

## Cultivation of potato in dryland system of Western Rajasthan for improving food security and income generation

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**Abstract:** Results of four years' field trial of evaluating heat and drought tolerant potato clones of International Potato Center (CIP) at Jodhpur district indicated, the great potential of potato cultivation to make the dryland farmers self-reliant. The marginal farmers are still unable to utilise the natural resources and technological developments efficiently, and are still depending on subsistence farming. The socio-economic profile of nearby district Banaskantha in Gujarat State with "similar climatic situation" changed living standard completely by introduction of potato cultivation by majority of farmers. The major limiting factors to cultivate potato in dryland sand dunes are lack of awareness of improved potato production technologies, non-availability of quality seed and lack of initiative by public or private sectors on potato production. CIP in partnership of public and private sectors introduced potato in arid-region to enhance income of poor farmers by producing table, seed and processing potatoes during short winter period. A baseline survey for 110 households on characterize the environment, farming system and social system revealed strong points for introducing potato in a non-traditional potato growing area based on suitable temperature, soils free from soil borne diseases, high potato bulking rate and excellent tuber quality on sandy soils. Farmers would get remunerative price of their produce as at present potato is imported from other States for local consumption. The mild climate would provide ideal environment for processing varieties. CIP and Central Potato Research Institute (CPRI) have jointly made systematic effort to evaluate CIP clones/varieties in the Thar deserts of Rajasthan to identify varieties, which can bear drought and heat stresses. The farmers broke the norms of traditional subsistence farming by adopting potato as income generating crop in the system. In 2015-16 crop season, 342 stakeholders including farmers, consumers, researchers, traders, extension workers of public and private sectors trained during planting to harvest on best production and post-harvest practices. Sixteen farmer at Jodhpur and fourteen at Jaisalmer districts harvested first time potato successfully on sandy soils. In Jodhpur region, the total yield of farmers ranged 9.73.00 to 28.55 ton/ ha. Farmers who applied recommended management practices obtained total yield over 20 tons/ha. In Jaisalmer, the highest yield was recorded 31.52 ton/ha compared to 23 ton/ha of national average production. The introduction of locally adapted technologies and varieties can bring about 20,000 ha under potato and can increase potato productivity by 40% in Rajasthan by 2021.

**Key words:** drylands, productivity, stakeholders, varieties, quality seed

### INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important crop to alleviate poverty and to enhance food security especially during lean season, by storing potatoes after processing at a household level, in a very cost

effective manner providing high quality protein. International Potato Centre (CIP) and Central Potato Research Institute for past four years have made a systematic effort to introduce potato crop in the Thar deserts of Rajasthan by identifying locally adapted

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suitable clones Sharma *et al.* [1], which can produce economic yield under arid region. On an average all the farmers are under loans in Jodhpur district for Tube-well installations (as under-ground water is the only source of irrigation especially in Jodhpur area). They have limited water to grow crops and get very little income, not enough to repay the loans taken, Bhati [2]. While Banaskantha district in Gujarat with similar abiotic and biotic factors, has become prosperous by cultivating potato and adopting micro-irrigation. "if it can happen in Gujarat, then WHY NOT potato holds a great opportunity to alleviate poverty in the similar arid regions of Rajasthan, India". Almost three decades back Banaskantha district was poverty-stricken but introduction of potato crop brought a huge change in their socio-economic profile. Some farmers have become entrepreneur by manufacturing potato planters, and diggers locally which they used to get from Punjab earlier and building cold stores.

Micro-irrigation systems though are available at Jodhpur but not adopted by most of the farmers to improve the system productivity due to cumbersome procedures of subsidy, lack of finances and more importantly due to lack of awareness. Particularly, in sandy soils potatoes need moisture, not drenching. Just as much water needs to replenish as it evaporated from the sandy soils and transpired through leaves. This situation can improve by incorporation of potato crop with sprinklers to intensify the cropping system of the area, in a sustainable way and for its efficient forward-linkages to fast growing potato processing industry.

In year 2015-16, the project took the shape to realise a dream to make farmers self-reliant and free from the huge loans by cultivating potatoes at large scale. The farmers got quite involved in the project, and broke the norms of old traditional subsistence farming by adopting potato as an important income-generating crop. However, at this stage, the farmers need continuous technical support for few more years. It can turn into a regular cash crop, which can be adopted equally by aggressive as well as an ordinary small farmer, resulting to bring out drylands from the symbolic chronic poverty-stricken area.

## MATERIAL AND METHODS

The study was carried out in the arid districts, Jodhpur and Jaisalmer of Thar desert in 2015-16 potato crop season. Two villages of these two districts 'Mansagar' in Jodhpur and 'Didoo' in Jaisalmer were selected based on selection criteria of CGIAR centres of drylands project. For potato cultivation, CIP gave preference to the farmers having sandy loam soils with good irrigation sources of water and sprinkler systems in the field. CIP in partnership with NARS and CGIAR-Centers introduced potato for the first time in Jaisalmer and Jodhpur project sites. Thirty farmers (16 in Jodhpur and 14 in Jaisalmer) completed planting with quality seeds of Kufri Pukhraj and Kufri Badshah on 30 acres. Since potato is labour intensive crop, one potato planter and one potato digger introduced at Jodhpur and Jaisalmer each to reduce labour costs and complete the planting and the harvesting timely. The farmers dehaulmed the crop after 90 days of planting. The crop harvested after one week and sold to nearby market of Jodhpur.

### Socio-economic profile and resource structure of sample farmers

The selected farmers grow agricultural crops, mainly millets, oil seeds and wheat on the total cultivable land. The family size is one of the important factors for cultivation of labour intensive crop such as potato. On an average, size of families in the present study was found to be considerably large (in most cases 6 in number) which is favourable for cultivating potato. The selected farmers were a mix of "literate - knowledgeable" and "not so informed" both took up challenge of cultivating potato successfully. All farmers were dependent on pump set for irrigation. Some of them had sprinklers and others bought sprinklers immediately to be associated with the project.

#### 1. *Baseline Study to characterize environment, farming systems, natural resources and social system to introduce income generating potato crop in the dryland agro-ecology:*

The major research questions were: i) how to introduce potato in cereal based system as income generating crop? ii) Which abiotic and biotic factors

influence the adoption of potato in Dryland Systems? iii) Which potato varieties can adapt to arid-region of Rajasthan? iv) Which, one is the most cost effective and appropriate water saving technology for introducing potato into the system? To answer these questions a baseline survey was conducted in February 2015 in partnership with Central Potato Research Institute (CPRI) covering 110 households of Mansagar, Govindpura, Danwara and Bansi (Jodhpur district) as respondents, Anonymous [3], to characterize farming systems, environment and social systems. The methodology and results of survey presented to explore the potential for growing potato in the selected Dryland-Systems' sites. The data was gathered from State Stakeholders and farmers, on factors such as temperature, rainfall, water table, soils, irrigation, cropping and social systems. The survey and discussions with farmers and also with local scientists revealed strong points for introducing potato in a non-traditional potato growing area, on the basis of suitable temperature, photoperiod the sandy loam soils free from soil borne diseases and fast potato bulking environment. The farmers would get remunerative price of their produce as the potato is imported from Gujarat and Uttar Pradesh for local consumption. The sites were selected with a conscious effort like Mansagar, Jodhpur through survey and later on Didoo, Jaisalmer was selected after a brainstorming meeting. Both the sites were suitable for potato cultivation despite the fact that at that moment there was no potato cultivation in these areas, The Central Arid Zone Research Institute (CAZRI), Government officials of Horticulture and Agriculture Dept., and scientists from CPRI, PepsiCo, ITC Pvt. Ltd., ICRISAT, Bioversity and local NGO, Didoo facilitated in selection of sites.

Another survey in May 2015 exclusively of 25 women from farmers' families was conducted to understand the socio-economic situation of women of different castes. The survey identified that women have very limited access to land property, lesser access to education and little/negligible participation in farming decisions. Awareness and information through surveys and meetings increased the participation of women in the use of inputs as well as produce, allowing an equitable

sharing of increased income, food for better nutrition and livelihood of the families.

## **2. Capacity Building**

Several trainings on innovative potato production technologies for dryland systems conducted in 2015-16 crop season at two project sites, Jodhpur and Jaisalmer counting in total with 342 participants, which included farmers, consumers, researchers, traders, extension workers of public and private sectors. Of the total participants, 200 were men, 109 were women and 33 youth. The youth indicated their interest to learn potato cultivation if they were given opportunities. The trainings were conducted at different occasions of potato cultivation like planting time, vegetative stage, harvesting. The farmers were trained on the preparation of seed, treatment of seed to check dissemination of skin borne disease, appropriate depth of tuber at planting, use of weedicides and sprinkler irrigation.

## **3. Public Private Partnership**

A brainstorming meeting of public private partnership (PPP) was organized to discuss the pros and cons of potato cultivation. This meeting motivated PepsiCo to join the program immediately. Five farmers brought under contract farming in collaboration with PepsiCo at Didoo to generate sustainable higher income, based on the agreed price of the produce (contract farming). By developing potato value chain, the more area and more farmers can be accommodated for facing the challenge of reducing the poverty at war footing.

## **RESULTS AND DISCUSSION**

Successful introduction of Kufri Pukhraj and Kufri Badshah varieties improved productivity of the cereal based dryland systems for 30 households. The introduction of planter and digger for the cultivation of potato reduced labor cost by over 60%. A study during 2000-02 by Singh et. al [4]; showed that a tractor mounted two-row potato digger elevator was tested for its performance at various locations in farmers' field. The labour requirement in different treatments showed a saving of 1280 man-hours per hectare in case of machine as compared to manual harvesting. The lowest tuber damage was recorded

(0.8%) in potato digger-elevator as compared to other methods. The use of paired row potato cultivation and sprinkler irrigation reduced about 40% of water use and improved potato quality. On an average, farmers earned an additional US\$ 1500 per hectare, which is more than double compared to wheat and cumin.

Potato production on an average was 19 tons per hectare in Jodhpur of 16 farmers 'who cultivated potato, with the highest yield of 28.55 tons per ha (Table-1). While at Jaisalmer, average yield is 16 tons per hectare of 14 farmers who cultivated potato on their fields'. However, the highest yield recorded in Jaisalmer with 30.52 tons per hectare (Table-2). It had been the very first attempt to grow potatoes in this arid zone, suggesting a great future to enhance livelihood of resource-poor farmers. Although, now in some of the pockets where potato is being grown in Rajasthan, the state level productivity is only 12 tons per hectare, Anonymous [5].

The project encouraged women's participation in decision-making despite being a very conservative society there was more than 80% participation of women in most of the meetings.

### Field Exposures

Field exposure of farmers to Deesa, the adjacent potato-growing district of Gujarat, motivated and prepared the farmers to grow potato. The "farmer to farmer" meeting and discussion with progressive farmers of Gujarat gave an opportunity to learn more about potato cultivation and it helped to develop the confidence of DS farmers to amazing heights.

### Experience of farmers cultivating potatoes

CIP held a meeting with farmers during harvesting of potato and informed them about the available market in their district, best market prices possibilities at particular time of the year, best time

**Table 1**  
**Performance of Kufri Pukhraj and Kufri Badshah at farmer's field trial at Jodhpur, 2015-16**

S.No	Farmer (variety)	Tuber yield (t/ha)		
		Marketable	Total	Dry Matter (%)
1	Anna Ram (K Pukhraj)	7.93	9.73	18.80
2	Gopal (K Pukhraj)	11.36	14.56	21.73
3	Hukam Kanwar (K Pukhraj)	17.50	19.27	17.73
4	Jatu Singh (K Pukhraj)	8.77	12.24	20.60
5	Kan Singh (K Pukhraj)	17.57	22.41	19.07
6	Manohar Singh (K Pukhraj)	10.16	12.27	18.53
7	Narayan Singh (K Pukhraj)	15.75	16.94	20.20
8	Raghunath Singh (K Pukhraj)	25.51	28.15	18.67
9	Rajender Shyam Singh (K Pukhraj)	19.10	21.88	17.73
10	Raju Kanwar (K Pukhraj)	16.93	20.56	18.00
11	Sardar Mal (K Pukhraj)	12.41	14.88	18.27
12	Gorkha Ram (K Badshah)	14.72	16.75	21.73
13	Jala Ram (K Badshah)	27.50	28.55	22.20
14	Kana Ram Singh (K Badshah)	19.02	21.49	20.13
15	Mahender Singh (K Badshah)	19.16	21.81	20.53
16	Ramrakha (K Badshah)	22.60	23.72	21.80
	Mean	16.63	19.08	19.73
	C.V.	5.88	7.13	1.51
	C.D. 5%	1.63	2.26	0.49
	Range Lowest	7.93	9.73	17.73
	Range Highest	27.50	28.55	22.20



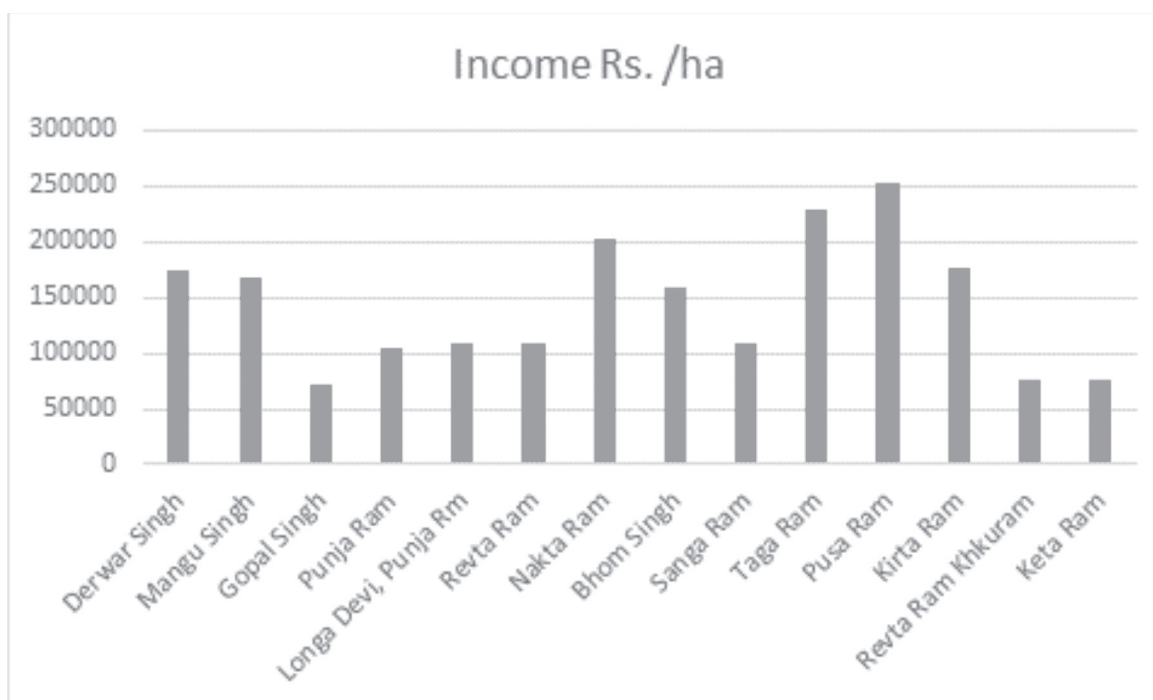
**Table 2**  
**Performance of Kufri Pukhraj and Kufri Badhshah at farmer's field trial at Jaisalmer, 2015-16**

S.No	Farmer (variety)	Tuber yield (t/ha)		Dry Matter (%)
		Marketable	Total	
1	Bhom Singh (K Pukhraj)	15.61	19.99	19.13
2	Derwar Singh (K Pukhraj)	18.89	21.91	19.13
3	Gopal Singh (K Pukhraj)	6.82	8.92	20.93
4	Keta Ram (K Pukhraj)	6.21	9.44	20.20
5	Kirta Ram (K Pukhraj)	19.29	22.00	19.87
6	Mangu Singh (K Pukhraj)	18.61	21.02	19.47
7	Punja Ram (K Pukhraj)	10.01	13.05	19.13
8	Pusa Ram (K Pukhraj)	27.81	31.52	19.13
9	Revta Ram (K Pukhraj)	9.13	13.61	20.53
10	Revta Ram Khakuram (K Pukhraj)	6.57	9.57	21.73
11	Sanga Ram (K Pukhraj)	10.36	13.75	20.80
12	Longa Devi	9.92	13.56	19.47
13	Punja Ram (K Badhshah)	22.13	25.24	20.40
14	Nakta Ram (K Badhshah)	23.11	28.64	21.80
	Mean	14.61	18.01	20.12
	C.V.	9.60	11.92	1.34
	C.D. 5%	2.35	3.59	0.45
	Range Lowest	6.21	8.92	19.13
	Range Highest	27.81	31.52	21.80

to sell the produce, and perishability aspects of potato. The mechanism of daily selling prices of potato in the wholesale markets, daily demand of the districts, details of traders dealing with potato were also informed to the farmers so that they can sell their produce at maximum price. Most of the farmers could sell potato at very good prices making huge profits. Although, we tried to get the actual income they could get by selling the potatoes. But as usual we did not get correct information as the tendency amongst farmers not to tell the real income because they presumed if they will tell less income they may get some other financial help from the organisation. On the other hand, we had more reliable scientific cross cutting estimate to calculate the yield and income of the farmers, and it was possible to extract the information from a few progressive framers and others who could not do well in the field as well as in marketing.

The present findings revealed that the average sale price of potato crop was Rs.8 to 11.50/kg.

Average gross income of potato farmers was Rs. 142,740/ha. To analyse the economics of potato crop, simple cost accounting method was followed. The yield was calculated by scientific cross-cutting estimates by forming a team of CPRI scientist, Gujarat Farmers, Local Farmers and CIP Staff. This was very reliable information in which the fixed area of 3 X 3 sq. m from three different locations of an acre of field was harvested manually under the supervision of the above mentioned team. This procedure helped to get the uniformity and reliability in data of harvests of 30 farmers in both the districts. The total tuber number counted and segregated in marketable and non-marketable yield. The potato yield was recorded and later adjusted as tons per ha. The income generation was calculated by taking a conservative fixed price of selling rate at Rs.8/kg. After the cross-cutting estimates the farmers harvested the crop by using the potato digger. The estimated income generated by farmers growing potatoes in Jaisalmer is presented in Figure.



In general, the farmers had large holdings with limited water access growing mainly subsistence crops. Most of them have tractor or motorcycles. According to farmers' local traditional crops grown at Mansagar, are cumin, wheat, guar, cotton, and castor. On an average, most of the crops roughly fetch between Rs. 6000 to Rs. 10,000 per bigha (local unit of land 2.5 bigha/acre) and maximum Rs. 50,000/ ha by progressive farmer.

After seeing, the harvest farmers realized that potato crop is much better than mustard, cumin, wheat, and castor. It is ready in short span 75-90 days and gives the income more than all the other crops. Instead of that if farmer grows only the potato crop by saving the water reserves used for other crops and uses the money for buying costly potato seeds and fertilizers then he can grow enough potato to meet all his requirements of living for the year by growing potatoes alone. Moreover, mechanization makes it cost effective and affordable because now the labour is not only very costly, it is a big constraint too as most of the labour are busy under the MNERAGA scheme of Government.

Difficulties encountered for cultivating potato first time:

1. Farmers did not believe that potato would really grow in Jodhpur and Jaisalmer

area, so they did not irrigate potato crop the way it should have been.

2. Farmers sold potato in hurry at a lesser rate, due to lack of experience to handle the crop, and there was a sudden rain, which drenched the potatoes lying in the field.
3. The farmer wanted to keep potato for seed but there is no cold store in close by area.
4. Electricity is not enough to irrigate the crops. If solar pumps given at cheaper rates to the farmer, yield will improve dramatically.
5. Farmers realised that if they delayed selling of the potato by few more weeks, they could have got even more profits.
6. Due to attractive skin colour of Jodhpur potatoes, it was sold at better prices than Gujarat or UP potato.

## CONCLUSIONS

- Potato crop successfully introduced for the first time in cereal-based system of dryland at Jodhpur and Jaisalmer districts in Rajasthan. Potato varieties, which are performing well in

Gujarat (particularly, Deesa having the similar climatic conditions like Jodhpur and Jaisalmer) Kufri Badshah and Kufri Pukhraj, were introduced in a non-traditional potato growing area of Thar Desert. The yields were similar to what was expected.

- Farmer's income increased not just marginally but significantly manifold in a difficult area of arid region, and also generated rural employment by growing potatoes in the subsistence farming areas.
- Consumption of potato can improve nutrition of women and children in the project areas especially during lean season of the summer.
- The capacity building on potato production technology created equal opportunity of employment for both the genders.
- Field exposure of farmers to Deesa - a major potato growing, region enhanced the confidence of the farmers and they got motivated to explore possibilities in future too.
- A new concept of contract farming introduced in the area by PepsiCo. Initially with five farmers contract farming introduced, which increased the income of farmers appreciably with a little effort. Convinced by the extremely encouraging results achieved from five contract farmers, PepsiCo has planned to increase the area about 10 times at Jaisalmer

for quality seed production through contract farming in 2016.

- Impact on youth after the harvesting of potato: Laxami - a young girl mentioned that she was just not interested in agriculture and never ever bothered which crops grew on her fields or on her neighbour's fields. However, after the exposure of working with CIP and knowing about potato crop and potential to get income by growing potato, she got so much interested in agriculture. Now she knows what is happening on her field and she even tries to figure out the pros and cons of growing a particular crop.

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