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Management of agronomical constraints for enhancing seed spice production in Rajasthan

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Abstract

Rajasthan is the largest state comprising of 11% of the total geographical area of the country. It experiences a vast diurnal variation in weather vagaries i.e. temperature ranging from (-)2^0 to 48^0C during winter and summer season, respectively and rainfall from 193 mm in the west to about 370 mm in east of western Rajasthan. The soils of arid region are characterized as aeolian and coarse having calcareous pan with low water holding capacity. These soils are more prone to runoff and soil erosion, deficient in N, P, S, Zn with low organic matter content. Desertification mapping through remote sensing revealed that about 76% area in western Rajasthan is affected by wind erosion/deposition alone, followed by water erosion (11%), salinity/alkalinity (5%) and water-logging (0.7%) (Jain *et al.*, 2014). The seed spices viz. coriander, cumin, fennel and fenugreek are considered as major whereas ajwian, dill, celery, anise, nigella, caraway etc. are as minor seed spices. The some seed spices that are almost exclusive or grown in Rajasthan (coriander, cumin, fennel, fenugreek, ajwainan, dill and nigella) (Fig.1 and Table 1) and popularly called as the arid land spices and are grown largely in the arid and semi-arid zone covering major area of Rajasthan and Gujarat states. These states combined together contribute to the extent of 72% of the total Indian seed spices production. The low productivity of seed spices is a result of abiotic and biotic factors including cultural/agronomical like germination problems, soil quality constraints, poor fertility, scarcity of water, poor quality of water, high weed infestation, shattering problems and mishandling during harvesting and threshing. These constraints affect the production resulting into wide variation and instability in seed spices yields. These factors are mostly anthropogenic and largely as a result of mismanagement starting from field preparation to harvesting and threshing. Under such circumstances, practicing ITK's, follow early sowing, use of soil amendments, improved irrigation methods, use of improved seed with seed treatment, use of resistant varieties, alternate land uses, diversification, mechanization and role of extension services may play an important role in mitigating or modifying these constraints for higher production and productivity of seed spices in Rajasthan.

Key words : Crop, diversification, management, productivity, seed spices.

Introduction

One of oldest folded mountain chains of the world, the Aravalli stretches from southwest to northeast of the state playing a major role in the climatic as well as physiographic pattern of Rajasthan. The Arabian branch of monsoon hits the Eastern slope of Aravalli and Eastern part gets sufficient rain whereas the Western part remains dry, thus the North-Western part of Aravalli experiences arid or semi arid condition with Thar desert (a unique desert ecosystem). It also affects the spatial pattern of precipitation from east to west in the state as associated with the pattern of relief of this area along with highly erratic distribution of rainfall. The 40 % of total cultivated area in state is irrigated with a share of agriculture and allied sector in GSDP-20-29% (Horticultural statistics at a glance 2015). Almost major seed spices are cultivated under assured irrigated condition during rabi season. Spices are used to flavor the food therefore, considered essential items for kitchen not only in India but throughout the world. In addition, spices have economic values because they possess antioxidant properties, form important constituent of many Aurvedic medicines and are also used in making of perfumery, cosmetics, pickles, etc. The agronomical factors influence ecosystem causing land degradation and adversely affecting the sustainability of entire production system. Sometimes the major impacts of agronomic constraints cause partial or complete crop failure. Managing these agronomical constraints can change the production and productivity of seed spices in the states of Rajasthan and Gujarat.

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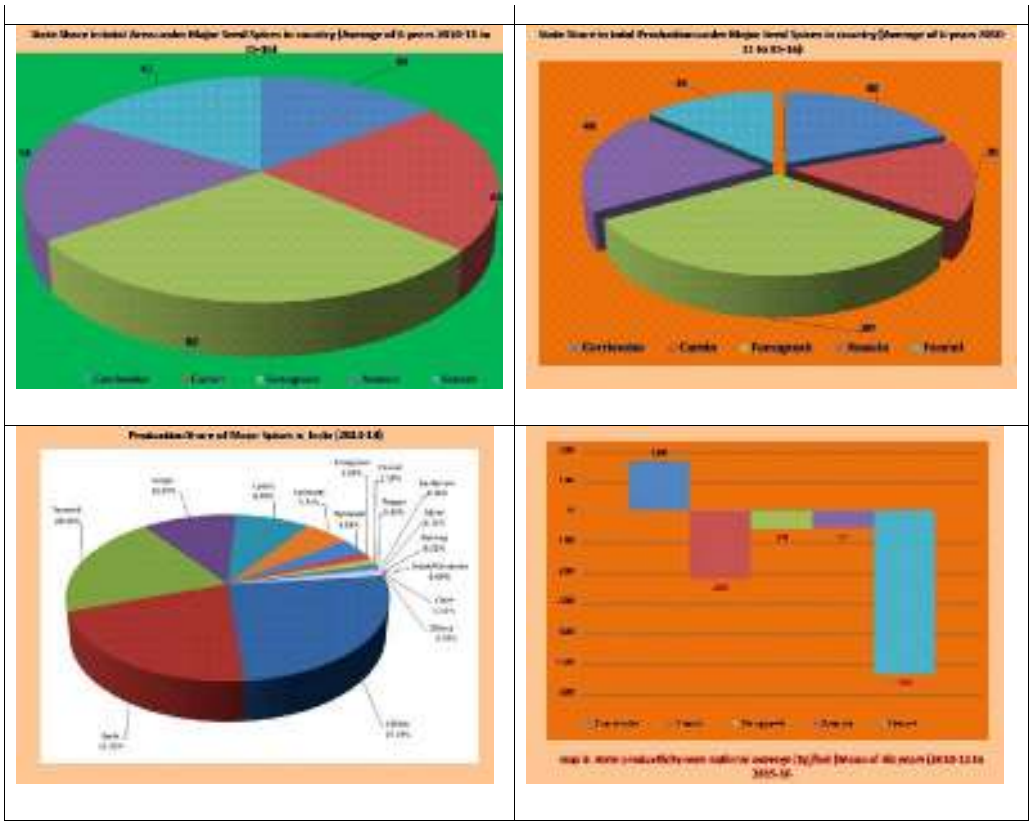

Fig.1. State share in area, production and gap exist in different seed spices in Rajasthan.(Source: Horticultural Statistics at a Glance 2015 and Website of GOI and Rajasthan)

Seed spices production scenario in Rajasthan and India

India is the only country renowned for home of spices around the world and prime producer, consumer and exporter. Spice production in India is currently estimated at 5.7 million tonnes from an area of about 3.2 million hectares. The major spice producing states are Gujarat (18 per cent), Andhra Pradesh (14 per cent), Rajasthan (11 per cent) (Fig.1), Madhya Pradesh (8 per cent) and Karnataka (6 per cent) (State of Indian Agriculture, 2015-16). At a micro level, on an average 43 per cent of the area under the spices crops are treated with pesticides. The seed spices have emerged as one of the important groups of spices crops in India. Seed spice production in India is currently estimated at 1.20 million tonnes from an area of about 1.75 million hectares. There are about 20 seed spices grown in India. Almost all the states in India grow one or more seed spices. The global demand estimated for seed spices worldwide is 98000 tonnes, of which, at present our country is able to export about 57000 tonnes annually, which is 58 per cent of the total demand. There has been an ever increasing demand of seed spices and importing countries look at India as consistent source. Rajasthan and Gujarat are major growing belt spreads from arid to semi arid region covering large area and called "Seed Spices Bowl", contributing to the extent of 80% of the total seed spices production of India. These seed spice crops are mostly cultivated either under rainfed production system or in the limited available water conditions. The demand of the seed spices will increase nearly by two and half fold than present demand up to 2030 and three fold by 2050 (Ref). To meet the demand of our increasing population and world demand, the productivity and production has to be increased in significant proportion. Due to unscientific cultivation methods and impact of biotic and abiotic stresses, large gap exists in spices production in Rajasthan (Table 1 and Fig 1). There is tremendous scope for increasing production of seed spices by introducing them in new areas. The higher production of seed spices also can be achieved easily through getting higher yields by better application of cultural, biotic and abiotic stress management and putting more area under these crops.

Strengthening seed spices cultivation

The cultivation of seed spices can give a good and high economic returns i.e. in the range of 2.5-5.0 in terms of

Table 1. Area, production and productivity of major seed spice in Rajasthan and gaps in productivity Data average of six year 2010-11 to 2015-16)

Crop	Rajasthan					India			Name of popular variety	Potential yield of recent variety	Gaps in production level (Kg ha^{-1})	
	Area		Production		Productivity	Area	Production	Productivity				
	('000 ha)	% share in country	('000 Mt)	% share in country	(Kg ha^{-1})	('000 ha)	('000 Mt)	(Kg ha^{-1})			State v/s National	State v/s Potential
Coriander	212	40.8	221	47.8	1051	519	461	888	RCr 446	1500	163	-449
Cumin	55	30.6	171	38.2	372	751	447	598	GC 4	700	-226	-328
Fenugreek	87	81.9	99	79.9	1121	106	123	1181	RMT 305	1800	-60	-679
Azwain	15	50.8	10	48.4	666	30	21	723	PA 1	900	-57	-234
Fennel	27	46.5	31	33.9	1059	57	91	1597	RF 143	1800	-539	-741

Source: Horticulture Data base 2013, Horticultural Statistics at a Glance, 2015, Website of Horticulture Directorate GOR and POP.

B:C ratio providing income security to the people of semi arid to arid region. In India about 50 % land is facing various problems like degradations of soil and water, lowering down of water table, salinity, alkalinity, macro and micronutrient deficiency, leaching of salts and poor underground water quality, heavy metals and various pollutants contamination. Saline/alkaline soils may be utilized for the production of fennel, dill and celery which are fairly tolerable to mild soil acidity and alkalinity. Coriander, fenugreek and celery can tolerate up to 5.5 soil pH levels. Dill can be grown in eroded soil, while coriander, cumin and fenugreek are suitable for nutritionally eroded soil. Seed spices are arid and semi-arid crops and may be cultivated with limited water conditions, crops like dill, anise, and fennel are found fairly tolerant to moisture stress conditions. Effective extension mechanism for spreading the advanced and improved technologies at grass root level and executed timely. Prominent agronomical and management constraints in production of seed spices in Rajasthan are mentioned below:

Cultivation on marginal lands

The seed spices are generally grown on marginal lands traditionally under poor crop management practices by the marginal and sub-marginal farmers. Their investment and risk bearing capacity is very low affects adoption of improved varieties. Lack of proper adoption of improved package of practices along with sufficient production technology for rainfed production systems particularly.

Lack of suitable and high yielding varieties

Mostly local varieties are under cultivation and lack of high yielding varieties tolerant to drought specific for different agro-climatic zones. Non-availability of quality planting material on large scale is another barrier for seed spices business to flourish. The varieties available have limited variability along with inadequate response to fertiliser (fertilizer irresponsive varieties). Similarly, a time gap in availability of quality seeds of recommended varieties is a major constraint for adoption along with higher cost. Inherent nature of slow germination and slow initial growth leads to poor stand of the crop. Undulating land surfaces cause uneven germination also.

Higher weed infestation

Weeds compete with crops for nutrient, light, water and space as well as cause several adversities like harbouring of insect pests and diseases, difficulties in harvesting and threshing, deteriorate the quality of produce etc. Lack of post emerge herbicides for weed control in standing crops is still a great challenge for researchers.

Climatic constraints

Climate change including low and erratic rainfall with limited surface water resources leads to various agricultural production problems and changes in natural agro-ecosystem i.e., aberrant weather conditions, soil salinity/alkalinity, soil acidity, flood, drought, insect-pest, diseases etc. Occurrence of climatic hazards untimely like mid season drought, hail and frost are the major hurdles for successful production of seed spices.

Nutrient imbalance

Characterization of seed spices growing soils and assessing soil quality for developing soil based agro-techniques including rhizosphere for sustainable spices production is a must. The timely un-availability of quality inputs especially for biofertilizers is also a major threat.

Problematic soils

Soils are saline, alkali, prone to erosion or underlying by hard pan are major soil quality constraints in higher production. One or more of the adverse feature are prevalent in different agro climatic regions.

Lack of mechanization

Most seed spices like cumin, ajwain, fennel etc. are sown by broadcasting methods. This method results in un-uniform germination with uneven plant stand. It causes difficulties in inter culture from sowing to harvesting. Lack of cost effective machineries particularly for sowing on undulating lands or following land levelling for uniform germination and adoption is a big challenge.

Improper harvesting and threshing

The losses during harvesting and threshing contribute significantly to decrease in production level. The shattering problem in fenugreek causes great loss in production qualitatively as well as quantitatively. Threshing on mud floor or pasted with cowdung causes infection with some objectionable pathogens and aflotoxins.

Lack of crop insurance and minimum support price (MSP)

The seed spices are very sensitive to light fluctuations against their climatic normal. The relative humidity in combination of low temperature causes congenial environment for higher infestation of disease causing pathogens. There is no crop insurance facility to cover the losses and to protect growers for an extended period. Similarly, the CACP/ GOI does not fix MSP's though some of seed spices cover a large area.

Inadequate extension web

There is a considerable difference between achievable and realized productivity as expected that, advanced and improved technologies may increase the present productivity level by 30-40 % in about 15 years period if implemented at grass root level and executed timely. At present, the extension system is good but not appropriate in the state to execute the technologies on time.

Management of constraints

Developing efficient agro-techniques for achieving the high production and productivity like:

Seed and variety related management

* Focus should be given for the improvement of agro-techniques suitable under varying agro-climatic conditions and identification of the gaps in the standard production technologies for further refinement in accordance to local environmental and socio-economic condition for a successful commercial venture of seed spice crops under semi-arid to arid region under rainfed, irrigated and organic production systems (Vision 2025).
* Seed priming for hastening germination through use of polymers or hygroscopic inert material without affecting germination adversely.
* Evolving eco-friendly and efficient weed management strategies to control weeds especially under post emergence situations.
* To develop short duration varieties, management of biotic and abiotic stresses and coping up mechanisms against the aberrant weather conditions.
* Breeding and selection of drought resistant/tolerant high yielding varieties especially under rainfed production system.
* The shattering problem in fenugreek may be overcome by harvesting in early morning under the impact of dew and reduce the inoculums by threshing on cement plastered floor to improve export quality.
* Modification in crop geometry and change in sowing time as per weather forecasts to gave weather normal for better germination.

Farm Mechanization

* The sowing on undulating soil surface in western Rajasthan could be managed by adopting lesser land levelling followed by drilling the seed with seed drill. A massive scale land levelling programme may benefit farmers for adoption of mechanizations besides facilitating uniform germination along with higher water use efficiency. It will decrease the cost of cultivation in long term, increase the production and ease in cultivation.
* Custom hiring centres for marginal and small farmers facilitates mechanization from sowing to threshing. A direct subsidy on costly inputs from government agencies to promote mechanization of through PPP models for betterment of farmers.

Soils related management

* The integrated, balanced and precision nutrient management is the best option to overcome the production gaps in seed spices caused by poor nutrient efficiency.
* The problematic soils may be reclaimed by using amendments, breaking hard pan or adopting green manuring during kharif season.
* New innovation through novel bio-fertilizers including plant growth promoting rhizobacteria and genetically modified microorganisms for promoting integrated nutrient management.
* To ensure availability of inputs in time with quality concern (especially biofertilizers).
* Promotion of organic farming modules for sustainability and viability of farming system of the seed spices for environment security.

Diversification

Promotion of organic farming modules for sustainability and viability of farming system of the seed spices for environment security.

* Adoption of integrated approach in water and nutrient management for better management in the agro climatic region.
* Development of planting models involving crop combinations for different habitats.
* Crop diversification by intercropping and crop rotations. Intercropping and relay cropping to achieve maximum crop-diversification with seed spices (Vision 2030 and Vision 2050).
* Standardization of seed spices based cropping systems including spices, vegetable crops and arid fruit crops.

Precision agriculture management

* Precision agriculture using sensor based technology and other resources conservation techniques and integrated approaches for better yields.
* Timely weather forecasting with high precision under the reach of farmers will helps in slight adjustments in field operation under prevailing weather.
* Evaluation and popularization of irrigation methods particularly the micro-irrigation and irrigation scheduling for proper use of poor quality and limited water resources. The micro-irrigation is the best option to overcome the production gap caused by poor fertility and moisture stress. Similary, water harvesting for crops like ajwain and dil. Technology for off-season cultivation of seed spices should be promoted to gain better profits.
* Characterization of seed spices growing soils and assessing soil quality for developing soil based agro-techniques.
* Studies on honeybee population management in cross pollinated seed spices to enhance yield and simultaneously to produce honey as by product for additional income.
* Technology for off-season and protected cultivation of seed spices to harvest assured and maximum production per unit area and time.

Social parameters

* Massive transfer of technology programme, so that the existing gap in state v/s national and national/ potential yields may be narrow down. There is an urgent need to strengthen the effective and extension mechanism to disseminate the modern technologies to the growers. In near future it will act as a centre for imparting training on seed spices crops (Vision 2030).
* Subsides on costly inputs like improved seeds, genetically modified seeds, protected cultivation, micro irrigation, power operated machineries may add in production by timely cultivation.

Conclusion

There is tremendous scope for increasing production of seed spices by introducing them in new areas. The higher production of seed spices can be achieved easily through getting higher yields by better application of cultural, biotic and abiotic stress management and putting more area under these crops. Many production technologies have been generated including seed priming for hastening germination. The present production level of seed spices is around 1.2 MT and was projected to 1.50MT by 2050. The difference is only 25% to be covered in next 35 years from the present area of 1.20 mha. The present status is really good but future will be bright if increase in productivity by 25% may full fill the projected demand of seed spices in India without increasing the more area under cultivation- an impossible task. There is an increasing demand of seed spices globally and many importing countries look at India as a consistent source of supply. India has significance in quality production, processing, capability, research and managerial skills. The efforts should be have a strong infrastructure in respect of supply of high quality exportable varieties of seed spices, easy availability of credit, market infrastructure and training of farmers.

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