost injury in arid ecosystem. Attention needs to be paid therefore, to the indigenous adapted species for rainfed arid ecosystem involving multiuse species. The following woody perennials need attention for rainfed system in western Rajasthan.

***Acacia jacquemontii* Benth. (Leguminosae)**

Local names : Bawli, Bui-bawli

This much-branched shrub naturally occurs in sand dunes and well adapted to drought and frost. Its gum is used to cure body ache, joints pain and also in sunstrokes. Its gum is reputed with high medicinal value in the area and has local demand.

***Acacia senegal* (L.) Willd. (Leguminosae)**

Local names: Kumat, Kumatiyo

This much-branched thorny tree with pale smooth bark is commonly found on hillsides, stabilized sand dunes and adapted to adverse arid climatic condition. Its gum is one of the main cash crops of the desert (Paris and Dillemann, 1960) and used as a demulcent and emulsifying agent in pharmaceuticals (Chopra *et al*, 1960).

***Balanites aegyptiaca* (L.) Del. (Balanitaceae)**

Local names: Hingota, Hingotio, Hingorni, Ingudi

This spinous shrub or a small tree is one of the characteristic woody species of dry parts and commonly found in open sandy areas. Its fruits are the source of diosgenin.The outer rinds of the fruit is used as a remedy for skin diseases and cough. Its seeds, fruit, bark and leaves are reported to be anthelmintic and purgative properties. Seed oil applied in rheumatic pain (Maheshwari and Singh, 1988). Fruit stone pounded with chilly and paste given to cattle for constipation. Leaf paste is applied on eye for conjunctivitis in cattle (Sikarwar, 1996). Stem bark powder is given to cattle for intestinal worms (Singh and Pandey, 1998).

***Calligonum polygonoides* L. (Polygonaceae)**

Local names: Phog, Phogaro

This is much-branched leafless shrub, which is the key woody perennial species of Thar Desert particularly on sand dunes. The roots used as gargle for sore gums (Kirtikar and Basu, 1935). Branch juice used as antidote to milky juice of Aak (*Calotropis procera*) when enters in the eyes (Bhimaya *et al.*, 1961). The flower buds have a cooling effect and used in treating sunstrokes (Shekhawat, 1961). Also used as antiemetic, and in typhoid (Kumar *et al.*, 2005).

***Capparis decidua* (Forsk.) Edgew. (Capparaceae)**

Local names: Ker, Kerro, Kair

It is much-branched leafless spiny shrub or a small tree and naturally occurs on rocks, gravel and sandy plains. Its bark and fruits are utilized in Ayurvedic and Yunani medicines. Its bark is acrid, laxative, diaphoretic, anthelmintic and useful against cough, asthma and inflammation. The root and bark are given in cases of intermittent fever and rheumatism (Chopra *et al.*, 1960). The fruits are eaten and are believed to cure stomach disorders (Bhimaya *et al.*, 1961). .Root paste is applied on eye for conjunctivitis in animals (Sikarwar, 1996).

***Citrullus colocynthis* (L.) Shard. (Cucurbitaceae)**

Local names: Tumba, Indrayan

This creeping under-shrub occurs in sandy plains and sand dunes. This cucurbit species possesses exceptional soil binding and drought resistance capacity has multiple uses. Fruits are used as purgative and root in jaundice and urinary diseases. It is commonly used ethnoveterinary medicinal plant in western Rajasthan.

***Clerodendrum phlomidis* L. f. (Verbenaceae)**

Local names: Arni, Inni, Bharangi

This shrub is grown along the boundaries of cultivated fields. Root is given in convalescence of measles. Leaf juice is given in neglected syphilitic complaints. The leaves are applied locally against guinea-worm (Kirtikar and Basu, 1935). The leaf used in prolonged body ache, constipation and dropsy in Andhra Pradesh (Venkata Raju, 1996). Seed oil used as hair tonic by Garasias (Singh and Pandey, 1998). Also used in arthritis, sciatica and in ringworm (Kumar *et al.*, 2005). Leaves are fed to animals as vermifuse at many places.

***Commiphora wightii* (Arn.) Bhandari (Burseraceae)**

Local name: Guggul

This much branched spinous shrub or small tree naturally occurs on open dry hills and other rocky habitats. Presently it is a threatened species due to its over exploitation for its gum-resin. Its gum resin is used as an astringent and an antiseptic in old wounds and bleeding gums; internally it act as a bitter, stomachic and carminative, stimulating the appetite and improving digestion. The resin is used in the form of lotion for indolent ulcers and as a gargle in pyorrhea, chronic tonsillitis and pharyngitis.

***Cordia gharaf* (Forsk.) Ehrenb. & Aschers. (Boraginaceae)**

Local names: Goondi, Guindi

This shrub or small tree occurs in forests and often cultivated for its edible fruits. Bark decoction is used for gargles and has astringent properties (Kirtikar and Basu, 1935). There is also the domestic demand of this species by local Ayurvedic practitioners (Singh and Kumar, 2005).

***Ephedra foliata* Boiss. & Kotschy ex Boiss. (Gnetaceae)**

Local names: Andho khimp, Sui phogaro,

This much-branched climbing shrub occurs on sandy to gravelly or even in rocky plains on native woody perennials like *Prosopis cineraria, Maytenus emarginata,* and *Euphorbia caducifolia.* It is the only Gymnoperm species of hot arid zone and needs attention for its conservation. Aerial parts are used in asthma bronchitis and severe cough (Sinha and Sinha, 2001).

***Grewia tenax* (Forsk.) Fiori (Tiliaceae)**

Local names: Gangerun, Gangan

This straggling shrub occurs naturally on buried pediments, hill-slopes, wastelands and boundaries of fields. The fruits are given for colds. The wood decoction is given for curing coughs and pains in the body (Caius, 1989). Leaves are used for stone problems and urticaria (Kumar *et al.*, 2005). Leaf used in gripe (Diallo *et al.*, 1996) in Africa.

***Haloxylon recurvum* (Moq.) Bunge ex Boiss. (Chenopodiaceae)**

Local names: Khar, Khara lana

This succulent halophyte shrub is strongly xeromorphic in structure occurs in saline depressions of western Rajasthan. The plant ash is given in water against internal ulcers (Bhandari, 1990). Recently, Recursterols A and B the new C-24 alkylated sterols, have been isolated from *H. recurvum* in Pakistan (Hussain *et al*, 2006).

***Haloxylon salicornicum* (Moq.) Bunge ex Boiss. (Chenopodiaceae)**

Local name: Lana

This much-branched shrub occurs in sandy undulating hummocky plains, dunes, interdunes and the former river courses of the ancient river Saraswati. Plant ash is applied on boils and to cure skin diseases. Plant ash is also applied on the body of sheep and goats to kill lice and other external parasites. The seeds are said to be used in asthma by local *Vaids*. A new pyranone-5-hydroxy-3 methoxy-4H-pyran-4one was isolated from the aerial parts of *H. salicornicum* (Gibbons *et al.*, 2000).

***Indigofera oblongifolia* Forsk. (Leguminosae)**

Local names: Goilia, Jhil, Bekar, Raktpala

This erect shrub is found in open dry places. It is considered as an antidote to all kinds of poisons. Boiled root is used as a purgative and stem decoction as a gargle in mercurial salivation and for washing teeth (Caius, 1989). It is also employed for curing stomachache. Roots are used for tooth brushes. Lodha *et al.* (1990) reported ten compounds in it; four of these have been characterized as psyllostearyl alcohol, triacontanol, β-sitosterol and β- sitosterol- β-D glucoside.

***Lycium barbarum* L. (Solanaceae)**

Local name: Morali

This much-branched spinous shrub is common on sandy scrub lands. The leaves pounded and mixed with ghee are applied to abscesses. The berries are bitter, emmenagogue, enriches the blood; useful in bleeding piles, scabies, toothache; also used as an aphrodisiac. In Yunani system, the leaves improve the eyesight. (Kirtikar and Basu, 1935). Also used for cold and skin irritatuiin (Kumar *et al.*, 2005). The bark powder used against bronchitis in horses (Bhandari, 1990).

***Maytenus emarginata* (Willd.) Ding Hou (Celastraceae)**

Local name: Kankero

This large spinous shrub or small tree traditionally used as biofence. The leaf juice taken to cure spermatorrhoea (Maheshwari and Singh, 1988). Leaf paste is used to heal sores. The fruits used to purify blood (Bhandari, 1990). In Maharashtra bark and leaves are used to cure stomachache, cough and as tonic (Kumbhojkar *et al.*, 1999).

***Salsola baryosma* (Roem. & Schult.) Dandy (Chenopodiaceae)**

Local name: Lani

This much-branched pale hoary shrub is found in saline depressions in western Rajasthan. The plant is used as a vermifuge and the plant ash is applied to itch (Kirtikar and Basu 1935).

***Salvadora oleoides* Decne. (Salvadoraceae)**

Local name: Pilu

This much branched evergreen shrub or small tree occurs on medium heavy to heavy saline soils of alluvial plains. It tolerates both aridity and salinity and thrives well even in 100 mm rainfall. Root bark is used as a vesicant and it helps in regulating the menses in women. Fruits are employed in treatment of enlarged spleen, rheumatism and low fever (Jindal and Singh 2005). Leaves used to relieve cough, and also given to horses as purgative (Singh *et al*, 1990).

***Salvadora persica* L. (Salvadoraceae)**

Local name: Kharo jal

This much branched evergreen shrub or small tree is found on saline soils of alluvial plains. Root bark is applied on blisters. Fruits are used to overcome heat strokes. The oil is used in skin diseases, snakebites and also in joints pain. Root paste is applied as substitute for mustard plaster and decoction is used against gonorrhoea and vesical catarrh. It is widely used in the toothpaste preparations (Jindal and Singh, 2005).

***Sarcostemma acidum* (Roxb.) Voigt (Asclepiadaceae)**

Local names: Khir khimp, Khursani tanto, Arr thor, Somlata

This is a leafless, straggling jointed climbing shrub. In Ayurveda the plant is used to cure biliousness and thirst (Kirtikar and Basu, 1935). Root paste applied to snake bite and taken an infusion in dog-bite (Bhandari, 1990). It is said that the plant has been used in Soma of the Veda (Pal and Jain, 1998).

***Suaeda fruticosa* (L.) Forsk. (Chenopodiaceae)**

Local names: Lunaki, Lunak ,

This much-branched shrub is found on sandy saline depressions in western Rajasthan. The leaf paste is applied as a poultice to opthalmia and also used as emetic (Kirtikar and Basu, 1935). Leaves used as vegetable to cure indigestion and flatulence. Its tender shoots and leaves

are also used as vegetable in the Salsette Island in Maharashtra and also sold in the market (Shah, 1984). Whole plant sap is applied on sores on back of camel (Singh and Pandey, 1998).

***Tinospora cordifolia* (Willd.) Miers. (Menispermaceae)**
Local names: Guruch, Giloy, Guduchi

This glabrous shrub is found climbing on trees and bushes. It is used in more than 88 pharmaceutical preparations in India (Kapur and Mitra, 1979). Dried stem with bark is used to cure all kinds of fever and for urinary diseases, dyspepsia and flatulence. Roots and leaves are used for lowering blood pressure (Sinha and Sinha, 2001). It has approximate Rs. 20-30 million domestic sale (Rawat and Garg, 2005).

The other native woody shrubs/trees viz., Khejri (*Prosopis cineraria* (L.) Druce), Rohida (*Tecomella undulata* (Smith) Seem), Kheep (*Leptadenia pyrotechnica* (Forsk.) Decne.), Bordi (*Ziziphus nummularia* (Burm.f.) Wight and Arn.), Bui (*Aerva pseudotomentosa* Blatt. and Hall.), Safed Aak (*Calotropis gigantea* Ait), Aak (*Calotropis procera* (Ait.)R. Br.), Jinjni (*Mimosa hamata* Willd.), Sinia (*Crotalaria burhia* Buch.-Ham ex Benth.), Gangeti (*Grewia villosa* Willd.), Pilwan (*Cocculus pendulus* Diels.) Nagphani (*Opuntia elatior* Mill.), Thor (*Euphorbia caducifolia* Haines), Jhau (*Tamarix troupii* Hole) etc. are also having medicinal properties. The other semi arid woody species like Neem (*Azadirachta indica* A. Juss.), Ardu (*Ailanthus excelsa* Roxb.), and Sahajan (*Moringa oleifera* Lamk.) have medicinal value and planted in the arid region.

Life Support System:

Most of these indigenous woody species of arid ecosystem provide variety of products of economic importance along with ecological and social services (Table 1) and essential component of life support system. Livestock has vital role in agrarian economy of arid region and fodder scarcity is major handicap for its sustainable development. Therefore integration of the species, which have fodder and medicinal value, need greater attention as they can supply fodder along with materials for pharmaceuticals. These species of medicinal importance also show impact on quality and quantity of milk. Traditionally, some of the plants fed to animals to increase the quality of milk like fruits of Pilu (*S. oleoides*) and Phog (*C. polygonoides*). In ancient Indian literature the *Agnipuran* instructs to give the cow morsels composed of several sticks of Ashwagandha (*W. somnifera*) and sesame (Anonymous, 1964). The leaves and shoots of Giloy (*T. cordifolia*), Pilwan (*C. pendulus*) also supposed to increase milk yield in livestock. There is need to evaluate some of these species to observe the effect on quality of milk as well as health of livestock. The species like Tumba (*C. colocynthis*), Aak (*C. procera*), Guarpatha (*A. barbadensis*) etc. are the common species used in ethno veterinary medicine in western Rajasthan. Likewise some of these species produces products that have industrial demand viz. *Saji* and gum, and their integration can broaden the economic base of farmers. Some of these species provide raw materials for small scale cottage industries which are life line of rural economy, and by the integration of such species the livelihood security of rural inhabitants can be ensured to a great extent. Besides economic importance all these species have great ecological significance by arresting wind erosion and conserving biodiversity of fragile arid ecosystem.

Table 1: Significance of indigenous perennial plants of arid regions.

Product/ service	Plant species
Human Food	
Leaves/ shoots	Luni (*S. fruticosa*), Guarpatha (*A. barbadensis*)
Flower buds	Phog (*C. polygonoides*), Kair (*C. decidua*)
Unripe fruits	Kheep (*L. pyrotechnica*), Kair (*C. decidua*),
Ripe fruits/ seeds	Goondi (*C. gharaf*), Kair (*C. decidua*), Gangeran (*G. tenax*), Pilu (*S. oleoides*), Lana (*H. salicornicum*)
Gum	Bawli (*A. jacquemontii*), Kumut (*A. senegal*)
Food Additives/ Saji	
Shoots	Khara lana (*H. recurvum*), Luni (*S. fruticosa*), Lani (*S. baryosma*)
Feed for Livestock	
Leaves / shoots	Khejri (*P. cineraria*), Phog (*C. polygonoides*), Bawli (*A. jacquemontii*), Bordi (*Z. nummularia*), Lana (*H. salicornicum*), Kair (*C. decidua*), Arni (*C. phlomidis*), Pilwan (*C. pendulus*), Giloi (*T. cordifolia*), Andhokheep (*E. foliata*)
Flowers/ fruits	Phog (*C. polygonoides*), Pilu (*S. oleoides*), Tumba (*C. colocynthis*)
Food for Bees and other invertebrates	
Flowers	Bawli (*A. jacquemontii*)
Leaves/shoots	Phog (*C. polygonoides*)
Fuel	
Shoots & roots	Phog (*C. polygonoides*), Bawli (*A. jacquemontii*), Kair (*C. decidua*), Khejari (*P. cineraria*), Lnni (*S. fruticosa*), Bordi (*Z. nummularia*), Aak (*C. procera*)
Thatching Materials	
Shoots	Phog (*C. polygonoides*), Kheep (*L. pyrotechnica*), Sinia

	(*C. burhia*), Aak (*C. procera*), Khejari (*P. cineraria*), Arni (*C. phlomidis*)
Fibres	
Stem	Sinia (*C. burhia*), Kheep (*I. pyrotechnica*), Aak (*C. procera*), Goondi (*C. gharaf*)
Environmental Uses	
Arresting soil erosion	Tumba (*C. colocynthis*), Phog (*C. polygonoides*), Khara lana (*H. recurvum*), Lana (*H. salicornicum*)
Shade & Shelter	Kair (*C. decidua*), Pilu (*S. oleoides*)
Live fence	Bawli (*A. jacquemontii*), Kumat (*A. senegal*), Arni, (*C. phlomidis*), Gangeran (*G. tenax*), Mural (*L. barbarum*), Kankera (*M. emarginata*)
Saline soils	Khara lana (*H. recurvum*), Lani (*S. baryosma*), Luni (*S. fruticosa*), Khara jal (*S. persica*)
Social & Ethical Uses	
Ritual/ religious significance	Safed Aak (*C. gigantea*), Kair (*C. decidua*), Khejari (*P. cineraria*), Phog (*C. polygonoides*)
Cosmetics	Goondi (*C. gharaf*)
Detergent	Hingot (*B. aegyptiaca*), Khara lana (*H. recurvum*)
Weather Forecast	Phog (*C. polygonoides*)

Integration of Woody Perennials in Production Systems

Sole cultivation of these perennials are neither practically feasible nor economic viable. They need integration with crop-based production system for sustained economic gains. System based production systems having diverse type of plants is a time tested strategy which provides stability in production along with catering diverse needs of farmers. Earlier experience shows that the selection of system-based production should be in accordance with prevailing agro ecological and socioeconomic milieu. Therefore these plants can be integrated in various production system viz. agri-horti, agri-silvi, boundary plantations in farming system prespective. Certain possible avenues for integrating them are outlined in Table 2. In arid region woody perennials have a great promise and socio-economic role to play for rehabilitation of degraded lands (Singh *et al.*, 2004) by strip plantation of shrub/trees in village common lands, field boundary, sand dunes, canal banks, road sides etc. The wastelands and other areas lying unused around the villages can be utilized for planting woody species having medicinal value. The saline wastelands unsuitable for crop cultivation can be utilized for planting halophyte shrubs which are adapted to saline conditions. A number of species can be used as live fence along the border of agricultural fields to demarcate boundaries and to protect home yards, agricultural crops from livestock and wild animals. They can also used as shelterbelts/wind breaks and creates favorable microclimate for crops. The climbing shrubs like Giloy (*T. cordifolia*), Pilwan (*C. pendulus*), Andhokheep (*E. foliata*) etc. can be very well planted in the Agri-silvi system by utilizing their suitable shrub/tree species as support system.

Table 2. Suitable woody medicinal species for different Alternate Land Use Systems/Habitats.

Systems/ Habitats	Plant species
Agri-Horti System	Kair (*C. decidua*), Gondi (*C.gharaf*), Bordi (*Z. nummularia*), Pilu (*S. oleoides*)
Agri-silvi System	Phog (*C. polygonoides*), Bordi (*Z. nummularia*), Khejari (*P. cineraria*), Neem (*A. indica*), Ardu (*A. excelsa*) Climbers: Giloy (*T. cordifolia*), Andhokheep (*E. foliata*), Pilwan (*C. pendulus*)
Sand dune stabilization	Bawli (*A. jacquemontii*), Phog (*C. polygonoides*), Kumat (*A.senegal*), Lana (*H. salicornicum*), Tumba (*C. colocynthis*)
Bio-fence/Boundary Plantation	Bawli (*A. jacquemontii*), Phog (*C. polygonoides*), Kumat (*A. senegal*), Arni (*C. phlomidis*), Gangeran (*G .tenax*), Mural (*L. barbarum*), Kankera (*M. emarginata*), Thor (*E. caducifolia*)
Salt affected areas	Khara lana (*H. recurvum*), Lani (*S. baryosma*), Luni (*S. fruticosa*), Kharo Jal (*S. persica*), Jhau (*T. troupii*)
Rocky	Gugal (*C. wightii*), Goondi (*C. gharaf*)

Conclusion

Indigenous medicinal plants of arid region are under stress due to their indiscriminate collection from wild sources, destruction of natural habitats coupled with frequent drought. Integration of drought resistant under-utilized woody perennials having medicinal value in various production systems have a great role in economic development as well as maintaining the ecological balance of the arid environment. These species can supply the raw material even in the times of drought and low rainfall

condition. Moreover the species having fodder value can be very well utilized at the time of drought as an emergency fodder. There is urgent need to create awareness amongst the farmers regarding the significance of these indigenous plant species. Increased and sustainable supply of raw herbal material by integrating medicinal plants will boost pharmaceutical sector in arid region and *inter alia* income and living standard of the peasantry. The crop diversification through medicinal plants in the farming system perspective can reduce pressure on wild sources as well as strength to the conservation of available medicinal plant diversity in the arid ecosystem. Paris and Dillemann (1960) rightly remarked that "The xerophile medicinal plants can play a part in the economic reclamation of the arid zones". Thus, genotypes of woody medicinal species must be conserved *in situ* and *ex situ* clones for genetic improvement programme.

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