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Sustainable Agricultural Development through Value Addition and Linking of Farmers to Markets in Telangana State of India

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AS, RVK and SDM were the Principle Investigators of the project; authors HM and PD were involved in implementation of the project; author ASS was involved in field data collection. Authors GDN and BS were involved in preparation of the manuscript.

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ABSTRACT

Sustainable agricultural development can be ensured by empowering smallholder farmers with inclusive business models that enhance their livelihoods. This paper outlines the interventions by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in collaboration with Integrated Tribal Development Agency (ITDA), Telangana, to enhance livelihoods of tribal smallholders in Adilabad district of Telangana State, India, by providing value addition opportunities and market linkages. Tiryani, Wankidi and Karameri mandals of Adilabad district of Telangana were selected for the interventions, being some of the most backward regions inhabited by tribals. Data analysis was done using MS Excel software. The interventions focused on providing access to seed, establishing pilot processing units for value addition to pigeon pea, training and capacity building on crop production and handling of processing units and providing market linkages. Efficiency of the processing units and the effect of pre- treatments on milling efficiency was also studied and processing parameters optimized. The interventions helped increase income of farmers by 86 per cent, established two pigeon pea processing units and streamlined the pigeon pea value chain in the region.

Keywords: Agriculture; Pigeon pea; value chain; Telangana; tribal; farm income.

1. INTRODUCTION

Investing in agriculture has globally been accepted as one of the most significant strategies for poverty reduction, addressing inequality and hunger, increasing nutritional status of rural households, and empowering women and youth. A major portion of the development efforts need to be directed to smallholders, who dominate the agriculture sector in low and middle income economies [1]. While majority of the Asian and African smallholder farmers are responsible for a large share of the world's food production, they are also some of the poorest in the world, a fact that is causing the newer generation to abandon their farms in search of better opportunities in urban areas. This shift contributes to two very real risks: jeopardizing world food security with rising population and demand; and secondly, increasing urban poverty. Hence, it is imperative that smallholder farming becomes a much more profitable and sustainable venture requiring all stakeholders – especially the government, public research institutes and development organizations – coming together to address this major problem affecting the growth of sustainable agriculture.

The challenges of Indian agricultural sector are becoming complex with increased effects of globalization and liberalized economies, expected reduction in farmers' income by 25% [2] due to enhanced effects of climate change, fluctuating prices for agricultural commodities and rising input costs – together increasing the challenges of smallholders in spite of increased production threatening the goals of food availability and accessibility for the poorest sections of the society. Agriculture being a pivotal sector of the Indian economy, there is a need to view agricultural development as a means of welfare, prosperity and social security of farmers with focus on making farming socio-economically sustainable.

Increasing fragmentation of land holdings in India is a continuing cause for concern. Around 85 percent of the operational holdings in the country are small and marginal. Medium holdings are getting converted frequently into small and marginal holdings, with no signs of reversal in the foreseeable future. Average land holding in the country has reduced from 1.16 ha in 2012-13 to 1.1 ha in 2015-16 and is expected to reduce further in the future, with 67 percent of the farmers owning land less than 1.0 ha [3]. Marginal holdings are often too small to provide the farm household with surplus production and incomes to support a family. However, because of the resource constraints, small farms have proven to be more efficient than large ones in using land and resources, especially in labor-intensive crops or tending livestock. Specifically small farmers suffer serious disadvantages in primary processing and value addition, marketing and distribution. Fragmented landholdings, smaller outputs, lack of access to cost-effective primary processing technologies and modern storage facilities for perishable items and distribution networks, and often distant location from major markets deprive small farmers of the benefits that accrue from effective market linkages. Small scale operations reduce the bargaining power of farmers, making them vulnerable, increases costs and adversely affect access to markets and sometimes to technology. Access to inputs, markets and creating employment opportunities in the sector remains a major challenge. Collective farming, value chain integration, and setting up of small-scale processing units like *Dhal* (pulse) mill can be viewed as an effective approach to address various problems faced by the small and marginal farmers. Processing of agricultural commodities, by the farming communities themselves, can play a vital role in value addition, reduce agricultural wastage, promote employment generation, and increase income of farmers.

Article 342 of the Constitution of India classifies Scheduled Tribes as communities of states and Union Territories (UT) declared so by the President of India after consultation with the respective Governor thereof by public notification. While there are no fixed criteria to identify Scheduled Tribes, attributes like geographical isolation, distinctive culture and social values, archaic agricultural ways of livelihood, and marginal contact with other cultures and communities are some of the broad categories considered [4]. Constituting 7.5% of its total population, India has the largest tribal population in the world and agriculture in its traditional form is still the primary source of their subsistence. Telangana has the highest concentration of tribal population (9.5%) among the southern states, who form also a major part of the most disadvantaged population in terms of social, economic, and infrastructural opportunities. Livelihood opportunities are needed in these tribal regions where value addition of crops is minimal, and youth and women are actively seeking employment opportunities in other areas. Further, there are no primary processing activities that can provide enhanced market prices to the farmers. Presently, primary processing and value addition is handled by middle men and traders, who pay a very nominal amount to the farmers for their produce and capture a majority of the profit resulting from processing and value addition. Thus, providing the tribal communities with opportunities for processing of pulses and coarse cereals can provide entrepreneurial opportunities to the local farmers/farming communities and at the same time strengthen the backward and forward linkages through the value addition centers.

In Adilabad district of Telangana, the Tribal population is about 17.78% of the total population according to 2001 Census. A number of different tribal groups, including Gonds, Naikpods, Kolams, Pardhans, Koyas, Manne, Andhs, Thoties, Lambadas and Yerukals inhabit this district. The Kolams and Thoties are the most backward as well as the poorest, and these two are classified under Primitive Tribal Group (PTG) for special attention and support from the Government of Telangana. The farmers in the district do not have timely access to good quality seeds, nor do they have awareness on the new varieties prevalent in the market. Tribal farmers prefer traditional cultivation methods, which result in minimum yield with substandard produce quality, thus bringing lower prices in the market. To address these problems, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India and Integrated Tribal Development Agency (ITDA)-Utnoor (Utnoor is a revenue division (Revenue divisions are administrative sub-divisions under districts) in Adilabad district) collaborated to enhance livelihood of tribal farmers of Wankidi, Tiryani and Kerameri of Adilabad district by providing access to quality pigeon pea (*dhal*) seed, value addition opportunities for their produce through establishing processing units for Pigeon Pea and linking them to markets.

This article discusses the activities carried out as part of the proposed interventions in the project area, the processing conditions and efficiency of the dhal mill; and short term and long term impact of the interventions on livelihood of the tribal population and opportunities for scaling up under similar conditions. The action research was further designed to increase production of pigeon pea in the area through introduction of a high yielding variety and minimizing loss of pigeon pea (*dhal*) during processing through monitored performance.

2. METHODOLOGY

The interventions by ICRISAT and ITDA-Utnoor were implemented in Adilabad district of

Telangana state of India, having 31.69 per cent and 26.26 per cent of tribal population respectively. Tiryani, Wankidi and Karameri mandals [1] of Adilabad are some of the most backward regions inhabited by tribals. The agriculture and farming systems that the smallholder farmers practice are largely traditional that use local indigenous seeds passed on for generations which produce lower yields, thereby resulting in a not-so-profitable agricultural outcome. Pigeon pea was identified as the primary crop of the region after a detailed field study of 8 randomly selected villages in Wankidi, Tiryani and Kerameri mandals of Adilabad. ICRISAT supplied 2 tons seed of high yielding pigeon pea variety (ICPH 2740) to 2000 farmers in June of 2016.

Two pilot processing units (*dhal* mill) were set up at Wankidi and Tiryani for preliminary treatment (Table 1) and dehulling of pigeon pea. Two different time combinations of soaking and heaping (T1 and T2) were evaluated as part of the pre-treatments of pigeon pea grains prior to milling (Table 2), in order to reduce dehulling losses and enhance the efficiencies of the dhal mill.

Efficiency of *dhal* mill in wet milling method was calculated using the following formula [5,6,7]

$$\text{Dhal yield (\%)} = \frac{\text{Wdh} + \text{Wds}}{\text{Wt}} \text{ X } 100$$

$$\text{Dhal recovery (\%)} = \frac{\text{Wds}}{\text{Wt}} \text{ X } 100$$

Percentage of dehulling loss in terms of broken *dhal* and fines were calculated using [8] formula as below

$$\text{Dehulling loss (\%)} = \frac{\text{Wr} + \text{Wo} + \text{Wh}}{\text{Wt}} \text{ X } 100$$

Where, Wt is the total weight of sample; Wdh is the weight of de-hulled whole grain; Wds is the weight of dehulled splits; Wr is the weight of broken; Wo is the weight of fines; and Wh is the weight of hull/husk.

Grading efficiency and polishing efficiency were calculated using the following formula:

$$\text{Grading efficiency (\%)} = \frac{\text{Weight of bold pigeon pea grain}}{\text{Total weight of sample}} \text{ X } 100$$

$$\text{Polishing efficiency (\%)} = \frac{\text{Weight of polished dhal}}{\text{Total weight of dhal input}} \text{ X } 100$$

The required analysis were carried out using MS Excel software.

3. RESULTS AND DISCUSSION

The results and discussion part of the study have been structured in four parts – interventions by ICRISAT and ITDA, performance analysis of *dhal* mill, grading and polishing performance, and impact of interventions in terms of increased farmer income and reduced post-harvest loss of *dhal*.

3.1 Interventions through Extension Services and Implementation of *dhal* Mill

3.1.1 Increased access to quality seeds and advisory services

Through a comprehensive focus group study in eight randomly selected villages of Wankidi, Tiryani and Kerameri mandals of Adilabad district, it was observed that pigeon pea was the predominantly cultivated crop in the region, intercropped with cotton under rain-fed conditions (Table 1).

Locally grown indigenous varieties were more preferred by the farmers compared to high yielding varieties (HYVs) (LRG-40, LRG-30, Asha) supplied at subsidized rates by the Department of Agriculture. The recorded average yield is around 2 to 2.5 quintals per acre. Sluggish production, increasing demand, and prices, and import of pigeon pea was also identified as challenges for the farmers in the region. As a coping strategy to the challenges, ICRISAT introduced its own variety ICPH 2740, the first commercial pigeon pea hybrid released in Telangana state as “Mannem Konda Kandi” in 2015. The variety was resistant to wilt and sterility mosaic diseases, is suitable for deep black soils, and has a yield potential of 3.5 tons per ha (registered a 40% yield increase over the local cultivars). ICRISAT supplied two tonnes of ICPH 2740 to 2000 selected tribal farmers in Kharif 2016 along with crop production protocols developed for the purpose. On an average, the yield observed was 5 q/acre, a 100 per cent increase, compared to the yield of traditional varieties.

[1] *Mandals are administrative sub-divisions under revenue divisions in Telangana and Andhra Pradesh states of India (https://mahabubnagar.nic.in/administrative-setup/mandals/)*

Table 1. Preferred variety of and area under Pigeon pea in the selected mandals

Mandal	Crop	Total area under cultivation (acres)	Preferred variety
Kerameri	Pigeon pea	3913	Local, Ganesh, Yashoda
Tiryani	Pigeon pea	4272	Local, Ganesh, Yashoda
Wankidi	Pigeon pea	3258	Local, Ganesh, Yashoda

(Data collected during field study)

3.1.2 Establishment of pilot processing units to facilitate value addition opportunities for the tribal farmers

Two primary processing plants were set up at Wankidi and Tiryani mandals, respectively after a scoping enumeration of prospective locations by ICRISAT and ITDA. Depending on availability of raw material, location, and ease of running the plants, Mandal Samakya office buildings at Wankidi mandal and ITDA godown at Tiryani were identified for housing the *dhal* mills. To ensure their long term sustainability, management of the plants were best left to the local communities for increased accountability and responsibility. Formation of informal producer aggregates was taken up by ITDA, constituting groups of smallholder tribal farmers. Considering the raw material were to be procured locally to keep the production cost down, PKV mini dhal mill was established with 200 kg/hour capacity to ensure a cost effective performance. The particular model of dhal mill used in the intervention was developed by Dr. Punjabrao Deshmush Krishi Vidyapeeth, Akola [9]. The selected equipment was capable of processing chickpea and green gram apart from pigeon pea thus ensuring its year round operations. The intervention in terms of establishment of *dhal* mill and following operational protocols increased the pigeon pea productivity by 78-80 per cent and 60-63 per cent increase in *dhal* recovery was observed, thus increasing the availability of raw as well as processed pigeon pea in the region.

3.1.3 Handholding and mentoring on crop production and handling of processing units

Following of appropriate production techniques are imperative to increased yield and reduced yield gap in field conditions. Capacity development as well as advisory services were provided to the tribal farmers of Tiryani and Wankidi through training programmes on improved crop production practices for pigeon pea. Crop production protocols were distributed to the farmers along with seeds and ICRISAT team was actively involved throughout the process of cultivation. In addition, to provide communities with local resource and contact person regarding any problem faced during cultivation, young educated tribal farmers were identified and trained on technical guidelines regarding handling of processing units at Wankidi and Tiryani. They were provided with Standard Operating Procedures (SOPs) for operating the processing units efficiently. Five youth were employed at each processing unit through the intervention including two women, and the teams were trained and continuously mentored by ICRISAT on operations, maintenance, and hygiene and safety protocols towards ensuring efficient performance of the processing units.

3.1.4 Marketing linkages for processed pigeon pea

Aimed at increasing the income of pigeon pea producers, developing market linkage was an important component of the interventions. The production practices introduced by ICRISAT were designed to minimize long term use of chemicals in farming practices. The produce was tested for pesticide residues and as per the report obtained from an ISO 17025: 2005 accredited laboratory (National Collateral Management Services Limited (NCML), Hyderabad, India), the samples were found to have no pesticides residues (below limit of quantification, which is less than 0.01mg/kg for pesticide residues and 0.05mg/kg for Dithiocarbamates). This enabled the marketing of the processed produce (*dhal*), as “naturally grown”, helping fetch better price of Rs. 80/kg against Rs. 75/kg of existing market price. Along with retailing in markets within and outside Adilabad, the produce was also sold to residential hostels and schools managed by Tribal Welfare Department and Social Welfare Department of Telangana, thus contributing the food and nutritional security of tribal children.

3.2 *Dhal* Mill Performance

During dehulling, noticeable amounts of cotyledon material and germ are removed, which results in considerable losses of produce. In large-scale processing of pigeon pea, the loss of cotyledon in terms of powder and broken grain can be as high as 12.8% and 4.4%, respectively. The method of pre-treatment of the pigeon pea grains prior to dehulling significantly affects the formation of broken and powdered particles and in the case of pigeon pea, it varies between 9 to 24.6% for brokens and fines and 5.5 to 6.1% for fines [10].

Hull/husk adherence to the cotyledons in pigeon pea is due to the presence of calactomonus disaccharide, glucoronic acid and glycol protein [11]. Arabinogalactan type polysaccharide was found responsible for adherence of hull to the cotyledons, which is gummy and hygroscopic in nature [12]. The presence of these complex carbohydrates makes the dehulling of pigeon pea a difficult process. Therefore, milling the pigeon pea without pre-treatment results in low *dhal* recovery. Pre-milling treatments plays an important role in improving *dhal* recovery by loosening husk/hull from cotyledons [13]. Also, outer layers of pigeon pea are rich in protein compared to the inner layers of seed, and dehulling removes the nutrient rich germ and outer cotyledon layer with higher protein deposition along with 20 per cent of calcium and 30 per cent iron [14]. This makes it more important to introduce effective dehulling methods in the rural areas [15], especially for low cost milling which is mostly consumed by the nutritionally insecure at the grassroots.

Thus, appropriate pre-treatment of seed is necessary to prevent dehulling losses during milling operations. Two different types of pre-treatments were used with respect to soaking and heaping practices for the pigeon pea grains, obtained from the cultivation of the variety ICPH 2740 (Table 2).

During milling operations *dhal* yield varies with dehulling losses (broken and powder of dhal). In pre-treatment 1, the dehulling losses were more compared to pre-treatment 2. The observations recorded at Wankidi and Tiryani are given in Table 3.

Table 2. Pre-treatments of pigeon pea

Process	Pre-treatment 1	Pre-treatment 2
Soaking in water (hours)	10	6
Heaping in shade (hours)	6	3
Pre-treatment with oil (g/100 kg)	200	200
Tempering in shade (hours)	6 to 8	6 to 8
Sun drying (days)	2 to 3	2 to 3
Final moisture of grain before milling (wb, %) *	10 to 11	10 to 11

*(*grain moisture was measured on wet basis (wb %) using digital moisture meter from National Instruments, Vadodara – 390012, Gujrat, India)*

Table 3. *Dhal* mill unit performance at Wankidi and Tiryani

***Dhal* mill unit performance at Wankidi**					
Month	**Treatment**	***Dhal* recovery%**	**Round dhal%**	***Dhal* yield%**	**Dehulling loss%**
February	T1	61.5±4.6	-	61.5±4.6	-
March	T1	60.9±4.0	13.1±2.6	72.2±5.7	25.6±3.6
April	T2	63.8±4.1	13.9±3.9	76.7±5.4	20.1±3.5
May	T2	59.6±2.8	17.4±2.8	77±1.3	20.3±1.3
June	T2	60.2±5.5	17.3±5.5	77.6±3.1	20.5±3.0
***Dhal* mill unit performance at Tiryani**					
Month	**Treatment**	***Dhal* recovery%**	**Round dhal %**	**Dhal yield %**	**Dehulling loss %**
April	T2	61.5±9.5	18.8±6.7	80.3±5.6	19.7±5.6
May	T2	60.7±2.6	19.2±2.4	79.9±0.8	20.1±0.8

Note: the study was done from the data collected for five months (Feb-Jun 2017) at Wankidi and two months (Apr-May 2017) at Tiryani.

It may be noted that the significant improvements in Dhal yields was obtained after the adoption of pre-treatment 2 (T2) in the Wankidi processing unit. Subsequently, this optimized pre-treatment was directly adopted for the Tiryani processing unit, with promising results. Dhal mill efficiency was estimated by considering the dhal yield, dhal recovery, round dhal and dehulling losses like husk/hull, fines and brokens obtained during milling. Total dhal yield was calculated after complete dehulling of raw pigeon pea. In Wankidi unit, the maximum *dhal* yield was 77.6±3.1% (Table 3) recorded in the month of June and in the Tiryani unit the maximum dhal yield was recorded as 79.9±0.8% (Table 3) in the month of May, both using pre-treatment 2. *Dhal* yield was a combination of *dhal* and round *dhal*. The ratio of *dhal* to round *dhal* depends on final moisture content of grain mostly. The optimum moisture of 10-11% yields best result as asserted by researchers [16,17,18]. Operators maintained optimum moisture but sometimes final moisture was manipulated with climatic conditions, soaking and heaping times, etc. In the month of February and March, pre-treatment 1 was followed (soaking time 10h and heaping time 6h) and maximum dehulling loss was recorded at 25.6±3.6% whereas in case of pre-treatment 2 (soaking time 6h and heaping time 3h) these losses were substantially reduced and the lowest loss recorded was 19.7±5.6% in Tiryani. The average dhal recovery, considering data from both the units, was optimized at approximately 61.0±1.6%.

3.3 Grading and Polishing Performance

Seeds that are too large or too small are often not suitable for milling, mainly due to milling equipment limitations [19]. The more uniform the seed size, the higher the milling yield, resulting in reduced shattered/broken (larger seeds) seeds. Grading equipment is used to segregate bold grains from the whole stock. The grader and polisher efficiency for Wankidi is given in Table 4.

Table 4. Grader and polisher efficiency

Month	Grading efficiency%	Polisher efficiency%
February	93.1±3.2	93.4±3.2
March	96.3±2.8	97.4±1.8
April	96.7±1.9	97.8±3.8
May	98.0±2.5	99.4±0.4
June	99.3±0.8	-

Polishing equipment is used to remove adhered fines on *dhal* and provide shine to the processed product to improve consumer acceptability. Efficiency of polisher improved in May (99.4±0.4%) as compare to February (93.4±3.2%) and March (97.4±1.8%) and can be attributed to steps taken to optimize processing parameters, including introduction of effective pre-treatment of grains and enhanced operator skills.

3.4 Impact of Interventions

3.4.1 Impact of interventions on pigeon pea production and profitability of farmers

Prior to the interventions, the producers in the selected areas were growing traditional varieties of pigeon pea as an intercrop with cotton. Through the interventions, high yielding variety ICPH 2740 was introduced and distributed to the smallholders. After this intervention, a 33 per cent increase in yield was observed in the farmers' field. Further following the production protocol, the farmers moved towards organic and natural cultivation, thus reducing pesticide and chemical residue in the produce, increasing its market price (Table 5).

As part of the interventions, the produce (raw pigeon pea) was bought directly from the farmer at Rs. 50.20/kg for processing, instead of the then prevailing minimum support price (MSP) of Rs. 44/kg existing during the time. This resulted in two-fold increase in farmers' income – from increased production and from higher selling price – totaling to 86 per cent increase in net returns during the intervention period.

3.4.2 Increased profitability from dhal processing unit

Processed dhal recovery also increased with the introduction of pre-processing Treatment 2, thus reducing treatment time as well as post-harvest losses. Following the ICRISAT and manufacturer protocol for the dhal mill, 78-80 per cent *dhal* yield. The final product (processed *dhal*) was sold at MRP of Rs. 80. Operating economics of the dhal mill is discussed in Table 6.

The initial net profit per day for dhal mill (500 kg/day capacity @ 70% output) was estimated at Rs. 2,489. Operational management of the mills were taken up by farmer collectives, thus circulating the revenue within producer groups, further increasing the income of the community.

Table 5. Impact of interventions on yield and income of tribal farmers

	Cost of cultivation/ ha (Rs.)	Yield/ha (Kg)	Production cost/kg (Rs.)	Selling price/kg Rs.)	Return/kg (Rs.)	Net return/ha (Rs.)
Before intervention	10,000	600	17.00	44.00	27.00	16,200
After intervention	10,000	800	12.50	50.20	37.7	30,160
Increased profit after intervention						Rs. 13,960/ha

3.4.3 Impact on value chain of pigeon pea

Prior to the interventions, the traditional channel for pigeon pea marketing in the district was Farmer - Commission agent (15%) - Trader (20%) - Processor (40%) – Wholesaler (20%) – Retailer/Retail chain (15%) - Consumer. Producers' share in consumers' price was considerably low in the traditional model, and enhancement of this producer's share which was one of the key objectives of the intervention. With the introduction of a new pigeon pea variety, enhanced production practices and new market linkages, 86 per cent increase in farm income was observed, much of which is attributed to the increased selling price of raw materials with reduced market intermediaries. In addition the profits generated by the Dhal mill operations can also be shared among the farming community/collective, once a formal operating business model involving the framers is established, resulting in further enhancement of the farmers' income. Under the market linkage component of the interventions, raw produce was directly procured from the producers at higher price and processed dhal from the dhal mill was

Table 6. Operating economics of *Dhal* Mill

Sl	Item	Expense (Rs. per 100Kg)	Remarks
1	Procurement of *dhal*	5020	
2	Input Cost for oil treatment(250 ml @ Rs. 60/liter)	15	
3	Input Cost for oil -polishing (1000ml @Rs. 60/liter)	60	
4	Electricity Cost @ Rs. 10 per unit for 6.5 units (approx.)	65	
5	Cost of packing bag	20	
6	Net expense per 100 kg	5180	
Sl	**Item**	**Fixed expense per day (Rs.)**	
1	Labour cost per day @ Rs. 25000 for 25 days	1000	per day fixed
2	Provision for maintenance and repair (@5% of 4 lakhs* in a day	111	Assuming that the machine runs for 6 months a year
	Net	1111	
Sl	**Item**	**Revenue (Rs. per 100Kg)**	
1	Sale of *Dha*l @ 70% output @ Rs. 80 per kg	5600	
2	Sale of *Dhal* dust @ 20% output @ Rs. 15 per kg	300	Assuming 10% loss
3	Net Revenue @ 70% *dhal* and 20% dhal dust	5900	
Sl	**Item**	**Profit (Rs. per 100 kg)**	
1	70% *dhal* and 20% *dhal* dust	720	
Sl	**Item**	**Profit per day (Rs.)**	
1	Net profit per day @ 500 kg per day @ 70% output	2489	

*(*Cost of each dhal mill unit is Rs. 4 lakhs)*

sold in the local market as well as purchased by the ashram schools (residential schools), integrated hostels, and hostels run by the Tribal Welfare Department of Telangana. Producers' share increased in the end consumers' price as a result of reduction in the number of intermediaries (compression of the value chain) and streamlining of the pigeon pea value chain. Establishing direct linkages of producers with consumers and retail chains, further helped in enhancing the entrepreneurial skills of the farmers. Due to promotion of the sale of both dhal and *dhal* dust (fines), post-harvest loss was further reduced as a result of the interventions.

Another direct impact of the interventions was in form of employment generation of rural educated youth and women in the processing units. 10 tribal youth including two women were employed, in various capacities in the dhal mills, and were given regular technical and business development trainings to develop their skillset and further increase their employability.

4. CONCLUSION

Development interventions in agriculture sector have far reaching impact as they affect the livelihood of rural agricultural communities both directly and indirectly. The current interventions had manifold effects in improving cultivation practices of tribal farmers, streamlining pigeon pea value chain, directly and indirectly increasing farm income by a large margin, and creating entrepreneurial opportunities in a disadvantaged area. Creating farmer aggregates and increasing their accountability, fluctuating prices of dhal, procurement of raw material were major challenges at the initial stages of the intervention, and addressing these challenges required extensive extension activities in the form of awareness campaigns and training programmes. The positive impact of the interventions ultimately emphasizes the need to further scale-up and replicates similar efforts to boost farmer income and by creating efficient and inclusive value chain in rural and tribal areas.

CONSENT

Purpose of the study was explained and verbal consent was taken from the respondents before collecting the data whenever necessary.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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