

# Economic return from the land race vegetables and their importance in sustainable production systems in the hot arid region

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## ABSTRACT

The present study was conducted in hot arid region of the Western Rajasthan during 2012 – 2014. Three districts of hot arid region namely; Naguar, Bikaner, Churu district were selected randomly for the study. During the study, there were found several potential landrace vegetables in the hot arid region which play significant role as the leading component crops of the sustainable production system and source of income generation in the study areas/district. Among the evergreen bush/tree type landrace vegetables were *khejri*, *ker*, *Khimp*, moringa, *phog*, *lasoda* (*Cordia myxa* Roxb.), Indian aloe, and cactus (*Opuntia ficus indica*). Under the group of the seasonal leafy vegetable, fenugreek, amaranth, chinopodium (*bathua*), mustard (leaves), green onion, were found the major landrace leafy vegetables contributing in sustainable production system and income generation in hot arid region (study areas). In case of cucurbitaceous vegetable group, the *kachri*, snapmelon, *mateera*, roundmelon, bottlegourd and *kakoda* were found the most important landrace cucurbitaceous vegetables which play leading role in sustenance and sustainable production system of the crops in hot arid region (study areas). They are the backbone of the world famous mixed cropping system of the hot arid region which makes the existing cropping system most suitable and sustainable with high economic viability. Other important landrace vegetables were cluster bean, moth bean, cowpea, green gram, brinjal, chilli and local mushroom which play vital roles in sustainable crop production system and generating substantial amount of income in the study areas/districts. Further, it was found that the majority (86.8%) of the farmers of the study areas of the hot arid region mainly follow mixed cropping system and some of them follow intercropping and sole cropping system also. With respect to economic gain from the landrace vegetables, it was found they have high economic value and marketing viability. They are very good source of income and trade specific activities for the farmers/dwellers in the study areas of the hot arid region. The *ker* (*Capparis deciduas* Edgew), *khejri* (*Prosopis cineraria* L.) Druce and cluster bean (*Cyamopsis tetragonolobus* (L.) Taub were found the most economic landrace vegetable among all in the hot arid region/ study areas.

**Keywords:** Evaluation, landrace vegetables, sustainable production, hot arid region, spectrum.

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The hot arid zones of the country are spread over 32 million ha in the state of Rajasthan (61%), Gujarat (20%), Andhra Pradesh (7%), Punjab (5%), Haryana (4%), Karnataka (3%) and Maharashtra (0.4%), in addition to the cold deserts in the states of Jammu and Kashmir and

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Himachal Pradesh which are characterized by hostile agro-climate and fragile eco-system. In Rajasthan, the hot arid zone covers 12 district of whole western Rajasthan. It covers the 61 % area of the Rajasthan State and characterized by an annual rainfall between 100 – 500 mm with a coefficient of variation (CV) varying from 40 – 70 per cent. low and erratic rainfall combined with extremes of temperature (450-500 cal/cm<sup>2</sup>/day); low relative humidity; high potential evapo-transpiration value ranging from 1600 mm in eastern part and 1800 mm in western part of the region. The relative humidity (RH) is highest during monsoon season (July – August) and may goes upto 60 – 80 % and starts dropping down sharply from October and onward. Other important characteristics of hot arid region are, hot and high wind velocity (25 – 35 Km/ hr) ; poor soil condition; in large tracts the ground water is poor, brackish and saline in reaction; high rate of evapo-transpiration; poor vegetation; frequent occurrence of drought and frost, etc. (Yadava and Soni,2008). In such hard and harsh climatic condition, the sole cropping or mono cropping system is very risky and unprofitable. The main cropping season in hot arid region like Western Rajasthan is the *kharif* (rainy season). Due to the uncertainty of rainfall and scare water resources, more than 85 % population of the farmers of these regions follow mixed cropping system at large scale and intercropping system at small scale during the year. However, some of the farmers which have irrigation facilities follow sole cropping system also at very small scale during different seasons of the year. In above cropping systems, various crops, including the landrace vegetables are grown. It is supposed that the landrace vegetables of the hot arid region, play a leading role as component crops in sustenance and sustainable production in existing different cropping systems, their exact production climax was not clear. Further, without knowing the pattern of the existing cropping and production system, the suitable technological interventions meant for improvement of the crop production system was not possible. Keeping these facts in mind, the present study was conducted to “evaluate the role of landrace vegetables of the hot arid region in sustainable production system and their economic viability.”

## METHODOLOGY

The present study was conducted in hot arid region of the Western Rajasthan during 2012 – 2014. Three districts of hot arid region namely; Naguar, Bikaner, Churu district were selected randomly for the study. Further, two blocks were selected randomly from each so selected districts for study purpose. Thus, a total of 06 blocks were selected randomly amongst all above districts. Further, 03 villages were selected from each so of selected blocks for the study point of view. Thus, a total of 18 villages (including big, medium, and small) were selected for the study. Further, 09 farmers (03 big, 03 medium and 03 small farmers) were selected randomly among the each of 18 selected villages. In this way, a total of 172 farmers (respondents) were selected to collect the desirable data/information about contemporary spectrum of the landrace vegetables of the hot arid region and their role in sustainable production system to get conclude findings of the study. The farmers/respondents were individually contacted and interviewed. In addition, to strengthen the data/ information, the secondary sources were used and group discussions with respondents were also held as per need. For the calculation of the marketing viability of the landrace vegetables of the hot arid region 50 shopkeepers/whole sellers and 50 end users of these landrace vegetables were selected from all selected districts and they were interview personally and through online service. The secondary data/ information were also utilized to calculate the authentic market price or economic viability of the concerned landrace vegetables. The data/responses of farmers, shopkeepers/whole sellers, end users and secondary sources were recorded on a semi-structured interview schedule, specially prepared for this study. At the end, the targeted data/information so collected were coded, decoded, compiled, tabulated and analyzed using reliable statistical tool and techniques to draw the conclusion and final inferences of the study.

## RESULTS AND DISCUSSION

During the study, the intensive as well as extensive evaluation of the landraces vegetables grown in hot arid region of the Western Rajasthan was done. It was observed that there were various well adopted and

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**Table 1:** Leading land race vegetables play vital role in sustainable production system and economy in hot arid region of the western Rajasthan

Sr. No.	Land race vegetable group and name	Scientific Name of land race vegetable	Growing season	Edible/consumable part
<b>(A)</b>	<b>Evergreen tree/ bush type vegetables</b>			
1	Khejri	<i>Prosopis cineraria</i> (L) Druce	Evergreen tree	Tender pods ( <i>sangari</i> )
2	Ker	<i>Capparis deciduas</i> Edgew.	Kharif & Summer*	Tender /immature fruits
3	Khimp	<i>Leptadenia pyrotechnica</i> (Fork.) Decne	Evergreen Bush	Tender pods ( <i>kimpoli</i> )
4	Moring	<i>Moringa oleifera</i> Lamk	Evergreen tree	Tender pods/flowers/leaf
5	Phog	<i>Calligonum polygonoides</i> Linn.	Evergreen Bush	Mature flower buds
6	Lasoda	<i>Cordia myxa</i> Roxb.	Evergreen tree	Tender/immature fruits
7	Cactus (veg. type)	<i>Opuntia ficus indica</i>	Evergreen Bush	Tender nopales/Cladodes
<b>(B)</b>	<b>Seasonal leafy vegetables</b>			
8	Fenugreek	<i>Trigonella foenumgraecum</i> L.	Rabi	Tender leaves/ twigs, seeds
9	Amaranth	<i>Amaranthus</i> spp.	Kharif/Rabi/-Sum.	Tender leaves and twigs
10	<i>Bathua</i>	<i>Chenopodium album</i>	Rabi	Tender leaves and twigs
11	Mustard	<i>Brassica</i> Spp.	Rabi	Tender leaves and twigs
12	Gram	<i>Cicer arietinum</i> Linn.	Rabi	Tender leaves/twigs, seeds
<b>(C)</b>	<b>Cucurbitaceous Vegetables</b>			
13	Kachri	<i>Cucumis callosus</i> (Rott.) Cong.	Kharif & summer	Fruits
14	Snapmelon	<i>Cucumis melo</i> var. <i>momordica</i>	kharif & summer	Fruits
15	Mateera (loia)	<i>Citrullus lanatus</i> (Thunb.)	kharif & summer	Fruits
16	Roundmelon	<i>Citrullus vulgaris</i> var. <i>fistulosus</i>	kharif	Fruits
17	Bottlegourd	<i>Lagenaria siceraria</i>	kharif & summer	Fruits
18	Kakoda	<i>Momordica dioica</i> Roxb.	kharif	Fruits
<b>(D)</b>	<b>Leguminous Vegetables</b>			
19	Cluster bean	<i>Cyamopsis tetragonolobus</i> (L.) Taub.	Kharif	Tender pods
20	Mothbean	<i>Vigna aconitifolia</i>	kharif	Tender pods and seeds
21	Cowpea	<i>Vigna sinensis</i> Savi.	Kharif	Tender pods and seeds
22	Green gram	<i>Vigna radiate</i>	kharif & summer	Tender pods and seeds
<b>(E)</b>	<b>Solanaceous Vegetables</b>			
23	Brinjal (Spiny type)	<i>Solanum melongena</i>	Rabi/ kharif	Fruits
24	Chilli (Local type)	<i>Capsicum annum</i>	Rabi/ kharif	Fruits
<b>(F)</b>	<b>Other vegetables</b>			
25	Local Mushroom	<i>Podaxis pistillaris</i>	kharif	Button / Gleba

\* Evergreen but pods/fruits are born during summer season in case of *khimp*, *khejri* and *phog* while *ker* bears fruits during summer as well as in rainy (*kharif*) seasons.

**Table 2:** Land race vegetables grown as integral component crops for the sustenance and sustainable production of the different cropping systems in hot arid region during the seasons of the year

Season	Category of cropping system	Major crops & crops' combinations under cropping systems	Range of area (ha)*	Adopters/ Growers (%)
(i) Kharif (Rainy) season	Mixed cropping			
	I	Cluster bean + Pearl millet + Sesame <i>Mateera</i> + Snap melon+ <i>Kachri</i> + <i>Round melon</i>	0.5 – 21.0	86.8
	II	Moth bean + Pearl millet+Snap melon + <i>Mateera</i> + <i>Kachari</i> + <i>Round melon</i> + <i>Ridge gourd</i> + <i>Local Mushroom</i>	0.5 – 17.0	
	III	Pearlmillet + Moth bean + Cluster bean + Sesame + <i>Kachari</i> + Snap melon + <i>Kachri</i> + <i>Round melon</i> + <i>Kakoda</i>	0.5 – 15.7	
	IV	Pearl millet + Cluster bean <i>Mateera</i> / Snapmelon/ <i>Kachari</i> / <i>Round melon</i> / <i>ridge gourd</i>	0.5 – 13.1	
	V	Pearl millet/Moth bean/ Green gram + Cow pea <i>Mateera</i> / Snapmelon/ <i>Kachari</i> / <i>Round melon</i> / <i>Ridge gourd</i>	0.5 – 12.2	
	VI	<i>Mateera</i> + Snapmelon+ <i>Kachri</i> + <i>Round melon</i> + <i>Ridge gourd</i> / <i>bottle gourd</i> + <i>Moth bean</i> + <i>Cow pea</i> + <i>Pearl millet</i> + <i>Sesame</i> + <i>cluster bean</i> + <i>Local Mushroom</i>	0.5 – 10.2	
	VII	<i>Mateera</i> / Snapmelon/ <i>Kachari</i> / <i>Rond melon</i> + <i>Groundnut</i>	0.5 – 8.8	
	Inter cropping system	<i>Mateera</i> /Snapmelon/ <i>Kachari</i> / <i>Rond melon</i> / <i>Bottle gourd</i> / <i>Kakoda</i> / <i>Brinjal</i> / <i>Chilli</i> / <i>cluster bean</i> , <i>Moth bean</i> , <i>cowpea</i> , <i>Indian aloe</i> , <i>Amaranth</i> , etc. in <i>ber/ kinnow/ pomegranate orchards</i>	0.25 – 2.3	28 – 46 (% Orchard growers)
	Sole cropping system	Cluster bean/ Moth bean/ Pearl millet/ <i>Mateera</i> / Snapmelon/ <i>Kachari</i> / <i>Rond melon</i> / <i>Bottle gourd</i> / <i>Kakoda</i> / <i>Brinjal</i> / <i>Chilli</i> / <i>Brinjal</i> , <i>Amaranth</i> , <i>Cowpea</i> , etc.	0.10 – 1.4	16 – 22
(ii) Rabi (Winter) Season	Inter cropping system	Bottle gourd, mustard (leaves), chilli, fenugreek, green onion, Indian aloe, etc. in <i>ber/ citrus/ kinnow / pomegranate orchards</i>	0.10 – 1.7	25 – 49 (% Orchard growers)
	Sole cropping system	Bottle gourd, mustard (leaves), chilli, fenugreek leaves, green onion, Indian aloe , etc.	0.10 – 1.3	23 – 34
(iii) Zaid (Summer) Season	Inter cropping system	<i>Mateera</i> /Snapmelon/ <i>Kachari</i> / <i>Rond melon</i> / <i>Bottle gourd</i> / <i>Brinjal</i> / <i>Chilli</i> / <i>cluster bean</i> , <i>green onion</i> , <i>Indian aloe</i> , <i>Amaranth</i> , etc. in <i>ber/ citrus/ kinnow /pomegranate orchards</i>	0.10 – 1.0	22 – 32 (% Orchard growers)
	Sole cropping system	<i>Mateera</i> /Snapmelon/ <i>Kachari</i> / <i>Rond melon</i> / <i>Bottle gourd</i> / <i>Kakoda</i> / <i>Brinjal</i> / <i>Cluster bean</i> , <i>green onion</i> , <i>Indian aloe</i> , <i>Amaranth</i> , etc.	0.10 – 0.6	16 – 24

In addition to above combinations, 04-44 perennial *khejri* (*Prosopis ceneraria*) plants/hectare, some *phog*, *lasora* plants and bushes of *ker*, *khimp* were also observed on the production sites/fields of the farmers which work as gourd crops/ augmenting crops/ trees which make production system more viable and sustainable.

\* The expansion of the areas under the cropping system may increase or decrease depends on the rainfall/ availability of lifesaving irrigation facilities and climatic conditions.

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**Table 3:** Economic viability and earning from the major land race vegetables of the hot arid region

Sr. No.	Land race Vegetables	Part/products sold as vegetable stuff	Range of market price/economic viability per kg (Rs.)	Ave. earning of farmers/ producers per kg (Rs.)	Ranks of Economic viability +earning
1	<i>Khejri (Prosopis cineraria L.)</i> Druce	Green tender pods ( <i>sangari</i> ) Dehydrated tender pods ( <i>sangari</i> )	70 – 100 500 – 750	78 466	II
2	<i>Ker (Capparis deciduas Edgew)</i>	Green tender fruits Dehydrated tender fruits	120 – 220 800 – 1000	146 690	I
3	<i>Khimp (Leptadenia pyrotechnica (Fork.) Decne)</i>	Green tender pods ( <i>khimpoli</i> ) Dehydrated tender pods	60 – 75 350 – 500	68 240	IV
4	<i>Lasoda (Cordia myxa Roxb.)</i>	Green immature fruits Dehydrated fruits	10 – 34 150 – 250	12 166	IX
5	<i>Kachri (Cucumis callosus Rott. Cong.)</i>	Green immature fruits Dehydrated fruits	20 – 44 200 – 340	32 222	VI
6	Snapmelon ( <i>Cucumis melo var. momrdica</i> ),	Green immature fruits Dehydrated fruits	11 - 26 210 – 280	16 178	VII
7	Roundmelon ( <i>Citrullus vulgaris var. fistulosus</i> )	Green tender fruits Dehydrated fruits	10 – 30 210 – 260	12 164	VIII
8	Cluster bean ( <i>Cyamopsis tetragonolobus (L.) Taub.</i> )	Green tender pods Dehydrated tender pods	30 – 80 340 – 600	42 390	III
9	<i>Mateera (Citrullus lanatus Thunb.)</i> ,	<i>Loia</i> (tender fruits)	30 – 80	48	XIII
10	Bottlegourd ( <i>Lagenaria siceraria</i> )	Tender fruits	8 – 20	11	XIX
11	<i>Kakoda (Momordica dioica Roxb.)</i>	Tender fruits	40 – 100	62	XI
12	Fenugreek ( <i>Trigonella foenumgraecum L.</i> )	Tender leaves with twigs Dry seeds	10 – 25 50 – 65	14 54	XV
13	Amaranth ( <i>Amaranthus spp.</i> )	Tender leaves with twigs	8 – 14	10	XX
14	<i>Bathua (Chenopodium album</i>	Tender leaves with twigs	12 – 18	12	XVIII
15	Mothbean ( <i>Vigna aconitifolia</i> )	Tender pods	50 – 100	56	XII
16	Cowpea ( <i>Vigna sinensis Savi.</i> )	Tender pods	30 – 54	36	XVI
17	Spiny brinjal ( <i>Solanum melongena</i> )	Tender fruits	30 – 56	38	XIV
18	Local type Chilli ( <i>Capsicum annum</i> )	Mature green fruits	24 - 40	28	XVII
19	<i>Phog (Calligonum polygonoides Linn</i>	Dry flower buds	125 – 180	184	X
20	Local Mushroom ( <i>Podaxis Spp.</i> )	Buttons	150 – 300	190	V



adapted unique landrace vegetables which make the existing cropping systems more sustainable and more economically viable in harsh and hard climatic conditions of the hot arid region/ study areas. The Table 1 reveals that there are several potential leading landrace vegetables in the hot arid region which work as the ruling component crops for the sustainable production system and rational income generation in the study areas/district. The details of the findings about the same are as follows.

**(A) Ever green bush/tree type landrace vegetables:**

Among the evergreen bush/tree type landrace vegetables observed during the study on crop fields/ boundaries of the crop fields were *khejri* (*Prosopis cineraria* (L) Druce), *ker* (*Capparis deciduas* Edgew), *Khimp* (*Leptadenia pyrotechnica* (Fork.) Decne), *moringa* (*Moringa oleifera* Lamk), *phog* (*Calligonum polygonoides* L.), *lasoda* (*Cordia myxa* Roxb.), Indian aloe (*Aloe vera barbadensis* Mill) and cactus (*Opuntia ficus indica*). The all above evergreen landrace vegetables play vital roles not only in protecting and sustaining the crop production systems in the hot arid region (study areas) but also have significant value in socio-economic up-liftment of the farmers and dwellers of the region. They also play a crucial role in producing the nutritionally rich organic food stuff in the forms of tender pods, flowers/ flower buds, leaves, fruits, nopales/cladodes, etc. for human beings (Table 1) and fodder with shelter for the animal kingdom of the region. The above mentioned landrace vegetables and their value added products/by-products have very significant value in the local markets/*mandies* which leads better opportunities of the earning for the farming communities and dwellers of the hot arid regions.

**(B) Land race vegetables of leafy vegetable groups:**

Among the group of seasonal landrace leafy vegetables, fenugreek (*Trigonella foenumgraecum* L.), amaranth (*Amaranthus spp.*), *bathua* (*Chenopodium album*), mustard (*Brassica Spp.*), gram (*Cicer arietinum* Linn), *gokharu* (*Tribulus terrestris* Linn.), *sathi/satha* (*Boerhaavia diffusa/Boerhaavia verticillata*), green onion (*Allium cepa*), etc. were found the major landrace vegetables which play

significant role in sustainable production system and income generation in hot arid region (study areas) of the western Rajasthan. The tender leaves or leaves with tender twigs of the above landrace vegetables are used by farmers/dwellers as raw material for preparing green vegetables and selling them in local markets/*mandies* to earn the money for livelihood security.

**(C) Land race vegetables of cucurbitaceous group:**

This group of land race vegetables is the super most group among all landrace vegetables found in hot arid region of the western Rajasthan. The Table 1 reveals that the *kachri* (*Cucumis callosus* Rott. Cong.), snapmelon (*Cucumis melo var. momordica*), *mateera* (*Citrullus lanatus* Thunb.), roundmelon (*Citrullus vulgaris*), bottlegourd (*Lagenaria siceraria*) and *kakoda* (*Momordica dioica* Roxb. were found the most important landrace cucurbitaceous vegetables which play leading role in sustenance and sustainable production system of the crops in hot arid region (study areas). They are the backbone of the world famous mixed cropping system of the hot arid region which makes the existing cropping system most suitable and sustainable with high economic viability. These are also important component crops of the intercropping and sole cropping system of the in the hot arid region. They grown and consumed by the large population of the hot arid region. Most of these are consumed in fresh condition or in value added forms throughout the year. The farmers/dwellers of the hot arid region used the immature/mature fruits of these cucurbitaceous landrace vegetables as the very good source of the nutritious vegetables and various value added products to earn money for the livelihood security. These findings are in the conformity of research finding as reported by Meena, *et.al.*(2009), Goyal and Sharma (2008).

**(D) Land race vegetables of leguminous group:**

The another important group of the land race vegetables was the leguminous group of vegetables which were found predominantly grown under

different sustainable production/cropping system of the hot arid region and consumed by more than 90 % of the farmers/dwellers of the hot arid region. Among these major were cluster bean (*Cyamopsis tetragonolobus* L. Taub), moth bean (*Vigna aconitifolia*), cowpea (*Vigna sinensis* Savi.) and green gram (*Vigna radiata*). The tender pods/seeds of these vegetables are used for vegetable purpose and producing some value added products also, which leads to generating substantial amount of money and nourishment of the dwellers of the hot arid region.

**(E) Land race vegetables of solanaceous group:** The traditional land races of brinjal and chilli are grown in hot arid regions under different sustainable cropping systems and are consumed in various forms like vegetable, pickle, *chutney*, *bhurita*, spice, etc.

**(F) Other vegetables:** There was found a peculiar type land races of the mushroom which grow during the *kharif* season on farmers' fields /sand dunes of Thar desert of western Rajasthan. It has very high nutritional, calorific and markets value and used widely for vegetable as well as value addition purpose in hot arid region of western Rajasthan.

### ***Role of landrace vegetables as significant component crops of sustainable production systems of the hot arid region***

During the study, it was observed that the farmers of the study areas of the hot arid region follow 3 types of cropping systems. They were (1) mixed cropping system (2) intercropping system and (3) sole cropping system. Further, found that there were several landrace vegetables which play leading roles in sustenance and sustainable production of the crops in hot arid region under the umbrella of above cropping systems.

**(1) Land race vegetables and mixed cropping system:** The Table 2 reveals that the majority of the farmers of surveyed areas /districts follow the mixed cropping system in rainfed conditions during rainy (*kharif*) season. The mixed cropping system is the most prominent and important conventional cropping system of the hot arid region from ancient

time which is followed by majority (86.8%) of the farmers/growers of the study areas or districts. There were identified various unique land races of the vegetables which play a crucial role in sustenance and sustainable production under existing mixed cropping system. During the study, there were observed VII major combination/ type of mixed cropping system which were practiced by the farmers/growers in the hot arid region/ study areas of the western Rajasthan. In these VII combinations of the mixed cropping system, several land race vegetables including *mateera*, snapmelon, *kachri*, cluster bean, round melon, moth bean (veg.), cluster bean (veg.), cowpea, bottle gourd, *kakoda*, local mushroom, etc., play leading roles as an integral component crops of the existing mixed cropping system. These vegetables crops are grown in different combinations and in different intensities with other rainfed crops like cluster bean, moth bean, pearl millet, sesame, groundnut, etc. as shown Table 2. The trees/ bushes like *khejri*, *ker*, *khimp*, *lasoda*, *moringa*, etc. also play major role as the intercrops/gourd crops/augmenting crops under the existing mixed cropping system in the hot arid region. In the study areas 04-44 perennial *khejri* (*Prosopis ceneraria*) plants/hectare, some *phog*, *lasora* plants and bushes of *ker*, *khimp* were also observed on the production sites/fields of the farmers which work as gourd crops/ augmenting crops/ trees which make production system more viable and sustainable.

**(2) Land race vegetables and intercropping system:** Another important cropping system as observed during the study was "intercropping system". It is followed by the farmers/growers in all three seasons *viz*; rainy (*kharif*), winter (*rabi*) and summer (*zaid*) seasons of the year. The Table 2 revealed that the landrace vegetables including *mateera*/ snapmelon/ *kachari*/ rond melon/ bottle gourd/ *kakoda*/ brinjal/ chilli/cluster bean (vegetable type), moth bean (vegetable type)/ cowpea/ Indian aloe/ amaranth, etc. are grown during rainy *kharif* (rainy) season as intercrops by 28-46 % *ber*/ *kinnow*/ pomegranate growers in their orchards on area ranging between 0.25 – 2.3 ha. During *rabi* (winter) season (irrigated

conditions), the land race vegetables including bottle gourd/ mustard (leaves)/ chilli/ fenugreek leaves/ green onion, Indian aloe, etc. are grown as intercrops by 25 - 49 % *ber/ kinnow/ pomegranate* growers in their orchards on area ranging between 0.10 – 1.7 ha. The farmers which have irrigation facilities, grow landrace vegetables like *mateeral/ snapmelon/ kachari/ rond melon/ bottle gourd/ brinjal/ chilli/ cluster bean (veg.)/ brinjal/ green onion/ Indian aloe, amaranth, etc.* as intercrops by 22 - 32 % *ber/ kinnow/ pomegranate* growers in their orchards during *zaid* (summer) season also, on areas ranging between 0.10 – 1.0 ha during. Chundawat (1993) also reported the similar kind of findings in through his study on inter-cropping in orchards.

**(3) Land race vegetables and sole cropping system:**

The Table 2 reveals that during the *kharif* (rainy) season, the landrace vegetables including *mateeral/ snapmelon/ kachri/ round melon/ bottle gourd/ kakoda/ brinjal/ chilli/ amaranth/ cluster bean (veg. type)/ moth bean (veg. type), cowpea, etc.* are grown in sustainable manners as sole crops by 16 – 22% farmers on area ranging between 0.10 – 1.4 ha. During the *rabi* (winter) season and irrigated conditions, 23-34 % farmers grow landrace vegetables like bottle gourd, mustard (leaves), chilli, fenugreek leaves, green onion, Indian aloe, etc. as sole crops in sustainable manners on areas ranging between 0.10 – 0.7 ha. The farmers which have irrigation facilities grow landrace vegetables *viz; mateeral/ snapmelon/ kachari/ round melon/ bottle gourd/ kakoda/ brinjal/ chilli/ cluster bean (veg. type), green onion, Indian aloe, amaranth, etc.* during summer season also as sole crops in sustainable manners by 16 – 4 % on area ranging between 0.10–0.6 ha.

The concerned all landrace vegetables are highly drought hardy, quick growing and most suitable in fragile ecosystem of the hot arid region which work as integral component crops of the existing different cropping systems of the hot arid region/study areas. Hence, they play very important role in sustenance and sustainable crop production under existing cropping systems followed by the farmers during different seasons of the year. These findings are resembling with the finding of Meena et al. (2009).

***Economic viability the landrace vegetables grown in hot arid region of the western Rajasthan***

During the study, it was found that the landrace vegetables grown in hot arid region have high economic value and viability. They are very good source of income and trade specific activities for the farmers/dwellers in the study areas of the hot arid region of the western Rajasthan. The farmers produce these vegetables under different cropping systems of the year in considerable amount for own consumption and sale the surplus in the local markets/*mandies* to earn substantial amount of money from the same. The Table 3 reveals that *ker (Capparis deciduas Edgew)* is the most economic landrace vegetable among all in the hot arid region of the western Rajasthan which was ranked I<sup>st</sup> during the study with respect to its economic viability and per kg earning of the farmers/producers from it. The contemporary range of market price (economic viability) of green tender fruits and dehydrated fruits of the *ker* was ₹ 120 – 220/ kg and ₹ 800 – 1000/kg, respectively and average per kg earning of the farmers/producers from green tender fruits and dehydrated fruits was ₹ 78/ kg and ₹ 466/ kg, respectively. Singh and Sigh (2011) also revealed in his study that the *ker* fruits had high economic vale in the markets. The second most important landrace vegetable of the hot arid region as observed during the study was tender *sangari* (pods) of the *khejri (Prosopis cineraria L.)* Druce. The range of the contemporary market price (economic viability) of the tender green *sangari* (pods) and dehydrated *sangari* of the *khejri* was ₹ 70-100/ kg and 500 – 750/ kg, respectively, depending on quality and production factor of the of the same. Likewise, the average earning of the farmers/producers from the tender green *sangari* (pods) and dehydrated *sangari* was ₹ 78 and 466 per kg, respectively. Samadia (2013) also assessed the market value of tender green and dry *sangari* of the *khejri* of in his study and he mentioned that they had high economic value in local markets. Third important landrace vegetable as observed during the study was cluster bean (*Cyamopsis tetragonolobus (L.)*Taub and the contemporary market price (economic viability) of the tender green pods and dehydrated pods of the cluster bean was ranging between ₹ 70-100/ kg and 500 – 750/ kg, respectively which depends on quality, demand and supply factors of the same. In respect of the



range of market price (economic viability) and earning of the farmers/producers, IV<sup>th</sup>, V<sup>th</sup> and VI<sup>th</sup> ranked landrace vegetables of the hot arid region of the western Rajasthan were *khimp* (*Leptadenia pyrotechnica* (Fork.) Decne, local mushroom (*Podaxis pistillaris*) and *kachri* (*Cucumis callosus* Rott. Cong.), respectively followed by other. The least important landrace vegetables of the hot arid regions with respect range of their market price (economic viability) and earning of the farmers/producers from the same were *bathua* (*Chenopodium album*) bottle gourd (*Lagenaria siceraria*) and amaranth (*Amaranthus spp.*) with rank XVIII<sup>th</sup>, XIX<sup>th</sup> and XX<sup>th</sup>, respectively. These findings are on the findings lines of Chadha, 2002.

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