Agro-Economic Policy Briefs

Aiding the Future of India's Farmers and Agriculture

(Photo Source: https://indianexpress.com/article/cities/rajkot/as-sowing-ends-castor-acreage-logs-jump-of-20-in-gujarat-6004516/)

For kind attention of:

The Hon'ble Prime Minister's Office,
the Ministry of Agriculture and Farmers' Welfare,
and all others interested

On Critical Policy Issues in India's Agricultural Economy

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Contents

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Self Sufficiency in Pulses Production in India: An Analysis Based on the Successful Performance of Pulse Production and its Export from Myanmar

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Introduction

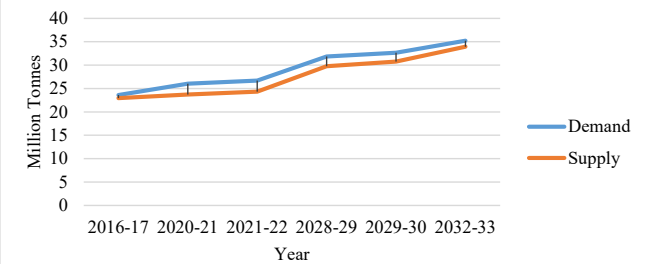
- Globally, there has been an emphasis on the potential of pulses to create economic, social and environmental opportunities for sustainable agri-food systems. In the case of India, pulses play a critical role in meeting the protein requirement of the Indian population and serve as a good substitute for superior alternatives such as livestock and meat consumption, especially for the rural population. The protein content in pulses is double the protein content of wheat and three times more than that of rice. While India is the largest producer of pulses in the world and has witnessed increased production in recent years due to the government's efforts such as the National Food Security Food Mission (NFSM), the production of pulses is not sufficient to meet the growing domestic demand.

- The study was based on a comprehensive primary survey undertaken in four major pulses producing states - Madhya Pradesh, Andhra Pradesh, Maharashtra and Rajasthan. Using a multi-stage random sampling technique, farmers were interviewed from districts which held one of the top ranks in terms of area under cultivation but were characterized by one of lowest yields for green gram and black gram in the respective state. The total number of cultivator households interviewed was 789. The total number of green gram cultivators was 390 whereas the total number of black gram cultivators was 399.

Findings from Secondary data

- As per the Working Group Report on Crop Husbandry, Agricultural Inputs, Demand and Supply Projections constituted by the National Institution for Transforming India (NITI) Aayog, the projected demand of pulses in 2032-33 is 35.23 million tonnes, while the projected supply is 33.95 million tonnes. Figure 1 draws out the demand supply gap as per these projections for the period 2016-17 to 2032-33.

Figure 1.1: Demand and Supply Estimates of Pulses as per the Working Group on Crop Husbandry, Agricultural Inputs, Demand and Supply Projections, 2018



Source: *NITI Aayog, 2018* https://www.niti.gov.in/sites/default/files/2021-08/Working-Group-Report-Demand-Supply-30-07-21.pdf

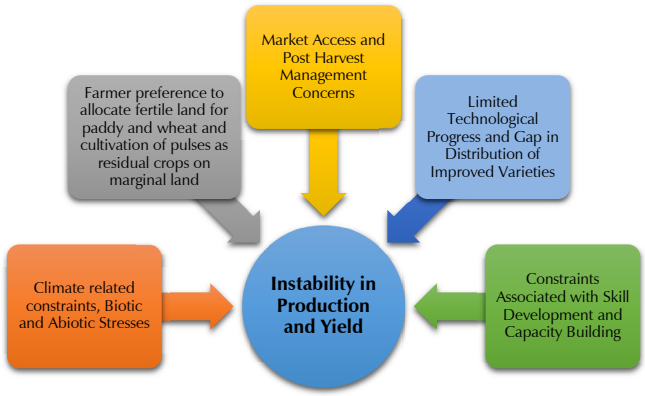
- The excess demand has resulted in high and volatile prices, as well as a growing dependency on pulse imports. The prices of pulses have also been continually increasing, especially after 2005.

- Studies such as Indian Institute of Pulses Research (2011) indicate that the losses due to biotic and abiotic stresses comprise 15-20 percent of normal production. The technological breakthrough in terms of crop protection to decrease the incidence of these stresses is yet to be realized.

- Farmers have been observed to not benefit from the high price of pulses due to the presence of middlemen such as large traders/ wholesalers, to whom the market surplus is sold immediately after harvest. Pulse production is also less lucrative for farmers compared to other crops due to trade liberalization, as the relative profitability of pulse crops has reduced in spite of an exorbitant increase in pulse prices (Thomas et.al. 2013).

- Reddy (2010) notes that post-harvest losses account for 9.5 percent of total pulses production. Storage is responsible for highest proportion of loss (6.5%). While losses during processing, threshing and transport amount to 1 percent, 0.5 percent, and 0.5 percent of total pulses production.
- Further, there is lack of awareness and capacity building in terms of mechanization adoption, input use efficiency, disease prevention and management, amongst others (Byerlee and White, 1997; Tripathi, 2019). Mechanical harvesting of the pulse crop and crop production and protection technologies have also been limited.
- With low yields, studies such as Gowda et al. (2013) and Srivastava (2010) have observed that low growth and uncertainty in yield have led to a farmer preference to allocate their best parcel of irrigated/ fertile land for high productivity-high input crops such as paddy and wheat, and pulses are grown as residual/ alternate crops on marginal lands with no use of production inputs. Thus, the vicious cycle of low yields continues in this manner. Figure 2 summarizes the key issues witnessed in terms of production of pulses.

Figure 2: Key Barriers Associated with Production of Pulses



Source: *Compiled by the author from the review of relevant literature and the field observations.*

Key Findings

- The results from the analysis of the adoption of various agronomic practices such as soil management, seed management, water management and plant management showed that (a) contact with government extension agents, (b) access to off-farm activities, (c) availing of MSP, (d) price at which the crop is sold and (e) own stock of seed increased the likelihood of adopting several agronomic practices for both black gram and green gram.
- While these results were aligned to the literature on the same, a negative relationship was found between membership in input supply cooperatives and adoption, and a positive relationship was found between distance to main market and adoption, which seemed counter-intuitive to extant literature.
- The negative relationship between membership in input supply co-operatives and adoption could be due to the fact the membership in input supply co-operatives indicates a better farming situation of farmers, wherein they cultivate more market oriented and less risky crops. In case of the latter (distance from market) it could indicate that the agronomic practices are mainly adopted by farmers who are less market oriented but are resource poor farmers as a livelihood maximization strategy.
- The results from size of the farm and education are also mixed. These results also point out that the adoption of agronomic practices is undertaken by resource poor farmers.
- An analysis to understand the impact of MSP in encouraging the adoption of various agronomic practices among black gram and green gram farmers showed that the availing of MSP is an important factor in positively affecting the adoption of almost all agronomic practices among the black gram and green gram farmers. The results showed that information about MSP received from radio was more important than newspaper and this was especially true in the case of black gram farmers.
- Similarly, crop failure and crop insurance resulted in the lowering of availing of MSP. This could be due to the insurance coverage that the farmers receive during crop loss, or the lack of enough crops to be sold when there is a crop loss.

- Membership in input supply co-operatives, education, knowledge of KCC and access to off-farm activities generally increased the likelihood of availing MSP.
- Household income lowered the probability in the case of black gram farmers and shows the importance of MSP as a risk mitigating strategy for resource poor farm households, especially when they experience crop failure.
- In the case of membership in farmer organizations, our results showed that the membership in input supply co-operative had a positive impact only on the adoption of soil management, whereas a negative and statistically significant impact in the case of seed and soil management, seed and plant management, seed, soil and plant management was observed. This result could be attributed to better crop cultivation and marketing prospects already existent for farmers who are members of farmer organizations due to their ability to leverage on the opportunities and information available, due to which they do not have any additional incentive to further engage in yield-enhancement measures specific to black gram and are adopting only soil management practices that are not black gram specific.
- The analysis on the impact of various seed sources (government, private, own stock from previous years and other farmers on the prices received by the farmers) showed that the percentage of farmers who use government seed was more among the green gram farmers than black gram farmers.
- Similarly, a greater number of black gram farmers obtained the seed from private companies. Still, it was observed that a large chunk of both green gram and black gram farmers were still using their own seed from previous year. Those who had better knowledge about the production techniques were not using their own seed.
- As far as the impact of seed sources on the prices received, the results were quite mixed. The black gram farmers who sourced their seed from government received higher prices for the crop while selling, whereas opposite was the case for green gram farmers.
- An analysis of the role of crop insurance in influencing the adoption of various agronomic practices showed that the availing of crop insurance has a positive impact on the adoption of almost all agronomic practices among black gram farmers. Similarly, variables such as farm size, membership in input supply co-operatives, crop failure, access to off-farm activities, etc. increased the likelihood of accessing the crop insurance.
- Apart from crop insurance, the other factors that affected the likelihood of adopting various agronomic practices were farm size, access to government's extension services and availing of MSP.
- The analysis of the production and export performance of Myanmar showed that India is the largest export destination of Myanmar for black gram and green gram, constituting almost 39 percent of total exports.
- The success of Myanmar in the export market is due to the relatively higher yield that they have achieved since 1960s. Whereas in India, the pulses production, including black gram and green gram were stagnant since the 1960s and the yield was also poor. The differences in the food security policies in the two countries are also a reason for the differences in the emphasis on the crops. In India, the Green Revolution shifted the focus more towards cereals production in order to meet the food security objectives in the 1960s and 1970s.

Conclusion & Suggestions

- The agronomic practices are yield enhancing without harming the environment. However, in order to remove the barriers that farmers face from adoption of these practices, the government needs to take effective measures to reduce the risk and uncertainty. Price risk and yield risk are the two main sources of uncertainty.

- The study showed that the MSP can reduce the risk and uncertainty faced by farmers and thereby encourage the adoption of yield enhancing agronomic practices. The price-stabilization policies would encourage farmers to adopt yield enhancing technologies. Thus, appropriate actions need to be taken to increase the awareness of MSP among farmers, scale up procurement operations, ensure that farmers can avail MSP (especially in states such as Andhra Pradesh) and make the procurement more effective in order to encourage the uptake of recommended yield-enhancing agronomic practices for black gram and green gram.
- Similarly, crop insurance plays a crucial role in encouraging farmers in adopting agronomic practices. Furthermore, in order to enhance the adoption of yield enhancing agronomic practices, the government can bolster training efforts in terms of **input requirements, crop management and post-harvest management** across the study states, especially in Andhra Pradesh and Maharashtra.
- Lastly, given that countries with high production, and a success in terms of pulse exports, such as Myanmar have been characterized by high levels of yield that they have achieved since 1960s. During the same period India's production of pulses declined and yield remained low.
- Currently also, the yield remains the lowest due to the lack of adequate public investment and the higher risk and uncertainty perceived by the farmers. Along with this, the cereal oriented food security policies followed by India until recently also resulted in the crowing out of the pulses from the farm. Correcting such biases and a more balanced approach in terms of incentives such as MSP will help the pulses sector to become self-sufficient.

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Castor Crop Cultivation in Gujarat: Problems, Prospects and Export Potential

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Introduction

- India is the leader in global castor seed production and dominates in the international castor oil trade. India supplies almost 85-90 percent of the world's requirement of Castor Oil and its derivatives. India became the first choice for the major importing countries like China, France, USA, Germany, Netherland, Thailand, Japan, UK and Korea, whereas for Italy, India was the second choice. This indicates that India's position in world's castor oil market is very strong and there is a great opportunity to expand it. The major castor-producing states in India are Andhra Pradesh, Gujarat, Karnataka, Odisha, Rajasthan, and Tamil Nadu. Though the area and production of castor as well as its export are on increasing trend, the castor cultivating farmers are facing problems in the cultivation of the crop.

Figure 1: Castor Plant

Source: *https://www.agrifarming.in/castor-cultivation-income-yield-project-report*

- The farmers have been reporting production as well as marketing constraints. Farmers are facing constraints such as rising costs of fertilizers, pesticides and irrigation. The present study was undertaken to understand the problems, prospects and export potential of castor crop cultivation in Gujarat. This study is based on secondary data from published sources and primary data. Primary data was collected during 2020-21 from five districts of Gujarat namely - Banaskantha, Kutch, Patan, Mehsana and Surendranagar. With the help of multistage random sample method, 400 castor farmers were selected for survey.

Findings from Secondary data

- Gujarat is India's largest producer of castor in India, accounting for about 85.60 percent of the total production in the country (2020-21). The productivity of castor in Gujarat state is highest not only in India but also in the world.
- Castor growing is considered a step forward towards diversification and commercialization of agriculture in Gujarat. The cropping pattern of Gujarat state has changed during the last five-decade period (1971-2021). Though the share of oilseed in total cropped area remained the same at around 20 percent, share of castor crop has increased from 0.61 percent in TE 1972-73 to 5.62 percent in TE 2020-21.
- In Kharif season, castor is the dominant non-edible oilseed crop while some farmers are also growing it in Rabi season. The castor varieties grown in the district are GCH-2, GCH-4, GCH-5, GCH-6, GCH-7, GC3, GNCH-1(Rabi), and GCH-8.
- Seed Replacement Ratio (SRR) of castor is reported to be 50 percent. Thus, the scope of SRR is ambient in the future to enhance the productivity of castor in the state, especially through the seed village concept and hybrid seed production programs.
- Global castor oil and derivatives key market players include Jayant Agro, NK Proteins, Adani Wilmar, etc. The three main global manufacturers hold a share over 50 percent. India is the largest market, with a share of over 90 percent, followed by China, and North America, both have a combined share of over five percent. In terms of product, Hydrogenated

Castor Oil is the largest segment, with a share of about 30 percent,

- Castor oil is a promising commodity that has a variety of applications in the coming years, particularly as a renewable energy source. Castor seed is not exported but castor oil and meal are exported. India exported more than 7.34 lakh tons of castor oil worth of Rs.6802 crore during the year 2020-21. Germany, France, UK, US, and other European countries were the major countries for the export of Oil.
- The seven major trading centers of castor and its derivatives in India are from Gujarat namely Rajkot, Ahmedabad, Gondal, Gadwal, Bhabhar, Deesa, Kadi, and the two from Andhra Pradesh are Jedcherla and Yemignoor. Also, castor and its derivatives such as castor seed, castor oil and castor oil cake are traded in Indian commodity exchanges.
- Castor markets in the state of Gujarat viz; Dasadi (Patdi), Radhanpur, Bhabhar, Thara, Mehsana and Kadi are closely inter-linked with each other in terms of price movements.
- The seasonal indices of market arrivals and prices of castor seed for different markets *viz;* Dasada (Patdi), Radhanpur, Bhabhar, Thara, Mehsana and Kadi shows the existence of seasonality in all the markets. Study of seasonal indices of market arrivals and prices of castor seeds reflects seasonality in markets. Higher indices of market arrivals of castor seed were noticed immediately after harvest.

Findings from Primary data

- From field survey, it is observed that almost all land under castor cultivation is irrigated. The average productivity of castor crop is estimated to be 26.5 qtls/ha.
- The total cost of cultivation of castor per hectare was estimated to be Rs.87,528/-. On average, per quintal price for castor seed output realized was Rs.4,872/-. Across the groups, 93.3 percent of marginal landholders, 86 percent of small landholders and 76 percent of large landholders had sold all output at first instance only. Marginal farmers sold their output within 20 days of harvest.
- The net income realized by the farmer was estimated to be Rs.42,983/- per hectare. The highest benefit-cost ratio was estimated for the large landholder group and the lowest was for small landholder.
- The major constraints faced by the castor seed growers were the long duration of crop followed by lack of production technology and lack of disease resistant varieties. Farmers are highly vulnerable to variations in temperature, biotic stress and excessive rainfall.
- The major source of procurement of the produce was large processing firm within the state. The major three problems faced at domestic markets were lack of regular supply and GST refund issues and high price compared to the quality.
- The major problems faced by the Commission agents were storage, TDS issues and payment problems. Lack of support from the government, competition from large processing units, high cost of processing, and credit access were major constraints faced by the processor.

Conclusions and Policy Implications

- In view of low SRR in Gujarat, there is a need to create awareness about the importance of improved/hybrid varieties through demonstrations, training programs, *shibir*, etc. Establishing well-organized seed multiplication systems, seed supply chain and commercial market are very important for faster adoption of castor in India. Quality of seeds should be given utmost importance. There is a need of providing training to progressive farmers for seed production at the local level.
- The partial adoption of recommended production/protection technologies affect the productivity of castor. Therefore, there is a need to create awareness among the castor grower about good agricultural practices about scientific crop management through demonstrations and training.

- Low-input production technologies with higher input efficiencies based on climatic changes need to be developed to sustain castor production. Research on the region or location-specific production and protection technologies should be given priority.
- The long growing season of castor may be a constraint to adopt crop cultivation. The instability observed in various districts during the study period needs to be reduced and yield should be improved by developing wilt-resistant, short-duration, location-specific high yielding varieties of castor.
- It was observed that castor seed produced after harvesting is not properly cleaned and dried which leads to low returns. Therefore, there is a need to propagate improved technology for drying, cleaning, grading and bulk packaging to improve the quality of raw materials for industrial supply and increase farmer's income.
- Extension services can encourage castor adoption in new areas through the dissemination of information on castor cultivation which would help generate interest in stakeholders. Interdisciplinary collaborations in research projects are needed to ensure the sustainability of castor adoption in newer areas. The physical logistics such as warehousing, scientific management of stocks, and transportation are also to be improved.
- International collaborations will increase both the efficiency and speed of research in developing castor as a bio-energy crop. This would further enable castor farmers to realize the higher value of their produce.
- There is a large scope for improving India's earnings from castor by converting castor oil to various derivatives. In the strive to replace natural products with environmentally friendly synthetic products, castor oil-based derivatives could find increasingly attractive markets worldwide.
- The governments and private stakeholders should come forward to support castor cultivation by establishing industries related to castor processing and production of castor derivatives to realize the great economic potential of castor.
- Besides, lack of adequate infrastructure and value additions are a couple of factors that are also responsible for making India a weak player on the price front. This anomaly can be corrected if the industry expands the market by developing castor oil derivatives and investing in research and development. If the industry works as a more cohesive unit, India could soon be in a better situation.
- In view of the numerous and significant threats, it is critical for all concerned to determine a strategy for initially protecting India's position in Castor and then chalking out a path to long-term sustainable growth. The current role of a commodity player supplying raw material (Castor Oil) to global consumer need to be upgraded and augmented into that of a value-added finished product (Castor Derivatives) supplier. The ability to achieve this will ensure a long-term and commercially profitable Castor business for the country.

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Supply Chain of Makhana Marketing and Processing in Bihar

Ranjan Kumar Sinha

Introduction

- Makhana *(Euryale ferox),* an important aquatic cash crop is unique, highly nutritious dry fruit, mainly grown in stagnant perennial water bodies, like ponds/jalkars, land depressions, oxbow lakes, swamps, ditches and low-lying agricultural fields. It has tremendous potential to support the livelihood of resource poor

farmers, particularly belonging to the fisherman/ mallah community in the Eastern region of India, where agriculture is complex and risk prone livelihood source. It is considered as a native of South-East Asia and China. In India, it is primarily cultivated in North-Eastern regions, Eastern Regions, and some parts of Jammu & Kashmir. The country produces 90 percent of the world's Makhana produce; however, its commercial cultivation is confined to northern Bihar. In Bihar, Makhana is mainly cultivated in the flood prone areas of Mithilanchal, Kosi and Seemanchal regions of the state, accounting for 90 percent of India's total Makhana production. It's about Rs.250 crore market at farmers' end, Rs.550 crore at traders' end and Rs.1500 crore at consumers' end.

- Makhana is a crop that undergoes 100 percent processing and the entire system of processing is carried out manually since many generations. Most of the experts of makhana processing are women of *'mallah'* community of north-Bihar. Naturally, concentration of these experts is limited to few areas of north-Bihar particularly Darbhanga and Madhubani districts and that is the prime reason for makhana processing to be restricted in Bihar region. After processing, popped Makhana is sold to local and distant markets. But the Makhana supply chain is lengthy as there are many market intermediaries between farm gates and consumers.

Figure 2: Makhana Cultivation site

Source: *Ranjan Sinha, AERC Bhagalpur*

- In 2020 under *Atmanirbhar Bharat Abhiyaan,* a scheme of Rs.10,000 crores was launched for Micro Food Enterprises (MFEs) to promote 'Vocal for Local with global outreach' for six agricultural produces and 'Makhana' was one of the crops included. Subsequently in 2022, Government of India awarded GI tag to Mithila Makhana. Further, Makhana Vikas Yojana was rolled out in nine districts of Bihar for the promotion of makhana cultivation among farmers. Under the Yojana, government provides subsidy upto 75% of total cost (about Rs.72,750 per hectare) for makhana cultivation with HYVs (Swarna Vaidehi and Sabour Makhana-1). Besides, the government provides 100% subsidy (about Rs.97,000 per hectare) for seed production of HYVs to BPS Agricultural College, Purnea and ICAR's RCM-Darbhanga. Despite all these efforts, the sector is highly unorganized and besieged with inefficiency.

- The study is based on primary data collected from 200 Makhana cultivators, distributed equally in two sample districts viz., Darbhanga (ACZ-I) and Katihar (ACZ-II); also, secondary data and case studies have been used for the study.

Findings

- Till 1980s, the area under Makhana cultivation was estimated at 10,000 ha which increased to 13,000 ha in 2012-13 and further to 35,224 ha in 2021-22. During the 2012-13 to 2022-23, the total seed production has increased from 20,800 tonnes to 56,389 tonnes. And the pop production increased from 9,360 tonnes to 23,656 tonnes. Thus, during the nine year period (2012-13 to 2021-22), land under makhana cultivation increased by 270%, seed production increased by 271% and pop production increased by 253%. The average yield rate of makhana seed production was 16 qtl/ha during the same period.

- The market surplus of the makhana produce ranges between 88-98% (Chaudhary et. al., 2003; Mahawar, 2016 and APEDA, 2017).

- The average operational area under makhana cultivation was 2.02 acre and average share of leased area in total cultivated area was close to 91% (1.08 acre) per household. This suggests, high proportion of land leasing and participation of marginal and small farmers. The annual average rental value of Makhana land/ pond was reported to be Rs.17,813/acre.
- Makhana seed cultivation practices can be differentiated in two ways - traditional (pond) and farm (field) system. In these two systems, the per acre paid out cost of cultivation was observed to be Rs.41,930 (Rs.5,554 /qtl) and Rs.46,175 (5,497/qtl) respectively.
- Among cost components, the combined share of land leasing and harvesting cost was highest at 80-87% of total cost.
- In traditional system, the per acre net returns were Rs.18,093 with a cost benefit (CB) ratio of 1: 1.43. While, in case of field system, the net returns were Rs.21,241 and CB ratio was 1: 1.46.
- The processing cost of Makhana seeds is Rs.2,575/qtl. The recovery rate of makhana pops out of seeds was 44.25% (44.25 kg/qtl). In total processing cost, labor charge accounts for highest share of about 70%.
- Based on the number of intermediaries, following market channels were observed in the field:

  I. *Producer --- Aggregator --- Processor (Phodia) --- Local Wholesaler/ Trader --- Distant Wholesaler --- Retailer --- Consumer*

  II. *Producer --- Processor (Phodia) --- Local Wholesaler/ Trader/Commission Agent --- Wholesaler (Distant or Regional) --- Retailer --- Consumer*

  III. *Producer --- Processor (Phodia) --- Trader --- Retailer --- Consumer*

- Nearly 70-80 percent of the volume of produce was disposed through channel-I (Distant Markets), 20-25 percent through channel-II (Regional Markets) and 10-15 percent through channel-III (Local Markets).
- The producer's share in consumer's price across the channels was 38.19 percent, 34.20 percent and 40.58 percent respectively. It reveals that the price spreads were 61.81 percent, 65.80 percent and 59.42 percent of the consumers price respectively.
- Marketing efficiency was measured through four alternate methods. *Traditional Method (TME)* suggests channel–II is more efficient, but not suitable as price received by the producer in this channel was lowest. *Shepherd Method (SME)* suggested channel–II as more efficient but it did not consider the price received by the producer. According to the *Modified Marketing Efficiency (MME)* channel-II was more efficient but the margins of marketing functionaries as compared to marketing cost were very high. *Acharya Method (AME)* suggested for channel–II followed by channel–I & III.
- Around 57 percent of the sample households reported credit borrowing and average credit amount was Rs.15,893. The average amount outstanding with the household was reported to be Rs.10,663. In terms of credit source, 88% household reported borrowing from non-institutional sources.
- Among the production related constraints faced by growers, use of traditional cultivars was the Garret's first rank constraint. This was followed by uncertainties in profit due to short term settlement of jalkars and renting of fields, inadequate working capital, drudgeries and costly harvesting, climatic stress, lack of irrigation facilities, numerous inefficiencies in the distribution of jalkar (government pond), siltation of beds in water bodies, lack of technical interventions, health risks to women and children and infestation of aquatic weeds.
- Among the processing related constraints, lack of mechanical processing was the Garret's first rank constraint followed by lack of ready to consume local market, drudgery activity, high dependence on traders, small size of output,

low demand due to low popularity of the produce, weak socio-economic conditions of processors, lack of infrastructural facilities, tight supply of skilled labour and lack of subsidies on machines.

- A glimpse of market-related constraints shows that there is one causal factor for many constraints. Concentration of market in the hands of few big traders (cartel) is one of the biggest hurdles in efficient market functioning. This has been responsible for high marketing costs, lack of transparency in price determination, lower share of producer in retail price and low bargaining power of farmers in the market. Besides, the lack of terminal market in the state and export opportunities aggravates producers' situation.

Figure 3: Makhana Processing in Field Site

Source: *Ranjan Sinha, AERC Bhagalpur*

Conclusion & Suggestions

- The study recognizes the immense scope of development in production, processing and marketing if following interventions are taken care of:

- Popularization and availability of improved varieties of seeds *(Swarna Vaidehi & Sabour Makhana – 1)* for commercial cultivation should be undertaken to increase production. At present about 400 quintals of improved seeds are produced by two prominent institutions viz., BPS Agricultural College, Purnea (BAU) and ICAR's – Research Centre for Makhana at Darbhanga at 100 percent subsidy, provided by the Directorate of Horticulture, Government of Bihar. But there is a need for seedlings preparation at the farmers' level for providing alternatives.

- Promotion of R & D for crop improvement and harvesting machines, strict and timely adherence to Bihar Fish Jalkar Management Act (2006), cleaning of Jalkars (ponds), scientific and technical support etc., are to be ensured.

- In case of processing, improvement in mechanization is the need of the hour. This can be addressed by inventing a cost-effective and successful popping machine. It requires incentivizing institutions like CIPHET (ICAR), BAU (Sabour, Bihar) and ICAR's – Research Centre for Makhana Darbhanga, Bihar and other interested entrepreneurs. Besides, subsidization of machines, establishment of processing clusters/common facility centers at Makhana locations, support to Makhana enterprises for value addition etc., should be prioritized.

- Creation of mass awareness about high nutritional value of Makhana in exhibition, fair, meet/conclave, etc., farmers' integration with markets (domestic & export), FPOs/ Co-operatives participation, branding and certification, facilitating transportation through railways, etc., are required for hassle free marketing of the produce.

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