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Early Pigeonpea - A Viable Option for Subsistence Farming in Rajasthan

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Abstract: ***Pigeonpea is a valuable pulse that grows well under stressed eco-systems, but in Rajasthan it occupies only 6332 ha. Considering the demand for pulses in India, the government made plans to expand pigeonpea in different states. In this regard, an early-maturing variety ICPL 88039 was identified for testing in eight districts under the aegis of the National Food Security Mission. The adaptation results showed that its productivity varied considerably across districts and seasons. Overall, it was tested on 3925 ha and, on average, produced 704 kg/ha of grains. ICPL 88039 was found to be well adapted in Alwar district with a mean productivity of 1060 kg/ha. The studies concluded that pigeonpea can be grown successfully in the low-fertility rainfed areas of Rajasthan, and its productivity can be increased if specifically adapted cultivars are identified for different agro-ecologies. Pigeonpea, therefore, offers a viable option for diversifying the cropping system in subsistence farming.***

Keywords: *Cajanus cajan*, On-farm demonstration, Adaptation, Value addition, Farming income, Production constraints

1. Introduction

Rajasthan is a major agriculture province with over 85% of its population earning their livelihoods from this noble profession. In the degraded soils of rainfed areas, the farmers usually cultivate coarse cereals and a little of pulses. This crop combination provides them the much-needed carbohydrates and proteins. According to the Department of Economics & Statistics (2022-23) the main pulse crops of Rajasthan include green gram (23, 32, 255 ha), chickpea (19, 37, 321 ha), moth bean (8, 61, 653 ha), black gram (3, 21, 894 ha), and lentil (20, 884 ha) with a total annual production of about 40, 00, 000 tonnes. In general, these crops are grown on nutritionally poor marginal lands where droughts, soil erosion, and land degradation are the perennial production issues.

Pigeonpea-A Potential Pulse Crop for Rajasthan

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] commands a high place in the semi-arid agriculture in India, mainly because of its drought tolerance and the soil amelioration properties such as, fixing atmospheric nitrogen, releasing soil-bound phosphorus, and re-cycling some key macro and micro nutrients (Saxena et al., 2021). In India, the crop is grown on 3.95 m ha land (DES, 2022-23) and the major pigeonpea growing states include Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh, Uttar Pradesh, Bihar, and Gujarat. The national production of pigeonpea is about 3.26 m tonnes and this produce is insufficient to feed the ever-growing population of the country, and hence, the situation necessitates huge (500, 000 tons) annual imports from Africa and Myanmar. Therefore, to offset the imports and achieve self-sufficiency of this commodity, plans have been made at the national level to increase its production; and the present effort is a part of the same endeavour.

At present pigeonpea is not an important crop of Rajasthan and according to the Department of Economics & Statistics, in 2022 the crop was sown only on 6332 ha land with a total production of 5680 tonnes and productivity of 940 kg/ha (Table 1). To identify some new production areas in the state, a pigeonpea promotional project was launched, jointly by the Government of Rajasthan (GoR) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). This project was funded by the National Food Security Mission (NFSM) of Indian Council of Agricultural Research (ICAR).

Table 1: Production data of pigeonpea producing districts of Rajasthan

SN	*District*	*Area (ha)*	*Prod (t)*	*Yield (kg/ha)*
1	Banswara	3, 408	2, 859	840
2	Udaipur	1, 705	2, 147	1260
3	Dungarpur	928	313	340
4	Pratapgarh	139	209	1500
5	Dholpur	41	41	1000
6	Others	111	111	700
Total/Mean		6332	5680	940
Source: Department of Economics & Statistics, 2022-23				

To conduct the initial adaptation trials of pigeonpea, a survey of the key agro-ecological parameters of different regions was conducted and the data revealed that early maturing pigeonpea cultivars could be introduced successfully in some districts of Rajasthan, where the traditional long-duration pigeonpeas would fail. In such areas, the adaptation of early maturing pigeonpea was tested through farmers' participation. This paper, besides reporting results of the pilot testing programme, also highlights the production constraints and future plans.

2. Materials and Methods

Selection of Cultivar and Demonstration Areas

The pigeonpea promotional initiatives were located in the rainfed regions of Rajasthan and the districts identified were Alwar, Jaipur, Dausa, Karauli, Sawaimadhopur, Bharatpur, Tonk, and Dholpur (Fig 1). Further, it was thought that a reduction in crop maturity could help in the adaptation of pigeonpea in new areas where terminal drought is prevalent. Besides this it will also fit well in irrigated lands and allow an additional rabi season crop. The cultivars of this maturity group have already made significant contribution in diversifying cropping systems and increasing pigeonpea area in the states of Punjab, Haryana, Uttar Pradesh, and Uttarakhand (Saxena et al., 2011; Sekhon and Singh, 2015; Saxena et al., 2019). Considering these facts, an early maturing (120-140 days) pigeonpea cultivar ICPL 88039 was selected for this project. This cultivar is photo-insensitive and its plants are semi-spreading with non-determinate growth habit. To grow a good crop of ICPL 88039 on one hectare, about 15-20 kg seed was required and the sowing was done at the onset of rainy season. Since the pigeonpea field was vacated by November end, it provided sufficient time for the sowing a post-rainy season crop (such as wheat) in the same field. This variety has also demonstrated high yield and wide adaptation in diverse agro-ecological conditions in India.

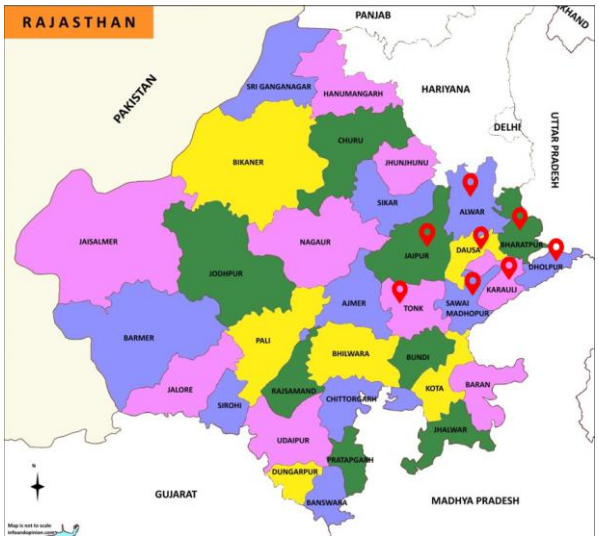

Figure 1: Districts identified for field demonstrations

Trainings and Farmers' Group Meetings

A key component of this promotional project was to train a number of farmers on the cultivation practices of this new pigeonpea cultivar. These training programmes were organized each year at different project sites.

Value Addition of the Produce

The value addition of the grains was aimed to promote the consumption of pigeonpea and provide additional income to the farmers. This was done by producing high-quality *dal* (decorticated splits) using four mini processing mills. These mills were imported from Akola (Maharashtra) and strategically installed in the selected villages of the project districts.

3. Results

Project Implementation

The project was managed and implemented jointly by ICRISAT and GoR. For conducting the of-farm testing appropriate sites were selected in consultation with local researchers and farming communities using a participatory approach. Since pigeonpea was a new crop in the target districts, the training of farmers was given high priority in the project. The subjects included were raising a healthy crop, plant protection, post-harvest handling of seed, and value addition through grain milling. These training programmes witnessed enthusiastic participation from both male and female farmers and achieved remarkable success. During the project tenure, 52 training sessions were organized and a total of 4, 093 male and 1, 345 female farmers were trained in the crop husbandry (Fig 2). Besides these, more than 500 farmers, including 100 women, were also trained in the key aspects of quality seed production in some selected villages.

Figure 2: The first training programme organized in Padsoli village, Jaipur

Participatory Seed Production Programme

Availability of quality seed is necessary for raising a healthy crop. To meet this requirement the farmers were encouraged to participate in a community seed production programme of the project. This approach was quite successful in achieving self-sufficiency in the availability of quality seed. All the seed-related activities were facilitated through the ''Farmers' Welfare Committees''. The selected farmers were provided with breeder seeds to produce certified seed. To facilitate procurement and marketing of seed four small seed collection centres were also established**.** A private seed company was engaged in purchasing the seed lots from each village (Fig 3) for further processing and marketing. These initiatives not only eliminated of the middlemen, but also reduced the transport and storage expenditures.

Figure 3: Pigeonpea seed sold through Farmers' Welfare Committee to a private seed company

On-farm Productivity of ICPL 88039

The project activities started with field demonstrations in 2012 in four districts namely, Jaipur, Dausa, Karauli, and Alwar. Subsequently, the districts of Sawaimadhopur, Bharatpur, Tonk, and Dholpur districts were also included. To meet the enthusiasm of farmers, in the very first year a total of 5055 kg seed of ICPL 88039 was provided; and against the target of 40 ha, 270 ha was sown and 276 tonnes of grain was produced with the mean yield of 1022 kg/ha (Tables 2, 3). In 2013, 2014, and 2015 respectively, 12075, 20250, and 22250 kg seed of ICPL 88039 was supplied. In the cropping seasons of 2013, 2014, and 2015 respectively, 805, 1350, and 1500 ha area was sown (Figs 4, 5). The production data of pigeonpea in the four cropping seasons are summarised in Table 3. The productivity over the years ranged from 629-1022 kg/ha. Over the four years, Alwar was found to be the best district as for as the adaptation and yield of ICPL 88039 is concerned. Pigeonpea in this district was sown on 617 ha with a mean yield of 1060 kg/ha. In contrast, in Sawaimadhopur the mean productivity was lowest (411 kg/ha) that was harvested from 195 ha of land area. In other districts the performance of ICPL 88039 was average with mean productivity over the years ranging from 455 kg/ha (Karauli) to 909 kg/ha (Bharatpur). Overall, a total of 3925 ha was son over the four years and 2763 tonnes grain was harvested with average yield of 704 kg/ha (Tables 2, 3).

Figure 4: A commercial crop of ICPL 88039 in Padsoli village near Jaipur

Figure 5: Transporting the bumper harvest of ICPL 88039 for threshing

Table 2: Target and sown area (ha) of pigeonpea in the on – farm trials under the project

Year	*2012*		*2013*		*2014*		*2015*		*Total*	
Dist.	*Target*	*Sown*	*Target*	*Sown*	*Target*	*Sown*	*Target*	*Sown*	*Target*	*Sown*
Jaipur	10	212	330	373	350	300	600	600	1290	1485
Dausa	10	6	50	58	120	230	200	200	380	494
Karauli	10	40	125	135	150	160	100	100	385	435
Alwar	10	12	100	115	300	340	150	150	560	617
SM-pur	-	-	15	35	50	60	80	100	170	195
Bharatpur	-	-	40	44	150	160	200	200	365	404
Tonk	-	-	15	20	30	50	50	50	105	120
Dholpur	-	-	25	25	50	50	100	100	165	175
Total	40	270	700	805	1, 200	1, 350	1, 480	1, 500	3, 420	3925
Seed supplied: 5, 055 kg in 2012; 12, 075 kg in 2013; 20250 kg in 2014; and 22250 kg in 2015.										
Grand total: Target area = 3, 420 ha; Sown area = 3, 925 ha, Seed supplied = 59, 630 kg										

Table 3: Year-wise yield data from 2012-15

District	*Parameter*	*2012*	2013	2014	2015	Total
Jaipur	Area (ha)	212	373	300	600	1485
	Prodn. (t)	241	300	99	398	1038
	Yield (kg/ha)	1119	804	330	663	726
Dausa	Area (ha)	6	58	230	200	494
	Prodn. (t)	-	65	53	80	198
	Yield (kg/ha)	-	1119	409	401	643
Alwar	Area (ha)	12	115	340	150	617
	Prodn. (t)	16	67	440	193	716
	Yield (kg/ha)	1076	586	1293	1285	1060
Bharatpur	Area (ha)	-	44	160	200	404
	Prodn. (t)	-	31	164	198	393
	Yield (kg/ha)	-	713	1023	991	909
Karauli	Area (ha)	40	135	160	100	435
	Prodn. (t)	19	25	54	84	182

	Yield (kg/ha)	475	186	335	837	455
Sawai - Madhopur	Area (ha)	-	35	60	100	195
	Prodn. (t)	-	21	15	47	83
	Yield (kg/ha)	-	584	179	470	411
Tonk	Area (ha)	-	20	50	50	120
	Prodn. (t)	-	20	14	12	46
	Yield (kg/ha)	-	1001	272	236	503
Dholpur	Area (ha)	-	25	50	100	175
	Prodn. (t)	-	16	23	68	107
	Yield (kg/ha)	-	624	520	683	609
Total/mean	Area (ha)	270	805	1350	1500	3925
	Prodn. (t)	276	545	849	1080	2763
	Yield (kg/ha)	1022	677	629	720	704

Benefit-Cost Ratio

In one of the villages of Jaipur district, project scientists calculated the economics of cultivating the early maturing pigeonpea. Data on cost of production were collected from nine farmers. The estimated mean grain yield, production cost and gross income were respectively 1119 kg/ha, ₹3500/100 kg, and ₹39, 165. Using these data, the estimated profit from growing one-hectare of early maturing pigeonpea was Rs ₹30, 165. This production data yielded a healthy benefit-cost ratio of 4.35.

This information suggested that the farmers can generate a reasonable income from the cultivation of pigeonpea which can help in improving their livelihoods. We believe that the results obtained from this vast exercise will contribute towards promoting pigeonpea cultivation among smallholder farmers in the region.

Value Addition for Enhancing Income

The primary objective of this initiative was to make high-protein dal available to farmers and help in bridging the nutritional gap and enhancing their overall well-being. As pigeonpea is a new crop in the target areas, most farmers were not aware of the process of converting pigeonpea grains into its edible form *dal*. As a part of value addition one mini dal mill was installed each in Padasoli, Lalwas, Karauli and Dudu villages (Fig 6). Some farmers in the villages took the responsibility of maintaining these dal milling units.

Figure 6: Pigeonpea dal produced by a women farmer using the Mini Dal Mill

4. Discussion

Early maturing pigeonpeas have emerged as a new crop commodity for diversifying cropping systems in the tropics and sub-tropics. This genetic material was tried in some rainfed districts of Rajasthan through NFSM-sponsored on-farm trials. Initially, the farmers were hesitant to adopt the new crop, but after our team's efforts they agreed to participate in this endeavour. This programme was undertaken for four years in eight districts using an early maturing cultivar ICPL 88039. The yields varied considerably but overall productivity levels were convincing. The information generated from this effort also showed that with the selection of adapted varieties the yields could further be increased and research efforts in this direction are warranted. The most important constraint faced by the farmers in this endeavour was limited and irregular rainfall in the target areas. This situation often led to terminal drought and reduced productivity. Also, some farmers abandoned pigeonpea cultivation due to disappointing crop growth. However, our dedicated staff convinced them to give ICPL 88039 another try. The impressive yields achieved by many farmers sparked greater interest in pigeonpea cultivation. Besides yield, empowering the farmers with knowledge, skills, and technology to process and produce dal for their own consumption and local marketing further encouraged farmers to grow pigeonpea. As farmers continued to reap the benefits, the pigeonpea cultivation is poised to become an increasingly attractive option for the farmers. The authors believe that the limited success in promoting pigeonpea has created new avenues for transforming the agricultural landscape at least in some parts of Rajasthan state.

5. Conclusion

At present, pigeonpea grows on a small area in Rajasthan. Lately, a need was felt to increase its production in the state. To achieve this, a promotional project involving an early variety ICPL 88039 was implemented. The highlights of this endeavour include (i) recording high yield (1060 kg/ha) in Alwar district, (ii) providing opportunities to increase the cropping intensity by growing a follow-up Rabi crop, (iii) enhancing family income, and (iv) providing high-protein food and much-needed fuel wood. In conclusion, the early

pigeonpea has demonstrated a high potential in Rajasthan and it can help in bringing prosperity among the farmers.

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Authors Contributions

KBS and SJS conceptualized this project, obtained NFSM grant from ICAR, and implemented the project. SJS, UC, and KBS undertook various on-station and on-farm research and development activities.

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