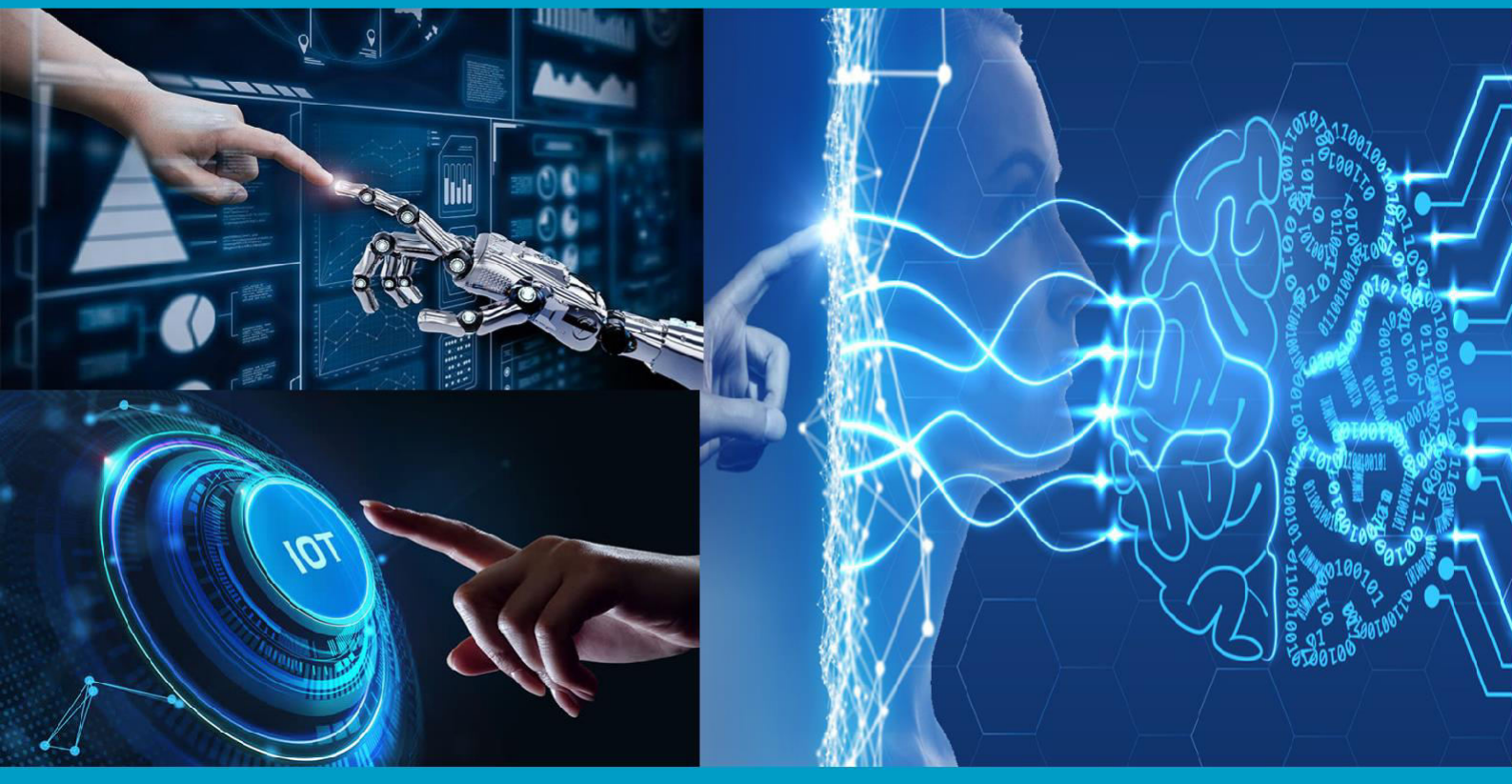
IJMRSETM

e-ISSN: 2395 - 7639



INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING, TECHNOLOGY AND MANAGEMENT

Volume 9, Issue 9, September 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.580

| ISSN: 2395-7639| www.ijmrsetm.com| Impact Factor: 7.580 | A Monthly Double-Blind Peer Reviewed Journal |

| Volume 9, Issue 9, September 2022 |

| DOI: 10.15680/IJMRSETM.2022.0909034 |

Agricultural Practices for Growing Medicinal Plants in Rajasthan

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ABSTRACT: Medicinal plants have so far been collected from wild resources. However, the plant material collected from these sources is replete with the problems of adulteration and misidentification. Further, the plant material collected from the wild may also be contaminated by other species or parts thereof. The wild varieties also differ with respect to the presence of the active constituents from area to area. All such conditions may have adverse consequences on the quality and efficacy of the ASU drugs. In view of this, cultivation of genuine, authentic variety of plants may be the only way to have raw material of required quality. However, cultivation of these plants has never been easy and commercially viable. This is the basic reason for their exploitation from wild sources. Non-availability of proper techniques and authentic planting material are also some of the main constraints. The safety and quality of medicinal plant materials and finished products depend on various factors like genetic makeup, environmental conditions, collection and cultivation practices, harvest and post-harvest processing, transport, storage practices etc. The Agro-techniques included in this book provide information on propagation material, nursery technique (raising propagules, propagule rate and pre-treatment), planting in the field (land preparation & fertilizer application, transplanting & optimum spacing, intercropping, interculture & maintenance practices, irrigation practices and disease & pest management), harvest management (crop maturity & harvesting, post harvest management, viability of seed, chemical constituents, yield & cost of cultivation). The medicinal plants are the basic source of raw-material for preparation of Ayurvedic medicines. Therefore, the quality of Ayurvedic products critically depends upon the quality of raw-material. By adopting good agro-technique of medicinal plants, the safety and quality of medicinal plant materials and finished products could be assured.

I. INTRODUCTION

Government of India has notified Good Manufacturing Practices (GMPs) under Drugs and Cosmetics Act, 1940. The quality of raw-material, however, depends upon the collection and cultivation practices used for procurement of medicinal plants. World Health Organization (WHO) has already published guidelines on Good Agriculture & Collection Practices of medicinal plants.[1,2] National Medicinal Plants Board has also finalized guidelines for cultivation of medicinal plants and collection from wild sources. The Board has also approved Scheme for voluntary certification of standards under Good Agriculture Practices (GAPs) and Good Field Collection Practices (GFCPs) through the Quality Council of India, which is the national nodal agency for accreditation of certification bodies. Adoption of the agro-techniques available in the book would help in following Good Agriculture Practices as well as getting certificates[3,4]

1. Agro-technique of *Acacia* species crop is grown during cooler climate and it remains for 120 days in field; usually, ratoon crop is also taken all over north India. Cooler climate helps plants in synthesizing more bitter ingredients. Nursery Technique Raising of Nursery: Seeds are soaked in water for 24 hours and sown in the nursery beds in early September. About 650-750 gm seeds are required for raising nursery for one hectare of land. Nursery is prepared with soil, sand and organic matter in 1:1:1 ratio and sown in early September at 5 cm spacing in rows and it takes 8-10 days for germination to commence. Six weeks old seedlings are planted in field at 30X15 cm or 15X15 cm spacing. Direct sown crop is broadcasted thinly and has a seed rate of 1.5 kg/ha. It matures early, but nursery raising is preferred. [4,5]For nursery beds, FYM @ 20 kg per square meter as basal dose is mixed in the soil. Planting in the Field Land Preparation and Fertilizer Application: The land should be prepared well by repeated ploughing to make soil pulverized. For main field, FYM @ 20 t/ha is given as basal application. It is given NPK (75:75:50 kg/ha) in two split doses i.e. first at planting stage and second 40 days after plantation. Use of 5 kg Azospirillium + 5 kg Phosphobacteria per hectare has also given good results. Transplanting and Optimum Spacing: 10-25 cm long seedlings raised in the nursery beds during September are transplanted in the main field (after 6 weeks of sowing) at a distance of 30X15 cm between plant to plant and row to row. Irrigation: 4-6 light irrigations are required till harvesting the crop. Weeding: Since it is a herbaceous plant, the field should be free from weeds. Two to three weedings are essential during

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the crop season viz. at 20 days and 60 days after transplantation. Disease and Pest Control:It is a hardy plant and not attacked by any pest and disease[6,7]

Harvest Management Crop Maturity and Harvesting of *Acacia* species: The crop matures after 120 days of sowing. It is harvested when most plants are in bloom. It is at this stage, the plants should be uprooted. However, a small lot of healthy plants should be left in the field for seed production. When the fruits become mature, these should be picked up and dried in the sun and seeds are collected. The seeds should be kept in open sun for complete drying. After this, these are stored in air-tight containers for next sowing. Post-harvest Management: After uprooting the plant, first it should be dried in the sun for two days and afterwards in the shade. This properly dried material should be packed in laminated gunny bags, lest it absorbs moisture. The harvested dry material should be stored in dark, airy and moisture-free places. Viability of Seed: One year of storage from the time of harvest. Chemical Constituents: The leaves contain three bitter principles; deoxyandrographolide, andrographolide and neoandrographolide. These are also present in whole plant. The leaves should yield 2.5% chemical constituents on analysis. Yield and Cost of Cultivation: The yield (whole plant) is 2.5 t/ha. It has sizeable demand and yields a reasonable profit to the growers. It is commercially cultivated in several States of India. Rs. 25000/- is the cost of cultivation for one hectare.[8,9]

2. *Aristolochia* species Agro-technique Nursery Technique Raising Propagules: Seeds mature during May-July. Germination of seed is about 80%. Seeds may be sown in rows over raised beds and 10 cm apart. Seedlings at 4-5 leaves stage can be transferred in polybags or kept in the nursery bed till it attains 15 cm height, when it is ready for transplantation. Seed viability remains at 70-80% up to one year. Seeds should be treated in Bavistin/Captan/Thiram before sowing. About 30,000 seedlings are needed for one hectare land. Planting in the Field Land Preparation and Fertilizer Application: Land should be deeply ploughed and harrowed twice and made into good tilth. FYM @ 10 t/ha alongwith NPK @ 25:60:100 kg/ha during land preparation may be applied. Later N @ 25 kg/ha may be applied after planting and again at 3 months interval. Transplanting and Optimum Spacing: Seedlings may be raised in May-July and their transplantation done in August-September. 60X60 cm spacing is optimal requirement. Intercropping System: Annual herbs like chilli can be grown as intercrop. Inter-culture and Maintenance Practices: Hoeing and hand weedings are carried out simultaneously 45 days after planting, thereafter at 6 months interval in first year. In second year, periodicity of interculture remains same. Irrigation Practices: Usually rainfed crop, but supplementary irrigation is needed during dry seasons. Weed Control: Pre-emergence application of Pendimethaline @ 1.0 kg/ha or Simazine @ 2.0 kg/ha may be applied, thereafter hand weeding at 90 days after transplanting and later as per weed population. Application of post-emergence herbicides is not suggested. Disease and Pest Control: Leaf blight is observed in the plantation during winter season. Application of Dithane M-45 @ 3 gm/lit at 15 days interval is found to control the disease. Infestation of Pachlioptera aristolochia is found to attack the vines and eat on tender leaves during May-August. Application of Rogor 30 EC @ 0.02% keeps the moth away. Thiodan 35 EC @ 0.09% is also found effective against the insect. Crop Maturity and Harvesting: Crop matures after one year growth but the leaves are pruned and harvested after 180 days onwards periodically. The collection of roots is advisable after two years of age. Post-harvest Management: Leaves and roots after collection are cleaned thoroughly and all foreign matters are removed. These may be dried in shade for a week when it has 10-12% moisture and then it is ready for storage. It is packed in air tight polythene bags and stacked in bamboo or wooden crates. Chemical Constituents: Plant possesses aristolochic acid upto 0.017% and essential oil upto 0.5%. Besides, it has potassium and β-sitosterol. Two sesquiterpene hydrocarbons viz. ishwarane and aristolochene have been identified from the root and their structure is established. Yield and Cost of Cultivation: Estimated yield is 640 kg/ha/year in the second year and onwards.[10,11]

3. *Catharanthus* species: Agro-technique Nursery Technique Raising Propagules: Freshly harvested seeds (not older than one year) should be used. Seeds can be sown either in a nursery and then transplanted or sown directly in the field. Propagule Rate and Pretreatment: Direct sowing can be adopted during the monsoon months, particularly if large area has to be cultivated. About 2.5 kg of seeds are required per hectare. Seeds are mixed with about 25 kg of fine, moist sand to ensure even distribution. Seeds are sown in rows 45 cm apart; subsequently seedlings are thinned maintaining a distance of 30 cm between plant to plant. Transplanting the Seedlings to Main Field and Optimum Spacing: If seeds are scarce and irrigation facility is available, transplanting can be adopted with advantage since only about 500 gm of seeds will be enough to plant one hectare. Seeds are sown in nursery beds, two months before transplanting. An area of about 200 sqm under nursery gives enough seedlings for transplanting one hectare land. The seeds take about ten days to germinate and about 60 days to reach transplanting stage.

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Transplanting is done at 45X30 cm spacing. One hectare requires about 74,000 seedlings. Planting in the Field Land Preparation and Fertilizer Application: The field should be ploughed thoroughly followed by harrowing to bring the soil to a fine tilth and free from weeds. After the green manure crop is ploughed in or after the application of farmyard manure, as the case may be, the land is prepared as usual practices for any other agricultural crop. A basal dose of 250 kg of superphosphate and 65 kg muriate of potash are also incorporated in the soil. 110 kg urea is applied to the crop in two splits. First application is made 10-15 days after transplanting and the second application is made one month later. This is for an irrigated crop. When the crop is grown under rainfed conditions, half the quantities of manure and fertilizers mentioned above should be applied. Green Manuring: Farm yard manure at the rate of about 10 t/ha is applied in those areas where it is available at reasonable rate. If irrigation is available, it is advantageous to grow a leguminous crop, such as sunhemp or horsegram, prior to sowing or transplanting and ploughing it when it attains flowering stage. When this is done, application of farmyard manure may be dispensed with. This helps in building up the fertility of the soil. The green manure seeds should preferably be treated with bacterial inoculum, prior to sowing, to increase the development of root nodules which absorb atmospheric nitrogen and fix it in the soil. For treating seeds with inoculums jaggery solution is prepared by dissolving about 50 gm of jaggery in 500 ml of water, boiled, cooled and green manure seeds are wetted with this solution. Then, rhizobium culture (@ 300 gm/ha) is sprinkled and mixed well. The stickiness of the jaggery helps the rhizobium culture to adhere to the seeds. Irrigation and Intercultural Operations: Places where rainfall is evenly distributed throughout the year, the plants do not require any irrigation. However, the areas where the monsoon is restricted to a particular period, 4-5 irrigations once in fifteen days during February, March and April months are needed to get optimum yield. The first weeding is done after about 60 days from sowing or transplanting and the second after additional 60 days. Diseases and Pest Control: The plant is generally resistant to the attack of various pests and diseases. Occasionally, some plants have been found to suffer from 'Littleleaf' disease, resulting in stunted growth of the plant. The disease can be checked from spreading by uprooting and destroying the affected plants and spraying organic phosphorus insecticides once in 15 days when the infection is prevalent. A, die-back, caused by Pythium aphanidermatum Edson Fitzp., has been found to affect the crop during the monsoon. It is observed that mulching between the rows with any straw reduces the incidence of die-back to a considerable degree. Varieties 'Nirmal' and 'Dhawal' developed by CIMAP have a high level of field resistance to the die-back disease. Harvest Management Crop Maturity and Harvesting: The crop is harvested after about 12 months from sowing. The crop is cut at about 7.5 cm above the ground and dried in shade. The field is then copiously irrigated and when it reaches at proper moisture level, it is ploughed and the roots are collected. The roots are washed thoroughly and dried in shade. If there is demand for leaves, two leaf-stripping can be taken, the first one after 6 months and the second one after 9 months from sowing. Post-harvest Management: After harvesting, the whole plant is dried in shade. At this stage, light threshing will separate the seeds, which can be used for the next sowing. The leaves and stems are also then separately collected. Seeds collected this way will have fruits of various degrees of maturity and hence will have poor percentage of germination. It is, therefore, advisable that only mature pods should be collected during two or three months before the crop is harvested. Chemical Constituents: At present, more than 100 alkaloids have been isolated from the various parts of the plant, of these vinblastine (VLB) and vincustine (VCR) present in its leaves, and ajmalicine, present in its roots are medicinally important. VLB is used in the treatment of Hodgkins disease, non-Hodgkin lymphomas, testicarcinomas, and sometimes against breast cancer and chorio-carcinomas. VCR is used against acute leukemia, Hodgkins disease, non-Hodgkin lymphomas, rhabdomyosascomas, Wilm's tumors in children and breast cancer. Ajmalicine is used for the treatment of hypertension. Yield: Under irrigated conditions, about 1.5 tonnes of leaves, and 0.5 tonnes of roots on air-dry basis are obtained per hectare. The yield of leaves and roots under rainfed conditions is 0.75 t/ha each on air-dry basis. Rs. 25000/- is the cost of cultivation for one hactare.[12,13]

III. DISCUSSION

Eight villages in the arid regions of western Rajasthan are fast progressing towards sustainable development by venturing into growing Shankhpushpi, a medicinal herb which is scientifically proven to enhance memory and brainpower. Situated in the arid region with annual rainfall less than sufficient even for one crop in a year, the farmers grows traditional crops Bajra, Guar and Moth that have less commodity value.
Until recently, they weren't aware that organic composition of the soil added with integrated farming system can yield them two other crops - Shankhpushpi and another traditional crop - which can increase their annual incomes significantly. The move came after Central Arid Zone Research Institute (CAZRI) in Jodhpur and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) based in Hyderabad identified this high value commodity under the project

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"Dry Land Systems" in 2014 to turn arid land into a high yielding zone. Dheerasar and Dhonk in Barmer, Mansagar and Govindpura in Jodhpur, Damodar, Didu and Deda and Sankariya in Jaisalmer were chosen under the project in 2014. The efforts yielded results as Shankhpushpi herb fetched them a profit of Rs 25, 000-Rs 30, 000 per hectare against Rs 5, 000-Rs 10,000 per hectare under the traditional cropping system.[24,25]
"Shankhpushpi acted as a lifeline for my family as I earned Rs 80, 000 in the drought-like situation last year when other farmers end up earning nothing," said Debaram, a farmer from Dheersar Village in Barmer. He grew the herb on eight hectares of farmland. Last year, 100 farmers grew this herb on 120 hectares of land and now this figure has jumped to 500 farmers cultivating the herb in around 300 hectares.
The Krishi Vigyan Kendra based in Barmer and ICRISAT have been promoting the crop in the region by holding workshops and also helping farmers find a market to sell the herb.
"The revenue can increase significantly by cultivating a high value commodity crop like Shankhpushpi together with traditional crops like Bajra and Gaur. The Shankhpushpi crop requires water during sowing and once the seed germinates, it requires the same quantity of water as is needed for any dry land crop," said Shalander Kumar, scientist at ICRISAT.
The scientists have identified Barmer as ideal for growing medicinal herbs like Shankhpushpi and Jeevanti. "The kind of soil here is sandy loam and added with dry climate, it becomes ideal for growth of these herbs," said Kumar. The biggest challenge scientists are facing is the scarcity of water. This has been a major problem leading to mass migration. "Our emphasis is on saving water not only for drinking but also for irrigation. We are developing Khadin, a traditional water conservation technique prevalent in the arid regions," said Kumar.

IV. RESULTS

Private and forest nurseries in the state are witnessing a rapid rise in demand for medicinal plants during Covid pandemic as residents are increasingly buying such plants for their gardens.
As many of these plants with medicinal values including Tulsi significantly improve air quality as per the traditional medicine system, the demand in recent past has increased manifold. Other plants with medicinal value including turmeric, ashwagandha (within somnifera) and guduchi are also in tremendous demand.
Ratan Saini, a nursery owner in Jagatpura said, “In a new trend, people are opting for medicinal plants over ornamental plants. Tulsi, which is known to increase the supply of oxygen and absorbs harmful gases, is in high demand.”
The forest department also soon plans to implement its ‘Ghar Ghar Aushadhi Scheme’ to promote medicinal herbs with multiple health benefits. Under the scheme, the department targets to distribute medicinal plants including Kalmegh, Tulsi, Giloy and Ashwagandha.[14,15]
Principal chief conservator of forests (development) DN Pandey said, “To benefit every household, the department shortlisted four species of plants which can be planted in pots after studying 1,100 research papers and evaluating 3.5 million database. Even before the scheme is rolled out, people are expressing interest to procure these plants from forest nurseries.”
Though these medicinal plants are in demand, experts warned residents to contact doctors before consuming any herb for cure from any particular disease. A senior forest official said, “A committee has been constituted comprising ayurvedic doctor to educate people to consume these plants which can scientifically provide health immunity.”
Expert also believe as these plants are anti-viral and proved multi-functional to cure several diseases, the demand would increase in coming years. Radha Jain, an ayurvedic doctor said, “All these medicinal plants in one’s diet provides rich nutrients to help you make your defence mechanism stronger. It’s an age old proven fact, but people forgot it over the years. The pandemic has brought many close to roots.”
Rishi Sharma, who has been growing these trees in his garden said, “I have a dedicated medicinal plant area in my garden. During the pandemic, doctors advised me to consume juice to improve immunity.”[16,17]

V. CONCLUSIONS

In ana attempt to become economically self-sufficient, the traditional farmers of Rajasthan's harsh, desert regions have begun working with the government's integrated agriculture project.Eight villages in Rajasthan are quickly moving towards economic self-reliance through herbs production and turning into a role model for others, thanks to the government’s integrated agriculture project which has rekindled a new hope in the western parts of the state.[18,19]

Rainwater-being-harvested-in-masonry-check-dams-in-Govindpura
The development could have gone unnoticed had the herbal medicinal giant Dabur not signed a memorandum of understanding (MoU) with the farmers of Dheerasar and Dhonk villages in Barmer last year to purchase the entire lot of ‘Shankhpushpi', [23]a medicinal herb.
These two villages are among the eight being developed under the project.

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The others are: Mansagar, Govindpura in Jodhpur district, Damodar, Didu, Deda, Sankariya villages in Jaisalmer district. Gramin Vikas Samiti director (NGO partner of the project) Shashi Tyagi said the cultivation of other medicinal herbs, like Arana, Vajradanti and Isabgole was also being encouraged under the project which were sure to attract other pharmaceutical giants like Dabur.[20,21]
In fact, Dabur had purchased 10 quintals of Shankhpushpi at ` 1,600 to ` 2,000 per kg from the two villages. This may encourage even more farmers to grow herbs, sources said.[22]

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| ISSN: 2395-7639| www.ijmrsetm.com| Impact Factor: 7.580 | A Monthly Double-Blind Peer Reviewed Journal |

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Impact Factor: 7.580

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