Arid Horticulture- An Aid in Combating Desertification

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Abstract- Arid ecosystem can be converted into horticulture bowl provided adequate production technologies are available. it can ameliorate the ill effects of desertification and help in improving economic conditions of the farmers. The present status and prospects for horticulture development in arid India has been presented in this paper.

Key words: Arid Horticulture, Desertification, Production technologies, Value added products

1. Introduction

Arid regions are spread over about 31.7 million ha area mainly in the States of Rajasthan, Gujarat, Andhra Pradesh, Punjab and Haryana which inhabit on an average 61 persons per square km making up a population of nearly 20 million people besides a high population density of animals. The Indian arid zone is characterized by high aridity index (74-78%), wind velocity, intense solar radiation (320-619 / cm^2/ day), high temperature (during summer) and low and variable precipitation, which limit the scope for high horticultural productivity. In addition to this, the productivity of the horticultural crops is also limited by low fertility soils. However, these conditions greatly favour development of high quality in a number of fruits such as date palm, ber, pomegranate, grapes, citrus, guava and in vegetables such as cucurbitaceous, solanaceous, leguminaceous and cruciferous crops, spices and some medicinal plants. Following optimized technologies and inputs could increase the existing low productivity. The amelioration of the extreme conditions is also considered vital for life support to the inhabitants of this area. The present status and prospects for horticulture development in these areas has been presented in this paper.

2. Present Status

India is one of the largest fruit producing countries and stands only behind China in vegetable production. In Indian arid regions, the production of fruits and vegetables was 0.6 and 0.75 million tonnes respectively during 1983-84. This rose to 0.92 and 1.32 million tonnes respectively during 2002-03. The current requirements of fruits and vegetables for this region are 1.3 and 1.9 million tones respectively. Considering the current trends in population growth, these requirements are expected to reach 2.5 and 5.0 million tonnes respectively during the next two decades. (Fig. 1 & 2). This calls for concerted efforts to increase production. Although the recent scenario indicates an increasing trend in the production of both fruits and vegetables but the pace has been rather slow.

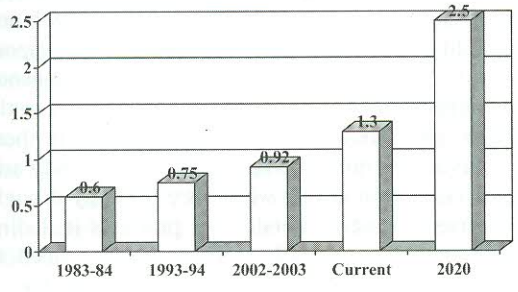

Fig. 1: Current Status And Future Requirement of Fruits in Arid Region of India

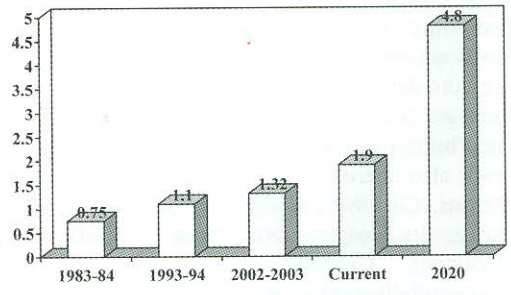

Fig. 2 Current Status and Future Requirement of Vegetable in Arid Region of India

Hot arid region of India encompasses 31.7 m ha (NW – 28.57 m ha, W. Rajasthan – 19.6 m ha, NW Gujrat – 6.2 m ha, SW Punjab – 1.5 m ha, SW Haryana – 1.3 m ha); while cold arid region encompasses 7.0 m ha (J & K and H.P.). In arid region, the area under fruits increased from about 50,000 ha in 1984-1985 to about 95,000 ha in 2002-2003 and that of vegetables from about 63,000 ha in 1984-85 to 110,000 ha in 2002-2003. Considerable area has come up under fruits like ber, pomegranate and aonla in different part of

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the country, which had negligible spread in the recent past. Ber has spread from northern states to the western and southern India from a mere 12000 ha in 1978 to nearly 70,000 ha in 1994-95 with a production of about 0.87 million tonnes. Similarly, the area under pomegranate has also leaped to over 80,000 ha. Varieties such as Gola, Seb, Mundia, New Umran, in *ber;* Jalor Seedless, Ganesh and Mridula, Bhagawa, Ruby & Arakta in pomegranate; Krishna, Kanchan, NA 6 and NA 7 in aonla; Balanagar and Arka sahan in custard apple; Poona Fig and Conardrio in case of fig; and Halawi, Barhee, Khuneizi and medjool in case of date palm are developed. Techniques for propagation, water and paste management have also been standardized in several cases.

3. Prospects

The potential evapotranspiration in the arid districts of Rajasthan varies from over 2000 mm at Jaisalmer to about 1500 mm at Sikar with a moisture index value from -68.9 to -91. The atmospheric vapour pressure deficit reaches as high as 30mb during the summer. However, There is ample scope to introduce the potential fruit and vegetable crops from iso-climatic regions of the world and in this context the germplasm of cactus pear, marula nut, carob, white sapota, Chinese jujube have been introduced in the arid region. The peculiar agroclimatic conditions impart unique quality in fruits such as Ber (*Zizyphus mauritiana*), Bordi (*Z. rotundifolia*), Pomegranate (*Punica granatum*), Aonla (*Emblica officinalis*), Date palm (*Phoenix dactylifera*), Gonda (*Cordia myxa*), Ker (*Capparis decidua*), Bael (*Aegle marmelos*), Cactus pear (*Opuntia ficus indica*), Kachri (*Cucumis melo*), *Mateera* (*Citrullus lanatus*), Snap melon (*Cucumis melo* var. agrestis), Chilli (*Capsicum* spp.), Musk melon (*Cucumis melo*). Arid region is the only area where commercial date palm production is possible. The indigenous products from *Capparis* and *Cucumis* can be exploited for preparation of value added products for internal as well as export consumption. High solar radiation provides opportunity for harvesting by optimisation of cropping system models incorporating multi-layer receptor crops. The availability of considerable amount of surplus family labour in the arid region farming communities is also a great resource to be put to use.

Most of the rainfall in the arid lands is erratic and occurs during the monsoon season (July-September). In western India, 54% of the area receives less than 250 mm rain and 43% area is covered with sand dunes where horticultural production is negligible; 26.5% of the area receives 250-350 mm rain and 15% area is under sand dunes and only 17% area receives rainfall of 350-600 mm. These areas grow plants such as *ker (Capparis decidua), phog (Calligonum polygonoides), kheep (Leptadenia pyrotechnica), tumba (Citrullus colocynthis), mateera (Citrullus lanatus), clusterbean (Cyamopsis tetragonoloba),* etc. which yield fruits and vegetables. The latter two are cultivated during *kharif* season. About 3.5% area is under riverbeds where vegetable cultivation is done, usually in two consecutive seasons. Out of the 16% area under flat alluvial plains and pediments receiving over 250 mm rainfall, about 4.5% is saline and stagnated but most of the remaining 11.5% land is cultivable (Pareek, 1983). Systematic production of horticultural crops is rare in arid region mainly because of lack of suitable plant varieties. Since atmospheric water deficit exceeding 24 to 30 mb during May-June, therefore, selected crops must complete most of the growth and development during the period of maximum water availability in the soil and low atmospheric vapour pressure deficit. Early ripening cultivars, which make maximum use of the residual water from the monsoon rains are considered suitable for rainfed production. Among vegetable crops, the hardiest types belong to the cucurbitaceous and solanaceous groups. Cowpea, clusterbean, okra are also very drought hardy. In these crops also, there is need to select the most drought hardy cultivars for rainfed production. In the sandy arid regions, *Citrullus colocynthis (tumba)* is a perennial natural vegetation cover, which is extremely drought hardy. Its seed (contains about 15% oil) and fruit can be used for various industrial products including medicines. Growing of this plant should be encouraged wherever possible. There is also need to commercially exploit the existing stress hardy genetic resources for development of horticultural industry.

4. Germplasm evaluation

As per research conducted so far, among 318 ber (*Ziziphus mauritiana*) genotypes, the ber varieties Gola, Seb, Umran, Kaithli and Banarasi Karaka are performing well under hot arid climate. Out of 152 genotypes of pomegranate (*Punica granatum*), Jalore Seedless (32 kg/tree), Ganesh (30 kg/tree), G-137 (29 kg/tree), P-23 (27 kg/tree) and P-26 (24 kg/tree) are the better genotypes from yield and quality point of views. In case of aonla (*Emblica officinalis*), NA-7 is a prolific bearer (51 kg/tree) followed by Chakaiya (34 kg/tree) and NA-6 (28 kg/tree). Among 9 beal (*Aegle marmelos*) genotypes, NB-5 and NB-9 are performing well under irrigated hot arid ecosystem. A five-year old budded plant of NB-5 had given 40 fruits/tree while

NB-9 yielded 29 fruits/tree. The fruit size of NB-5 is smaller (1.0 kg /fruit) than NB-9 (1.4 kg/fruit). The fruit quality is excellent in both the varieties. Varietal performance studies carried out at the CHES, Godhra revealed that varieties viz. NA-7 of aonla, Umran and gola of Ber, Ganesh of pomegranate, Kesar and Rajapuri of mango and Kalipatti of sapota were found most suitable for profitable cultivation.

5. Improvement in Arid Crops

5.1 Fruit crops: A clonal selection in ber "Goma Kirti" has been identified from the germplasm and released for commercial cultivation from CHES, Godhra. In addition to above two promising lines are in pipelines. They are CIAH-H-1 a hybrid of Seb x Katha is precocious and prolific bearer and early in fruit maturity (first week of January). CIAH-Sel.-1 tree size is medium with upright growth habit. Average fruit weight is 25g, yellow in colour, TSS is about 24 ^{0}Brix with excellent taste. It is resistant to fruit rot.

5.2 Vegetable crops: Systematic production of vegetable crops is rare in the hot arid regions mainly because of lack of suitable varieties for the cultivation under prevailing agro-climate. Realizing the importance of arid cucurbits, non-availability of standard varieties for commercial cultivation and also to supply uniform and good quality produce in the market; systematic research efforts were started at this Institute from 1994. After evaluation of large number of collections of *mateera* (*Citrullus lanatus*), *kachri* (*Cucumis melo*), snapmelon or *phoot* (*Cucumis melo* var. *momordica*) and *salad kakdi* (*Cucumis spp.*), two varieties each of these cucurbit vegetables were released at Institute level in 1998, which have excellent yield potential under hot arid conditions and are recommended for the systematic cultivation.

5.3 New varieties released: ***Mateera* (*Citrullus lanatus*):** *Mateera* is one of the most important rainy and summer season cucurbit vegetables in the hot arid ecosystem where it appears to have acquired the drought hardy characteristic. The ripe fruits are predominantly eaten as a dessert while immature small green fruit (*loyia*, 80-100 g weight) are used as vegetable. Till recently, there was no standard variety of *mateera* available to obtain uniform and good quality fruits on commercial scale.

i) AHW19: It is a medium-early maturing (75-80 days after sowing) variety developed through selection from the local land races found in arid region. Vine produces 3.0-3.5 fruits. The flesh is dark pink, solid (firm) with good eating quality and taste having 8 to 8.4% TSS. The variety gives heavy yields (460-500 q/ha) and tolerates high temperature.

ii) AHW 65: It is a very early maturing (72 days after sowing) variety developed by selection from local germplasm and is suitable for dessert and vegetable purpose. Harvesting of tender fruits (100 g weight) is recommended for use as vegetable. Yields 3-4 mature fruits per vine and 375-400 q/ha. The flesh is delicious, pink, solid (firm) having 8-8.5 per cent TSS.

Kachri (Cucumis melo): *Kachri,* is a very drought hardy cucurbit vegetable, found growing in the arid region during rainy season. The mature fruit are usually cooked with various vegetable preparations, *chutneys,* pickles and is also used for garnishing the vegetables or as *salad. Kachari* is one of the components of the delicious vegetable popularly known as *Panchkuta* in the desert districts of north-western India.

i) AHK 119: The fruits are suitable for dehydration. The fruits are small, egg shaped weighing 50-60 g. Harvesting begins 68-70 days after sowing and continues up to 110-120 days. On an average, 22 fruits are borne per vine giving an yield of 95-100 q/ha.

ii) AHK 200: The fruits are suitable for garnishing the vegetables and *salads.* The fruits are 100-120 g in weight. Fruits become ready for harvest in 65-67 days after sowing and harvesting continues upto 90-100 days. On an average, 20 fruits can be harvested from a vine giving a yield of 115-120 q/ha.

Snapmelon (*Cucumis melo* var. *momordica*): Snapmelon is a very common cucurbit vegetable in the arid region. Its unripe fruits are used as vegetable and to prepare *rayta.* Ripe fruits are used as dessert fruit or as *salad.* Snapmelon is cultivated mixed as well as self-sown with other rainfed crops in arid region during rainy season. It can also be cultivated in summer season.

i) AHS 10: Fruits can be harvested 68 days after sowing. The fruit are oblong and medium in size (900 g weight). The flesh is whitish pink, sweet in taste having 4.5-5.0 per cent TSS. The vines bear 4.0-4.5 fruits each giving an yield of 225-230 q/ha under arid conditions.

ii) AHS 82: Fruit harvest starts 67-70 days after sowing and continues upto 110-115 days. Each vine bears 4.5-5.0 fruits giving an yield of 245-250 q/ha. The Fruits are 925 g in weight. The light pink flesh is very sweet and tasty having 4.3-4.9 per cent TSS.

***Kakdi* (*Cucumis* spp.):** Out of the six *Cucumis* species found in India, *C. sativus* and *C. melo* are widely cultivated. The North- western arid part of Rajasthan is rich in the land races of *C. melo* var. *momordica* and *C.* melo. As a result of natural crossing among different species of *Cucumis*, several new forms have stabilized which are quite different from the traditional forms. Some of the natural combinations of *Cucumis* species resemble cucumber or long melon and are commonly used for salad pupose and are thus called *salad kakdi.* Besides *salad,* the tender fruits can be used for garnishing the vegetables. The unripe mature fruits are cooked as vegetable.

i) AHC 2: It is a very early maturing variety bearing uniform, long fruits. The fruits are medium long with light green skin without furrows. Harvesting of tender fruits can be done 8-12 days after fertilization for *salad* or for garnishing vegetables. Fruits become ready for harvest in 53-55 days after sowing and harvesting continues upto 95-110 days. Fruits weighing 275-300 g are suitable for slicing when their length is 30-35 cm and diameter is 3-3.5 cm. The flesh is crisp textured, solid and 1.4-1.5 cm thick. About 12-15 tender fruits can be harvested giving an yield of 4 kg per vine and 175-202 q/ha under arid situations.

ii) AHC 13: It is a very early and highly productive variety with profuse hermaphrodite flowers. For slicing, the fruits can be harvested at very early stage (3-6 days after fertilization). First harvest can be obtained 50 days after sowing and harvesting continues upto 95-110 days. Continuous picking results in higher yield. About 20-25 fruits are borne per vine. The tender fruits weighing 75-100 g are harvested when the length is 5.5-7.0 cm and diameters is 4.4-5.0 cm. The flesh is crispy and tasty which is about 1.0 cm in thickness. On an average 2.15 kg tender fruits can be harvested per vine giving an yield of 85-125 q/ha. The variety also has high heat tolerance.

Clusterbean: A high yielding clusterbean collection named Goma Manjari has been identified and released for cultivation from CHES, Godhra. The yield is about 90-100 q/ha green pods in 75-85 days.

6.5 Plant protection and management: Isolates of *Trichoderma* as well as *Pseudomonas flevorescens*, which are resistant to fungicides and high pH were screened out from desert ecosystem. Variability in powdery mildew isolates from various locations of the country has been found. Molecular characterization and identification of powdery mildew resistant markers are carried out. Utilization of fruit rot pathogen toxins for screening of ber germplasm against fruit rot has been standardized and in turn a large number of ber cultivars are being evaluated under laboratory conditions. At Godhra, best control of Cercospora leaf spot of pomegranate was achieved by 3 fortnightly sprays of Topsin M (0.1%), Captaf (0.2%) or Dithane M-45(0.2%). Fruit rot of aonla was controlled by 2-3 sprays of Dithane M-45 (0.2%) or Kavach (0.2%). At Godhra, schedule involving two application of either fenvalerate (0.005%) or dimethoate (0.05%) at 21 days interval commencing from second fortnight of September followed by two application of NSKE (5.0%) at 10 days interval proved to be effective against fruit fly and fruit borer infestation in ber.

To minimize the use of chemical fertilizes, use of vermicompost and inorganic fertilizers (50:50) had given good response in term of plant vigour, leaf nutrient content and fruit yield of pomegranate under arid region. In case of pomegranate and ber, alternate day irrigation through drip at 0.75 CPE with 75 per cent recommended dose of nitrogen had given promising response in term of plant vigour, fruit yield and leaf nutrient content. By drip fertigation, there is saving of 25 per cent fertilizer and more than 25 per cent of irrigation water with maximum water use efficiency as compared to pipe irrigation.

7. Conclusion and Future thrust

From the foregoing account, it is evident that the desertification can be ameliorated provided adequate horticulture technologies in terms of improved germplasm, production technologies, quality planting and seed material, strategies to conserve water, nutrients and other natural resources are judiciously applied and harvested in time. This will result into the developing a self sustainable farming system for arid regions. To achieve this the research and developmental work on following aspects needs to be strengthen. Strengthening of National Field Repository of arid zone fruits is further required through comprehensive survey, collection, characterization and conservation of available plant bio-diversity in the arid region. In-depth studies are required for optimizing input supply to maximize production both under rain fed and irrigated situation by overcoming stress conditions due to drought, salinity and low or high temperature. This would involve applying both the conventional and biotechnological approaches to transfer gene from the available gene pool into standard cultivars for resistance against biotic and abiotic stresses.