AERC RESEARCH REPORT 200

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

S. S. Kalamkar and H. Sharma

Report submitted to the

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For the states of Gujarat, Rajasthan, Dadra and Nagar Haveli
(Ministry of Agriculture & Farmers Welfare, Govt. of India)
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AERC RESEARCH REPORT 200

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Foreword

Castor is an important industrial non-edible oilseed crop and India is the world's largest producer of castor seed accounting for 85.02 per cent share of total world caster seed production. India also dominates in the international castor seed oil trade as India is a leading exporting country of castor oil and its derivatives. China imports castor oil from India, converts it to derivatives and sells these as high value-added products. There is a large scope for improving India's earning from castor by converting the castor oil to various derivatives. With the world becoming more environmentally conscious and with increasing replacement of synthetic products with naturally derived products, castor oil-based derivatives could find increasingly attractive markets worldwide. The major castor producing states are Andhra Pradesh, Gujarat, Karnataka, Odisha, Rajasthan and Tamil Nadu. Gujarat is the India's largest producer of castor in India, accounting for about 85.09 per cent in total production of castor in the country (2019-20). The productivity of castor in Gujarat is the highest not only in India but also in the World. Not only area and production of castor but also its export is the on increasing trend. However, the castor farmers are facing the problems in the cultivation of crop. The farmers have been reporting production as well as marketing constraints. The input costs also have been reported risen, mostly on fertilizers, pesticides and water. Thus, there is a need to have insights into the problems, prospects and export potential of castor crop cultivation in Gujarat. The Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India has entrusted our Centre to undertake a state-specific study on 'Castor Crop Cultivation in Gujarat: Problems, Prospects and Export Potential'.

The present study is based on both secondary and primary data. The secondary data were compiled from published sources and primary data were collected from the selected 400 castor growers from selected five districts (Banaskantha, Kutch, Patan, Mehsana and Surendranagar) of Gujarat. The multistage random sample method was used for the selection of castor growers. The reference period for the primary data collection was the agriculture year 2020-21. Simple tabular analysis was used for data analysis. The study found that castor growing is a step forwards in the diversification and commercialization of agriculture. The benefit-cost ratio was found to be economically efficient in castor cultivation in all groups. The study came out with suitable policy implications.

I am thankful to the authors and their research team for putting in a lot of effort to complete this excellent piece of work. I also thank the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, for their unstinted cooperation and support. I hope this report will be useful for those who are interested in castor cultivation and its export.

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The study on 'Castor Crop Cultivation in Gujarat: Problems, Prospects and Export Potential' has been carried out at the Agro-Economic Research Centre, Sardar Patel University, Vallabh Vidyanagar, Anand, Gujarat, as entrusted by the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

We have benefited immensely from various scholars and officials from different government departments while carrying out this study. At the outset, we would like to thank **Dr. Shirish Kulkarni, Former Vice Chancellor and Prof. Niranjan Patel**, presently Officiating Vice-Chancellor of our University and Chairman, AERC Governing Body for their constant encouragement and support for undertaking such research activity at the Centre. We also thank **Dr. Jyoti Tiwari**, Former Registrar (In-charge), **Dr. Mitesh Jayswal,** Registrar (Incharge), and **Dr. Bhautik A. Patel** (Deputy Accountant & CAO Incharge) of our University for their administrative support for this project.

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The study would not have reached this stage without the active co-operation of the respondent from selected villages in Gujarat who provided all the required data for the study without any hesitation and expectation. Thanks to each of market functionary for sharing their experience and data. We thank each one of them for their invaluable support.

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Project Team

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List of Abbreviations

$	-	Dollar
APEDA	-	Agricultural and Processed Food Products Export Development Authority (APEDA)
APMC	-	Agricultural Produce Market Committee
Av.	-	Average
CACP	-	Commission for Agricultural Cost and Prices
CDVI	-	Cuddy Della Valle index
CGR	-	Compound Growth Rate
COC/CoC	-	Cost of Cultivation
CV		Coefficient of Variation
FAOSTAT	-	Food and Agriculture Origination of United Nation Datasets
FLD	-	Farm Level Demonstration
GOG		Government of Gujarat
GOI	-	Government of India
ha	-	Hectare
hh/HH	-	Household
HYV		High Yielding Varieties
KVK	-	Krishi Vidyan Kendra
L	-	Large
LDB	-	Land Development Bank
M	-	Marginal
M.T./mt	-	Metric Tone
MJ/ha	-	Energy input
MOA&FW	-	Ministry of Agriculture and Farmers Welfare
NDEX	-	National Commodity & Derivatives Exchange Limited
NPC	-	Nominal Protection Coefficient (NPC
NPK	-	Nitrogen Phosphorus Potash
NSA	-	Net Sown Area

OBC		Other Backward Class
RA	-	Ricinoleic Acid
RRB	-	Regional Rural Bank
Rs.	-	Rupees
Su	-	Sulphur
S	-	Small
SAP	-	State Agricultural Plan
SAUs	-	State Agricultural University
SC	-	Scheduled Caste
SCR		Season and Crop Report
SD		Standard Deviation
SHG		Self Help Group
Sig.	-	Significance
SM	-	Semi-Medium
SOEI	-	Solvent Extractor's Association of India
SRR	-	Seed Replacement Ratio
ST	-	Scheduled Tribe
TE		Triennium Endings
VECM	-	Vector Error Correction Model
Y	-	Yield

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 per cent to 90 per cent of the world's requirement of Castor Oil and its derivatives. The 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 farmers are facing problems in the cultivation of crop. The farmers have been reporting production as well as marketing constraints. The input costs also have been reported risen, mostly on fertilizers, pesticides and water. Thus, there was a need to have insights into the problems, prospects and export potential of castor crop cultivation in Gujarat. In view of the same, the present study was undertaken. The present study is based on both secondary and primary data. The secondary data were compiled from published sources and primary data were collected from the selected 400 castor growers from selected five districts (Banaskantha, Kutch, Patan, Mehsana and Surendranagar) of Gujarat. The multistage random sample method was used for the selection of castor growers. The reference period for the primary data collection was the agriculture year 2020-21.

2. Findings from Secondary data

- Gujarat is India's largest producer of castor in India, accounting for about 85.60 percent of the total production of castor in the country (2020-21). The productivity of castor in the state is the highest not only in India but also in the world.
- Castor growing is considered as 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 around 20 per cent during last five-decade period, share of castor crop in total cropped area has increased from 0.61 per cent in TE 1972-73 to 5.62 per cent 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 given in GCH-2, GCH-4, GCH-5, GCH-6, GCH-7, GC3, GNCH-1(rabi), and GCH-8.
- At present, the 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

andhybrid seed production programs.

- Global castor oil and derivatives key players include Jayant Agro, NK Proteins, Adani Wilmar, etc. Global main three manufacturers hold a share over 50 per cent. India is the largest market, with a share of over 90 per cent, followed by China, and North America, both have a share of over 5 percent. In terms of product, Hydrogenated Castor Oil is the largest segment, with a share of about 30 per cent,
- 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.
- The major trading centers of castor and its derivatives in India are Rajkot (Gujarat), Ahmedabad (Gujarat), Gondal (Gujarat), Gadwal (Gujarat), Bhabar (Gujarat), Disa (Gujarat), Kadi (Gujarat), Jedcherla (Andhra Pradesh) and Yemignoor (Andhra Pradesh). Also castor and its derivatives like castor seed, castor oil and castor oil cake are traded in Indian commodity exchanges.
- 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. Higher indices of market arrivals of castor seed were noticed immediately after harvest.
- The season behavior of castor prices revealed the existence of seasonality in all the markets. Higher indices of market arrivals of castor seed were noticed immediately after harvest in the selected markets arrivals reached peak during April and relatively shoot up in September and October. The different markets of castor in the state of Gujarat were closely linked with each other for the movement of castor seed prices

3. Findings from Primary data

- The field survey results indicate that almost all the farmers had irrigated land which was put under castor cultivation. The average crop productivity of castor crop is estimated to be 26.5 qtls/ha.
- The total cost of cultivation of castor seed per hectare was estimated to be Rs. 87528/-. On average, per quintal price for castor seed output realized by the sample households was Rs 4872/- per quintal. Across the groups, 93.3 per cent of marginal holders, 86 per cent of smallholders and 76 per cent of marginal holders had sold all output at first instance only. Marginal farmers sold their output within 20 days of harvest.
- The net income realised by the farmer was estimated to be Rs. 42983/- per hectare. The benefit-cost ratio of 1.36 was found to be economically efficient in castor cultivation in all groups. The highest benefit cost ratio was estimated for large landholder group and the lowest was in case of small land holder group.
- The major constraints faced by the castor seed growers were the long duration of crop followed by lack of production technology and lack of resistant/tolerant varieties are major three technological constraints were cited by the sample farmers. The extreme variations in temperature followed by biotic stress and inadequate/excessive rainfall are three major agro-climatic factors were faced by the sample farmers.
- The major problems faced by Commission agent were of storage, TDS issues and payment problems were faced by the commission agents. While major constraints faced by the processor were lack of support from the government,

competition from large processing units, high cost of processing, and availability of credit. The exporter mentioned that Germany, France, UK, US, and other European countries were the major countries for the export of Caster Seed Oil in 2020-21.

- The major source of procurement of the produce- Castor seed oil during 2020-21 was processor within the state and mostly from the wholesaler. The major three problems faced at domestic markets were lack of regular supply and GST refund issues and high price compared to the quality.
- While at the international level, lack of knowledge about the standard quality norms in the international markets, lack of pre-shipment agency for inspection during export and a lack of export subsidy or support from the Government.

4. Conclusions and Policy Implications

- In view of low SRR in Gujarat, there is a need to create awareness about the importance of improved hybrids/ varieties through demonstrations, training, *shibir*, literature, 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 seed 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 a package of practices, about scientific crop management through demonstrations and training.
- Low-input cost crop 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.
- In view of a large variation in productivity of castor seed crop across the districts, there is a need to narrow the yield gap across districts as well as in irrigated and rainfed conditions without mining natural resources.
- It was observed that castor seed produced after harvesting is not properly cleaned and dried, packing material used is mostly gunny bags and also contains foreign materials like iron nails, dust, stone, etc., such poor quality product gets less price for castor produce. Therefore, there is a need to propagate improved technology for drying cleaning, grading and bulk packaging to improve the quality of raw material for industrial supply and increase the 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.
- The international collaborations will increase both the efficiency and speed of research in developing castor as a bioenergy 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. With the World becoming more environmentally conscious and with the increasing replacement of synthetic products with naturally derived 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, a 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 consumers' needs 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.

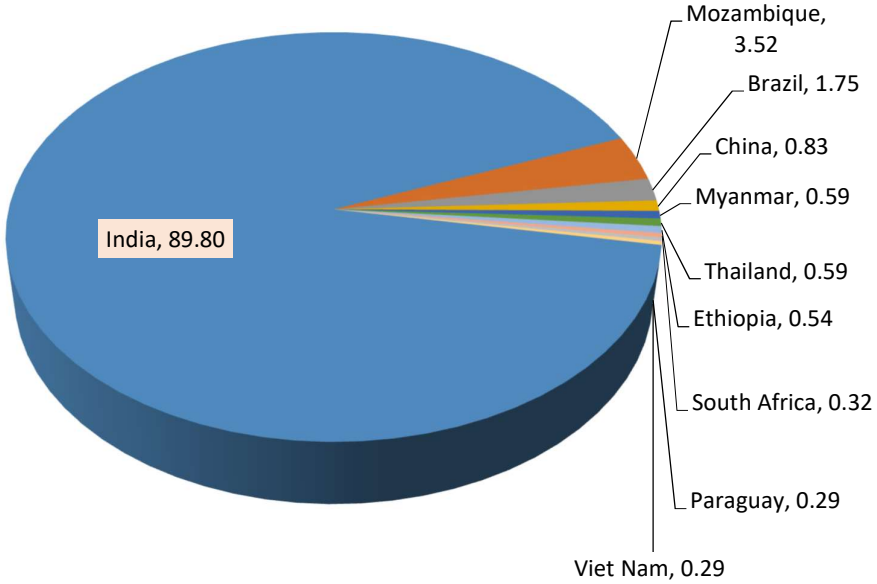
Chapter I

Introduction

1.1 Introduction

Castor is an important industrial non-edible oilseed crop in arid and semi-arid regions. It is reported to have originated in the tropical belt of both India and Africa. It is drought-tolerant and grown well in a wide range of rainfall and climatic conditions[1]. It is cultivated around the world because of the importance of its oil. The oil produced from this crop is considered to be of importance to the global specialty chemical industry because it is the only commercial source of hydroxylated fatty acid. It is cultivated in about 32 different countries on a commercial scale of which India, Mozambique, China, and Brazil together account for about 96 percent of the world's castor seed production (2020). India is the world's largest producer of castor seed accounting for 89.8 percent share in total world caster seed production (18.42 lakh tonnes) in 2020, followed by Mozambique (3.52%), Brazil (1.75%) and China (0.83%) (Fig.1.1).

Fig.1.1: Major Castor Producing Countries in the World, 2020 (%)

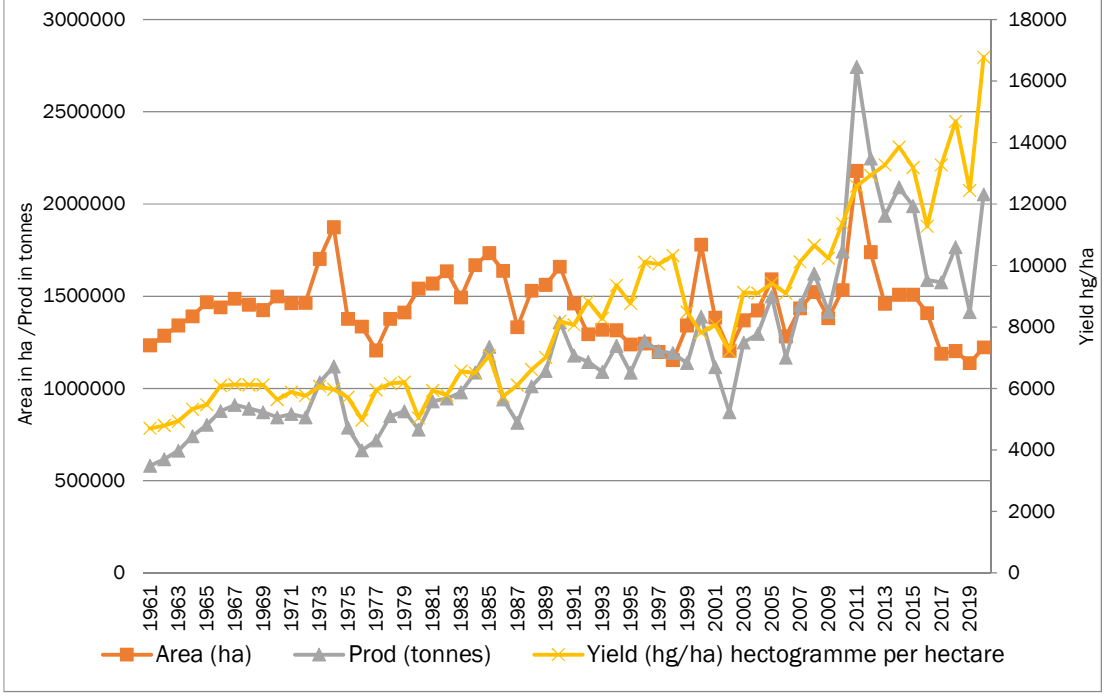


Source: FAOSTAT, 2022.

[1] http://www.commoditiescontrol.com/eagritrader/commodityknowledge/castor/castor1.htm

Castor (Ricinus Communis L.) has been transformed from a wasteland colonizer to an important industrial oilseed crop. Its seed oil is one of the most sought-after vegetable oils because of its rich properties and variety of end-users (Kammili, 2014). Castor is one of the oldest cultivated crops; however, it contributes to only 0.15 per cent of the vegetable oil produced in the world[2]. Castor is also known as the "Palm of Christ" or "Palma Christi," which derives from castor oil's reputed ability to heal wounds and cure ailments (Saisri and Dhandhalya, 2020). Over the period, World castor seed production has increased by 3.5 times during the period from 1961 to 2020, i.e. from 5.8 lakh tonnes in 1961 to 20.5 lakh tonnes in 2020, while the area was stable over the last six-decade period at around 1.2 million hectares (Fig. 1.2). Thus, the increase in production is attributed mainly to the increase in productivity from 4.7 qt/ha to 16.7 qt/ha during the corresponding period.

Fig. 1.2: Growth in Castor Seed Production in World



Source: FAOSTAT, 2022.

India also dominates in the international castor seed oil trade as India is a leading exporting country of castor oil and its derivatives of worth more than Rs.

[2] https://pjtsau.edu.in/files/AgriMkt/2021/September/castor-September-2021.pdf

5762 crore in 2020[3]. In 2019[4], the total world trade of Castor oil seeds was $15.8 million in which top exporters were Ethiopia ($7.48 million), India ($3.97 million), Myanmar ($1.45 million), Paraguay ($0.941 million), and Pakistan ($0. 827 million) while top importers were China ($13.3 million), Brazil ($1.12 million), UAE ($0.349 million), Thailand ($0.240 million), and Zimbabwe ($0.175 million). China was found the most stable market for Indian castor oil with a retention probability of 40.1 per cent (AAU, 2020). China imports castor oil from India, converts it to derivatives, and sells these as high-value-added products. There is a large scope for improving India's earnings from castor by converting castor oil to various derivatives. With the World becoming more environmentally conscious and with the increasing replacement of synthetic products with naturally derived products, castor oil-based derivatives could find increasingly attractive markets worldwide.

The Indian variety of castor has an oil content of 48 per cent. Out of 48 per cent, about 42 per cent of oil is being extracted and the cake retains the rest. Castor seed oil is rich in triglycerides called ricinolein. Castor oil is a potential raw material for many industries viz., paints, lubricants, pharmaceuticals, cosmetics, paper, rubber, food additives, etc. Castor oil is used as a lubricant in high-speed engines and airplanes. Hydrogenated castor oil is used in polishes, ointments, waxes, printing inks, cosmetics, hair dressings, soaps and disinfectants. It is also used for medicinal and lighting purposes. Castor oil is also used in many veterinary uses. Castor meal has uses in agriculture as organic manure (Pawar, *et al*., 2019). In Asian countries like India, Pakistan, Nepal, and Bangladesh, food grains are preserved by applying castor oil. It stops rice, wheat, and pulses from rotting. Castor oil cake is rich in protein but due to the presence of 'ricin' it is unfit for cattle feed. It is used as manure.

As per the data reported by the Solvent Extractors' Association of India (https://seaofindia.com), India produced 19.03 lakh tons of castor seed from 8.26 lakh ha with average productivity of 2303 kg/ha during the year 2020-21 (Table 1.1). The major castor-producing states in India are Andhra Pradesh, Gujarat, Karnataka, Odisha, Rajasthan, and Tamil Nadu. Gujarat has emerged as the

[3] https://seaofindia.com/export-of-castor-oil-2018-to-2021-jan-dec/
[4] https://oec.world/en/profile/hs92/castor-oil-seeds

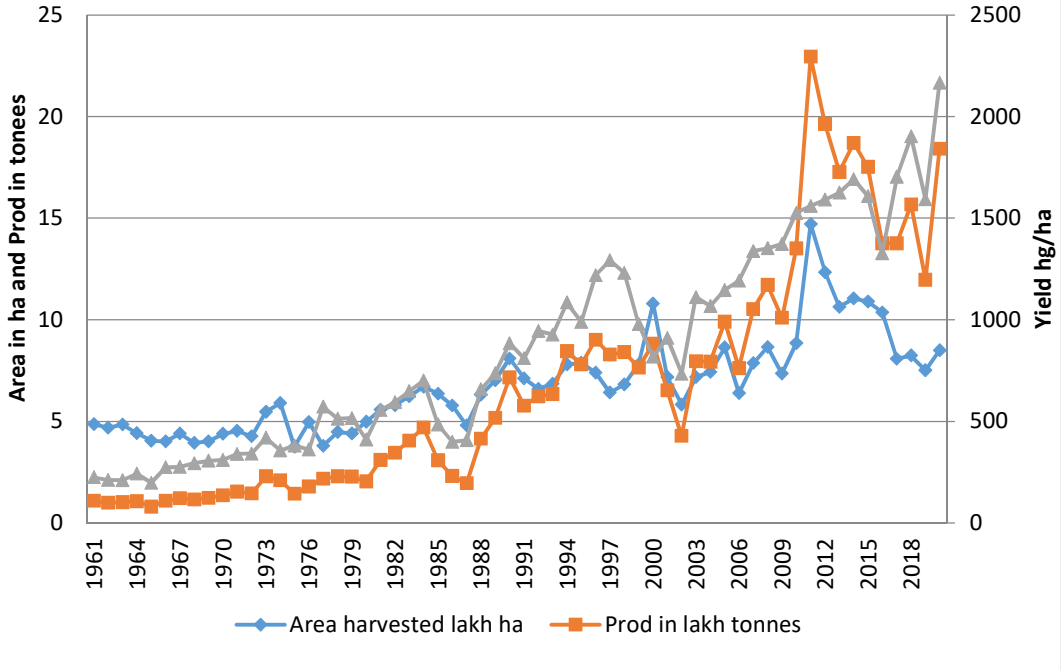
largest castor-producing state in the country with 77.24 per cent share in area and 85.6 per cent share in production followed by Rajasthan and Andhra Pradesh (including Telangana) in 2020-21. Over the period, castor seed production in India has increased by almost 17 times in 2020 over 1961, i.e. from 1.09 lakh tonnes to 18.42 lakh tones, which was mainly due to an almost 10 times increase in productivity, followed by 1.7 times increase in area under castor oilseed crop (Fig. 1.3). Thus, an increase in castor seed production has also automatically resulted in increase in castor oil production in India (Fig. 1.4)

Table 1.1: State-wise Area, Production and Yield of Castor Seed in India 2019-20

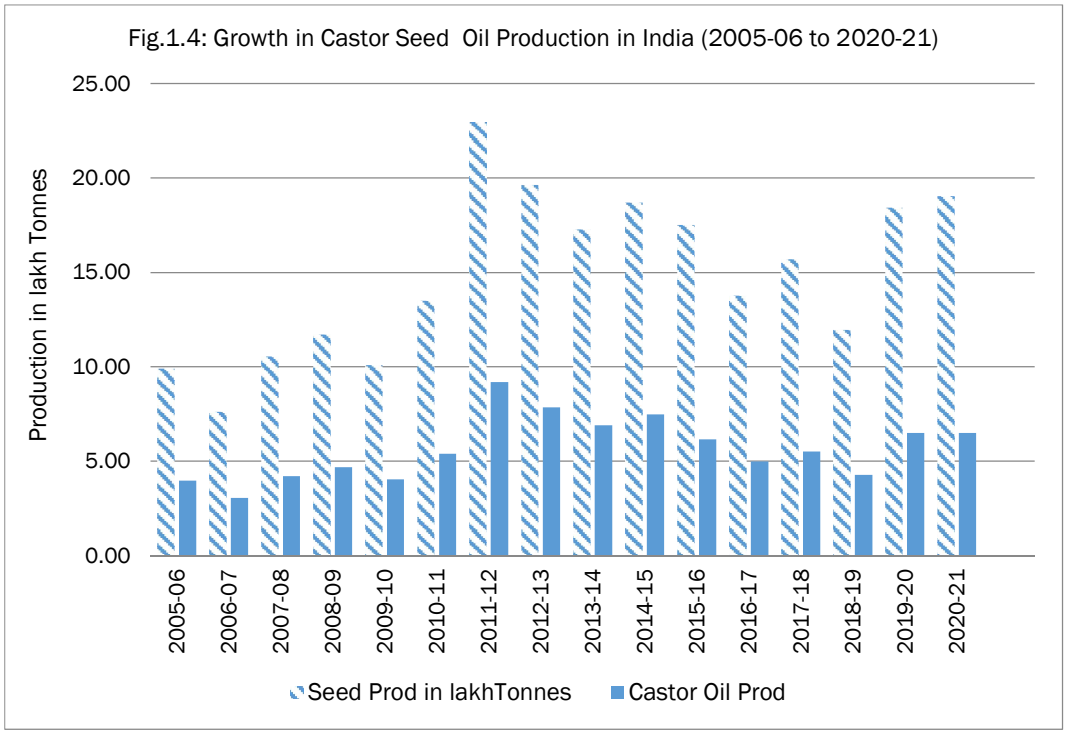
Sr. No	States	Area in 000 ha		Production (000 tonnes		Yield (kg/ha)	
		2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
1	Gujarat	741	638	1659.3	1629	2231	2553
2	Rajasthan	154	126	245.3	236	1593	1876
3	AP & Telangana	57	38	33.0	23	575	589
4	Others	40	24	24.00	15	600	630
	India	992	826	1961.6	1903	1968	2303

Notes: Other states include Maharashtra, Karnataka, Tamilnadu and Odisha.
Source: https://seaofindia.com/castor-seed-area-production-yield-2014-15-to-2017-18/

Fig. 1.3: Growth in Castor Seed Production in India (1961-2021)



Source: FAOSTAT, 2022.



Source: Estimated from data- GOI (2022), Agricultural Statistics at a Glance.

The area under castor crop was reported to be 8.26 lakh ha (20.42 lakh acres) during 2021-22 as against 9.92 lakh ha (24.52 lakh acres) during the 2020-21. Among states, Gujarat is leading with 6.38 lakh ha (15.77 lakh acres) under castor followed by Rajasthan (1.26 lakh ha, 3.11 lakh acres), Andhra Pradesh (0.38 lakh ha, 0.94 lakh acres) and Telangana 0.24 lakh ha, 0.59 lakh acres). According to advance estimates, castor production was at 19.03 lakh tonnes in 2020-21 and estimated to be about 15.08 lakh tonnes in 2021-22.

Table 1.2: State-wise area under castor in India (2020-21 & 2021-22 Provisional)

State	2020-21			2021-22 (Provisional)		
	Area (lakh ha)	Area (lakh acres)	% to total area	Area (lakh ha)	Area (lakh acres)	% to total area
Gujarat	7.41	18.32	74.70	6.38	15.77	77.24
Rajasthan	1.54	3.81	15.52	1.26	3.11	15.25
AndhraPradesh	0.57	1.41	5.75	0.38	0.94	4.60
Telangana	0.4	0.99	4.03	0.24	0.59	2.91
All India	9.92	24.52	100.00	8.26	20.42	100.00

Sources: www.agricoop.nic.in, https://seaofindia.com/castor-seed-area-production-yield-2014-15-to-2017-18/

Thus, the cultivation of castor seed is mainly confined to Indian western states like Gujarat and Rajasthan which together contribute 98 per cent to total production in 2020-21. Gujarat has the largest share in the country's castor seed production with 85.60 per cent share followed by Rajasthan (12.40%). Gujarat state ranks first position in the country with respect to area and production and productivity because the majority of farmers are adopting hybrid varieties and cultivating this crop as an irrigated crop. In Gujarat, the *kadi* area (Mehsana district) has the world's highest castor seed yield in kilograms per hectare. Important castor growing districts in Gujarat are Mehsana, Sabarkantha, Banaskantha, Kutch, Ahmedabad, Kheda, Vadodara, Rajkot, Jamnagar and Gandhinagar. Important castor growing districts of Rajasthan are Barmer, Jalore, Jodhpur and Sirohi. Productivity of farms in Rajasthan has been on a rise too owing to the adoption of quality or hybrid variety castor seed, favorable weather, and adequate availability of water for irrigation. The most important castor growing districts in Andhra Pradesh and Telangana are Ananthapur, Kurnool, Mahbubnagar, Wanaparthy, Gadwal.

During the last four decades, Gujarat state has registered the highest area under castor as well as the highest production and productivity (Saisri and Dhandhalya, 2020). In the beginning of the 1970s, the area under castor in Gujarat was just 58.5 thousand ha which increased to around 6.38 lakh ha in 2020-21. Besides, production and productivity also increased remarkably during the last five decades. Rajasthan also witnessed the same trends, but Andhra Pradesh, Karnataka, Odisha and Tamil Nadu did not observe such trends (Saisri and Dhandhalya, 2020). Production, as well as productivity of castor in Gujarat, has significantly risen during the last decade. The details analysis of sources of output growth of Castor in Gujarat is presented in Chapter II.

1.2 Review of Literature:

There is very little research work being done on the topic under study which is reviewed and presented in this section.

SADU (2012) noted that castor crop productivity is low due to various biotic and biotic factors, amongst these wilt caused by *Fusarium oxysporium* is the major constraint followed by partial/improper adoption of recommended technology also

led to low productivity of castor. Besides, for value addition in the harvesting and processing, it was found that the local sickle, improved sickle, and secator were evaluated for efficient harvesting of castor crop (variety- GCH-7) and minimum losses. The author suggested that improved technology for drying cleaning, grading and bulk packaging will improve the quality of raw material for industrial supply and increase the farmer's income.

Devi and Suhasini (2014) attempted value chain mapping and value chain analysis of castor in the Mahabubnagar district of Andhra Pradesh by evaluating marketing margins and price spread marketing efficiency and economics of value addition in different marketing channels and problems associated with it. The study concluded that if proper marketing arrangements are carried out to facilitate the contracts with farmers, the share of a farmer in the value addition would necessarily enhance. Since the oil extraction units are of small scale in nature in this backward district of the state, the cost of value addition realized was quite high and this can be reduced by increasing the capacity of the existing firms thereby reducing the long-run average costs so that large scale economies can be realized.

Kammili Anjani (2014) reviewed the global scenario of castor growing and noted that there is a tremendous scope to establish castor as an added crop production option for smallholder farmers which can provide significant returns on investment as well as help to build sustainable agriculture in the future in many quarters. The author suggested that the governments and private stakeholders should come forward to support castor cultivation and establish industries related to castor processing and production of castor derivatives to realize the great economic potential of castor. Besides, inter-disciplinary collaborations in research projects are needed to ensure the sustainability of the castor.

Bhatt, *et al.*, (2018) analyzed the economics of castor production and identified problems faced by farmers in the production and marketing of castor seed in Rajkot district. The authors have concluded that in the study area, the farmers between 36 to 50 years have adopted agriculture as their profession and all farmers were married. It was found that the majority of farmers lived in a nuclear family. The majority of the farmers have up to 5 members in their family thus, belong to a small size family, education was up to higher secondary level,

annual income was between Rs. 1 lakh to 2 lakhs and the majority of the farmers were small farmers (own land up to 2 ha). It was further observed that castor seed production is a profitable activity. The major problems faced by farmers in castor production and marketing were insufficient/ delayed rainfall and high transport cost.

Kumar et al., (2019) studied energy usage and benefit-cost analysis of castor production in Haryana state through farm-level data collected from rain-fed and irrigated castor seed cultivators from three purposively selected districts namely Rewari, Sirsa and Hisar. From each selected district, two villages were selected purposively having a large number of castor cultivators. Using the survey method, relevant information related to various energy utilized in castor seed production was extracted from sixty castor cultivators. The aim of this research was to determine the energy input and output involved in castor production in Haryana. The average energy consumption of the farms investigated in this study was estimated to be 11064.18 $MJha^{-1}$ of the total energy, 23.67 per cent was direct and 56.56 per cent was indirect. Renewable energy accounts for 3.49 per cent and energy usage efficiency was found to be 5.92. The total energy input into the production of one kilogram of average castor was estimated to be 8.55 MJ. The dominant contribution to input was energy in the form of nitrogen fertilizer (32.86%), followed by water for diesel oil (20.61%) and irrigation (19.77%). The cost of castor production was found to be Rs. 97412/- per hectare in the region, with 52.70 per cent of this being fixed costs. It can be concluded that intensive castor farms are being operated in the area since the fixed cost was quite high. As a result of the benefit-cost ratio (1.48) analysis, castor production was found to be economically efficient.

Kumar and Yamanura (2019) attempted to know the farmer's perception on castor-based farming and reasons for the yield gap in the traditional and non-traditional tracts of Karnataka. It was known from the status report of Directorate of Economics and Statistics, Government of Karnataka 2017-18 that, Karnataka has an immense potentiality of castor, especially in the agro-ecosystems which are often threatened by the vagaries of monsoon. However, a total of 9527 ha farmland was occupied by castor with average productivity of 522 kg/ha as against the national average productivity of 1713 kg/ha. With this, Karnataka could contribute 4722

tons of castor to national production. Concurrently, a study was initiated through purposive sampling techniques to understand the probable reasons for the huge gap in yield. The sample unit in traditional castor growing areas consisted of the farm units of Tumkur, Chitradurga, Ramanagar, Hassan, Bengaluru Rural and Kolar Districts where annual rainfall ranges from 550-700 mm whereas non-traditional castor growing track which receives a fairly higher amount of rainfall (850-2000 mm) coupled with time-bound irrigation facilities included Mandya, Mysore and Chamarajanagar districts. From the study, it was observed that the average productivity of castor in traditional and non-traditional tracts seldom exceeds 500 kg/ha except in Chitradurga district (1875 kg/ha). Further, it was also observed that more than 70 and 92 per cent of the farmers in traditional and non-traditional areas respectively were not been exposed to present-day improved cultivars and production technologies. The important factors which discouraged the castor farmers were inadequate rainfall, lack of farm gate procurement, longer duration of crop, lack of fodder value, lack of quality seed material in the state seed chain with subsidized distribution and biotic stresses like gray-mold and capsule borer infestation, etc. These factors are limiting the farmers to adopt improved technologies as a result of which the gap in the yield is widening over the years.

Guha and Sankarsana_(2014) estimated the economics of castor seed cultivation in India_from the available databases of cost of cultivation study and generated estimates on gross return from castor cultivation in India and its economic viability. The study has revealed that the cultivation of castor plants and production of castor seed is economically viable to the farmers as the farmers are expected to get a good return from the cultivation of castor though there is sluggish demand during the current year which may be a temporary phenomenon. There is a demand for castor oil in the domestic and international markets. The average gross return from castor production in Gujarat was estimated to be Rs. 32, 344 per hectare and estimated average (A2+FL) cost per quintal and C2 cost per quintal were Rs.1883/- and Rs.2679/-, respectively. The average gross return from castor production in Rajasthan was estimated to be Rs. 16,506 per hectare and estimated average (A2+FL) cost per quintal and C2 cost per quintal were Rs. 2447/- and Rs. 3848/- respectively. In the international market, prices range from

$44 to $70 and in the domestic market price was Rs.3550/- Rs.4000/- per quintal so at present cultivation of castor seed plant is economically viable in India.

Sodhi and Thakar (2019) conducted a study in Banaskantha district of Gujarat covering five talukas and analysed the marketing problems faced by castor growing farmers. Primary data were collected from 225 castor growing farmers. Six marketing problems were focused on and the study includes price information and fluctuation, delay in cash payment, high cost of transportation, lack of transportation facility, lack of storage facility, and distant markets. The farmers were confronted with major problems viz., lack of information on price fluctuation followed by the high cost of transportation and lack of transportation facilities in Palanpur and Kankrej taluka. In addition to these constraints, the distance market was also identified as a major constraint faced by the farmers in the marketing of castor.

Gondaliya *et al.,* (2020) noted that India has emerged as the largest exporter of castor oil with 86.1 per cent share in the world market during the year 2018. India exported more than 6.9 lakh tons of castor oil worth Rs. 6730 crore during the year 2017-18. Export of castor in terms of quantity as well as in terms of value has been significantly risen by 7.19 per cent and 11.93 per cent, respectively during the last decade. There is a large scope for improving India's earnings from castor by converting castor oil to various derivatives. With the world becoming more environmentally conscious and with the increasing replacement of synthetic products with naturally derived products, castor oil-based derivatives could find increasingly attractive markets worldwide.

Saisri and Dhandhalya (2020) analyzed the growth and instability in castor area, production and productivity during the period from 1976-77 to 2017-18. Authors noted that India has achieved a high rate of growth in area, production and yield of castor during 1986-87 to 1995-96 at the remarkable rate of 3.89, 15.42 and 11.10 percent per annum, respectively which was mainly due to the notable performance of Gujarat and Rajasthan. The major reason behind this performance was the release of hybrid castor varieties like GAUCH-1 in 1973 and GCH-2 in 1985. Besides, the release of castor varieties, viz., GCH-6 in 2000 and GCH-7 in 2006, Gujarat contributed largely in the recent production of castor. It was found that during the overall study period (1976-77 to 2017-18), at all India

level also, the rate of growth of area, production and yield increased considerably. Moreover, Andhra Pradesh recorded significant growth in production and productivity of castor, but its area declined significantly in the recent period. While, Karnataka and Odisha had witnessed deterioration in growth rates both in area and production. Rajasthan recorded the highest instability of 56.90 percent in the area, 74.21 percent in production and 33.24 percent in yield during the study period. It was suggested that instability observed in various states 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. The existence of wide variation in castor yield across growing states due to differences in climatic conditions, infrastructural developments, and utilization patterns need to be focused on for further improvement in yields.

The review of the literature indicates that though castor seed production is profitable and has export potential, issues like lesser adoption of a package of practices, high instability in production in some states, yield gap, and constraints in production and marketing still exist. Therefore, there is a need for proper in-depth analysis of the same.

1.3 Need of the Study:

Though the area and production of castor as well as its export are on an increasing trend, the castor farmers are facing the problems in the cultivation of crop. The farmers have been reporting production as well as marketing constraints (Bhatta, *et al*., 2018; Sodhi and Thakar, 2019). The input costs also have been reported to be risen, mostly on fertilizers, pesticides, and water. SDAU (2012) had noted that recommended technologies are being adopted partially or not adopted as the application of a recommended dose of fertilizer, application of sulphur, irrigation schedule, spacing and harvesting, etc. Further, castor seed produce after harvesting is not properly cleaned and dried, packing material used are mostly gunny bags and also contains foreign materials like iron nails, dust, stone, etc., such poor-quality produce gets less prices for farm produce.

Thus, there is a need to have insights into the problems, prospects and export potential of castor crop cultivation in Gujarat. In view of the same, the present study was undertaken with the following specific objectives.

1.4 Objectives of the study

The specific objectives of the study were as follows:

(i) to examine trends and pattern of growth of Castor area and production over time and across districts/regions and identify the sources of growth in Castor output in Gujarat;

(ii) determine the impact of price and non-price factors influencing the supply and demand for castor seeds in the state; and

(iii) to estimate the cost of cultivation and cost of production of castor seed in selected districts of Gujarat.

(iv) to identify major constraints in cultivation and suggest policy options to increase castor production and productivity in the state.

1.5 Data and Methodology:

1.5.1 Study Area

The present study was conducted for the state of Gujarat. For time-series data analysis, all the districts are classified into five regions, such as South, Central, North, Saurashtra, and Kutch regions as follows (Table 1.3):

Table 1.3: Details on Five regions in Gujarat

Sr. No.	Regions	No. of districts	Name of the Districts
1	Central Gujarat (CG)	10	Ahmedabad, Anand, Bharuch, Chota Udaipur, Dahod, Kheda, Mahisagar, Panchmahal, Vadodara, Narmada,
2	South Gujarat (SG)	05	Dang, Surat, Tapi, Navsari, Valsad
3	Saurashtra Gujarat (SUA)	11	Amreli, Bhavnagar, Jamnagar, Junagadh, Dev Bhoomi Dwarka, Gir Somnath, Porbandar Rajkot, Surndranagar, Morbi, Botad
4	North Gujarat Gujarat (NG)	06	Aravalli, Banashkantha, Ghandhinagar, Mehsana, Patan, Sabarkantha
5	Kutcchh Gujarat (KUTCH)	01	Kutcchh
	Gujarat (GUJ)	33	-

Source: GOG (2020).

1.5.2 Sources of Data

The present study is based on both secondary and primary data.

The secondary data were compiled from published papers, reports, and related websites (e.g. FAOSTAT, Solvent Extractors' Association of India, APEDA, MOA & FW GOI, etc.). The data on arrival and market rates were collected from the selected five APMCs in Gujarat to study the trend in the same. The secondary data on district-wise area, production, and productivity of castor crop in Gujarat were compiled for the period of last five-decade period, i.e. from 1970-71 to 2020-21. For the purpose of analysis, the total study period was divided into four sub-periods. The reasons[5] for studying these periods are the availability of reliable data from reliable sources (Table 1.4).

Table 1.4: Study Periods and Study Points for the Study

Sr. No.	Period	Years	Triennium Endings
1	Period I	1970-71 to 1979-80	TE 1972-73
2	Period II	1980-81 to 1989-90	TE 1982-83
3	Period III	1990-91 to 1999-00	TE 1992-93
4	Period IV	2000-01 to 2020-21	TE 2002-03, TE 2020-21
5	Overall	1970-71 to 2020-21	TE 2020-21

The primary data were collected from the selected castor growers from selected districts and villages in Gujarat. The multistage random sample method was used for selection of castor growers. The reference period for the primary data collection was the agriculture year 2020-21.

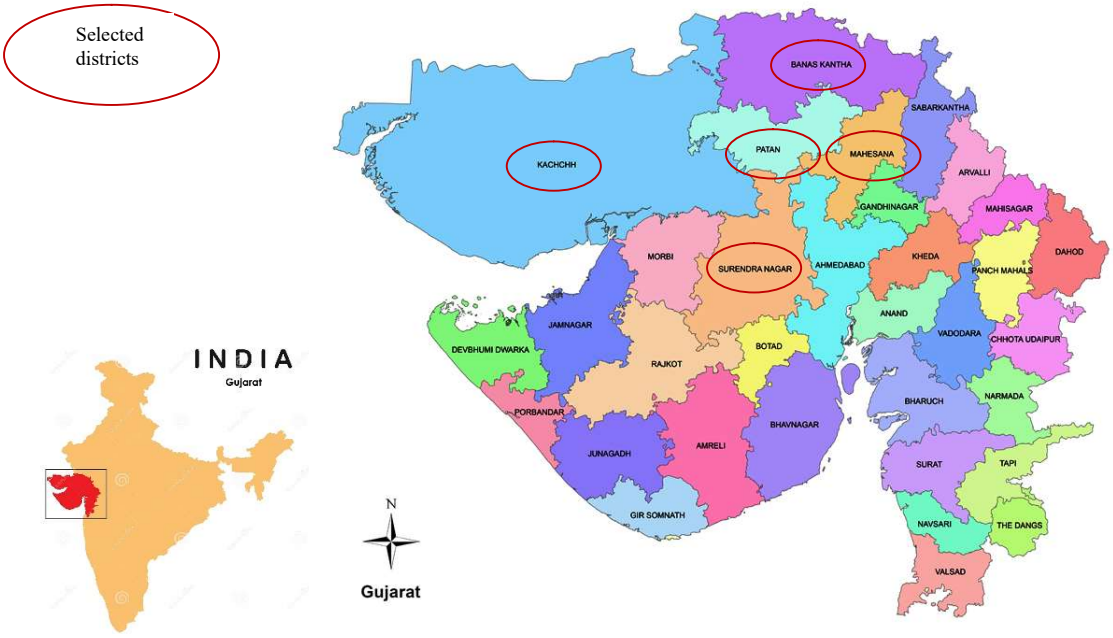
1.5.3 Sampling Framework:

- Out of the Castor growing states in India, the state having the highest area coverage under castor seed and its production was selected (proportion in production in total production at national level), i.e. state of Gujarat.
- Out of total 25 castor growing districts in Gujarat, top five major castor growing districts (on the basis of area under castor cultivation in 2020-21), viz. Banaskantha, Kutch, Patan, Mehsana and Surendranagar districts were selected for the detailed study (Map 1.1).

[5] The Gujarat state come in existence on 1960 as a result of this time series data for the period of 1960 decade are inadequate. Growth performance of Agriculture in Gujarat state gradually started in 1970 and it was better during 1980s (Pawar, 2022).

- From each district, two taluks/tehsils were selected on the basis of area coverage as per method adopted for the selection of districts.
  - Banaskantha -Bhabar, Kankrej
  - Kutch -Bhachau, Nakhatrana
  - Patan -Santalpur, Patan
  - Mehsana - Kadi, Mehsana
  - Surendranagar —Dashada, Lakhatar

Map 1.1: Location Map of the Study Area



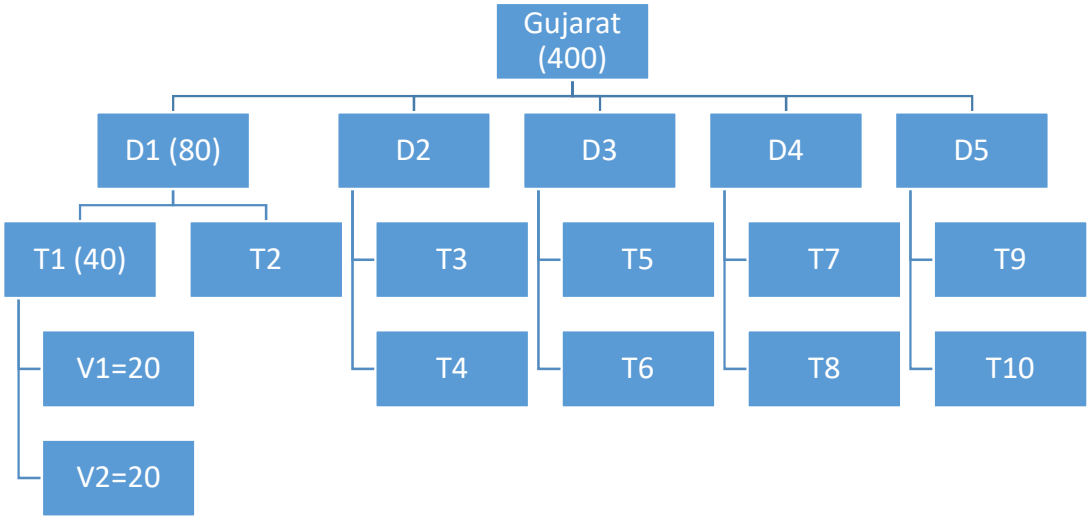
- From the selected taluka, two villages/cluster of villages (comprising 2-3 villages) were selected for conducting the survey, on the basis of the area under castor cultivation.
- A sample of 80 sample farmers were selected randomly from each district (40 from each tehsil- 20 from each village/village cluster).
- The total sample size was 400 respondents from five selected districts of Gujarat (Table 1.5).

- The sample farmers were classified into different farm size groups post-survey as per the size of the net operated area.
- Two farmers were selected by SRSWOR method from each land holding class. If in any village/cluster, a particular size class did not have two holdings or nil holdings, more holdings were selected from the adjacent size-classes so as to select total 20 cultivators per village.
- Currently the five size classes are operational holdings with area less than 1 hectare; operational holdings having area between 1 and 2 hectares, between 2 and 4 hectares, between 4 and 6 hectares and above 6 hectares (as per Cost Division, MOA&FW/CACP, MOA&FW, GOI classification).
- Castor- farmers growing castor as a **sole crop** were selected to estimate the cost of cultivation of same to avoid the joint cost intercropping/mixed cropping method if exist.
    - Data were collected for irrigated and rainfed cultivation as well as for local and hybrid cultivars.
    - Data were collected on
        - land holdings and cropping pattern
        - cost of cultivation
        - production and marketing constraints
- Few stakeholders (e.g. processor, exporter were interviewed in semi-structured schedules to get an idea about the issues related to the processing of castor seed and export of castor seed oil from India.

Table 1.5: Details on Number of Sample respondents

Sl.	Districts	Talukas	Farmers
1	Patan	Santalpur, Patan	80
2	Banaskantha	Bhabar, Kankrej	80
3	Mehsana	Kadi, Mehsana	80
4	Surendranagar	Dashada, Lakhatar	80
5	Kutch	Bhachau,Nakhatrana	80
T	05	10	400

Fig.1.5: Sampling Framework for Selection of Sample Castor Growers



1.5.4 Analytical Tools:

Simple tabular analysis was used for data analysis. SPSS 20 data analysis package was used for data analysis. The statistical tools like mean, standard deviation, standard error and 't' test were used for data analysis.

1.5.4.1 Extent of Instability- Coefficient of Variation (C.V) & CDVI

Inter-regional variations in area/production/yield of crop was examined by estimating the statistical measure of mean and coefficient of variation (C.V).

Coefficient of Variation = (Standard Deviation / Mean) * 100.

$$CV = (SD/\bar{X}) * 100.$$

Cuddy Della Valle Instability index (Cuddy and Della Valle 1978) is a modification of the coefficient of variation to accommodate trend present in the data, which is commonly present in economic time series data. This method is superior over the scale-dependent measures such as standard deviation. The Cuddy Della Valle index (CDVI) is calculated as follows:

CDVI = CV*X or CDVI = $CV^* (1 - R^2)^{0.5}$

Where, X = $\sqrt{1 - R^2}$, CV is the coefficient of variation, and R^2 is the adjusted coefficient of determination.

The ranges of CDVI (Rakesh Sihmar, 2014) are given as follows:

- Low instability = between 0 and 15
- Medium instability = greater than 15 and lower than 30.
- High instability = greater than 30

1.5.4.2 Compound/Annual Compound Growth Rate:

In order to examine the growth performance, the compound growth rates were estimated for different periods by fitting the exponential function given below:

The CGR was calculated by fitting the exponential function given below:

$Y = a\, b^t$ ..... (1)

Where, Y = area/production/productivity

a= constant

b= regression co-efficient

t= time variable

Thus, natural log on both the sides of eq-(1) was taken to convert it in to linear form.

Log Y = log a + t log b ..... (2)

and CGR (%) was work out using following formula:

CGR (%) = antilog of b – 1 × 100

1.5.4.3 Component Analysis

In order to measure the relative contribution of area and yield (independent variable) towards the total output change (dependent variable) with respect to individual crop, component analysis model has been used by many researchers (Bastine and Palanisami, 1994, Bhatnagar and Nandal (1994), Mundinamani *et. al.*, (1995), Gupta and Saraswat (1997), Singh and Ranjan, (1998), Siju and Kombairaju (2001) has been used in this study.

$\Delta P = A \circ \Delta Y + Y \circ \Delta A + \Delta A \Delta Y$ ... (3)

Where,

$P_n - P_o = \Delta P$

$A_n - A_o = \Delta A$

$Y_n - Y_o = \Delta Y$

Change in production = Yield effect + Area effect +Interaction effect

Thus, due to two major parameters/variables, viz. Area and Yield, change in production is possible which can be decomposed into three effects viz. Yield, Area and Interaction effects.

As mentioned earlier, the selection of the study period was mainly due to the availability of data for this period of time (Table 1.6).

Table 1.6: Data Points for Decomposition Analysis

Sr. No.	Period	Years
1	Period I	Base TE 1972-73, Current TE 1982-83
2	Period II	Base TE 1982-83, Current TE 1992-93
3	Period III	Base TE 1992-93, Current TE 2002-03
4	Period IV	Base TE 2002-03, Current TE 2020-21
5	Overall	Base TE 1972-73, Current TE 2020-21

1.5.4.4 Decomposition Analysis:

In order to measure the relative contribution of Area, Yield, cropping pattern, and their first and second order interactions on the production at the State level, seven-factor decomposition technique developed by Minhas and Vaidyanathan (1965) was used.

$P_t = A_t \Sigma Wi\ C_t Y_t$

$P_0 = A_0 \Sigma Wi\ C_0 Y_0$

$P_t - P_0 = (A_t - A_0)\Sigma WiCioYio + Ao\Sigma WiCio\ (Y_{it}-Y_{i0}) + Ao\Sigma WiYio\ (C_{it}-C_{i0}) +$

$(A_t-A_0)\ \Sigma WiYio\ (C_{it}-C_{i0}) + (A_t-A_0)\ \Sigma WiCio\ (Y_{it}-Y_{i0}) +$

$Ao\Sigma Wi(C_{it}-C_{i0})(Y_{it}-Y_{i0}) + (A_t-A_0)\Sigma\ Wi(C_{it}-C_{i0})(Y_{it}-Y_{i0})$

Where,

P_t = Production in current period

P_0 = Production in base period

Wi = Weight used (average of three years farm harvest prices)

C_{io} =.Cropping pattern in base years.

C_{it} = Cropping pattern in current years

Y_{io} = Yield in base year

Y_{it} = Yield in current year

A_o = Area in base years

A_t = Area in current years

Farm Harvest Prices= 2014-15; 2015-16; and 2016-17

The factors responsible for a total change in the production of crops is decomposing into seven components, viz. Area Effect increase in production due to the area and in absence of any change in per hectare yield and cropping pattern, Yield Effect, the effect of Cropping Pattern (changes during the current period compared to the base period in the absence of any change in per hectare yield), first order interaction between area and yield, area and cropping pattern, yield and cropping pattern and the last component is the second-order interaction between the three variables viz. Area, Yield, and Cropping Pattern.

1.5.4.5 Cost of Cultivation and Production

The main focus of the study was on the estimation of the cost of cultivation and production of castor seed. The cost of cultivation of crops was worked out by using various cost concepts defined by CACP under item-wise breakup of operational cost of crop cultivation.

Incomes measure in relation to different cost concept:

- Farm business income = Gross income - Cost A1 .
- Owned farm business income = Gross income - Cost A2 .
- Family labour income = Gross income - Cost B2.
- Net income = Gross income - Cost C2.
- Farm investment income = Net income + Imputed rental value of owned land + Interest on fixed capital.
- Cost of production per quintal refers to the total cost divided by the main yield in the quintal.

- Cost A2+ FL refers to paid out cost or explicit cost plus imputed value of family labour.

The cost concepts like Cost A2+ FL was used for cost evaluation and to estimate the profitability in the cultivation of selected crops.

The cost of cultivation crop was worked out by using various cost concepts defined by CACP under item wise breakup of operational cost of crop cultivation.

Cost A1 : It includes all paid out cost

Cost A2 : Cost A1 + rent paid for leased-in land

Cost B1 : Cost A1 + interest on fixed capital (excluding land)

Cost B2 : Cost B1 + rental value of owned land + rent for leased-in land

Cost C1 : Cost B1 + imputed value of family labour

Cost C2 : Cost B2 + imputed value of family labour

Cost C3 : Cost C2 + 10 per cent of cost C2 as management cost.

1.5.4.6 Major Constraints faced by the Castor growers

Garrett ranking method was used to identify the major constraints faced the selected farmer in the production of castor seed crop in the state. The responses of the sample farmers on the extent of severity of various constraints faced by them were ranked by using ordinal scores from 4 to 1 (severe =4, Moderate = 3, minor = 2, not important =1).

Per cent position= 100 (Rij – .50)/Nj

where

Rij- Rank given for the i^{th} factor by the j^{th} individual,

Nj- Number of factors ranked by the j^{th} individual

The per cent position was converted into scores by referring to the method suggested by Garrett and Woodworth (1981). For each factor, the scores of the respondents were added together and divided by the total number of respondents for whom scores were added. The mean scores for all the factors were arranged in descending order and the most influencing factors were identified through the ranks assigned. The major constraints considered for the study were

- technological (non-availability of suitable varieties, poor crop germination, lack of irrigation facilities, weeds infestation etc.),

- **agro-climatic factors** (drought at critical stages of crop growth, excessive rains, extreme variations in temperature etc.),
- **economic and institutional** (high-input cost on diesel, fertilizers, agrochemicals, shortage of human labour, low and fluctuating prices, problem of timely availability of seed, non-availability of other inputs, lack/poor extension services etc.), and
- **post-harvest, marketing and value-addition** (availability of marketing infrastructures and transportation facilities, high transportation costs, exploitation by market intermediaries etc.).

1.5.4.7 Seasonal Behaviour and Co-Integration of Castor seed prices

- Seasonal indices of market arrivals and prices of castor seed in the selected markets were estimated.
- Monthly seasonal indices were calculated in order to ascertain the long-run seasonal variations in arrivals and prices of castor seed.
- The co-integration analysis was carried out for this purpose to know the inter-market relationship between the domestic markets.
- The data used in the co-integration analysis consists of monthly wholesale prices of six castor seed-dominated markets i.e. Dasada (Surendranagar District), Radhanpur (Patan), Bhabhar (Banaskantha), Thara (Banaskantha), Mehsana (Mehsana District) and Kadi (Mehsana district) markets of Gujarat for the period from 2011 to 2021.
- Granger and Vector error tests for basic relationships are commonly used to test for the existence of market integration (discussed in Chapter III).

1.5.4.8 Export Competitiveness

There are different measures to assess the global competitiveness of agricultural commodities. But commonly used global competitiveness indices are Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), Effective Subsidy Coefficient (ESC) and Domestic Resource Cost (DRC). NPC is the simplest one that measures the divergence of domestic price from the international price.

NPC was estimated as a ratio of domestic price to border prices.

$$NPC = Pd / Pb$$

Where,

P d = Domestic price

P b = Border price

An NPC greater than one discouraged the export of that particular commodity. On the other hand, NPC less than unity measures the degree of competitiveness. It measures the competitiveness from the viewpoint of a trader.

1.6. Limitations of the Study

The major limitation of the study was the non-availability of a particular size class of holdings in the selected village. Also, it was difficult to get an exporter of castor seed oil for an interview and therefore only one exporter was interviewed. The difference in data on APY of castor seed reported by MOA&FW and SOEI and online sources (GOG, etc) was another major issue.

1.7 Scheme of Chapters

The present report is organized into five chapters. The first chapter discusses the background, rationale, review of literature, objectives of the study, coverage, sampling design, limitations, and organization of the study. Chapter II presents the details on castor cultivation in Gujarat based on secondary data sets. The third chapter presents an overview of the supply and demand analysis of the castor seed as well as its castor seed oil market at the global level, followed by the co-integration of major castor seed markets in India. Chapter IV mainly deals with the estimation of the cost of cultivation and the cost of production of castor seed in selected districts of Gujarat. Besides, the socio-economic characteristics, holdings of assets and cropping pattern, and related details are also presented. The details of other stakeholders in the marketing and export of castor seed oil are also presented in this chapter. The last chapter presents the summary, concluding observations, and policy implications of the study.

The next chapter presents the details on castor crop cultivation in the state of Gujarat.

Chapter II

Castor Cultivation in Gujarat

2.1 Introduction

Castor growing is considered as a step forward in the diversification and commercialization of agriculture in Gujarat. As mentioned in earlier chapter, Gujarat is India's largest producer of castor, accounting for about 85.60 percent of the total production of castor in the country (2020-21). The productivity of castor in the state is the highest not only in India but also in the world. This chapter examined the trends and pattern of growth in the area under castor and its production over the period of time at the State level as well as across the regions and identifies the sources of growth of Castor output in Gujarat.

2.2 Overview of Agriculture in Gujarat

Gujarat has historically been known for the business acumen of its people. Gujarat state has made rapid strides in its agriculture sector including the agribusiness sub-sector in the recent past. The spectacular agricultural growth in Gujarat in recent times has been a result of a well thought out strategy, meticulously planned and coordinated scheme of action, sheer hard work, and sincerer implementation of programme, the political will to take bold decisions and commitments to economic policy reforms by the state government. Agriculture in Gujarat has been transforming over time from traditional to high value-added commercial crops which can be seen from a shift in its cropping pattern from food grains crops to high value cash crops. While Gujarat's dairy success is well known, which is growing at 6-7 per cent per annum on a sustainable basis, the recent phenomenon of high growth comes from fruits and vegetables (dominated by banana, mango, potato and onions). Gujarat is India's largest producer of cotton, castor, cumin and isabgul. The state is the second-largest producer of sesame and groundnut in the country. The agricultural productivity of some crops in the state is highest in India as well as in the World. The productivity of mustard, castor, cotton, onion and potato is highest in the state compared to other states in India. The productivity of groundnut, bajra and banana is the second highest in India. The

trend in shifting of cropping pattern paved the ways for many ancillary industries in the areas of processing, packing, storage, transformation, etc. Agricultural growth in the state is favoured by the prevailing eight agro-climatic zones, enterprenuring farming community, policy support from the government, wealth of livestock population, extended coastline and contribution by the agricultural scientist and dedicated NGOs (Swain et al, 2012; Parihar et al, 2014).

The Gujarat government has aggressively pursued an innovative agriculture development program by liberalizing markets, inviting private capital, reinventing agricultural extension (Krishi Motsav, ikisan portal), improving roads and other infrastructure (Jyotigram Scheme) (Gulati *et al*, 2009; Shah *et al*., 2009; Kumar et *al*., 2010, Dholakia, 2010). The mass-based water harvesting and farm power reforms in dry Saurashtra and Kachchh, and North Gujarat have helped to energise Gujarat's agriculture (Shah *et al*., 2009). These semi-arid regions have outperformed the canal irrigated South and Central Gujarat. The shift in agriculture to 8 percent growth rate during the first decade of this century was mainly responsible for the shift of the overall state economy to higher growth path with 10.6 percent annual growth rate (Dholakia, 2010). For ensuring a systematic and coordinated approach to all-around the development of its agriculture sector, the Government of Gujarat had prepared in the year 2000 a 10-year plan called 'Gujarat Agro-vision 2010'. A comprehensive New Agro-industrial Policy was also announced in 2000. In the new industrial policy, the state has identified agro-industries as the major thrust area. The policy aims to spur investment in agro-processing, agro-infrastructure and hi-tech agriculture by monetary incentives (Kalamkar *et al,* 2014).

2.3 Changes in Cropping Pattern of Gujarat

The cropping pattern of Gujarat state has changed during the last five-decade period (1971-2021). While oilseed crops and cotton have remained the major crops in Gujarat, other important crops are spices, fruits and vegetables, and flower crops which have gained a share in GCA in recent years (Table 2.1). Overall, cropping pattern in the state after mid 1990s is responding to the forces of globalization. Commercialization does show the signs of deepening, as the crops having greater market-orientation and consolidating their share in the farm

economy of Gujarat. Crops such as cotton, oilseeds, fruits, vegetables, spices and flowers, amenable to processing and value addition, are on the increase. This calls for expansion of post-harvest facilities (including foreign investments in processing, refrigerated transport and cold storage). These crops inherently provide higher returns per unit of land, resulting in higher incomes and employment generation in the rural areas. Though the share of oilseed in total cropped area remained the same around 20 per cent during last five-decade period, share of castor crop in total cropped area has increased from 0.61 per cent in TE 1972-73 to 5.62 per cent in TE 2020-21.

Table 2.1: Cropping pattern in Gujarat: TE 1972-73 to TE 2020-21

Crop	Cropping pattern in Gujarat (%)					
	TE 1972-73	TE1982-83	TE 1992-93	TE 2002-03	TE 2012-13	TE 2020-21
Rice	4.85	5.41	6.16	6.32	6.18	6.49
Jowar	11.25	10.22	6.22	2.11	0.86	0.77
Bajara	18.67	13.84	13.41	10.80	6.12	3.20
Maize	2.57	2.90	3.53	4.56	4.03	3.25
Wheat	4.95	5.96	5.46	3.99	11.40	7.80
Moog	1.10	1.81	1.56	1.63	1.65	1.22
Gram	0.55	0.97	0.98	0.41	1.44	1.50
Arhar	0.90	2.78	3.99	3.24	1.96	2.25
Food grains	49.00	48.26	44.24	35.55	34.50	28.04
Groundnut	18.31	19.88	17.73	17.70	14.12	12.71
Sesumum	1.15	1.22	2.34	3.24	1.74	1.14
Castor	**0.61**	**1.80**	**3.33**	**3.72**	**5.54**	**5.62**
Oilseeds	**20.72**	**24.73**	**26.84**	**27.01**	**22.48**	**21.19**
Cotton	19.52	14.11	9.52	15.93	21.14	20.29
Sugarcane	0.41	1.03	1.63	2.43	1.49	1.30
Tobacco	0.85	1.10	1.27	1.10	1.12	1.38
Spices	0.00	0.00	0.00	1.71	4.23	4.19
F & V	0.81	1.35	1.94	2.90	6.97	8.31
Flower	0.00	0.00	0.00	0.05	0.13	0.16
Other	8.69	9.42	14.57	13.32	7.93	15.14

Source: Crop & Season Reports, Department of Agriculture, GoG (Various years) & Office of GOG.

2.4 Growth in Oilseed Production and Share of Castor Seed

Gujarat is one of the leading states in the production of oilseeds in India. As per the latest available datasets (GOI, 2022), Gujarat is the fourth largest grower as well as producer of the oilseed in India contributing 10.6 percent and 14.9 percent respectively in 2020-21. The state is ranked second position in terms of productivity of oilseeds recording yield level of 1775 kg/ha. While across the

oilseed crops, State ranked top position in terms of acreage under and production of groundnut crop in India, contributing 33.12 per cent and 41.71 per cent respectively. Along with the increase in production of total oilseed in India, the share of castor seed in area and production of total oilseeds in Gujarat has increased during last five-decade period (Fig. 2.1 and 2.2).

Fig. 2.1: Growth in Total Oilseed Production in Gujarat

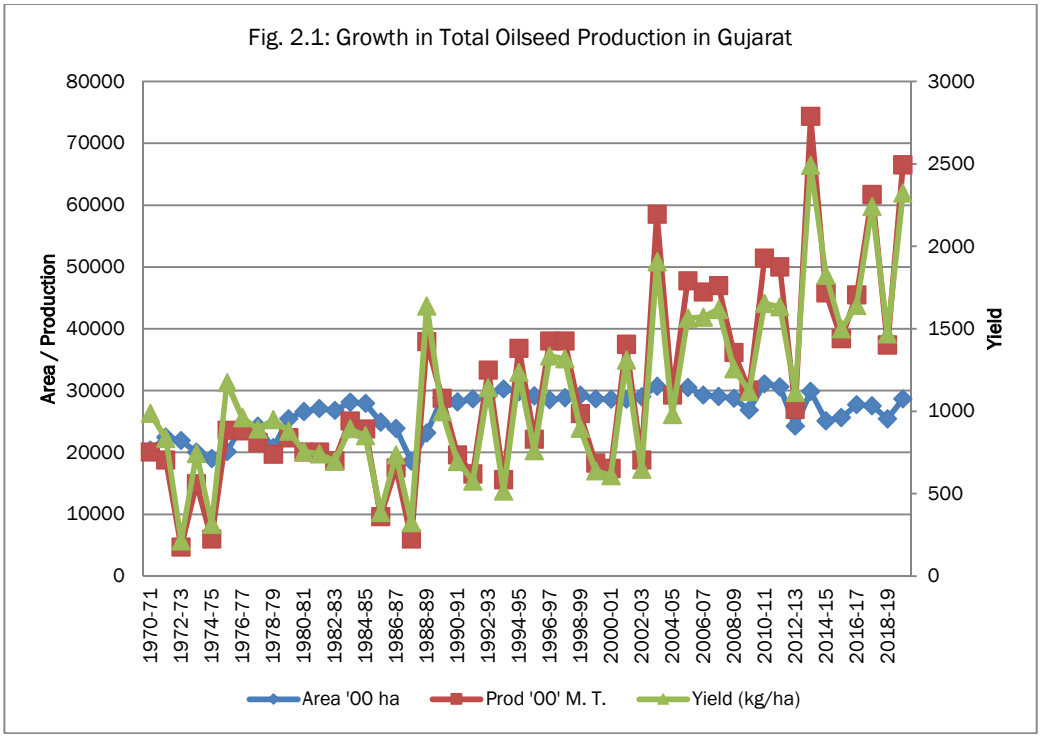
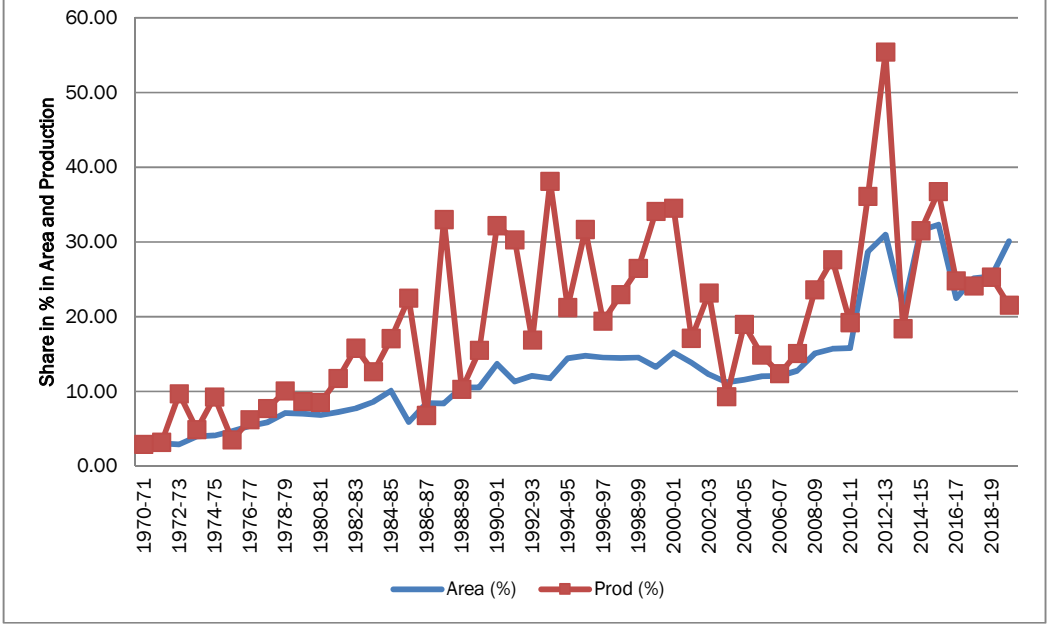


Fig. 2.2: Share of Area and Production of Castor Seed in Total Area and Production of Oilseed in Gujarat



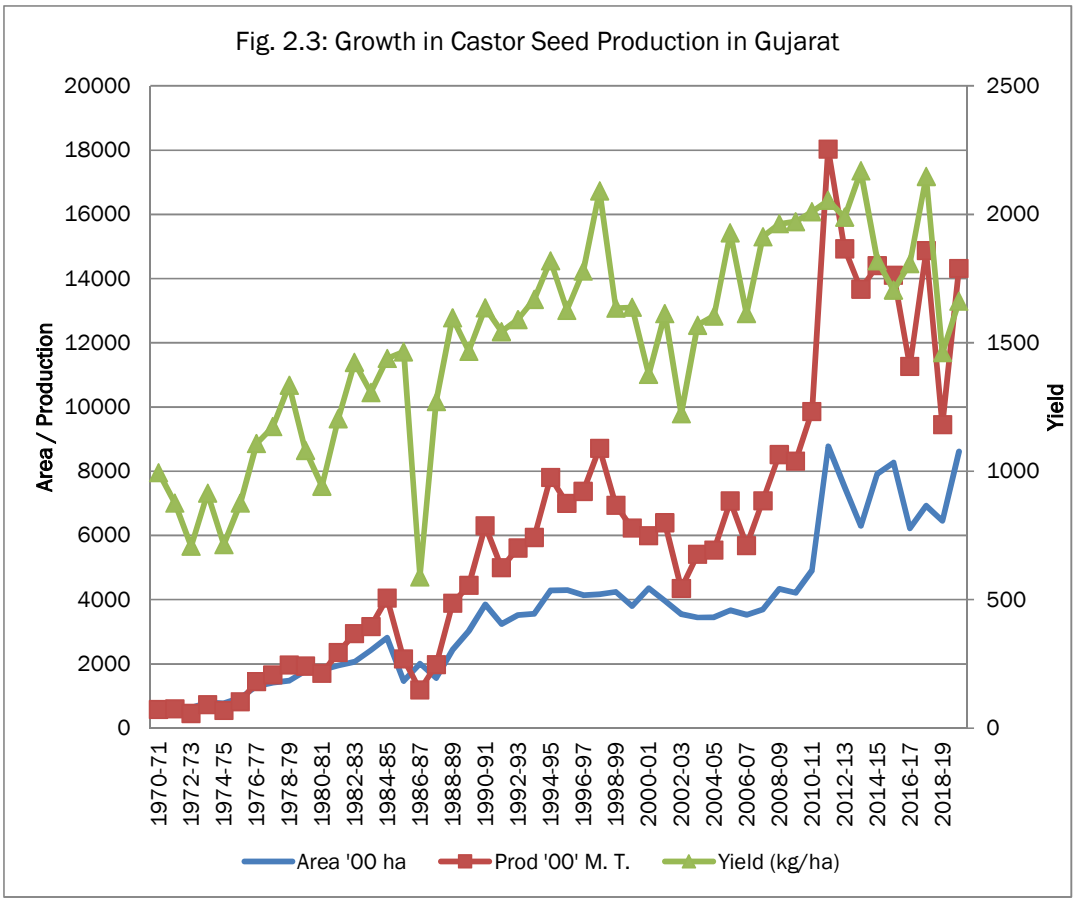
2.5 Sources of Output Growth of Castor

Castor is a *kharif* non-edible oilseed crop grown in the state, which had occupied around 6 percent share in the gross cropped area of the state during TE 2020-21 (estimated). The castor growing area in Gujarat is increasing day by day. Farmers are cultivating castor crop as a sole crop, intercrop and mix crops under irrigated as well as rainfed conditions. The top five major castor growing districts in the state are Banaskantha, Kutch, Mehsana, Surendranagar and Patan in 2020-21 (Table 2.2).

Table 2.2: Area under Castor Cultivation in Major districts of Gujarat in 2020-21

Sr. No.	District	Gujarat State – Castor Cultivation- (2020-21)	
		Area in ha	% to State total
1	Kachchh	126435	19.82
2	Patan	99588	15.61
3	Banaskantha	98866	15.50
4	Mahesana	81395	12.76
5	Surendranagar	65049	10.20
6	Ahmedabad	47571	7.46
7	Gandhinagar	24772	3.88
8	Vadodara	23899	3.75
9	Sabarkantha	23582	3.70
10	Kheda	12230	1.92
11	Aravalli	10551	1.65
12	Morbi	6585	1.03
13	Rajkot	5577	0.87
14	Jamnagar	3204	0.50
15	Mahisagar	3113	0.49
16	Panchmahals	1976	0.31
17	Bharuch	1860	0.29
18	Amreli	668	0.10
19	Anand	489	0.08
20	Narmada	166	0.03
21	Tapi	113	0.02
22	Botad	108	0.02
23	Surat	88	0.01
24	Devbhumi Dwark	74	0.01
25	Chhota Udepur	61	0.01
	Gujarat State	638020	100.00

Source: Office of the Department of Agriculture, Govt. of Gujarat.



Castor is heavily growth in the northern area of Gujarat. The region-wise share in area and production of castor in Gujarat at six time periods are presented in Table 2.3. It can be seen from the table that north Gujarat region alone accounted for half of the area and about 58 per cent of production of Castor in the state. During the last five-decade period, only Saurashtra region has gained significant share in total area while Saurashtra and North Gujarat reported increase in production in TE 2020-21 as compared to TE 1972-73 (Table 2.3). In absolute term also, except South region, all other regions have reported increase in area and production, while all regions reported increase in level of productivity of Castor (Table 2.4). The highest variability in area and production is estimated in Saurashtra region (Table 2.5). The significant positive growth rates were estimated in area and production of castor in both major regions of the states during all periods, while Central region in period I and North region in period III has experienced decline in productivity level as indicated by the negative rate of growth (Table 2.6).

Table 2.3: Region-wise Share in Area and Production of **Castor** in Gujarat

Sr. No	Region	Region-wise Share in total area/production (%)-**Castor**						
		TE 1972-73	TE 1982-83	TE 1992-93	TE 2002-03	TE 2012-13	TE 2020-21	% point increase in TE2020-21 over TE 1972-73
A	**Area**							
1	Central	10.07	13.02	14.49	11.69	13.97	17.96	7.89
2	South	2.67	1.18	0.26	0.19	0.21	0.04	-2.63
3	Saurashtra	3.62	1.85	11.27	13.46	14.86	13.86	10.24
4	North Gujarat	65.71	72.90	63.80	62.66	54.76	52.26	-13.44
5	Kutch	17.93	11.06	10.18	12.02	16.21	15.87	-2.06
	Gujarat	100.00	100.00	100.00	100.0	100.0	100.00	
B	**Production**							
1	Central	12.19	13.35	11.50	8.45	13.03	18.35	6.15
2	South	3.31	1.23	0.22	0.14	0.21	0.04	-3.26
3	Saurashtra	3.80	1.40	11.42	12.93	17.11	11.46	7.66
4	North Gujarat	58.15	80.21	71.19	66.29	54.40	58.43	0.28
5	Kutch	22.55	3.81	5.67	12.18	15.25	11.72	-10.83
	Gujarat	100.00	100.00	100.00	100.0	100.0	100.00	

Source: GOG (SCR, various years).

Table 2.4: Regionwise Growth in Area, Production and Productivity of **Castor** in Gujarat

Sr. No.	Region	Growth in APY- **Castor**						
		TE 1972-73	TE 1982-83	TE 1992-93	TE 2002-03	TE 2012-13	TE 2020-21	% increase over base
A	Area (00 ha)							
1	Central	64	254	515	463	987	1135	1674.19
2	South	17	23	9	7	15	3	-85.29
3	Saurashtra	23	36	401	533	1049	876	3709.28
4	North Gujarat	418	1422	2269	2480	3868	3304	691.06
5	Kutch	114	216	362	476	1145	1004	780.29
	Gujarat	636	1951	3557	3959	7063	6322	894.49
B	Prod (00 tonnes)							
1	Central	66	312	648	472	1860	2329	3411.13
2	South	18	29	13	8	30	6	-68.81
3	Saurashtra	21	33	643	721	2442	1454	6936.85
4	North Gujarat	316	1872	4010	3699	7766	7418	2245.02
5	Kutch	123	89	319	680	2177	1488	1113.10
	Gujarat	544	2334	5634	5580	14275	12695	2233.64
C	Yield (kg/ha)							
1	Central	1036	1227	1257	1019	1885	2051	97.90
2	South	1059	1246	1357	1091	2045	2245	112.06
3	Saurashtra	899	907	1604	1354	2327	1660	84.73
4	North Gujarat	757	1316	1767	1491	2008	2245	196.44
5	Kutch	1076	413	882	1429	1901	1483	37.81
	Gujarat	856	1197	1584	1409	2021	2008	134.66

Source: GOG (SCR, various years).

Table 2.5: Regionwise Variation in Growth in APY of **Castor** in Gujarat

Sr. No.	Region	Coefficient of Variations in APY Growth- **Castor**					
		Period I (1970-71 to 1979-80)	Period II (1980-81 to 1989-90)	Period III (1990-91 to 1999-2000)	Period IV (2000-01 to 2009-10)	Period V (2010-11 to 202-21)	Overall Period V (1970-71 to 2020-21)
A	Area (%)						
1	Central	39.49	26.13	6.89	16.47	19.22	65.94
2	South	18.83	24.58	26.46	59.22	123.13	63.91
3	Saurashtra	34.54	59.84	34.33	24.33	27.43	88.73
4	North Gujarat	41.40	17.59	8.17	11.40	18.12	47.68
5	Kutch	56.49	31.61	17.29	17.95	31.13	70.93
	Gujarat	40.59	20.31	9.52	9.55	17.68	55.68
B	Prod (%)						
1	Central	45.54	49.26	19.19	38.18	22.07	88.37
2	South	15.18	46.73	58.21	47.80	121.97	76.92
3	Saurashtra	42.07	83.34	51.14	29.21	36.66	99.19
4	North Gujarat	63.56	35.54	9.60	23.49	15.73	65.40
5	Kutch	60.94	83.61	45.30	28.33	34.68	106.74
	Gujarat	56.64	39.11	16.49	20.47	18.31	74.32
C	Yield (%)						
1	Central	16.08	35.45	14.84	24.03	14.11	31.31
2	South	16.47	38.94	56.74	50.11	18.67	46.98
3	Saurashtra	22.18	34.51	38.21	31.67	26.75	49.94
4	North Gujarat	27.40	23.37	6.92	17.37	10.24	29.57
5	Kutch	47.15	68.51	38.94	16.71	26.69	54.15
	Gujarat	20.38	25.97	9.49	15.50	9.19	29.66

Source: GOG (SCR, various years).

Table 2.6: Rate of Growth in Area, Production and Productivity of **Castor** in Gujarat

Item	Region	Compound Growth Rate (%) **Castor**											
		Period I		Period II		Period III		Period IV		Period V		Overall Period	
		CGR	Sig	CGR	Sig	CGR	Sig	CGR	Sig	CGR	Sig	CGR	Sig
Area	Central	12.62	0.00	4.72	0.09	1.94	0.00	3.65	0.02	1.92	0.38	6.06	0.00
	South	-0.25	0.90	-7.38	0.00	-6.75	0.00	-7.79	0.18	-16.52	0.04	-4.56	0.08
	Saurashtra	8.32	0.03	12.09	0.11	4.09	0.36	1.56	0.55	-2.12	0.48	4.63	0.00
	North Guj	14.64	0.00	2.20	0.30	1.50	0.10	0.83	0.54	-1.34	0.44	2.82	0.00
	Kutch	13.75	0.09	0.18	0.96	2.41	0.27	2.49	0.25	-1.05	0.78	3.79	0.00
	Gujarat	13.70	0.00	2.54	0.29	1.82	0.09	1.45	0.21	-0.79	0.66	3.68	0.00
Prod	Central	12.30	0.00	5.51	0.38	4.66	0.02	10.62	0.00	3.59	0.14	9.70	0.00
	South	-0.96	0.63	-7.80	0.21	-21.01	0.02	2.25	0.59	-15.05	0.06	0.68	0.79
	Saurashtra	7.57	0.14	17.48	0.05	10.78	0.14	8.16	0.01	-6.56	0.15	4.47	0.01
	North Guj	23.81	0.00	3.57	0.45	1.37	0.20	4.54	0.06	0.28	0.87	5.46	0.00
	Kutch	8.52	0.39	-3.27	0.86	3.84	0.51	4.40	0.17	-4.38	0.48	4.57	0.03
	Gujarat	18.57	0.00	4.06	0.42	3.04	0.10	5.56	0.01	-0.46	0.82	5.78	0.00
Yield	Central	-0.28	0.89	0.75	0.89	2.67	0.11	6.97	0.00	1.66	0.19	3.64	0.00
	South	-0.71	0.74	-0.45	0.93	-15.30	0.07	10.04	0.10	1.47	0.46	5.24	0.00
	Saurashtra	-0.69	0.80	4.82	0.27	6.43	0.12	6.60	0.06	-4.43	0.23	-0.15	0.91
	North Guj	7.99	0.00	1.34	0.68	-0.13	0.88	3.71	0.02	1.62	0.07	2.64	0.00
	Kutch	-4.60	0.33	-3.45	0.83	1.40	0.78	1.90	0.26	-3.33	0.34	0.78	0.45
	Gujarat	4.28	0.06	1.48	0.69	1.21	0.24	4.11	0.00	0.33	0.72	2.10	0.00

Notes: CGR- Compound growth rate (per cent per annum); Level of significance can obtained by *100.
Source: GOG (SCR, various years).

Component analysis results indicate that the interaction effect (area and yield) followed by area effect was accounted for output growth of the Castor crop (Table 2.7). Decomposition analysis results indicated that interaction between area, yield and cropping pattern accounted for the highest share of 48 per cent in the output growth during the overall period (Table 2.8). Due to the decline in the area during period V, output growth of castor was estimated negative.

Table 2.7: Decomposition of Output Growth of Castor in Gujarat

Sr No	Particulars	Castor					
		Period I	Period II	Period III	Period IV	Period V	Overall
A	**Central Gujarat**	100.0	100.0	-100.0	100.0	100.0	100.0
1	Yield effect	5.0	2.3	-69.6	28.8	140.1	4.3
2	Area effect	80.3	95.3	-37.6	38.5	-29.8	39.0
3	Interaction effect	14.8	2.4	7.1	32.7	-10.4	56.7
B	**South Gujarat**	100.0	-100.0	-100.0	100.0	-100.0	-100.0
1	Yield effect	29.9	15.9	-53.2	31.8	50.6	253.6
2	Area effect	59.6	-106.5	-58.2	36.4	-106.9	-130.0
3	Interaction effect	10.5	-9.5	11.4	31.8	-43.7	-223.7
C	**Saurashtra**	100.0	100.0	100.0	100.0	-100.0	100.0
1	Yield effect	1.7	4.1	-128.6	30.1	1.8	1.8
2	Area effect	97.3	54.2	270.8	40.7	-101.4	37.8
3	Interaction effect	1.0	41.7	-42.2	29.2	-0.4	60.5
D	**North Gujarat**	100.0	100.0	-100.0	100.0	100.0	100.0
1	Yield effect	15.0	30.0	-201.2	31.5	562.1	8.7
2	Area effect	48.9	52.1	120.0	50.9	-392.4	29.2
3	Interaction effect	36.1	17.9	-18.7	17.6	-69.8	62.0
E	**Kutch**	-100.0	100.0	100.0	100.0	-100.0	100.0
1	Yield effect	-224.6	44.0	54.9	15.0	-309.1	3.3
2	Area effect	324.9	26.2	27.8	63.9	241.3	63.1
3	Interaction effect	-200.3	29.8	17.2	21.1	-32.2	33.5
F	**Gujarat**	100.0	100.0	-100.0	100.0	100.0	100.0
1	Yield effect	12.1	22.9	-1149.3	27.8	3380.9	6.4
2	Area effect	62.9	58.2	1179.2	50.3	-2953.9	35.7
3	Interaction effect	25.0	18.9	-129.9	21.8	-327.0	57.9

Source: Author Calculations.

Table 2.8: Percentage Contribution of different Variables to total increased Production of Castor in Gujarat

Sr. No	Particulars	Castor					
		Period I	Period II	Period III	Period IV	Period V	Overall
1	Area effect	17.8	23.7	105.7	27.9	-105.3	4.2
2	Yield effect	3.4	9.3	-103.0	15.4	120.5	0.8
3	Cropping Pattern Effect	16.7	24.5	110.0	17.4	-103.2	3.4
4	Interaction between area and cropping pattern	34.6	20.2	12.4	13.7	10.0	30.3
5	Interaction between area and yield	7.1	7.7	-11.6	12.1	-11.7	6.8
6	Interaction between yield and cropping pattern	6.7	7.9	-12.1	7.6	-11.4	5.4
7	Interaction between area, yield and cropping pattern	13.8	6.5	-1.4	5.9	1.1	49.2
	Total	100.0	100.0	100.0	100.0	-100.0	100.0

Note: TE GCA 2016-17.

2.6 Issues related to Castor Cultivation in Gujarat[1]

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 given in GCH-2, GCH-4, GCH-5, GCH-6, GCH-7, GC3, GNCH-1(rabi), GCH-8.

Table 2.9: Major Castor Varieties Grown in Gujarat

Variety	Seed Rate (Kg/ha.)	Sowing Time (In days)	Production (qtl/ha)
GAUCH-1(Hy)	5	15 July-15 August	20-25
GCH-2(Hy)(C)	5	15 July-15 August	25-30
GCH-4(Hy)(C)	5	15 July-15 August	25-30
GCH-5(Hy)	5	15 July-15 August	25-30
GCH-6(Hy)	5	1 July-15 August	30-35
GCH-7(Hy)	5	15 July-15 August	30-35
GCH-4(Hy)(L)	-	-	-
GCH-2(Hy)(L)	-	-	-

Source: http://www.gurabini.com/cropDetails.aspx?id=6

[1] Based on GOG (2018).

2.6.1 Low rate of SRR:

At present, the seed replacement ratio (SRR) of castor is reported to be 50 percent (GOG, SAP, 2018). 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 andhybrid seed production programs.

2.6.2 Constraints Analysis and Recommended Interventions for Castor Crop:

The yield gap analysis of castor crop and enterprises were carried out by State Agricultural Universities (SAUs) resource team identifying different farming situations under which a crop or an enterprise is being grown under each AES in the state (GOG, 2018). The study of the existing practices was followed by identifying critical gaps in comparing the existing practices adopted by the farmers with recommended practices. The factors and/ or constraints leading to the gaps were arrived at before finalizing the strategies along with approaches and methodology to overcome the constraints and bridging the gaps. Thereafter, the performance indicators and sustainability output are indicated to ensure time-bound action and impact assessment. Afterward, the sustainability and gap analysis issues were sorted out in a log frame summary indicating the proposed mode of action, collaborations/targets along with the costs involved in addressing the issues critical for increasing productivity with sustainability.

Issues listed

- Use of inferior quality seeds due to lack of awareness
- Lack of availability of quality seed
- Limited irrigation facility
- Unscientific crop management like spacing, fertilization, harvesting technology
- Poor management of issues related to soil fertility like no/ less sulphur and micronutrientapplication
- The occurrence of wilt and root rot diseases
- Infestation of semi-looper, capsule borer, thrips and whiteflies

2.6.3 Yield Gaps Analysis:

It can be seen from Tables 2.10 and 2.11 that the castor productivity was lower in some districts than the state average. There are some key reasons for yield gap. The major constraints for castor production in the state are

- Use of inferior quality seeds due to lack of awareness,
- Lack of availability of quality seed,
- Limited irrigation facility and lack of knowledge of critical stages,
- Unscientific crop management,
- Poor management of issues related to soil fertility like no/ less sulphur & micronutrient application
- Occurrence of soil borne disease and other insects,
- Faulty harvesting methods.

Soil fertility and fertilizer management and agricultural practices are one of the key issues for the yield gap. It might be due to an imbalance of NPK ratio and low or negligible sulphur application. The ideal ratio of NPK is 4:2:1.

The expected yield of castor can be increased in the next three years by adopting scientific technologies of the crop of SAUs, recommended dose of NPK along with Sulphur and micronutrients, adopting good agricultural practices, judicious use of water, timely plant protection measures, *etc*.

2.6.4 Reason for yield gap:

The NPK ratio is high, whereas the ideal ratio of NPK is 4:2:1. Therefore, if the line department of Agriculture, SAUs, KVK, and the extension department give training to the farmers and educate them to apply the chemical fertilizer as per recommended dose of NPK and S for castor and mustard crops and as per soil test value. Before sowing the crop, soil analysis is required to know the nutrient status of the soils and thereafter, apply the nutrients in the soil so as that maximum crop yield could be obtained.

Table 2.10: Average Yield of Castor Crop of the State along with Yield Gap.

Sr. No.	Castor	TE 2020-21	Gap %
1	Ahmedabad	1884.8	6.14
2	Anand	1862.7	7.25
3	Bharuch	1051.7	47.63
4	Chhota udaipur	1684.4	16.13
5	Dahod	1845.7	8.09
6	Kheda	1895.3	5.62
7	Mahisagar	1745.2	13.10
8	Narmada	1397.5	30.41
9	Panchmahal	2000.5	0.38
10	Vadodara	2395.2	-19.27
11	Dang		
12	Navsari		
13	Surat	2046.8	-1.92
14	Tapi	2454.8	-22.24
15	Valsad		
16	Amreli	1186.1	40.94
17	Bhavnagar	2507.6	-24.87
18	Botad	1359.9	32.28
19	Devbhoomi Dwarka	1886.4	6.07
20	Gir Somnath	2779.5	-38.41
21	Jamnagar	2517.2	-25.35
22	Junagadh	2576.4	-28.29
23	Morbi	2858.9	-42.36
24	Porbandar	2243.6	-11.72
25	Rajkot	1402.6	30.16
26	Surendranagar	1424.7	29.06
27	Aravalli	1635.7	18.55
28	Banaskantha	2455.7	-22.29
29	Gandhinagar	2393.3	-19.18
30	Mehsana	2478.9	-23.44
31	Patan	1823.8	9.18
32	Sabarkantha	2477.3	-23.36
33	Kutch	1482.8	26.16
	Gujarat	**2008.2**	**0.00**

Source: Estimated using GOG data.

Table 2.11: District–wise Castor Yield Gap Analysis

Sr. No	District	Average yield in q/ha			Yield Gap (%)	Reasons for gap
		District Average	State Average	FLD*		
1	Ahmedabad	1491	2074	3000	101.2	Not adopting recommended package of practices
2	Amreli	1891	2074	3000	58.6	Unscientific cultivation & input management
3	Anand	1470	2074	3000	104.1	Non-traditional area, not aware of recommended package of
4	Banaskantha	2195	2074	3869	76.3	Unscientific cultivation & input management
5	Bharuch	1625	2074	3000	84.6	Non-traditional area, not aware of recommended package of
6	Bhavnagar	1880	2074	3000	59.6	Unscientific cultivation & input management
7	Dahod	2131	2074	3000	40.8	Non-traditional area, not aware of recommended package of
8	Dang	723	2074	3000	314.9	Non-traditional area
9	Gandhinagar	2461	2074	3989	62.1	Unscientific cultivation & input management
10	Jamnagar	2691	2074	3700	37.5	Unscientific cultivation & input management
11	Junagadh	2655	2074	3000	13	Unscientific cultivation & input management
12	Kheda	1712	2074	3000	75.2	Non-traditional area, not aware of recommended package of
13	Kutch	2128	2074	3000	41	Not adoption of latest released hybrids, Unscientific cultivation &
14	Mehsana	2195	2074	3787	72.5	Unscientific cultivation & input management
15	Narmada	1959	2074	3000	53.1	Non-traditional area, not aware of recommended package of
16	Navsari	723	2074	3000	314.9	Non-traditional area
17	Panchmahal	1559	2074	3000	92.4	Non-traditional area, not aware of recommended package of
18	Patan	1858	2074	4056	118.3	Unscientific cultivation & input management
19	Porbandar	2540	2074	3000	18.1	Non-traditional area, not aware of recommended package of
20	Rajkot	2113	2074	3697	75	Unscientific cultivation & input management
21	Sabarkantha	1993	2074	3937	97.5	Unscientific cultivation & input management
22	Surat	2131	2074	3000	40.8	Non-traditional area, not aware of recommended package of
23	Surendranagar	1948	2074	3000	54	Unscientific cultivation & input management
24	Tapi	2131	2074	3000	40.8	Non-traditional area, not aware of recommended package of
25	Vadodara	1840	2074	3000	63	Non-traditional area, not aware of recommended package of
26	Valsad	723	2074	3000	314.9	Non-traditional area, not aware of recommended package of
27	Aravalli	1111	2074	3000	170	Unscientific cultivation & input management
28	Morbi	1930	2074	3000	55.4	Non-traditional area, not aware of recommended package of
29	DevbhumiDwarka	1360	2074	3000	120.6	Unscientific cultivation & input management
30	Gir Somnath	1802	2074	3000	66.5	Non-traditional area, not aware of recommended package of
31	Botad	1622	2074	3000	85	Non-traditional area, not aware of recommended package of
32	Mahisagar	1024	2074	3000	193	Non-traditional area, not aware of recommended package of
33	Chhotaudepur	1367	2074	3000	119.5	Non-traditional area, not aware of recommended package of

Note: * Yield gap based on FLD
Source: GOG (2018)-SAP.

2.6.5 Production Constraints:

The constraints associated with low productivity are enumerated as under:

- Short and mild winter
- Improper selection of variety/hybrid as per seeding time
- Variable water supply in quantum and space
- Imbalanced fertilizers application
- Improper placement of seeds and fertilizers
- Poor crop management
- Poor insect and disease management
- Low organic matter due to poor awareness regarding soil health
- Poor resource conservation technology

The region-wise constraints for low productivity of Castor are presented in Table 2.12 while sustainability issues and gap analysis of productivity of castor crop and resources are presented in Table 2.13. The bridging of the Gaps for realizing the castor crop vision is highlighted in Table 2.14.

Table 2.12: Region-wise Constraints for Low Productivity of Castor

Sr. No.	Region	Constraints
1	North Gujarat	• Unscientific castor cultivation (especially spacing)
		• Too early or too late sowing of castor
		• Low organic matter in soil and imbalanced use of fertilizers, low use of sulphur
		• Abrupt climate change
		• Poor irrigation management
		• Poor adoption in mechanization
2	Middle Gujarat	• unscientific castor cultivation and poor awareness of package of practice for castor cultivation after rice under *Kyari land*
		• Imbalance use of fertilizers, low use of sulphur
		• Poor irrigation management
		• Poor adoption in mechanization
3	South Gujarat	• Mis-matching to existing cropping sequence
		• Unscientific castor cultivation and poor awareness of package of practice for castor cultivation after rice under *Kyari land*
		• Imbalance use of fertilizers
		• Poor adoption in mechanization
4	Saurashtra	• The uncertainty of water availability and poor irrigation management
		• Unscientific castor cultivation and imbalance use of fertilizers
		• Improper management of soil and salinity
		• Poor adoption in mechanization

Source: GOG (2018)-SAP.

Table- 2.13: Sustainability Issues and Gap Analysis of Productivity of Castor Crop and Resources

S. No	Gap	Factors/ constraints leading to gaps	Strategies	Approach and methodology	Performance indicators	Sustainability outputs
i	Untimely sowing	Farmers sow castor too early or too late	Follow recommended timeof sowing	Farmer's participatory approachand demonstration	Entire castor growing areas.	Improvement in productivity
ii	Not following recommen dedspacing	Farmers follow the closer row to row and/or plant to plantspacing	Adoption of the recommended spacing of castor	Farmer's participatory approachand demonstration	Entire hybrid and irrigated castor growing areas.	Improvement in productivity
iii	Poor fertilizer manageme nt	Farmers apply low or excess N & P fertilizer. Theuse of sulphur, micronutrients and biofertilizer are negligible	Application of recommended dose of fertilizers. Use of sulphur and micronutrients as per soil testing report.	Farmer's participatory approachand demonstration	Entire castor growing area	Improvement in productivity with sustainable soil health
iv	No use of Organic manure	Low availability of goodquality FYM/ organic manures and the higherprice of organic manures	Awareness campaign for production of good quality organic manures attheir own farms	Farmer's field schools, campaigns	Entire castor growing area	Improvement in productivity with sustainable soil health
v	Unscientific irrigation in castor	Irrigation water flooded throughout the crop season	Judicious use of water or adoption ofMIS.	Training and demonstrations on efficient water management practices.	Entire irrigated castor growing area	Increase in water use efficiency andsustain soil health
vi	High incidence of weeds	Grassy and broad leavesweeds are seriously affected yields in the different cropping system. Practices of the unscientificmethod of weed management by the	Following integrated weed management	Capacity building of extension agencies and farmers for appropriate spraying techniques.On-farm demonstrations of integrated weed management	Entire castor growing area	Increased profitability
vii	Adoption of seed treatment	Recurrence of fungal andsoil-borne diseases	To popularize the practice of seed treatment	Educating and motivating farmers on its importance and adoption through demonstrations and training.	Entire castor growing area	Productivitygrowth on a sustainable basis.
viii	Sowing of non-certified seeds	Low awareness about certified seed	Awareness campaign for use of certified seed.	Farmer's field schools, campaigns.	Entire castor growing areas.	Improvement in yield
ix	The traditional wayof harvesting	Sickles are used for castorharvesting	Promotion of secateurs for castorharvesting	Educating and motivating farmers on its importance and adoption through demonstrationsand training	Entire castor growing areas.	Reduction inyield loss
x	Poor pest anddisease management	Farmers apply an improper dose of pesticide.Not using resistant var./ hybrids for cultivation.	Application of recommended dose of pesticides. Use of IPM to control pests and diseases	Farmer's participatory approachand demonstration	Entire castor growing area	Improvement in productivity with less environmental hazard

Source: GOG (2018)-SAP.

Table2.14: Bridging the Gaps for Realizing the Castor Crop Vision

Activity Output Matrix			
Activity/Crop/ Commodity	Issues	Mode of Action	Collaborator/Target
1.Water management	Irregular water supply incanal water so farmers use more water. Lack of drainage facility.	Supply of water in the canal as per the crop requirement. Drainage facility to be created	Irrigation Department and SAUs have jointly worked to solve this problem.
	Salinity stress mitigationat farmers'fields	MIS, Green manuring and gypsum use.	Subsidy on gypsum (@75%) and its availability be ensured.
	Water harvesting andrecharging	Construction of water harvesting structures near catchment area of the drain, panchayat/farmers land.	DDA/ concerned departments
	Watershed development in rain fedareas	Micro-irrigation after creating afacility of community ponds/ water harvesting structure.	DDA/concerned departments in consultationwith GGRC
	Work is also needed toadapt agronomic practices, especially the time and method of sowing and amount of fertilizer and irrigation in order to increase ecological sustainability,	Follow a scientific package of practices for castor cultivation.	Demonstrations will be laid out by DDA
(iv) Green manuring or organic matter addition	The improvement in theproductivity of crops andalso an improvement in the soil health.	DDA will ensure the timely availability of green manureseed at 75 percent subsidy. Fifty percent area will be covered during the plan periodof five years.	DDA
4.Seed production	1. Seed planning	1. Production of released hybrids/varieties at farmers' field. 2. Motivating farmers to producethe seeds of suitable hybrids 3. Mandatory testing of newhybrids /variety through	DDAs in consultation with KVKs.
	2. Best quality seed	Seed production at farmers' field with farmers participatory,training of farmers for hybrid seed production techniques.	DDA and KVK.
	3. Seed treatment	Motivating farmers for seedtreatment Demonstrations will be laid	DDA and KVK
5. Site-specific nutrient management (SSNM)	Number of split application and timing oftop dressing with reference to irrigation	The project will identify, testand promote intervention cropping system through site-specific nutrient management.Fertilizer recommendation will be based on the principles of	DDA and KVK will conductthe survey.
	Monoculture	Follow recommended crop rotation and cropping sequence	DDA and KVK
	Crop residue	Crop residue management forimproving soil health. Improving the efficiency of nutrient utilization.	Machinery for uniform distribution of residue willbe ensured by DDA Residue retention machinery, inter-culturing,second-generation machinery, precision farming for crops and
	Bio-fertilizers	Integrate chemical fertilizerswith bio-fertilizers Improve the efficiency of chemical fertilizers	DDA will ensure the availability of quality bio-fertilizers
6. Integrated Weed Management (IWM)	Improper weedmanagement.	Demonstration of IWM methodsat farmer's field.	DDA / KVK
8. Timely sowing	More pest & disease problem, Conversion of female flowers into maleflowers, therefore, poor yield.	Extension and development agencies should approach in afarmers participatory approach for each of possible solution.	DDAs / KVK

Source: GOG (2018)-SAP.

2.7 Chapter Summary:

The cropping pattern of Gujarat state has changed during the last five decade period. Though the share of oilseed in total cropped area remained the same, the share of castor crop has increased by 5 per cent points. The top five major castor growing districts in the state are Banaskantha, Kutch, Mehsana, Surendranagar and Patan in 2020-21. Castor is heavily growth in the northern area of Gujarat, while highest variability in area and production is estimated in Saurashtra region. The significant positive growth rates were estimated in area and production of castor in both major regions of the states during all periods. The interaction effect followed by area effect is accounted for output growth of Castor crop. The low seed replacement ratio (SRR) of castor is a major concern.

The next chapter presents supply and demand for castor seed oil.

Chapter III

Supply Demand Analysis of Castor

3.1 Introduction

Castor is an ancient crop but its production now has been limited mainly to India, China, and Brazil, for many reasons. Castor oil is unique in having three reactive functional groups such as a double bond, hydroxyl group, and carboxylic group. Castor oil is a hot market commodity product. It has been recently recognized as an efficient feedstock for biodiesel production. Increasing demand the world over for biofuel resources and many recently identified industrial uses of castor oil has escalated castor oil demand. Global demand for castor oil is rising constantly at 3–5 per cent per annum. In the last decade, many countries have started making serious exploratory efforts at growing castor as there is tremendous scope to establish castor as a supplementary crop production option for farmers and to provide significant returns on investment given the high global demand for castor oil. The significance of the Indian castor crop has also increase the recent years, as it brings a sizeable amount of foreign exchange to the country. This chapter provides an overview of the supply and demand analysis of the castor seed as well as castor seed oil market at the global level, followed by the co-integration of major castor seed markets in India.

3.2 Global Production & Export of Castor

As noted earlier, India is the leader in global castor production (Table 3.1) and dominates in the international castor oil trade with 92 per cent share of total world's castor oil production. India supplies almost 85 per cent to 90 per cent of the world's requirement of Castor Oil and its derivatives[1]. The other castor producers in the rest of world are Brazil and China. As of 2019-20, three countries (India, China, and Brazil) produced 93 per cent of the world's supply of castor oil. As production is concentrated mainly in these three countries, total castor production varies widely from year to year due to fluctuations in rainfall and the

[1] https://www.jmbaxigroup.com/newsletter/issue-xxxiv/indian-castor-seedand-oil-scenario/

size of the area utilized for planting. Consequently, this concentration has led to cyclic castor production.

Table 3.1: Global Castor Production during 2016-17 to 2020-21

	Global Castor Production (QTY in 000 tons)					
	2020/21	2019/20	2018/19	2017/18	2016/17	2011/12
India	1800	1970	1127	1460	1260	1950
China	17	36	26	32	37	160
Thailand	12	12	12	12	11	11
Africa	20	20	21	17	19	17
Brazil	43	31	20	13	15	141
World	1974	2154	1289	1615	1424	2356

The global castor oil market reached a volume of 767.4 kilo tons in 2021 and expected to reach 859.1 Kilo tons by 2027, exhibiting at a growth rate of 2 per cent during 2022-2027[2]. The rising utilization of castor oil in the production of cosmetics, medicines, toiletries, polyurethane adhesives, machining oils, refrigeration lubricants, etc., represents one of the key factors catalyzing the global castor oil market.

Due to the COVID-19 pandemic, the global Castor Oil and Derivatives market[3] size is estimated to be worth US$ 1545.9 million in 2022 and is forecast to a readjusted size of US$ 2059.9 million by 2028 with a CAGR of 4.9 per cent during the review period. Fully considering the economic change by this health crisis, Castor Oil accounting for the Castor Oil and Derivatives global market in 2021, is projected to value US$ million by 2028, growing at a revised CAGR in the post-COVID-19 period. While the Food segment is altered to a CAGR throughout this forecast period.

Global castor oil and derivatives key players include Jayant Agro, NK Proteins, Adani Wilmar, etc. Global main three manufacturers hold a share over 50 per cent. India is the largest market, with a share of over 90 per cent, followed by China, and North America, both have a share of over 5 percent. In terms of product, hydrogenated castor oil is the largest segment, with a share of about 30 per cent and in terms of application, the largest application is food, followed by

[2] https://www.imarcgroup.com/castor-oil-manufacturing-plant
[3] https://www.globenewswire.com/news-release/2022/01/17/2367705/0/en/Global-Castor-Oil-and-Derivatives-Market-2022-Share-Size-with-Major-Manufacturers-Analysis-Growth-Rate-Revenue-Demand-Trends-Opportunities-and-Challenges-Segmentation-Business-Outl.html

drug, cosmetics, industrial, etc. The top exporters and importers of castor oilseeds in 2020 presented in Box 3.1.

Box 3.1: Top Exporters & Importers of Castor Oilseeds 2020[4]	
Top Exporters, 2020	Top Importers, 2020
India ($3.96M), Ethiopia ($3.06M), Pakistan ($1.3M), Nigeria ($1.22M), Myanmar ($539k)	China ($6.33M), Vietnam ($2.02M), Thailand ($680k), Brazil ($468k), India ($432k).

3.3 Export from India

In the agricultural economy of India, oilseeds are important next only to food grains in terms of area, production and value. Oilseeds have been the backbone of the agricultural economy of India for long. The Indian climate is suitable the for cultivation of oilseed crops therefore; large varieties of oilseeds are cultivated here. The major oilseeds grown in India are groundnut, soybean, rapeseed, sesame, linseed, safflower, castor, sunflower and niger. India is the largest producer of castor seed and largest exporter of castor seed oil. During the year 2020-21, India's Castor oil exports have grown remarkably resurgent and reached to record figure of about 7.34 lakh tons compared to about 5.94 lakh tons in the previous year (2019-20). This is a commendable achievement and shows the strength of the industry, that even COVID-19 could not slow it down. Improvement in Castor oil is the major export-oriented agricultural commodity earning high foreign exchange.

Table 3.2: Castor Domestic Supply & Demand (in lakh tonnes)

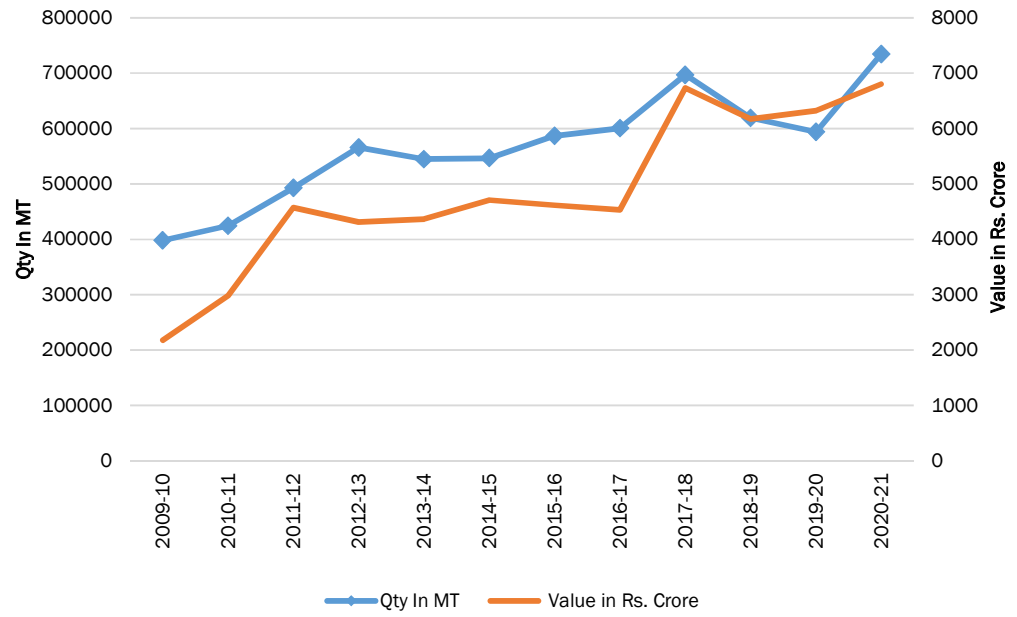
Sr. No.	Particulars	Castor Domestic Supply & Demand (in lakh tonnes)	
		2019-20	2020-21
1	Opening Stocks	2.30	6.22
2	Production	18.42	16.51
3	Imports	0.00	0.00
4	Total Supply	20.72	22.73
5	Consumption	14.50	15.00
6	Exports	0.00	0.00
7	Total Demand	14.50	15.00
8	Ending Stocks	6.22	7.73

Source: www.agriwatch.com

[4] https://oec.world/en/profile/hs92/castor-oil-seeds

Castor seed is not exported but castor oil[5] 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. The growth and instability in the export of castor oil from India during the period from 2009-10 to 2020-21 is presented in Table 3.2 and Fig. 3.1. The results indicate that the export of castor in terms of quantity as well as in terms of value has been significantly risen by 4.465 per cent and 8.288 per cent per annum, respectively.The export prices also increased by 3.824 per cent per annum during this period. The variability was found higher in prices than in quantity traded. Overall, the results indicate that the export of castor oil from India has bright prospects.

Fig. 3.1: Export of Castor Oil from India



India exports castor oil[6] to many countries across the world. However, the details of major export destinations for Indian castor oil during the year 2020-21 are depicted in Table 3.3 and Fig.3.2. The major countries have been ranked on

[5] Castor oil can be extracted from castor beans by mechanical pressing, solvent extraction, or a combinationof pressing and extraction. Extraction of oil from castor seeds is done in a manner similar to that for most other oil seeds. The ripe seeds are allowed to dry, when they split open and discharge the seeds. These seeds are cleaned, cooked and dried prior to extraction. Cooking is done to coagulate protein (necessary to permit efficient extraction), and to free the oil for efficient pressing.

[6] 120730 (HARMONIZED SYSTEM 1992 FOR 6-DIGIT)

the basis of value of export. Amongst these countries, China ranked first with the export of Rs 3124 crore contributing 46.22 per cent in total value of export of castor oil from India followed by Netherland (12.97%), France (9.42%) and USA (9.97%). These four countries jointly accounted for about 80 per cent of total castor oil export from India.

Table 3.3: Growth and Instability in Export of Castor oil from India

Sr. No.	Year	Quantity (M tonnes)	Value (Rs crore)	Price (Rs/tonne)
1	2009-10	397990.3	2179.3	54757
2	2010-11	424458.1	2982.9	70276
3	2011-12	492602.3	4571.4	92801
4	2012-13	565994.1	4309.8	76146
5	2013-14	544795.7	4364.3	80109
6	2014-15	546503.2	4710.2	86188
7	2015-16	586778.2	4616.1	78669
8	2016-17	600527.2	4532.9	75482
9	2017-18	697092.4	6730.0	96544
10	2018-19	619355.8	6169.9	99619
11	2019-20	593881.6	6323.9	106483
12	2020-21	734336.5	6802.0	92628
	CAGR (%)	4.465	8.288	3.824
	SIG	0.000	0.000	0.004
	CV	17.25	29.54	17.13
	Cuddy-Della Valle Index IX)	7.586	13.430	11.203

Table 3.4: Major Export destinations for Indian Castor Oil (2020-21)

Rank	Country	Value		Quantity	
		Rs Crore	%	Lakh tonnes	%
1	China P Rp	3144.08	46.22	346108.9	47.13
2	Netherland	882.12	12.97	97288.73	13.25
3	France	641.03	9.42	72494.56	9.87
4	U S A	678.14	9.97	70770.76	9.64
5	Japan	222.95	3.28	23164.38	3.15
6	Thailand	194.52	2.86	22244.35	3.03
7	Korea Rp	124.48	1.83	12344.78	1.68
8	Italy	95.43	1.40	10486.27	1.43
9	U K	95.92	1.41	10412.28	1.42
10	Turkey	83.96	1.23	8664.74	1.18
	Other (97)	639.33	9.40	60355.55	8.22
	Total	**6801.96**	100.00	**734335.3**	100.00

India's share in major importers of castor oil during the year 2021 was worked out which are presented in Table 3.5. The results revealed that India emerged as the largest exporter of castor oil with 87.5 per cent share in the world market. The 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. Besides over the last four years these countries share in total export of India castor oil is remaining near about almost same (Table 3.6).

Table 3.5: India's share (%) in major export markets of castor oil -2021

Rank	Major Importers	Major Exporters 2021 (**151530 Castor oil and fractions thereof, whether or not refined, but not chemically modified**)				
	World (100 %)	**India**	Netherland	France	Germany	USA
		87.5	4.1	3.0	2.0	1.1
1	China (38.9)	**India**	Thailand	Japan	USA	France
		98.95	0.37	0.17	0.16	0.0
2	France (12.2)	**India**	Germany	Netherland	Brazil	UK
		96.70	1.13	0.94	0.90	0.12
3	USA (10.4)	**India**	Brazil	UK	Canada	Indonesia
		98.02	1.04	0.41	0.28	0.06
4	Germany (10.3)	**India**	Netherland	France	Belgium	USA
		88.95	7.59	2.45	0.38	0.35
5	Netherland (5.4)	**India**	Germany	France	Belgium	Greece
		84.81	11.29	2.83	0.86	0.07
6	Thailand (2.5)	**India**	China	Japan	Germany	USA
		98.48	1.01	0.25	0.16	0.05
7	Japan (2.4)	**India**	USA	Spain	Brazil	Germany
		99.78	0.12	0.06	0.04	0.02-
8	Italy (2.2)	France	**India**	Germany	Netherlands	USA
		55.70	**27.60**	9.79	3.28	2.46
9	UK (1.4)	**India**	France	Netherland	Germany	USA
		84.94	6.87	2.91	1.87	1.08
10	Korea (1.7)	**India**	Japan	Malaysia	USA	UK
		95.29	3.92	0.58	0.15	0.06

Note: Product: **151530 Castor oil and fractions thereof, whether or not refined, but not chemically modified**
Source: https://www.trademap.org

Table 3.6: Major Importers of Castor Oil from India during 2017 to 2021

Importers	Export from India (% to total export)				
	2017	2018	2019	2020	2021
China	43.61	46.45	42.69	47.97	47.74
Netherlands	14.06	13.81	15.82	12.53	13.76
France	11.54	9.13	8.87	10.50	10.79
United States of America	10.35	10.20	10.04	10.21	10.33
Thailand	3.79	3.63	3.58	3.03	2.86
Japan	2.97	2.79	3.22	2.28	2.73
Korea, Republic of	1.53	1.52	1.92	1.70	1.69
Turkey	1.02	0.98	1.28	0.98	1.20
United Kingdom	1.32	1.74	1.89	1.47	1.13
Russian Federation	0.76	0.90	0.99	1.01	0.97
Others	9.04	8.85	9.69	8.31	6.81

Source: Estimated using data from https://www.trademap.org

3.4 Export Competitiveness of India

India is known as the world leader in castor seed and oil production and leads the international castor oil trade. As mentioned earlier, India is the leader in global castor production and dominates in the international castor oil trade with 92 per cent share of total world's castor oil production. Mandan (2019) estimated NPC for the year 2014-15 (Table 3.16) and found that export of castor oil from India was moderate competitive out of 40 castor oil importing countries, 22 were found moderate profitable (Indonesia (0.62) followed by Ghana (0.65), Bangladesh (0.67), Nigeria (0.67) etc., while other 18 countries were less competitive (Mexico (0.76) followed by Philippines (0.76), Brazil (0.76), Egypt (0.77), etc. (Table 3.7).

The data analysis for the data year 2020-21 presented in Table 3.8 indicate that castor oil is less competitive to the major importing counties and thus necessary steps to be taken to lower the cost of processing and export to make it feasible or convert same into derivatives.

Table 3.7: County wise analysis of castor oil export from India and NPC values 2014-15

Countries	Quantity (MT)	Value (Rs.Lakh)	Unit Value (Rs./Kg.)	Reference Price (Pb)	NPC (Pd/Pb)
Indonesia	341.6	388.81	113.820	112.220	0.628
Ghana	357.45	389.88	109.073	107.473	0.656
Bangladesh	56.43	60.37	106.982	105.382	0.669
Nigeria	278	296.02	106.482	104.882	0.672
Hong Kong	264.08	274.62	103.991	102.391	0.689
Canada	310.66	317.31	102.141	100.541	0.701
Germany	1921.55	1962.07	102.109	100.509	0.701
Kuwait	725.27	738.56	101.832	100.232	0.703
Kenya	119.5	121.18	101.406	99.806	0.706
Iran	1152.4	1164.33	101.035	99.435	0.709
Australia	1629.32	1641.29	100.735	99.135	0.711
Singapore	1518.07	1490.27	98.169	96.569	0.730
South	2822.52	2757.79	97.707	96.107	0.734
Jordan	395.7	386.28	97.619	96.019	0.734
Taiwan	2311.05	2248.28	97.284	95.684	0.737
Nepal	137.87	134.04	97.222	95.622	0.737
Saudi Arab	1317.49	1278.26	97.022	95.422	0.739
Argentina	711	687.32	96.669	95.069	0.742
Greece	167.4	161.03	96.195	94.595	0.745
Colombia	234	224.55	95.962	94.362	0.747
Spain	1465	1398.59	95.467	93.867	0.751
Iraq	102.87	97.31	94.595	92.995	0.758
Mexico	2655.84	2490.87	93.788	92.188	0.765
Philippines	233.8	218.1	93.285	91.685	0.769
Brazil	1543.67	1439.16	93.230	91.630	0.769
Egypt	1463.03	1353.72	92.529	90.929	0.775
Russia	3546.5	3278.78	92.451	90.851	0.776
Belgium	7500	6929.48	92.393	90.793	0.776
Turkey	7420.3	6840.4	92.185	90.585	0.778
Korea	7965.26	7337.49	92.119	90.519	0.779
Italy	4895.61	4494.5	91.807	90.207	0.782
Israel	856.6	779.77	91.031	89.431	0.788
Japan	22198.52	20159.58	90.815	89.215	0.790
UK	8565.44	7576.44	88.454	86.854	0.812
USA	64906.86	57317.98	88.308	86.708	0.813
Netherland	89746.63	77170.69	85.987	84.387	0.835
Thailand	20822.38	17475.42	83.926	82.326	0.856
China	157362.27	131604.36	83.631	82.031	0.859
Malaysia	50589.96	42228.27	83.472	81.872	0.861
France	68618.88	57038.23	83.123	81.523	0.865

Notes: Wholesale price (Pd) =70.5 per kg., Packing and handling cost=1.6 per kg.
Source: Mandan (2019).

Table 3.8: County wise analysis of castor oil export from India and NPC values 2020-21

Country Name	2020-21				
	Quantity (MT)	Value (Rs.Lakh)	Unit Value (Rs./Kg.)	Reference Price (Pb)	NPC (Pd/Pb)
China P Rp	346108.89	3144.08	90.84	89.90	0.95
Netherland	97288.73	882.12	90.67	89.73	0.95
France	72494.56	641.03	88.42	87.48	0.98
U S A	70770.76	678.14	95.82	94.88	0.90
Japan	23164.38	222.95	96.25	95.31	0.90
Thailand	22244.35	194.52	87.45	86.51	0.99
Korea Rp	12344.78	124.48	100.84	99.89	0.86
Italy	10486.27	95.43	91.00	90.06	0.95
U K	10412.28	95.92	92.12	91.18	0.94
Turkey	8664.74	83.96	96.90	95.96	0.89
U Arab Emts	6987.71	73.16	104.70	103.76	0.82
Belgium	5607	51.69	92.19	91.25	0.94
Russia	5138.43	49.4	96.14	95.20	0.90
Germany	4659.02	49.85	107.00	106.06	0.81
Mexico	4440.6	42.23	95.10	94.16	0.91
Malaysia	3880.62	43.17	111.25	110.30	0.78
Taiwan	2888.55	29.59	102.44	101.50	0.84
Egypt A Rp	2788.53	27.98	100.34	99.40	0.86
South Africa	2544.86	26.69	104.88	103.94	0.82
Singapore	2486.83	27.45	110.38	109.44	0.78
Brazil	2196	20.97	95.49	94.55	0.90
Spain	1944.4	19.93	102.50	101.56	0.84
Australia	1918.08	19.85	103.49	102.55	0.83
Iran	1380.31	17.73	128.45	127.51	0.67
Indonesia	1153.08	12.23	106.06	105.12	0.81
Saudi Arab	853.71	8.87	103.90	102.96	0.83
Argentina	815.52	8.34	102.27	101.32	0.84
Canada	670.92	23.22	346.09	345.15	0.25
Finland	659.37	6.15	93.27	92.33	0.93
Vietnam Soc Rep	552.79	6.04	109.26	108.32	0.79
Greece	494	5.49	111.13	110.19	0.78
Sudan	393.41	4.19	106.50	105.56	0.81
Slovenia	393	3.81	96.95	96.01	0.89
Ukraine	351.69	3.66	104.07	103.13	0.83
Nigeria	309.2	3.55	114.81	113.87	0.75
Morocco	308	3.12	101.30	100.36	0.85
Kuwait	296.14	3.22	108.73	107.79	0.79
Oman	291.96	3.01	103.10	102.16	0.84
Lithuania	265	2.36	89.06	88.12	0.97
Colombia	255.6	2.71	106.03	105.08	0.81
Jordan	237.08	2.54	107.14	106.20	0.81
Hong Kong	226.16	2.76	122.04	121.10	0.71
Iraq	217.66	2.44	112.10	111.16	0.77
Sri Lanka Dsr	201.26	2.08	103.35	102.41	0.83
Philippines	195.48	2.15	109.99	109.04	0.78
Chile	178	1.8	101.12	100.18	0.85
Bangladesh Pr	156.84	2.36	150.47	149.53	0.57
Kenya	155.03	1.71	110.30	109.36	0.78
Syria	147	1.55	105.44	104.50	0.82
Lebanon	131.3	1.49	113.48	112.54	0.76

Nepal	114.06	1.23	107.84	106.90	0.80
Ghana	110.2	1.21	109.80	108.86	0.79
Algeria	110	1.16	105.45	104.51	0.82
Latvia	101.7	1.32	129.79	128.85	0.66
Israel	98.1	1.06	108.05	107.11	0.80
Peru	96	1.12	116.67	115.73	0.74
Qatar	95.05	1.08	113.62	112.68	0.76
Tanzania Rep	88.83	0.95	106.95	106.00	0.81
Yemen Republc	86.6	0.98	113.16	112.22	0.76
Guatemala	83	1.2	144.58	143.64	0.60
Poland	76	0.77	101.32	100.37	0.85
Baharain Is	71.43	1.03	144.20	143.26	0.60
Norway	51.96	0.52	100.08	99.14	0.86
Romania	36	0.37	102.78	101.84	0.84
Dominic Rep	34	0.41	120.59	119.65	0.71
Burkina Faso	30.1	0.4	132.89	131.95	0.65
New Zealand	24.57	0.37	150.59	149.65	0.57
Haiti	22.9	0.32	139.74	138.80	0.62
Myanmar	22.2	0.25	112.61	111.67	0.77
Sweden	20.1	0.22	109.45	108.51	0.79
Panama Republic	19.02	0.24	126.18	125.24	0.68
Congo D. Rep.	18.89	0.26	137.64	136.70	0.63
Uzbekistan	18.01	0.19	105.50	104.56	0.82
Benin	16.02	0.2	124.84	123.90	0.69
Trinidad	16.01	0.18	112.43	111.49	0.77
Costa Rica	16	0.18	112.50	111.56	0.77
Cote D Ivoire	16	0.21	131.25	130.31	0.66
Serbia	16	0.21	131.25	130.31	0.66
Zambia	13.62	0.16	117.47	116.53	0.73
Guinea	12	0.12	100.00	99.06	0.86
Malawi	8.77	0.09	102.62	101.68	0.84
Senegal	8.01	0.08	99.88	98.93	0.86
Mauritius	7.39	0.2	270.64	269.69	0.32
Reunion	3.6	0.08	222.22	221.28	0.39
Turkmenistan	3.05	0.05	163.93	162.99	0.52
Guyana	3	0.05	166.67	165.73	0.52
Paraguay	2.8	0.04	142.86	141.92	0.60
Austria	2.31	0.05	216.45	215.51	0.40
Fiji Is	1.8	0.05	277.78	276.84	0.31
El Salvador	1.6	0.03	187.50	186.56	0.46
Georgia	1.6	0.03	187.50	186.56	0.46
Afghanistan Tis	1.5	0.02	133.33	132.39	0.65
Ethiopia	1.47	0.02	136.05	135.11	0.63
Maldives	1.42	0.03	211.27	210.33	0.41
Somalia	1.32	0.03	227.27	226.33	0.38
Rwanda	0.8	0.01	125.00	124.06	0.69
Jamaica	0.6	0.01	166.67	165.73	0.52
Total	**734335.29**	**6801.96**	92.63	91.69	0.93

Notes: Wholesale price- 85.50/kg at Kandal port; Packing and handling cost-Rs.0.94125 per kg
Source: Authors Calculations.

3.5 Export Specifications

India exports castor oil in two forms namely First Special grade and Castor Oil Commercial. The unique structure of castor oil offers interesting properties, making it appropriate for various industrial applications. Castor oil is known to consist of up to 90 per cent ricinoleic, 4 per cent linoleic, 3 per cent oleic, 1 per cent stearic and less than 1 per cent linolenic fatty acids.Castor oil is valuable due to the high content of ricinoleic acid (RA) which is used in a variety of applications in the chemical industry. Refined castor oil (FSG) is used in lubricants, paints, pharmaceuticals, cable insulators, inks, rubber and textiles etc. The export specifications of refined castor oil (FSG) are presented in Table 3.9.

Table 3.9: Export specifications of castor oil

Sr.No.	Property	Refined castor oil	Commercial castor oil
1	Appearance	Pale yellow, Viscous, Clear liquid	Yellowish, Viscous, liquid
2	M. I. V.	0.25% Max.	0.50% Max.
3	F.F.A. (as oleic)	1.00% Max	2.00% Max
4	Acid value	2.00 Max.	4.00 Max.
5	Iodine value (Wijs)	82 – 90	82 – 90
6	Saponification value	177 – 185	177 – 185
7	Hydroxyl value	158 – 163	158 – 163
8	Colour on lovibond	Y- 20.0 Max. R - 2.0 Max. (in 5.25" cell)	30.0 units Max. (in 1" cell (Y + 5R))
9	Unsaponifiable matter	-	0.70% Max.

Source: https://www.panagri.in

3.6 Export Potential

The suppliers with greatest potential to export 151530 Castor oil & fractions to World are India, Netherlands and France. Singapore has closest export links with World. India has the highest supply capacity in 151530 Castor oil & fractions. The exponential potential estimated for India is estimated about $1.3 billion while actual export was around $834 million and thus untapped potential is around $494 million (https://exportpotential.intracen.org) and same is presented in Fig. 3.2 to 3.4.

Fig. 3.2: Countries with Potential to Export Castor Oil and Fractions

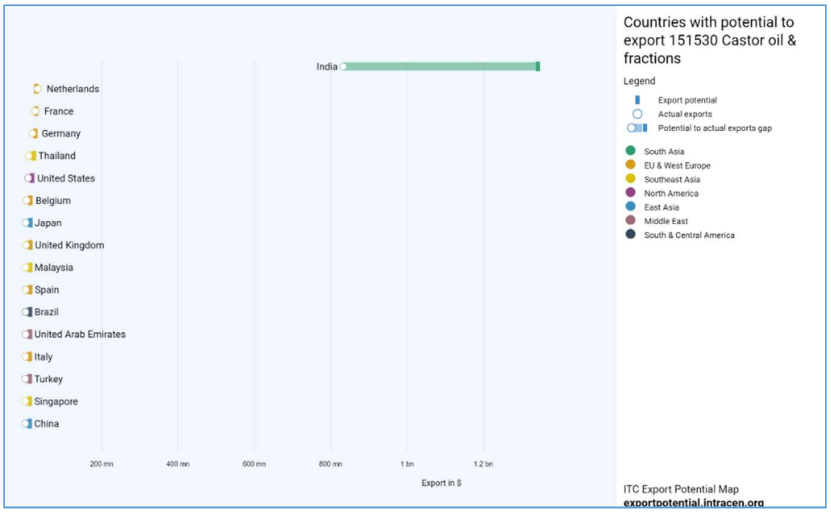


Fig. 3.3: Export Potential Map of Countries to Export Castor Oil and Fractions

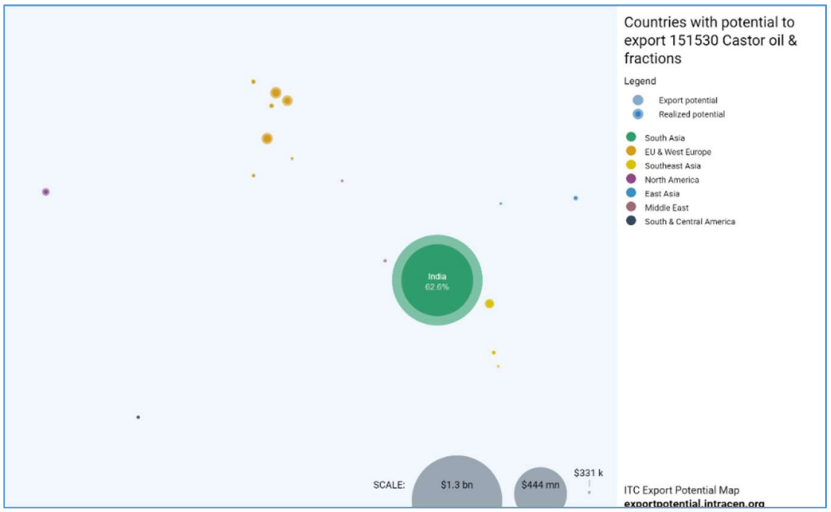
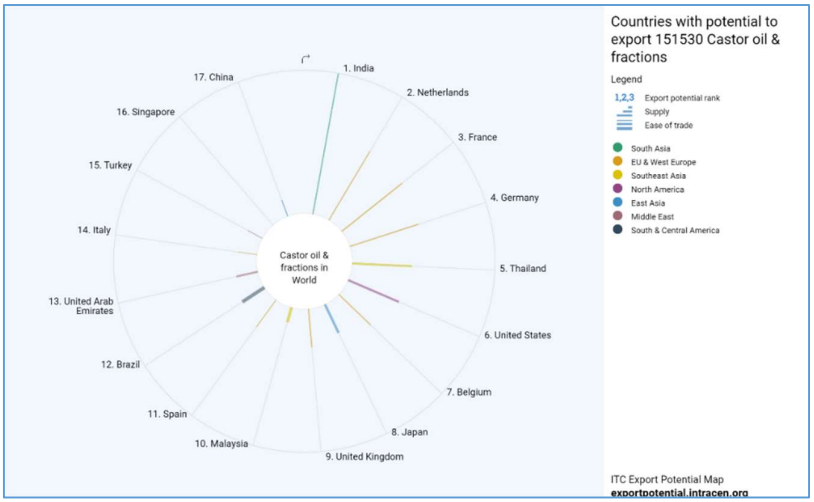


Fig. 3.4: Export Potential Map to Export Castor Oil and Fractions



Source: https://exportpotential.intracen.org

3.7 Trading of Castor in India

The major trading centers of castor and its derivatives in India are Rajkot (Gujarat), Ahmedabad (Gujarat), Gondal (Gujarat), Gadwal (Gujarat), Bhabar (Gujarat), Disa (Gujarat), Kadi (Gujarat), Jedcherla (Andhra Pradesh) and Yemignoor (Andhra Pradesh). Also, castor and its derivatives like castor seed, castor oil and castor oil cake are traded in Indian commodity exchanges namely, National Commodity & Derivatives Exchange ltd, Multi Commodity Exchange of India ltd, National Multi Commodity Exchange of India ltd, The Bombay Commodity Exchange Ltd, Mumbai, The Rajkot Seeds oil & Bullion Merchants' Association Ltd and Ahmadabad Commodity Exchange Ltd.

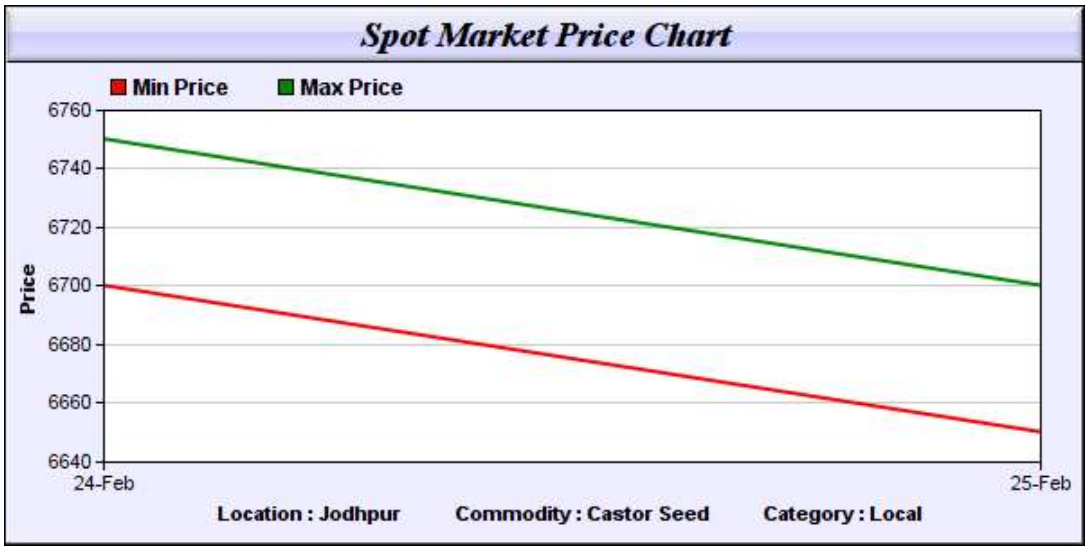
- Spot Markets[7]:

  Gujarat- Rajkot, Ahmedabad, Gondal, Gadwal and Bhabar

  Andhra Pradesh- Jedcherla
- Future Markets

  Future trading in castor seed is offered on NCDEX, NMCE and Rajkot Seed Oil and Bulllon Merchants (RBOT)
- Major export destinations: South Korea, Taiwan and France
- Major Import Sources: Nil

Fig. 3.5: Jodhpur Spot Market Chat for Castor Seed-February 2022



Source: https://www.agriwatch.com/castor/castor-seed-castor-oil/

[7] http://www.commoditiescontrol.com/eagritrader/commodityknowledge/castor/castor1.htm

Table 3.10: Castor Seed Spot Market Prices in Gujarat for February 25, 2022

Login to View the Latest Prices		
	25-Feb	24-Feb
Ahmedabad(Rs/Qtl)		
Local		5950-6600
Bhabhar(Rs/Qtl)		
Local	6650-6760	6750-6925
Deesa(Rs/Qtl)		
Local	6750-6825	6800-6950
Gandhinagar(Rs/Qtl)		
Local	6850-6950	6800-6900
Gondal(Rs/Qtl)		
Local	6655-6830	6555-6705
Harij(Rs/Qtl)		
Local	6750-6840	6700-6800
Jodhpur(Rs/Qtl)		
Local	6650-6700	6700-6750
Junagadh(Rs/Qtl)		
Local		5500-6090
Kadi(Rs/Qtl)		
Local	6800-6950	6600-6750
Mehsana(Rs/Qtl)		
Local	6600-6700	6650-6675
Patan(Rs/Qtl)		
Local	6650-7025	6400-6850
Rajkot(Rs/Qtl)		
Local	6520-6730	6440-6695
Sumerpur(Rs/Qtl)		
Local	6550-6600	6550-6600

The spot market chat for castor seed in February 2022 at Jodhpur (Rajasthan) and Major Markets in Gujarat is presented in Fig. 3.5 and Table 3.10. In January, Castor seed futures close higher in January 2022 after two months of correction. The prices have again increased mainly due to the report of lower production for the second consecutive year and there is consistent demand for its derivatives products– oil and meal. There are expectations of production losses this season due to deficient rains in the Gujarat during first three months, which limit the castor seed area despite higher prevailing prices for the castor seed.

In the calendar year 2021, India's castor oil exports increased by 4.11 per cent to 6.85 lakh tonnes while in the first 9-month (Apr-Dec) of FY 2021/22, the exports have been at par with the last year's exports at 5.15 lakh tonnes. The export prices of castor oil increase by more than 30 per cent in FY2021-22. In Dec 2021, the export prices of castor oil were higher by about 41 per cent on year at Rs. 1.32 lakh per ton compared to Rs. 0.93 lakh per ton last year.

India exported castor oil to 96 countries during the FY 2021/22 (Apr-Dec)

and the top three export destination for the castor oil were China (2.50 lakh tonnes), Netherlands (82000 tonnes) and USA (60200 tonnes). In 2021, country exported about 4.05 lakh tonnes of castor meal up by 7% on year. However, in 2021/22, India's castor meal export was down by 4.6 per cent Y/Y at 3.01 lakh tonnes due to increase in export prices. The average price of castor meal during the current financial year is more than $109/ ton compared to $ 67 / ton last year.

Castor meal is exported to over 20 countries. In the year 2020-2021 (Apr-Nov), India has exported castor meal worth of 20.96 USD million[8].

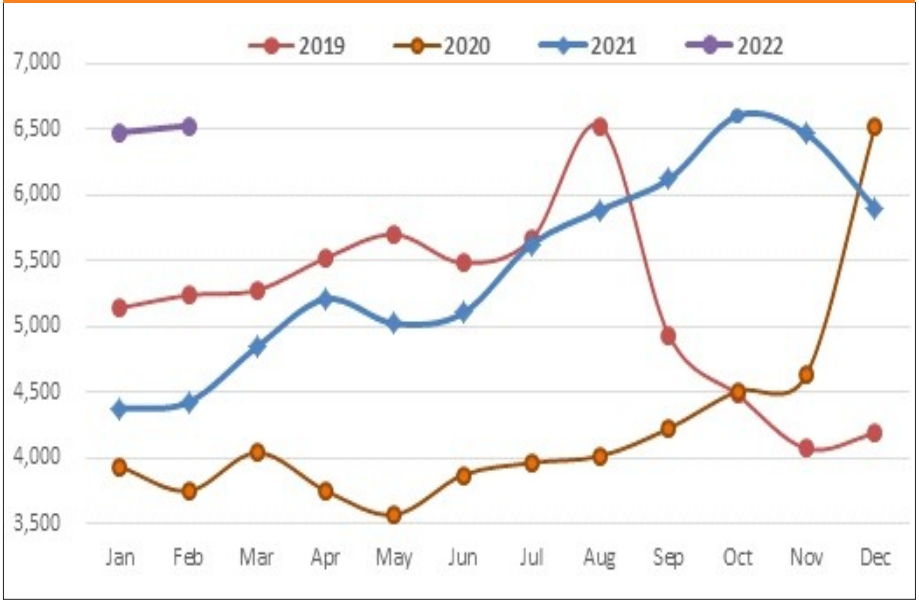
3.8 Castor Market Outlook

Currently the castor prices are higher by more than 45 per cent compare to last year prices mainly on the expectation of lowered crop this season. The new season crop is about to hit the market. As per the export seasonality, it is expected that the castor oil exports will increase during March, April and May. It is predicted that three may be some pressure on prices initially towards 6000 levels but due to prospect of export demand, the prices may still supported at higher levels and trade towards 6800 levels (Fig. 3.6 and 3.7).

Fig. 3.6: Castor Future - Jan-2022

[8] Castor Oiled Cake Export from India | Data, price & analysis of Castor Oiled Cake export (connect2india.com)

Fig. 3.7: NCDEX Castor seed: Monthly Closing (Rs per Qtl)



3.9 Factors influencing Castor Prices

- Expected demand -Average level of consumption and exports during the past few years
- Crop Acreage- Extent of area sown under the crop
- Production- Estimated output based on the acreage and weather conditions and pest infestation, etc.
- Imports and Exports- Traders need to know the important sources and destinations
- Government Policies- Any change in government policy relating to crops such as MSP
- Procurement: Direct procurement by the government agencies and storage in warehouses, change in tariff base prices of externally traded goods will have a direct impact on the respective commodity prices.

3.10 Price Behaviour of Castor seed in Study area

The analysis of prices and market arrivals over time is important for formulating a sound agricultural price policy. Fluctuations in market arrivals largely contribute to the price instability of castor seed in the state. The transaction in commodity exchanges also plays an important role on the spot price of castor seed as it gives some indication of future price. In order to reduce the instability in price fluctuations of castor seed, there is a need to have a thorough understanding of the price behaviour over time and over space. The long run equilibrium between the market prices of castor seed is indicated by the Vector Error Correction Model (VECM) for the non-stationary individually with a long run relationship in the time series data. Hence, the present study was an attempt to assess the seasonal analysis and market integration of castor seed crop in Gujarat. The data used in the co-integration analysis consists of monthly wholesale prices of six castor seed dominated markets i.e. Dasada (Surendranagar District), Radhanpur (Patan), Bhabhar (Banaskantha), Thara (Banaskantha), Mehsana (Mehsana District) and Kadi (Mehsana district) markets of Gujarat for the period from 2011 to 2021.

3.10.1 Seasonal Behaviour in Prices of Castor Seed

In this section, an attempt has been made to study the seasonal variation in arrivals and prices of castor seed for different markets *viz;* Dasada (Patdi), Radhanpur, Bhabhar, Thara, Mehsana and Kadi with the help of seasonal indices. The seasonal indices of market arrivals and prices of castor seed in the selected markets are present in Table 3.11 and 3.12 and line graph of arrivals and price indices are depicted in Fig. 3.8 to 3.13 of selected markets. Monthly seasonal indices were calculated in order to ascertain the long run seasonal variations in arrivals and prices of castor seed. The results revealed the existence of seasonality in all the markets. Higher indices of market arrivals of castor seed were noticed immediately after harvest in the selected markets arrivals reached peak during April (165.03) in Thara which decrease to 69.92 in August and relatively shoot up in September and October. In Dasada market, the peak indices were found in April (136.98) followed by May (120.15). Radhanpur market showed lowest arrivals in

December (66.85) while it peaked during April (155.91). Bhabhar market witnessed the lowest arrivals in December (70.57) and highest during April (154.17). Arrivals reached a peak during April (134.91) in Mahsana market while they were lowest in the month of January (70.88). In Kadi market, the peak indices were found in April (125.06) followed by May (124.20). The higher market arrival indices were observed (more than 100) in the months of April - May and September- October and lower arrival indices were found during November to February and July- August (less than 100).

The pattern of market prices showed slight differences among the selected markets. The price index in Dasada market was the highest in the month of August (102.31) and relatively higher during the months of November to January and March - April. Similarly in Radhanpur, Bhabhar , Mahsana and Kadi market witnessed peak price during August. The indices in February, May-June and September-October months varied low indices (less than 100). The majority of the produce was sold soon after the harvest probably for want of cash or lack of storage facilities. However, farmers who are financially sound can store for longer time to look forward for advantageous period and higher prices. To analyze the arrivals pattern of castor seed during different months of the year and their impact on price, seasonal indices were computed adopting 12 months moving averages. Castor seed crop were sown in the month of mid-July onward to end of September. It comes to harvest during Feb to April. Thus, fluctuation in the monthly indices of castor seed arrivals was more than the monthly indices of prices in the selected market during the study period. The price movement also demonstrates significant seasonal fluctuations in the selected markets. As a short-term fluctuation, one will notice a general finding that the price is low when the arrivals were large and the price being high when the arrivals were low.

Table 3.11: Seasonal Indices of monthly Arrivals of Castor seed in Major Market of Gujarat

Month	Dasada	Radhanpur	Bhabhar	Thara	Mehsana	Kadi
January	89.65	75.33	92.99	79.67	70.88	89.60
February	98.25	97.93	89.57	81.89	66.76	99.96
March	102.20	116.90	84.05	87.45	98.07	98.37
April	136.98	155.91	154.17	141.51	134.91	125.06
May	120.15	124.19	137.76	165.03	132.65	124.20
June	103.33	89.33	108.76	101.89	95.77	99.69
July	90.86	84.47	86.12	76.64	97.34	87.25
August	98.66	90.27	75.53	69.92	93.84	98.64
September	107.66	107.23	106.89	112.25	106.25	107.06
October	106.60	106.72	100.58	114.60	110.34	104.13
November	73.78	84.87	93.02	90.70	98.94	79.71
December	71.89	66.85	70.57	78.46	94.26	86.33

Table 3.12: Seasonal Indices of monthly Prices of Castor seed in Major Market of Gujarat

Months	Dasada	Radhanpur	Bhabhar	Thara	Mehsana	Kadi
January	100.59	100.56	100.66	100.75	100.36	100.81
February	98.04	98.09	98.12	98.23	98.12	98.31
March	100.77	100.07	100.65	100.60	100.48	100.00
April	101.19	101.67	100.79	101.38	101.26	100.83
May	98.46	98.46	98.24	97.73	97.61	98.47
June	97.84	97.56	97.85	97.99	97.39	97.78
July	101.10	101.56	100.87	100.92	101.95	100.79
August	102.31	102.24	102.33	101.73	102.61	102.11
September	98.58	99.30	99.69	98.99	99.13	99.84
October	98.11	97.84	97.89	98.39	98.61	98.28
November	101.92	101.40	101.53	101.89	100.58	101.45
December	101.09	101.26	101.37	101.41	101.91	101.31

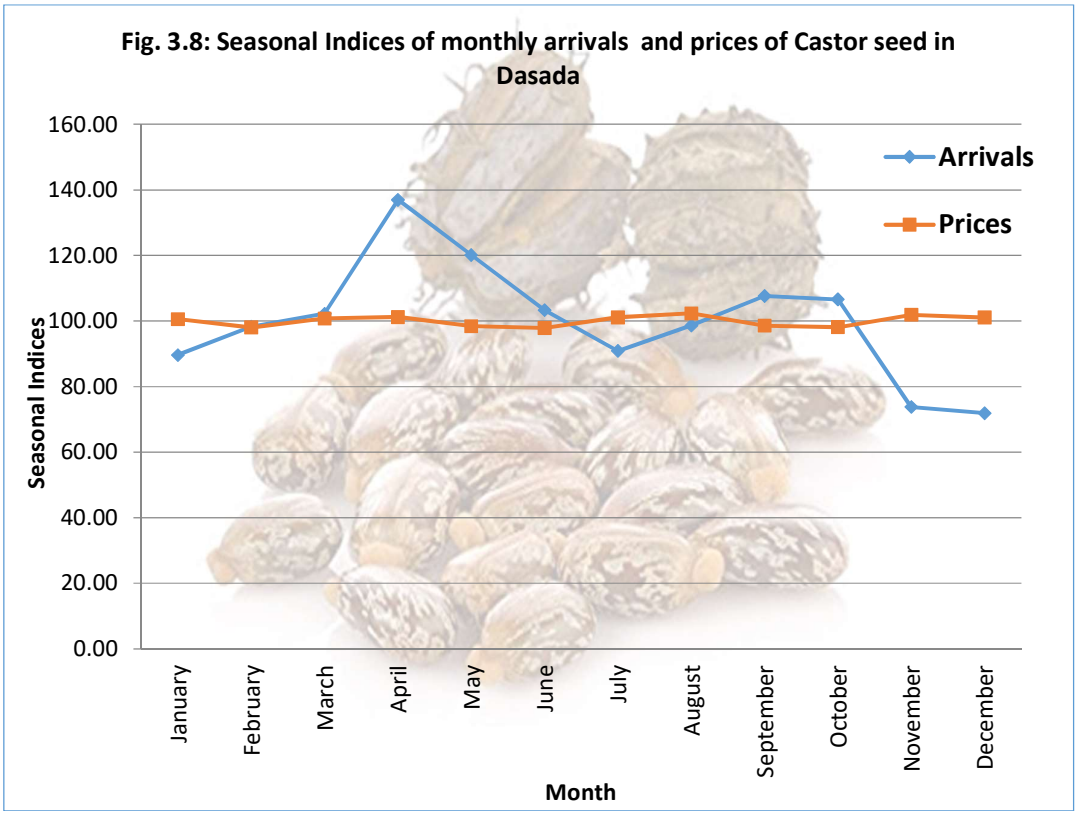


Fig. 3.8: Seasonal Indices of monthly arrivals and prices of Castor seed in Dasada
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Seasonal Indices
Arrivals
Prices
January
February
March
April
May
June
July
August
September
October
November
December
Month

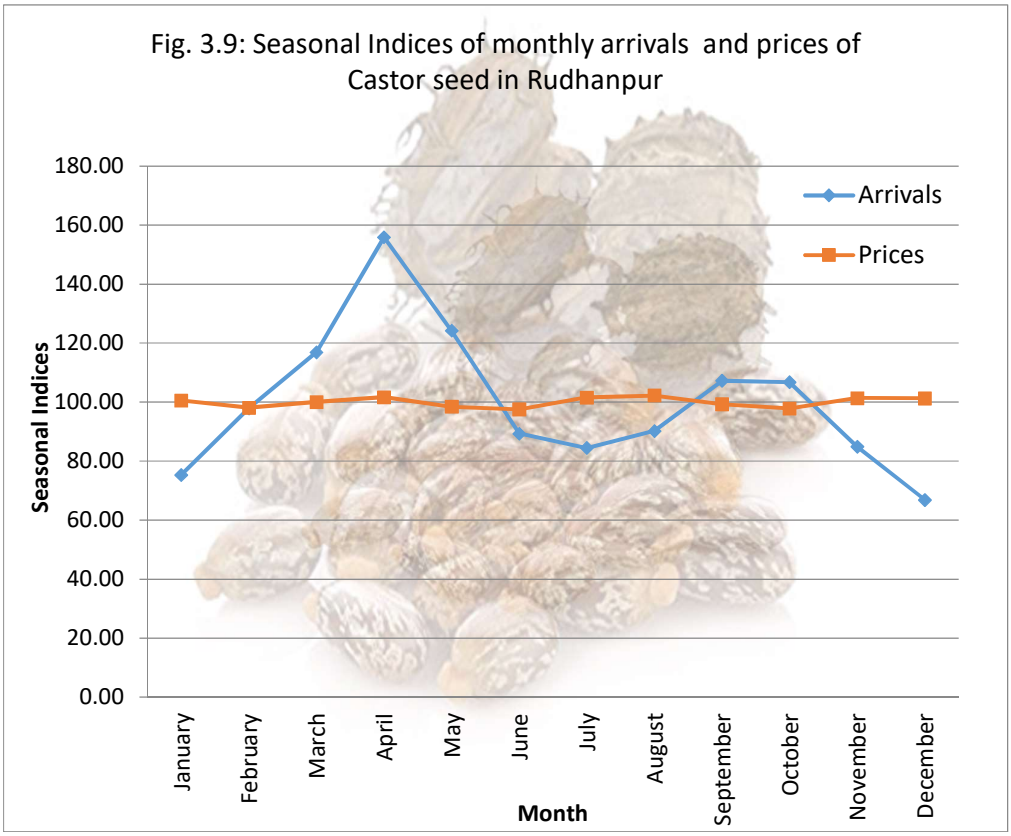


Fig. 3.9: Seasonal Indices of monthly arrivals and prices of Castor seed in Rudhanpur
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Seasonal Indices
Arrivals
Prices
January
February
March
April
May
June
July
August
September
October
November
December
Month

Fig. 3.10: Seasonal Indices of monthly arrivals and prices of Castor seed in Bhabhar

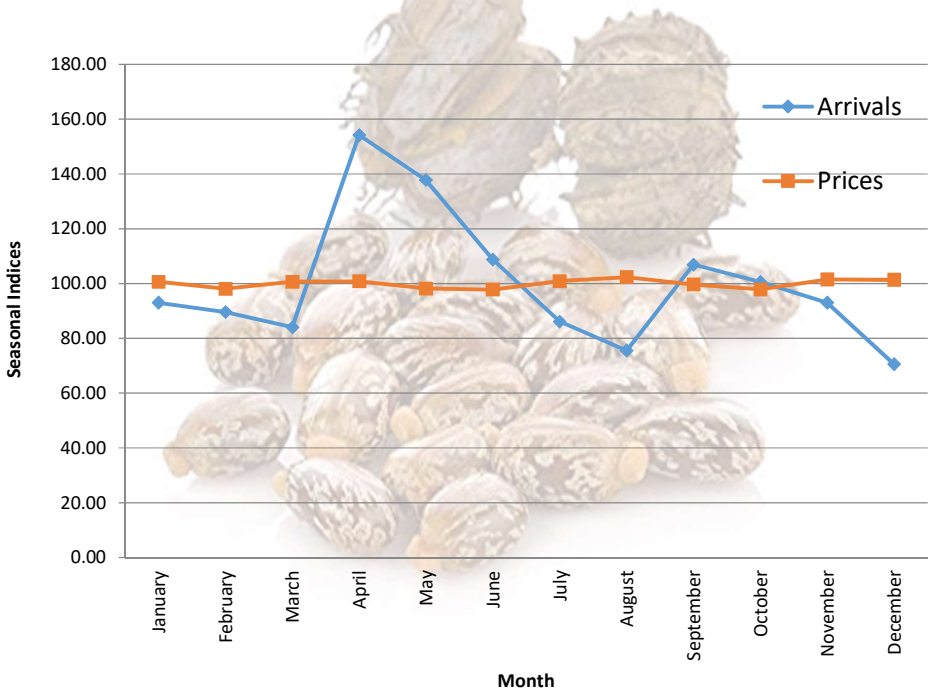
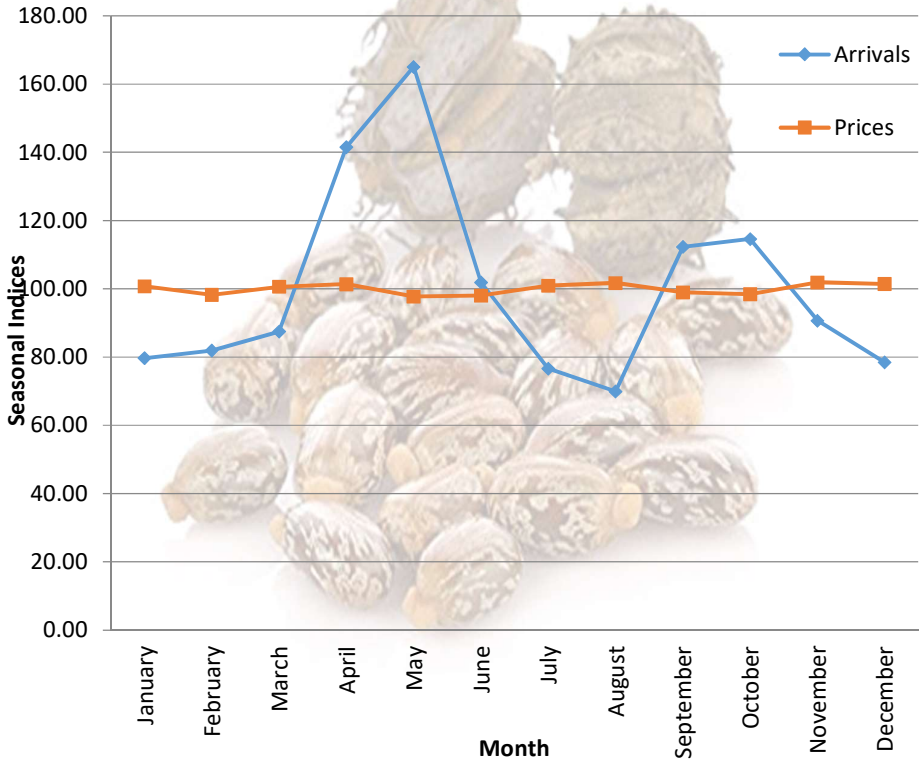


Fig. 3.11: Seasonal Indices of monthly arrivals and prices of Castor seed in Thara



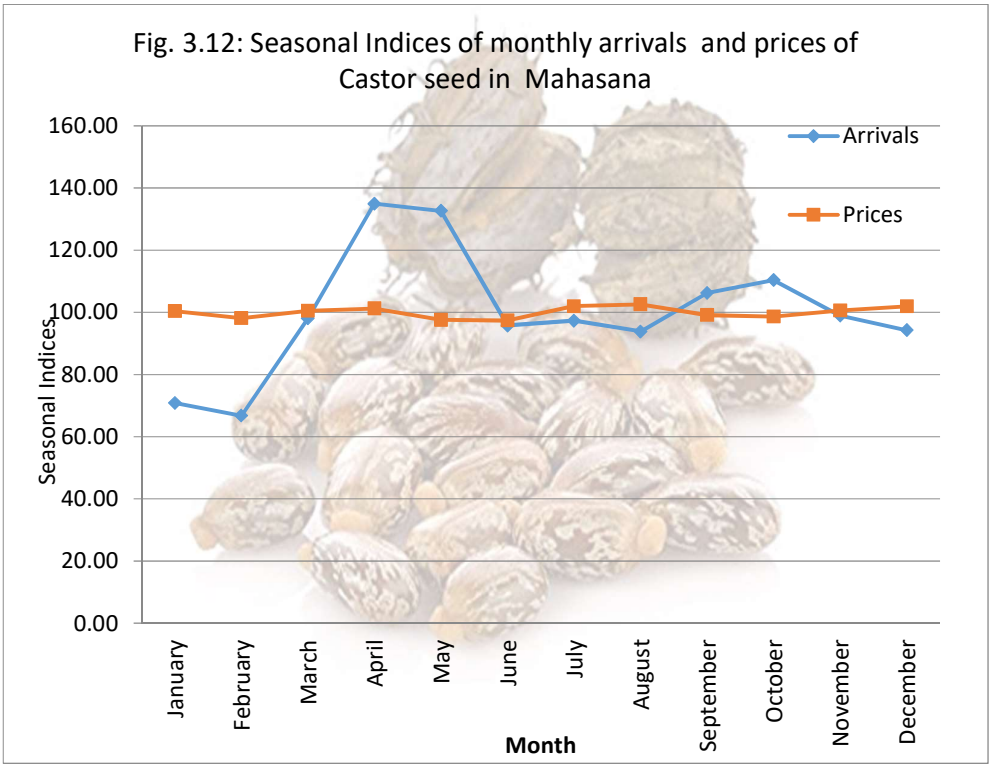


Fig. 3.12: Seasonal Indices of monthly arrivals and prices of Castor seed in Mahasana
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Seasonal Indices
Arrivals
Prices
January
February
March
April
May
June
July
August
September
October
November
December
Month

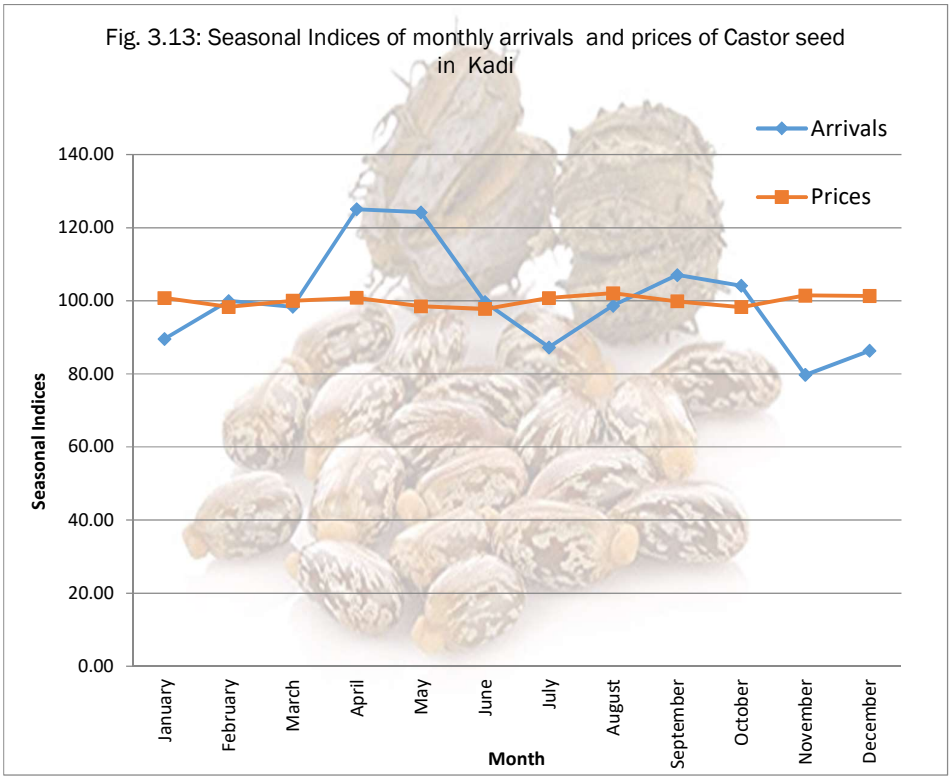


Fig. 3.13: Seasonal Indices of monthly arrivals and prices of Castor seed in Kadi
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Seasonal Indices
Arrivals
Prices
January
February
March
April
May
June
July
August
September
October
November
December
Month

3.10.2 Co-Integration of Castor seed prices in different markets

The market integration concept explains the relationship between the prices in two markets that are spatially separated. When markets are integrated it implies that the markets in the system operate in uniform, as a single market system. Co-integration is an analytic technique for testing of common trends in multivariate time series and modeling long run and short run dynamic. Two or more predictive variables in a time series model are co-integrated when they share a common stochastic drift. Variables are considered co-integrated if a linear combination of them produces a stationary time series.

This analysis was carried out to ascertain the response of price change in one market that is transmitted to other markets. The co-integration analysis was carried out for this purpose to know the inter market relationship between the domestic markets.

In short, if markets are efficient, then prices in different markets must be co-integrated. To examine the price relationship between two markets, Granger and Vector error test for basic relationship are commonly used to test for the existence of market integration.

Price relations are widely used to indicate the overall market performance as the usual definition is that integrated markets are those where prices are determined interdependently i.e. the changes in one market will be fully transmitted to the other markets.

In the present study co- integration method has been adopted with the use of E-views 11 software to study the market integration for modal prices of the selected markets. To carry out the analysis, data were made stationary mean that the process of generating the data is in equilibrium around a constant value and that the variance around the mean remains constant over a time. If mean change over time and variance is not reasonably constant, then series is non- stationary. To decide the stationerity or non stationerity of the data, for each of the market, ADF test has been conducted.

If calculated value of respective market in ADF test is less than critical value then that market prices data already stationary. But if the ADF value is greater than critical value then data are non-stationary. Such data are subjected to Ist

order differencing or IInd order differencing until it become stationary (as specified by a calculated value less than critical value).

When a co-integration relationship is present for two variables, a Granger Causality Test (Granger, 1969) can be used to analyze the direction of this co-movement relationship. Theoretically, a variable is said to Granger –cause another variable, if the current value of it is conditional on the past value of (1Y2Y2YY11, t1Y-.....)

Finally Vector Autoregressive Estimates were calculated for all the markets. The VEC (Vector Error Correction) estimates provide the short-term co-integration within the markets and between the markets which were expressed in percentage. The T- statistics were calculated to know the significance of the markets within them and also between markets, which decided on the basis of T- statistics value. If the T- statistics values are greater than 2.0 then the integration values were considered as significant, otherwise non-significant and were not considered for drawing the inferences.

3.10.3 Stationarity Test

The Augmented Dickey-Fuller (ADF) based unit root test procedure was done to check the stationarity in price series of castor seed. From the Table 3.13, it could be inferred that the original data were non-stationary but their first differences were stationary (i.e. implying the presence of unit roots in the series). Thus, the original price series of castor had a unit root. The occurrence of unit root in the price data generation process of castor seed gave a preliminary indication of shocks which may have permanent or long-lasting effect.

Table 3.13: ADF unit root test for prices of Castor

Market	Augmented Dickey-Fuller (ADF) test value		
	Level	1st difference	Critical value (1%)
Bhabhar	-2.886541	-8.863209	-3.486551
DS	-2.704159	-11.50787	
K	-2.682976	-8.965640	
MH	-2.867924	-9.251134	
RP	-2.673051	-9.001291	
Th	-2.453692	-9.629605	

From the table it could be inferred that Augmented Dickey Fuller test values are above the critical value (1 %) given by MacKinnon statistical tables at levels implying that the series are non-stationary at their levels indicating the existence of unit root. After taking first difference, all the series becomes stationary which is obvious from the fact that calculated values (-8.863209 to-11.50787) for all the markets were less than the critical value (-3.486551) and were free from the consequence of unit root.

3.10.4 Result of Lag Order Selection Criteria

For getting optimal lag length for co integration analysis, we have used five criteria namely, LR test statistic, Final prediction error(FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). Most of the criteria have suggested a leg length of 1 as an optimal leg length (Table 3.14).

Table 3.14: VAR Lag Order Selection Criteria for Castor Price

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-4412.737	NA	7.21e+24	74.26448	74.40460	74.32138
1	-4231.689	340.7947*	6.30e+23*	71.82671*	72.80758*	72.22501*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)

Result of Co-Integration Test Based on Johnson Juselius Method

Once we have the results of unit roots, the next step is to determine whether there exists cointegration, using the same order of integrated variables. To test for co-integration, the Johansen and Juselius (1990) procedure was used, which leads to two test statistics, trace test and maximum eigenvalue test, for co-integration.

Table 3.15: Results of multiple co-integration analysis for Castor

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.550464	255.9535	95.75366	0.0000
At most 1 *	0.377030	161.6079	69.81889	0.0000
At most 2 *	0.310431	105.7635	47.85613	0.0000
At most 3 *	0.259228	61.90434	29.79707	0.0000
At most 4 *	0.157303	26.49705	15.49471	0.0008
At most 5	0.052002	5.301544	2.841465	0.2121

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3.15 expresses the results of the co-integration test. There are two test statistics for co-integration, the Trace test and Maximum Eigen value test. Unrestricted co-integration rank tests (Trace and Maximum Eigen value) indicated the presence of at least five co-integrating equation at 5 per cent level of significance. Hence markets were having long run equilibrium relationship. Finally, it can say that there is a long run relationship between selected markets of castor.

The error correction term indicates the speed of adjustment among the variables before converging to equilibrium in the dynamic model. The coefficients show how quickly variables return back to equilibrium. The Table 3.16 clearly shows that Bhabhar, Kadi, and Rudhanpur castor markets came to short run equilibrium as indicated by the level of significance and the rapid speed of adjustment. In long run, Bhabhar castor market prices were influenced by its own and all other selected markets price in one month lagged lags. Similarly, Mahsana market prices were influenced by its own and Bhabhar, Kadi and Rudhanpur market price in one month lags.

Results of Vector Error Correction Model

Table 3.16 : Results of vector error correction model for domestic castor markets

	BH	DS	K	MH	RP	TH
CointEq1	0.025488	0.007766	-0.019296	-0.003977	0.015387	-0.002978
	(0.00979)	(0.00540)	(0.00855)	(0.00601)	(0.00661)	(0.00634)
	[2.60427]	[1.43899]	**[-2.25575]**	[-0.66201]	**[2.32880]**	[-0.46962]
BH(-1)	1.367047	0.649976	0.807917	0.830109	0.895387	0.819934
	(0.25668)	(0.26336)	(0.23724)	(0.24437)	(0.23572)	(0.26303)
	[5.32598]	**[2.46802]**	**[3.40542]**	**[3.39692]**	**[3.79859]**	**[3.11725]**
DS(-1)	0.232056	0.189231	0.067327	0.045708	0.108791	0.086909
	(0.12455)	(0.12779)	(0.11512)	(0.11857)	(0.11437)	(0.12763)
	[1.86323]	[1.48081]	[0.58486]	[0.38547]	[0.95118]	[0.68095]
K(-1)	0.293551	0.380428	0.947487	0.945237	0.406957	0.700657
	(0.52703)	(0.54076)	(0.48713)	(0.50177)	(0.48399)	(0.54008)
	[0.55699]	[0.70351]	[1.94502]	[1.88382]	[0.84083]	[1.29732]
MH(-1)	-0.309928	-0.233121	-0.346866	-0.286107	-0.342490	-0.292477
	(0.19175)	(0.19674)	(0.17723)	(0.18256)	(0.17609)	(0.19650)
	[**-2.61632**]	[-1.18490]	[**-2.95711**]	**[-2.56722]**	**[-2.94496]**	[-1.48845]
RP(-1)	-0.928406	-0.367747	-0.799820	-0.831434	-0.370092	-0.706950
	(0.48950)	(0.50225)	(0.45245)	(0.46604)	(0.44953)	(0.50162)
	[-1.89663]	[-0.73220]	[-1.76777]	[-1.78405]	[-0.82329]	[-1.40932]
TH(-1)	0.242303	0.281724	0.231434	0.182419	0.214036	0.305316
	(0.28094)	(0.28825)	(0.25967)	(0.26747)	(0.25799)	(0.28789)
	[0.86249]	[0.97736]	[0.89126]	[0.68202]	[0.82961]	[1.06052]
C	329.0459	338.1418	298.2934	377.0790	225.9391	315.6454
	(162.616)	(166.851)	(150.306)	(154.821)	(149.337)	(166.643)
	[2.02345]	[2.02661]	[1.98457]	[2.43558]	[1.51294]	[1.89414]
R-squared	0.845588	0.834425	0.865683	0.852311	0.868563	0.841025
Adj. R-squared	0.837316	0.825555	0.858487	0.844399	0.861522	0.832508
Sum sq. resids	6399510.	6737151.	5467288.	5800675.	5397032.	6720376.
S.E. equation	239.0366	245.2614	220.9413	227.5780	219.5172	244.9558
F-statistic	102.2220	94.07188	120.3080	107.7253	123.3533	98.75190
Log likelihood	-816.9639	-820.0231	-807.5963	-811.1182	-806.8267	-819.8748
Akaike AIC	13.84813	13.89955	13.69069	13.74989	13.67776	13.89706
Schwarz SC	14.01161	14.06303	13.85417	13.91336	13.84124	14.06053
Mean dependent	4005.334	3988.811	4021.468	4015.462	3923.697	4054.538
S.D. dependent	592.6410	587.2188	587.3264	576.9319	589.8992	598.5367

3.10.5 Granger Causality Test

Table 3.17: Pair wise granger causality tests results for castor seed wholesale prices.

Null Hypothesis:	Obs	F-Statistic	Prob.	Conclusion
DS does not Granger Cause BH BH does not Granger Cause DS	119	1.27083 36.2302	0.2619 2.E-08	unidirectional
K does not Granger Cause BH BH does not Granger Cause K	119	2.13692 10.1404	0.1465 0.0019	unidirectional
MH does not Granger Cause BH BH does not Granger Cause MH	119	4.60731 45.9195	0.0339 5.E-10	bidirectional
RP does not Granger Cause BH BH does not Granger Cause RP	119	4.47269 16.6707	0.0366 8.E-05	bidirectional
TH does not Granger Cause BH BH does not Granger Cause TH	119	0.21541 10.2763	0.6434 0.0017	unidirectional
K does not Granger Cause DS DS does not Granger Cause K	119	27.6703 0.82128	7.E-07 0.3667	unidirectional
MH does not Granger Cause DS DS does not Granger Cause MH	119	14.3149 13.0802	0.0002 0.0004	bidirectional
RP does not Granger Cause DS DS does not Granger Cause RP	119	26.7245 1.97489	1.E-06 0.1626	unidirectional
TH does not Granger Cause DS DS does not Granger Cause TH	119	29.3329 1.82128	3.E-07 0.1798	unidirectional
MH does not Granger Cause K K does not Granger Cause MH	119	2.49886 36.0803	0.1167 2.E-08	unidirectional
RP does not Granger Cause K K does not Granger Cause RP	119	0.00881 1.01967	0.9254 0.3147	
TH does not Granger Cause K K does not Granger Cause TH	119	2.12046 2.28462	0.1480 0.1334	
RP does not Granger Cause MH MH does not Granger Cause RP	119	28.3203 1.02971	5.E-07 0.3123	unidirectional
TH does not Granger Cause MH MH does not Granger Cause TH	119	31.2425 0.22246	2.E-07 0.6381	unidirectional
TH does not Granger Cause RP RP does not Granger Cause TH	119	3.26151 1.58745	0.0735 0.2102	

In order to know the direction of causation between the markets, Granger Causality test was employed. When a co-integration relationship is present for two variables, a Granger Causality Test (Granger, 1996) can be used to analyse the direction of this co-movement relationship. Theoretically, a variable is said to granger-cause another variable, if the current value is conditional on the past

value (1Y2Y2YY11,t1Y-....). It was observed that there was a bidirectional influence on castor prices of Mahsana and Bhabhar, Mahsana and Dashada, Bhabhar and Rudhanpur. Dashada castor price shows unidirectional causality with Bhabhar, kadi, Rudhanpur and Thara market prices. Kadi market price influenced Bhabhar market prices (Table 3.17). There existed unidirectional causality with castor market prices. The price at Thara market is influenced by the prices of Kadi market whereas the castor prices at Mahsana market are influenced by the prices of Kadi market. Since in all these cases the probability value was less than 0.05. Thus, different markets of castor in the state of Gujarat were closely linked with each other for the movement of castor seed prices.

3.11 SWOT Analysis:

Castor oil is a promising commodity that has a variety of applications in the coming years, particularly as a renewable energy source. In the background of the emerging International trends, India's Castor business strengths, weaknesses, opportunities and threats are presented in Box 3.2 (TIFAC, 2018). 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 consumers' needs to be upgraded and augmented into that of a value added finished products (Castor Derivatives) supplier. Ability to achieve this will ensure a long term and commercially profitable Castor business for the country.

There is a large scope for improving India's earnings from castor by converting castor oil to various derivatives. With the World becoming more environmentally conscious and with the increasing replacement of synthetic products with naturally derived products, castor oil-based derivatives could find increasingly attractive markets worldwide. Besides, a 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. Experts suggest that this anomaly can be corrected if the industry expands the market by developing castor oil derivatives and invests in R&D. They unanimously believe, if the industry works as a more cohesive unit, India could soon be in a better situation.

Box 3.2: SWOT Analysis of Castor Oil Export

Strength	Opportunities
• Dominant share of world trade in Castor. • Favourable agro climatic condition for Castor farming. • Low labour cost – farming. • Strong R & D Infra-structure both at production and technology levels. • Stable political Environment. Strong and decisive Government. • Tax reforms (GST) leading to more ease of doing business and reducing tax evasion and corruption. • Strong and stable Indian currency. • Agro is now the focus of policy makers.	• Improvement in productivity of castor seed through further R&D • Diversification of crop in non-traditional area, and Rabi and semi Rabi also under intercropping system • Opportunity for value addition • Convert dominant trade in raw material to that in value added specialties • Compete with other oils to develop "new" applications for Castor
Weakness	**Threats**
• Raw material supplier, and not derivative supplier • Reliability of supply - Low/fluctuating farm yield – dependence on rain. • Fluctuations/volatilities in castor seed prices • Lack of process technology for higher level Derivatives • Variable quality of Derivatives • Most Indian players deal through intermediaries and have little knowledge of end consumers and their requirements.	• Shift away from Castor by consumers due to price volatility • Experiments in Latin America, Africa and other countries with similar agro climatic conditions as India for cultivation of Castor • Research in Ricin free seed development in the US • China's rapid progress as cost-effective manufacturer of Castor derivatives (as in many other products) can severely affect India's prospects limiting India to a raw material supplier

Source: TIFAC, 2018.

China currently imports about one-third of its total castor oil requirement, valued at $314.4 million from India. However, despite these glorious numbers, India continues to be a price taker and not a price setter in the global castor oil market[9]. India, as the largest producer and exporter of castor oil in the world, is responsible for almost 83.65 per cent of total global exports in this segment. Its main trading partners in this specific sector are China, Europe, Thailand and Japan. China has been one of the biggest growth drivers for castor oil due to its demand for sebacic acid (a basic industrial chemical compound) which is developed from this oil. One major reason is that India became the largest producer of the seed by default. Brazil, which in the 70s was the largest producer of castor seeds in the world, moved away from this seed to soybean which has a higher yield and greater export demand for both its beans and oil. So did other major countries, leaving India with a virtual monopoly. Ironically, with synthetic substitutes being available at cheaper prices, India has not been able to leverage this monopoly.

3.12 Chapter Summary:

Castor oil is a hot market commodity product. India is the leader in global castor production and dominates in the international castor oil trade. Global castor oil and derivatives key players include Jayant Agro, NK Proteins, Adani Wilmar, etc. India exports castor oil in two forms namely first special grade and castor oil commercial. The major trading centers of castor and its derivatives in India are Rajkot (Gujarat), Ahmedabad (Gujarat), Gondal (Gujarat), Gadwal (Gujarat), Bhabar (Gujarat), Disa (Gujarat), Kadi (Gujarat), Jedcherla (Andhra Pradesh) and Yemignoor (Andhra Pradesh). Also castor and its derivatives like castor seed, castor oil and castor oil cake are traded in Indian commodity exchanges. The season behavior of castor prices revealed the existence of seasonality in all the markets. Higher indices of market arrivals of castor seed were noticed immediately after harvest in the selected markets arrivals reached peak during April and relatively shoot up in September and October. The different markets of castor in

[9] https://www.thedollarbusiness.com/magazine/castor-oil-it-promises-big-profits-patience-please/32744

the state of Gujarat were closely linked with each other for the movement of castor seed prices.

There is a large scope for improving India's earnings from castor by converting castor oil to various derivatives. Besides, a 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.

The next chapter presents the results of primary data sets.

Chapter IV

Castor Seed Production and Marketing in Gujarat

4.1 Introduction

The present chapter mainly deals with the estimation of cost of cultivation and cost of production of castor seed in selected districts of Gujarat. The socio-economic characteristics, holdings of assets and cropping pattern and related details are also presented and discussed. The responses of stakeholders are also presented and discussed in this chapter.

4.2 Findings from Field Survey data- Farmer:

4.2.1 Socio-Economic Characteristics of Sample Households

The details on the socio-economic profile of sample households are presented in Table 4.1. It can be seen from the table that out of the total 400 sample selected households, every group of landholders has representation in the sample contributing a share of around one-fifth of the total sample households. The dominance of male respondents can be seen from the fact that hardly 0.5 per cent of total respondents were female. The average age of the respondent was estimated to be about 49.5 years and it was almost the same in all categories of landholdings. The average size of the household was reported to be around 6 persons, of which around 41 per cent were adult male, 36.7 per cent were adult females and the rest were children below the age of 15 years. The family size was the lowest with the marginal landholder group and was the highest with the medium landholder group. The status of education has a greater role in the adoption of new techniques and technologies in agriculture. The survey sample indicates that at the overall level, more than 91 per cent of the respondents were literate and half of them were educated up to matric level and above.

The social classification of sample households indicates that the highest respondents belong to Other backward classes followed by the General/open category group which together accounts for more than 93 per cent in total sample households. The share of SC and ST respondents was 5.8 and 1 per cent respectively at the overall level. As was expected, more than 95 per cent

households had agriculture/crop cultivation as a primary occupation and dairy as a secondary occupation for almost 72 per cent of households. It was surprising to note that the marginal landholder group had relatively higher share of household having service as their main occupation as compared to other landholder group. On an average, castor farmers had a long experience of castor cultivation of 22.5 years which indicate their long engagement in this crop cultivation.

Table 4.1: Socio-Economic Characteristics of the Selected Farmer household

Sr. No.	Characteristics		Socio-Economic Characteristics of Sample HH					
			Marginal (M)	Small (S)	Semi Medium (SM)	Medium (MED)	Large (L)	Total (T)
1	No of HH		76	79	87	78	80	400
		% to total	19.0	19.75	21.75	19.5	20.00	100.0
2	Gender of Respondent (%)	Male	100.00	98.73	100.00	98.72	100.0	99.50
		Female	0.00	1.27	0.00	1.28	0.00	0.50
3	Age of the Respondent (Years)	Mail	51.30	48.58	48.52	50.35	48.95	49.52
		Female	0.00	70.00	0.00	60.00	0.00	65.00
4	Household size (av. numbers)	Total	5.38	5.59	5.48	6.68	6.48	5.92
		Male	2.42	2.29	2.26	2.58	2.64	2.44
		Female	2.04	2.11	1.99	2.35	2.39	2.17
		Children	0.92	1.19	1.23	1.76	1.45	1.31
5	Education status of Respondent, number of years of education (%)	Illiterate	6.58	8.86	9.20	7.69	8.75	8.25
		Up to Primary (5)	26.32	22.78	25.29	21.79	22.50	23.75
		Up to Middle (8)	19.74	11.39	17.24	23.08	20.00	18.25
		Up to Matric (10)	22.37	34.18	25.29	28.21	30.00	28.00
		Up to + 2	15.79	10.13	18.39	12.82	12.50	14.00
		Up to graduate	9.21	10.13	3.45	3.85	5.00	6.25
		Above graduate	0.00	2.53	1.15	2.56	1.25	1.50
6	Caste (% of households)	SC	9.2	6.3	6.9	3.8	2.5	5.8
		ST	2.6	1.3	0.0	0.0	1.3	1.0
		OBC	47.4	51.9	59.8	41.0	36.3	47.5
		General	40.8	40.5	33.3	55.1	60.0	45.8
7	Main Occupation of the respondent (%)	Agri. & allied	89.5	96.2	98.9	94.9	98.8	95.8
		Dairy	0.0	0.0	1.1	1.3	0.0	0.5
		Service	9.2	1.3	0.0	1.3	0.0	2.3
		Agricultural labour	1.3	1.3	0.0	0.0	0.0	0.5
		Salaried/ pensioners	0.0	1.3	0.0	2.6	1.3	1.0
		Others	0.0	0.0	0.0	0.0	0.0	0.0
8	Subsidiary Occupation of the respondent (%)	Agriculture and allied	10.5	5.1	1.1	5.1	1.3	4.5
		Dairy	57.9	67.1	77.0	71.8	83.8	71.8
		Service	3.9	0.0	1.1	1.3	1.3	1.5
		Agricultural labour	1.3	3.8	3.4	0.0	0.0	0.0
		Salaried/ pensioners						
		None	26.3	24.1	17.2	21.8	13.8	22.3
9	Castor Farming experience	Av in years	21.87	21.63	22.24	23.71	23.11	22.51

Source: Field survey data.

4.2.2 Details on Operational Land Holdings of Sample Households

The average size of land holdings of the sample household was estimated to be 4.21 ha of which 91.21 per cent reported as irrigated (Table 4.2). The irrigation coverage was almost same in all land holding categories which indicate availability of protective irrigation on the farm and thus, castor crop growing by the irrigated land holders. The land leased-in tendency was found prominent with higher landholder groups. In fact, the positive relationship was observed between land leased-in tendency with land size. Because, generally small and marginal farmers are found to be acquiring more land for cultivation through land leased-in tenancy. The leased-in criteria was either on sharing basis or cash basis (Table 4.3 & 4.4). The sharing basis criteria was of one-third of crop produce while some of the households had agreement of one half produce and few of them had one fourth produce sharing oral agreement. On cash basis, the average rent per ha land was reported to be Rs. 20431 per year. The unirrigated leased-in land average rent price varies from Rs.15000 to Rs.18000 per hectare while in case of irrigated land, it varied from Rs. 20000 to Rs. 25000 per hectare.

Table 4.2: Average Operational Land Holdings of Selected Farmers

Sr. No.	Particulars	Land	Land holdings (ha)					
			Marginal (M)	Small (S)	Semi Medium (SM)	Medium (MED)	Large (L)	Total (T)
1	Total owned land (ha.)	Total	0.80	1.45	2.71	3.66	8.11	3.36
		Unirrigated	0.13	0.19	0.33	0.65	0.67	0.41
		Irrigated	0.71	1.31	2.46	3.17	7.44	3.03
2	Current fallow 2020-21	Total	0.00	0.00	0.06	0.02	0.22	0.06
		Unirrigated	0.00	0.00	0.08	0.00	0.20	0.06
		Irrigated	0.00	0.00	0.00	0.02	0.09	0.02
3	Leased-in land (ha.)	Total	0.01	0.18	0.38	1.25	2.81	0.92
		Unirrigated	0.00	0.03	0.05	0.05	0.45	0.12
		Irrigated	0.01	0.15	0.34	1.21	2.47	0.83
4	Leased-out land	Total	0.04	0.01	0.00	0.00	0.00	0.01
		Unirrigated	0.02	0.00	0.00	0.00	0.00	0.00
		Irrigated	0.04	0.02	0.00	0.00	0.00	0.01
5	Total Operational Holding	Total	0.76	1.61	3.03	4.88	10.70	4.21
		Unirrigated	0.08	0.16	0.23	0.53	0.86	0.37
		Irrigated	0.69	1.45	2.79	4.36	9.84	3.84

Source: Field survey data.

Table 4.3: Land Leased-in Pattern of Selected household

Sl.		Land Leased-in Pattern of Selected household					
	Category	% HH	Leased-in	Share	% HH	Land	Rent (Rs/ha)
1	Marginal	0.00			1.32	0.72	25020
2	Small	2.53	3.36	1/3	15.19	10.49	23828
3	Sem Med	2.30	4.80	1/3	18.39	24.38	19976
4	Medium	5.13	16.07	¼ to ½	38.46	81.14	18896
5	Large	10.00	45.99	1/3	31.25	178.99	20431

Source: Field survey data.

Table 4.4: Leased -Out Land Pattern in Selected household

Sl.	Category	% HH	Leased out	Share	% HH	Land	Rent (Rs/ha)
1	Marginal	3.95	3.36	¼ to ½	-	-	-
2	Small	-	-	-	1.27	0.96	24000
3	Sem Med	-	-	-	-	-	-
4	Medium	-	-	-	-	-	-
5	Large	-	-	-	-	-	-

Source: Field survey data.

4.2.3 Sources of Irrigation:

As seen earlier, almost 93 per cent of the total land of the selected households had irrigation facilities available, which ranged from about 89.5 percent with marginal farmers to 98.75 per cent with large land holder farmers (Table 4.5). Thus, area under irrigation was positively related with land size group. The major source of irrigation was groundwater in all farm size categories having average share of about 74 per cent in total irrigation by tubewell, followed by around 21 per cent by canal and rest with both the sources.

Table 4.5: Source-wise Irrigation Facility available

Sr. No.		Sources of Irrigation (%)					
	Sources	Marginal (M)	Small (S)	Semi Medium (SM)	Medium (MED)	Large (L)	Total (T)
1	Rain fed	10.53	11.39	6.90	7.69	1.25	7.50
2	Irrigated	89.47	88.61	93.10	92.31	98.75	92.50
3	Sources of Irrigation						
a	Canal	29.41	20.00	16.05	20.83	20.25	21.08
b	Tubewell	67.65	77.14	77.78	70.83	74.68	73.78
c	Canal & Tubewell both	2.94	2.86	6.18	8.33	5.06	5.14

Source: Field survey data.

4.2.4 Livestock Holdings:

The livestock holdings of the selected household indicate that selected households had good support of livestock having three each of cows and buffaloes. The average present value of cow was estimated to be Rs. 37736/- and Rs.72199 for buffalo (Table 4.6).

Table 4.6: Livestock holdings with Sample Household

Sr. No.	Types	Units	Assets holdings					
			Marginal	Small	Semi Medium	Medium	Large	Overall Ave.
1	Cow	Number	1.8	1.7	2.3	3.5	3.1	2.6
		Present value (Rs.)	31428.6	28333.3	37222.2	43777.8	37127.7	37736.5
2	Buffalo	Number	2.9	2.2	3.4	3.0	4.1	3.2
		Present value (Rs.)	70192.3	75454.5	73333.3	73333.3	70151.5	72199.1

Source: Field survey data.

4.2.5 Assets Holdings:

The assets holdings of the selected household indicate that the study area had better extent of agriculture mechanisation having implements like tractor, threshers and electric motors/diesel engines, and others (Table 4.7).

Table 4.7: Assets holdings (Number)

Sr. No.	Types	Units	Assets holdings					
			Marginal	Small	Semi Medium	Medium	Large	Overall Ave.
1	Tractors, trailer/trolley	Number	0.5	0.9	1.2	1.4	1.5	1.2
		Present value (Rs.)	202857.1	222815.8	260673.1	251026.7	253719.6	247681.8
2	Harrow and cultivator	Number	1.2	1.5	1.6	1.7	1.8	1.7
		Present value (Rs.)	38333.3	32478.3	34307.2	37095.7	42397.6	37910.1
3	Electric motor/Diesel Engine	Number	1.1	1.1	1.3	1.3	1.6	1.3
		Present value (Rs.)	21741.4	34480.8	36104.7	45309.5	42128.0	38831.1
4	Thresher	Number	1.0	1.1	1.1	1.0	1.0	1.0
		Present value (Rs.)	72500.0	41636.4	79615.4	78235.3	106323.5	85493.5
5	Planker	Number	1.0	0.0	0.5	0.0	0.8	0.7
		Present value (Rs.)	27500.0	0.0	40000.0		41666.7	36666.7
6	Manual/power sprayer	Number	1.2	1.2	1.5	1.7	2.1	1.5
		Present value (Rs.)	3927.6	4536.0	5450.0	4310.0	6010.7	5018.8
7	Drip/sprinkler system	Number	0.0	1.0	1.0	1.0	1.0	1.0
		Present value (Rs.)	0.0	258750.0	185000.0	263000.0	434500	323261
8	Small tools (spade, hoe, sickle etc)	Number	8.0	8.9	9.5	11.3	12.7	10.2
		Present value (Rs.)	557.3	544.5	502.2	460.0	627.5	539.5
9	Animal shed/pump house	Number	1.0	1.0	1.0	1.2	1.2	1.1
		Present value (Rs.)	16610.3	25675.0	46090.9	38693.9	56502.9	40719.8
10	Combine Harvestor	Number	0.0	0.0	0.0	0.0	0.5	0.3
		Present value (Rs.)	0.0	0.0	0.0	0.0	160000	160000

Source: Field survey data.

4.2.6 Cropping Pattern:

The cropping pattern adopted by the selected sample households presented in Table 4.8 indicates that two-fifth of the gross cropped area was under castor crop cultivation, which comes to the almost two-third cropped area during kharif season. The other major crops grown were wheat and rapeseed mustard in rabi season.

Table 4.8: Cropping pattern of Selected Households

Sr. No.	Crop	Cropping pattern of Selected Households (% to GCA)					
		M	S	SM	MED	L	T
I	Kharif	79.9	70.0	65.5	66.0	48.4	62.0
1	Bajra	0.0	7.0	3.6	1.8	0.0	2.7
2	Jowar	0.0	0.0	0.0	0.2	0.0	0.0
3	Tur	1.0	0.0	0.0	0.0	0.0	0.2
4	Moong	0.0	1.8	2.0	1.6	0.4	1.4
5	Urad	0.5	6.5	0.4	0.2	1.1	1.8
6	Guar seed	0.0	0.7	1.4	0.7	0.0	0.7
7	Groundnut	7.3	5.0	5.0	6.3	0.0	5.9
8	Sesamum	0.0	2.7	0.4	0.2	0.2	0.7
9	**Castor**	**37.9**	**23.4**	**44.6**	**32.5**	**29.2**	**40.0**
10	Cotton	22.0	13.5	0.0	16.0	6.5	0.0
11	Vegetables	0.6	1.6	0.0	0.0	0.0	0.0
12	Fodder	10.5	7.9	8.1	6.5	10.9	8.6
II	Rabi	18.7	29.5	20.0	26.5	51.6	32.1
1	Wheat	7.5	7.7	6.7	6.0	12.4	9.0
2	Ajwain/Carom seed	1.4	4.7	0.0	0.0	1.1	1.6
3	Maize	0.0	0.0	0.2	0.4	0.0	0.0
4	Fennel /Sonf	0.0	0.7	0.0	0.0	0.7	0.2
5	Dilseed (Suva)	0.0	0.0	0.0	0.0	0.7	0.2
6	Rajgira/ Amranath	0.0	0.0	0.4	0.4	0.0	0.2
7	Lucern/Razkaseed	0.0	0.0	0.0	0.0	0.4	0.0
8	Gram	0.0	0.0	0.0	0.0	5.0	1.1
9	Coriander	0.0	0.0	0.2	0.7	0.0	0.2
10	R&M	0.3	10.1	6.5	8.8	23.3	9.5
11	Tobacco	0.0	0.2	1.2	0.2	1.1	0.7
12	Cumin	8.0	2.5	2.8	9.5	2.8	6.3
13	Potato	0.6	3.4	0.4	0.0	0.0	0.9
14	Vegetables	0.8	0.2	0.6	0.0	0.0	0.5
15	Fodder	0.0	0.0	1.0	0.5	4.1	1.6
III	Summer	1.4	0.5	14.5	7.6	0.0	5.9
1	Bajra	0.0	0.0	6.5	4.6	0.0	2.7
2	Groundnut	0.0	0.0	0.0	0.9	0.0	0.2
3	Other crops	0.0	0.0	2.2	0.4	0.0	0.7
4	Fruits	1.4	0.2	5.8	1.8	0.0	2.3
5	Others	0.0	0.2	0.0	0.0	0.0	0.0
IV	GCA	100.0	100.0	100.0	100.0	100.0	100.0

Source: Field survey data.

4.2.7 Production & Productivity of Major Crops:

The production and productivity of major crops by the selected households are presented in Tables 4.9 and 4.10. The average crop productivity of castor crop was estimated to be 26.5 qtls/ha. The highest productivity was reported in case of semi-medium land holders group which was 35.93 qtls per hectare while the lowest was in case of marginal farmer group (19.75 quintals/ha).

Table 4.9: Production of Major Crops

Sr. No.	Crop	Production of Major Crops (qtls)					
		M	S	SM	MED	L	T
1	Bajra	0.00	9.40	5.20	2.37	0.00	16.97
2	Jowar	0.00	0.00	0.00	0.15	0.00	0.15
3	Tur	0.63	0.00	0.00	0.00	0.00	0.63
4	Moong	0.00	1.31	1.70	0.63	0.11	3.75
5	Udad	0.24	8.71	0.53	0.06	0.38	9.92
6	Guar seed	0.00	0.48	1.86	0.50	0.04	2.88
7	Groundnut	7.79	6.00	5.14	7.63	0.00	26.56
8	Sesamum	0.00	1.13	0.10	0.04	0.01	1.28
9	**Castor**	**46.81**	**28.47**	**80.84**	**50.13**	**27.94**	**234.19**
10	Cotton	28.20	10.23	20.77	23.84	6.87	89.91
11	Vegetables	0.13	1.71	0.00	0.00	0.00	1.84
12	Fodder	127.83	66.79	60.49	58.85	84.01	397.97
13	Wheat	10.98	11.44	9.30	10.78	17.00	59.50
14	Ajwain	0.53	3.62	0.00	0.00	0.26	4.41
15	Maize	0.00	0.00	0.18	0.44	0.00	0.62
16	Sonf	0.00	0.27	0.00	0.00	0.68	0.95
17	Dilseed (Suva)	0.00	0.00	0.00	0.00	0.30	0.30
18	Rajgira	0.00	0.00	0.36	0.28	0.00	0.64
19	Razkaseed	0.00	0.00	0.00	0.00	0.13	0.13
20	Gram	0.00	0.00	0.00	0.00	2.47	2.47
21	Coriender	0.00	0.00	0.21	0.21	0.00	0.42
22	R&M	0.00	16.48	7.96	7.38	20.98	52.80
23	Tobacco	0.00	0.10	1.54	0.36	1.22	3.22
24	Cumin	2.96	0.27	1.88	7.06	0.60	12.77
25	Potato	0.18	55.70	5.98	0.00	0.00	61.86
26	Vegetables	0.24	0.23	1.84	0.00	0.00	2.31
27	Fodder	0.00	0.00	6.32	4.55	47.38	58.25
28	Bajra	0.00	0.00	8.55	6.44	0.00	14.99
29	Groundnut	0.00	0.00	0.00	1.50	0.00	1.50
30	Other crops	0.00	0.00	14.48	3.54	0.00	18.02
31	Fruits	0.00	0.00	0.00	3.33	0.00	3.33
32	Others	0.00	1.01	0.00	0.00	0.00	1.01

Source: Field survey data.

Table 4.10: Productivity of Major Crops

Sr. No.	Crop	Productivity (qtls/ha)					
		M	S	SM	MED	L	T
1	Bajra	23.06	28.66	27.89	30.68	27.29	28.58
2	Jowar	-	-	-	-	25.02	25.02
3	Tur	-	-	-	-	10.01	10.01
4	Moong	14.34	12.77	13.26	14.47	13.37	13.54
5	Udad	18.02	16.72	19.03	16.38	17.80	17.54
6	Guarseed	8.51	8.51	10.31	10.72	9.00	9.27
7	Groundnut	22.19	14.22	23.30	21.98	20.09	20.59
8	Sesamum	-	2.50	5.76	4.56	4.27	4.22
9	**Castor**	**25.76**	**22.16**	**24.41**	**26.49**	**29.07**	**26.79**
10	Cotton	22.81	20.37	28.40	20.78	22.68	23.03
11	Vegetables	141.78	16.68	71.18	20.45	24.19	42.85
12	Fodder	199.63	166.42	144.65	149.03	182.30	165.93
13	Wheat	34.32	33.09	26.88	31.94	27.03	29.01
14	Ajwain	17.51	21.11	12.23	9.90	12.34	13.02
15	Maize	-	26.13	-	25.02	33.36	27.91
16	Sonf	19.71	17.87	17.05	12.97	17.93	15.74
17	Dilseed (Suva)	-	-	-	-	9.02	9.02
18	Rajgira	-	17.71	15.16	17.35	-	16.62
19	Razkaseed	-	4.73	-	7.30	-	6.20
20	Gram	-	-	-	6.23	11.58	10.55
21	Coriender	-	-	15.00	5.71	-	8.50
22	R-mustard	24.42	22.42	25.29	26.01	18.23	22.28
23	Tobacco	33.36	29.80	25.02	21.37	25.02	25.36
24	Cumin	17.92	7.89	6.39	6.84	10.32	9.16
25	Potato	-	-	-	5.00	300.18	291.81
26	Vegetables	250.20	-	-	32.53	13.44	28.18
27	Fodder	158.46	282.63	221.05	205.80	215.69	216.32
28	Bajra	28.29	24.33	23.73	25.64	25.09	25.04
29	Groundnut	25.00	-	20.00	35.42	--	29.85
30	Other crops	229.35	163.09	139.00	157.53	122.32	136.28
31	Fruits	-	-	79.23	89.31	97.83	96.51

Source: Field survey data.

4.2.8 Castor Crop Cultivation Package:

4.2.8.1 Sources of Castor Seed:

The major source of seed for selected farmers was agro-service centre/market followed by seed provided by seed corporation and agricultural universities (Table 4.11) and reasons for the same was the quality of seed and reliability of seed. Generally, unirrigated farmers mainly used GCH-2 variety which was also used in irrigated condition but GCH-7 was only used in irrigated condition.

Table 4.11: Choice of Source of Seed

SN	Reasons	Source of Seed (%)	M	S	SM	Md	L	Total
1	Get quality seed	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	15.79	16.46	20.69	23.08	20.00	19.25
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	**81.58**	**77.22**	**74.71**	**73.08**	**76.25**	**76.50**
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00
2	Reliable	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	15.79	16.46	20.69	23.08	20.00	19.25
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	**81.58**	**77.22**	**74.71**	**73.08**	**76.25**	**76.50**
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00
3	Confidence in own seed	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	1.32	1.27	0.00	1.28	0.00	0.75
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	**48.68**	**48.10**	**47.13**	**39.74**	**42.50**	**45.25**
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00
4	Not available elsewhere	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	1.32	1.27	0.00	1.28	0.00	0.75
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	48.68	48.10	47.13	39.74	42.50	45.25
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00
5	For experimenting	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	1.32	0.00	0.00	1.28	0.00	0.50
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	48.68	48.10	47.13	39.74	42.50	45.25
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00
6	Easy availability & quick credit	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	1.32	1.27	0.00	1.28	0.00	0.75
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	69.74	68.35	72.41	69.23	71.25	70.25
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00
7	Available at cheaper or subsidized rate	Home Grown (retained produce)	0.00	0.00	0.00	0.00	0.00	0.00
		Village/Fellow Farmers	0.00	0.00	0.00	0.00	0.00	0.00
		Agricultural Universities	1.32	1.27	0.00	1.28	0.00	0.75
		Seed Corporations	30.26	31.65	27.59	24.36	17.50	26.25
		Agro-Service Centre/Market	48.68	48.10	47.13	39.74	42.50	45.25
		Any Other	0.00	0.00	0.00	0.00	0.00	0.00

Source: Field survey data.

4.2.8.2 Practices Followed:

The details on cultivation practises adopted in castor crop cultivation presented in Table 4.12 indicate that majority of the respondents had sown castor

crop in the month of August and was harvested in the month of April. All the seed sown was of certified type and germination of seed was more than 70 per cent. The seed replacement rate reported was almost 95 per cent which is the highest in oilseed crop. Some farmers had early harvested castor due to climatic or biotic attack on crop.

Table 4.12: Details Cultivation Practices adopted (Respondent %)

Sr. No.	Cultivation Practices	Marginal	Small	Semi Medium	Medium	Large	Overall
i	Crop Sowing date						
	June	0.0	3.8	5.7	9.0	20.0	7.8
	July	23.7	25.3	28.7	24.4	20.0	24.5
	August	76.3	70.9	65.5	66.7	60.0	67.8
ii	Harvesting date						
	January	0.0	10.1	11.5	5.1	15.0	8.5
	March	9.2	1.3	3.4	2.6	2.5	3.8
	April	64.5	73.4	66.7	71.8	60.0	67.3
	November	10.5	10.1	11.5	9.0	7.5	9.8
	December	15.8	5.1	6.9	11.5	15.0	10.8
iii	Seed Class						
a	Breeder	0.0	0.0	0.0	0.0	0.0	0.0
b	Foundation	0.0	0.0	0.0	0.0	0.0	0.0
c	Certified	100.0	100.0	100.0	100.0	100.0	100.0
d	not aware	0.0	0.0	0.0	0.0	0.0	0.0
iv	Variety of seed						
v	Sowing method						
a	Plough furrow	100.0	30.4	0.0	0.0	0.0	25.0
b	Seed drill	0.0	64.6	97.7	100.0	100.0	73.5
c	Hand dibbling	0.0	5.1	2.3	0.0	0.0	1.5
d	Other	0.0	0.0	0.0	0.0	0.0	0.0
vi	Spacing : Row to Row (cms)	144.2	114.8	90.0	90.0	90.0	105.2
vii	Height -crop (cms) @harvest	187.3	185.9	184.8	184.9	177.3	184.1
viii	Seed germination						
a	>90%;	10.5	60.8	81.6	71.8	93.8	64.5
b	70-90%,	63.2	39.2	18.4	25.6	6.3	30.0
c	50-70%,	26.3	0.0	0.0	0.0	0.0	5.0
d	less than 50%	0.0	0.0	0.0	0.0	0.0	0.0
ix	Do you change the seeds (HYV/local) year after year- YES	71.1	100.0	100.0	100.0	100.0	94.5
x	Harvested crop kept for drying under Sun for how many days	12.7	13.2	11.3	8.8	7.1	10.6
xi	Threshing						
a	beating the dried capsules	0.0	0.0	0.0	0.0	0.0	0.0
b	Bullock feet	0.0	0.0	0.0	0.0	0.0	0.0
c	Machine	100.0	100.0	100.0	100.0	100.0	100.0
xii	Winnowing is done: YES	73.7	74.7	77.0	74.4	75.0	75.0
xiii	Have you completed **Seed Processing** before sale						
	Drying of seeds-Natural drying	100.0	53.6	44.9	46.3	46.3	49.3
	Drying of seeds- artificial drying						
	Cleaning, Winnowing, Sieving						

Source: Field survey data.

The row to row distance in castor crop cultivation was found to be around 90-120 cm or 3-4 feet and plant to plant gap was around 60-90 cm or 2-3 feet. Seed drill method of sowing was used by the majority of the farmers. The height of the crop at the time of harvest was reported to be around 184 cm. Threshing was done by the machine and seed harvested was kept for natural drying. The castor crop duration varies between 145 and 280 days depending upon the variety.

4.2.8.3 Sources of Information on Inputs:

The major source of information about seed was the state department of agriculture while for various extension services, sources were the State department of agriculture, private company, and input dealer. The fellow farmers and APMC Mandi were the major sources for market information for the selected households (Table 4.13).

Table 4.13: Sources of Information on Inputs/Seeds, Technology and Market

Sr. No.	Particulars	Marginal	Small	Semi Medium	Medium	Large	Overall
I	**Seeds**						
	Own	26.3	22.8	33.3	35.9	32.5	30.3
	Fellow farmer	36.8	30.4	34.5	38.5	42.5	36.5
	State Dept. of Agri.	100.0	100.0	100.0	100.0	100.0	100.0
	ICAR/SAU/KVK	78.9	75.9	69.0	67.9	58.8	70.0
	Commission agent/ Ahrtiya	78.9	79.7	74.7	70.5	71.3	75.0
	Market	77.6	78.5	73.6	69.2	71.3	74.0
	Media- Print/Elect.	92.1	92.4	92.0	89.7	97.5	92.8
II	**Extension Services**						
	State Dept. of Agri.	100.0	100.0	100.0	100.0	100.0	100.0
	Private company	100.0	100.0	100.0	100.0	100.0	100.0
	Input dealer	100.0	100.0	100.0	100.0	100.0	100.0
	SAU/ICAR/KVK	78.9	75.9	69.0	67.9	58.8	70.0
	Others specify	0.0	0.0	0.0	0.0	0.0	0.0
III	**Market Information**						
	Newspaper/Radio/TV	78.9	79.7	74.7	70.5	71.3	75.0
	Print media/News Paper	78.9	79.7	74.7	70.5	70.0	74.8
	Fellow farmer	100.0	100.0	100.0	100.0	100.0	100.0
	APMC mandi	98.7	100.0	100.0	100.0	100.0	99.8
	Commission agent/ Ahrtiya	21.1	20.3	25.3	29.5	28.8	25.0
	Private company	77.6	79.7	74.7	70.5	71.3	74.8
	Others specific	26.3	29.1	28.7	19.2	21.3	25.0

Source: Field survey data.

4.2.8.4 Agricultural Loans Taken:

The selected households had taken loans from institutional sources (like Cooperative Credit Society, LDB, Commercial banks, RRB, etc.) while few of them had taken loans from non-institutional sources (like money lenders, friends, relatives, etc.) (Tables 4.14 and 4.15). Out of total sample households, one-third households had taken loans as crop loan.

Table 4.14: **Details on agricultural loan taken as on date of survey**

Sr. No.	Source	Percentage of Category HH	Amount borrowed Rs.)
1	**Marginal**		
i.	Co-operative credit society	3.68	66600.0
ii.	Land Development Bank	0.00	0.0
iii.	Commercial bank	3.68	176000.0
iv.	Regional Rural Bank	0.74	70000.0
2	**Small**		
i.	Co-operative credit society	3.68	120200.0
ii.	Land Development Bank	0.00	0.0
iii.	Commercial bank	13.24	160277.8
iv.	Regional Rural Bank	3.68	285000.0
3	**Semi Medium**		
i.	Co-operative credit society	5.15	260714.3
ii.	Land Development Bank	0.74	600000.0
iii.	Commercial bank	13.24	223777.8
iv.	Regional Rural Bank	2.21	255000.0
4	**Medium**		
i.	Co-operative credit society	3.68	188000.0
ii.	Land Development Bank	0.00	0.0
iii.	Commercial bank	16.18	330227.3
iv.	Regional Rural Bank	2.94	275000.0
5	**Large**		
i.	Co-operative credit society	4.41	283333.3
ii.	Land Development Bank	0.74	3500000.0
iii.	Commercial bank	19.12	481538.5
iv.	Regional Rural Bank	2.94	612500.0
6	**Overall**		
i.	Co-operative credit society	20.59	192821.4
ii.	Land Development Bank	1.47	2050000.0
iii.	Commercial bank	65.44	309865.2
iv.	Regional Rural Bank	12.50	341764.7

Table 4.15: Percentage of Household borrowed Loans

Farmer Category	Household borrowed Loans				
	Percentage of HH	Amount borrowed (Rs.)	Interest Rate (%)	Purpose	Period of Loan
Marginal	14.5	116636.4	4	Seasonal crop loan	6 to 12 Month
Small	35.4	175392.9	4	Seasonal crop loan	6 to 12 Month
Semi medium	33.3	248896.6	4	Seasonal crop loan	6 to 12 Month
Medium	41.0	303281.3	4	Seasonal crop loan	6 to 12 Month
Large	46.3	545135.1	4	Seasonal crop loan	6 to 12 Month
Overall	34.3	315963.5	4	Seasonal crop loan	6 to 12 Month

Source: Field survey data.

4.2.8.5 Resource Use Pattern:

The resource use pattern in castor seed production is presented in Tables 4.16 and 4.17. It can be seen from the table that around 8-9 machine hours were used for the preparatory tillage operations, about 8 hours for weeding operations and around 5 hours for harvesting operations. Average use of seed was used of 5.21 kg per hectare and around 322 kg Urea, 132 kg of DAP and 36.6 kg of MOP was used in castor crop cultivation. The total human labour used in castor production were estimated to be 72 labour. The human labour were mostly involved in the harvesting and threshing operations as castor is harvested two three times at interval. Castor is generally harvested by manually four times during month of November, January, March and May. SADU (2012) noted that for value addition in the harvesting and processing it was found that the local sickle, improved sickle and secator were evaluated for efficient harvesting of castor crop (variety: GCH-7) and minimum losses.

Table 4.16: Resource use pattern in Castor seed on different land size holdings (per hectare)

Sr. No	Input	Resource use pattern					Weighted Average
		Marginal	Small	Semi Medium	Medium	Large	
1	Preparatory tillage By Machine (Hr)	8.31	8.23	8.37	8.52	8.72	8.47
2	Seed (kg)	5.24	4.71	4.76	5.84	5.31	5.21
3	FYM (Tonnes/ha)	4.26	6.32	5.31	7.14	8.08	6.91
4	Fertilizers (Kg/ha.)						
	i) Urea	290.86	296.52	329.58	333.25	330.69	322.16
	ii) DAP	128.95	131.35	129.23	129.70	137.44	132.11
	iii) MOP	20.00	20.00	40.56	40.96	33.55	36.57
	iv) NP/NPK Mixtures	7.14	3.62	5.22	6.69	5.23	5.43
5	Weeding by Machine (Hours/ha)	7.75	7.26	6.93	8.32	8.06	7.75
6	Insecticides & Pesticide	1.05	1.18	1.60	1.31	1.85	1.56

	(Hour/Hat)						
7	Harvesting & Threshing Hr.)	4.10	4.70	4.06	3.99	4.46	4.26

Source: Field survey data.

Castor seed harvested from field is dried till the pods open. Seeds are hulled by using de-hullers or by hand to remove the seed from the pod. Seed contains about 50 percent of oil by weight.

Table 4.17: Operation-wise labour use pattern on different size holdings (Day/ ha)

Sr. No	Input	Operation-wise labour use pattern					Weighted Average
		Marginal	Small	Semi Medium	Medium	Large	
1	Preparatory tillage	0.79	1.06	1.02	1.02	0.98	2.36
2	Seed & Seed treatment	3.91	3.71	2.82	3.19	2.55	2.91
3	Fertilizers & FYM	7.85	7.02	5.11	5.90	4.24	5.21
4	Weeding	20.11	18.35	16.27	22.29	17.40	18.31
5	Insecticides & Pesticide	11.78	11.88	8.71	9.22	7.63	8.78
6	Irrigation	11.78	11.88	8.71	9.22	7.63	8.78
7	Harvesting & Threshing	28.47	27.57	26.03	26.93	25.16	25.92
8	Total	84.69	81.47	68.66	77.77	65.56	72.26

Source: Field survey data.

4.2.9 Production & Productivity:

The details on the production and productivity of caster seed crop are presented in Table 4.17. It can be seen from the table that the average level of productivity estimated for the sample households was 26.8 quintals per hectare. The highest level of productivity was reported in the large land size holders group (29 quintals/ha) while the lowest was reported in the small landholders group (22.16 quintals/ha). Total seven households have reported the failure of the crop, thus no outpt was reported in these cases. It was reported that the castor crop productivity is low due to various biotic and a biotic factors amongst these wilt caused by *Fusarium oxysporium* is the major constraints beside this. partial/improper adoption of recommended technology also led to low productivity of castor.

Table 4.18: Details on Crop Output of Castor seed

Sr. No.	Particulars	Crop Output of Castor seed					
		Marginal	Small	Semi Medium	Medium	Large	Overall
1	Total Area (Hectare)	44.97544	73.20384	123.6229	149.7461	317.1956	708.7439
2	Total Output in Quintals	1158.35	1622.1	3017.4	3966.2	9220.8	18984.85

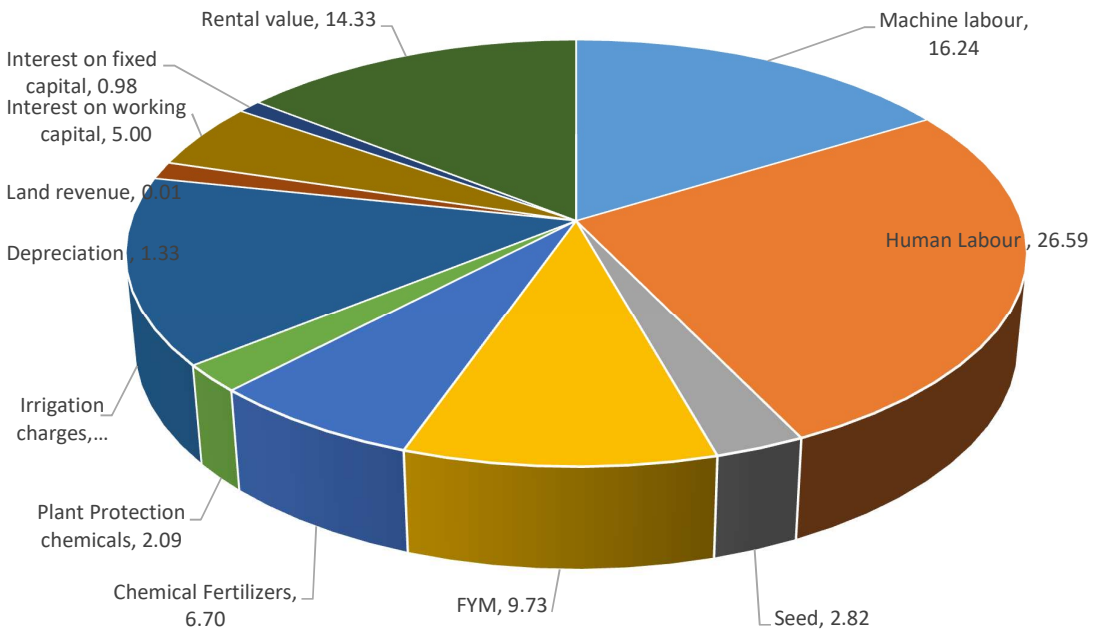
3	Productivity Per hectare	25.76	22.16	24.41	26.49	29.07	26.79

Source: Field survey data.

4.2.10 Cost of Cultivation:

The details on cost of cultivation of castor seed is presented in Table 4.18 and Fig. 4.1. It can be seen from the table that on an average, total cost of cultivation of castor seed per hectare was estimated to be Rs. 87528/-, while across the land holing group, same was the lowest in small land holder farmers group and the highest was in case of large land honing size group. Out of the total cost of cultivation, around 78.4 per cent was estimated to be paid out cost and remaining was the fixed cost. The component-wise share of each item in the total cost of cultivation indicate that the highest share of expenditure (one fifth of total cost of cultivation) was incurred on hired labour which was expected as castor seed crop is harvested in two-three times due to which it has become labour intensive crop. The other important operations were machine labour and irrigation charges which account for 16 and 14 per cent respectively in total cost of cultivation.

Fig. 4.1: Component-wise Share in Total Cost of Cultivation of Castor Seed



Source: Field survey data.

Table 4.19: Cost of Cultivation of Castor Seed (Rs/ ha)

Sr. No	Cost components	Cost of cultivation of Castor seed (Rs/ ha)					Overall
		Marginal	Small	Semi Medium	Medium	Large	
1	Machine labour	13984.66	13796.04	13612.85	14395.2	14755.86	14210.36
2	Hired labour	15954.65	16351.95	17364.71	17794.19	18853.03	17776.83
3	Imputed value of family labour	10216.6	8202.97	6110.86	5315.18	4151.87	5497.64
4	Including value of seed	2302.46	2276.77	2328.79	2555.583	2592.93	2466.25
5	FYM	6287.239	8323.77	9036.24	8418.783	8871.69	8512.81
6	Chemical Fertilizers						
	Urea	2019.942	2034.8	2192.76	2251.41	2220.77	2171.35
	DAP	3186.527	3188.79	3170.03	3199.16	3343.39	3229.67
	MOP	8.892841	13.66	59.05	178.08	80.39	84.37
	Mixture	300.1334	160.1	290.4	794.99	284.17	374.65
7	Plant Protection chemicals	1233.88	1278.75	1517.51	1969.21	2136.44	1830.62
8	Irrigation charges	13445.09	12941.94	12656.53	12157.29	12430.8	12426.62
9	Depreciation	1069.58	904.15	855.84	1079.7	1055.95	1159.96
10	Land revenue	14.6	9.38	11.61	14.49	14.84	13.00
11	Interest on working capital	3755.24	4035.43	4315.14	4459.37	4605.94	4373.59
12	Interest on fixed Capital	661.88	594.97	1638.4	24.64	861.77	861.00
13	Rental value	13031.58	12649.38	11759.05	12792.63	12562.96	12539
14	Total Cost	87472.95	86762.85	86919.77	87399.91	88822.8	87527.72
A	Total Variable Cost	68940.07	68569.54	68339.73	69029.08	69721.34	68581.17
b	Total Fixed Cost	18532.88	18193.31	18580.04	18370.83	19101.46	18946.55

Source: Field survey data.

If the only total paid out cost is considered, 28.2 per cent of total cost was incurred on hired labour, followed by machine labour (22.5 per cent) and irrigation charges (19.7 per cent). Thus, 70.4 of total paid cost was incurred on these three items only.

Fig. 4.2: Component-wise Share in Total Variable Cost of Cultivation of Castor Seed

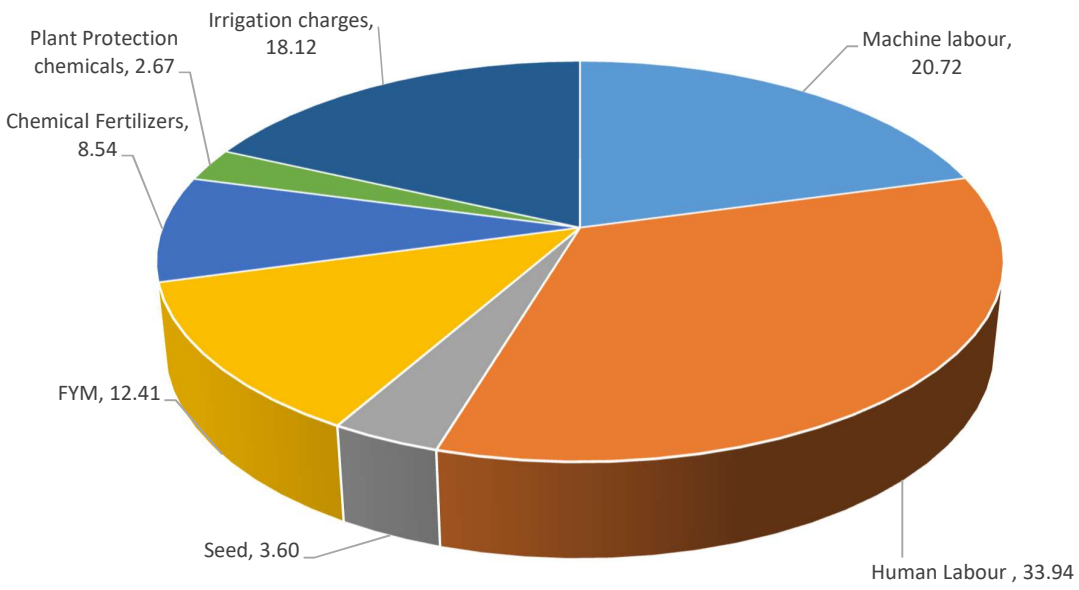
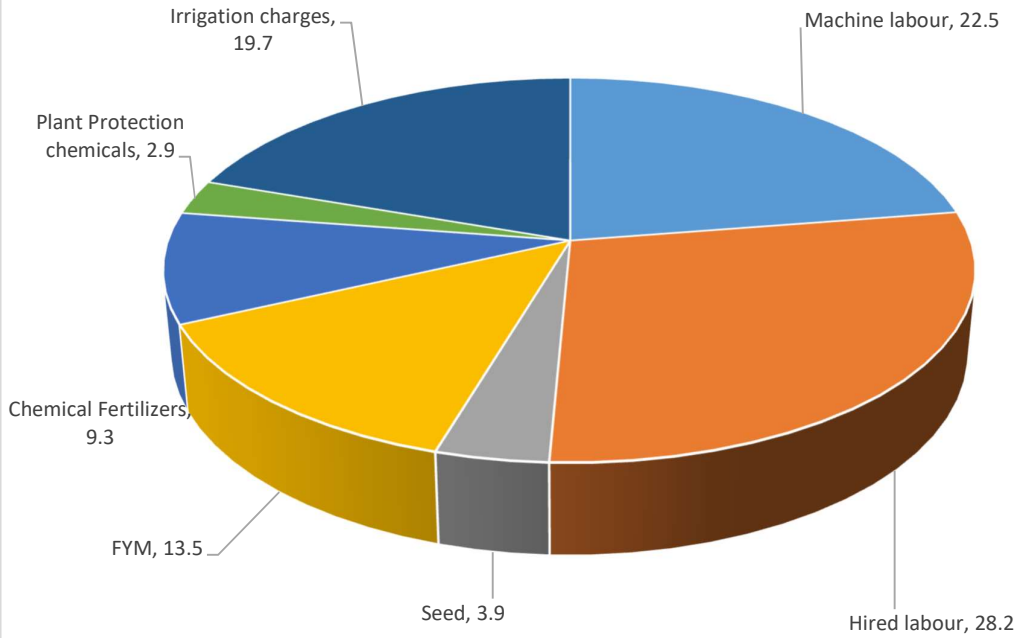


Fig. 4.3: Component-wise Share in Total Paid Out Cost of Cultivation of Castor Seed

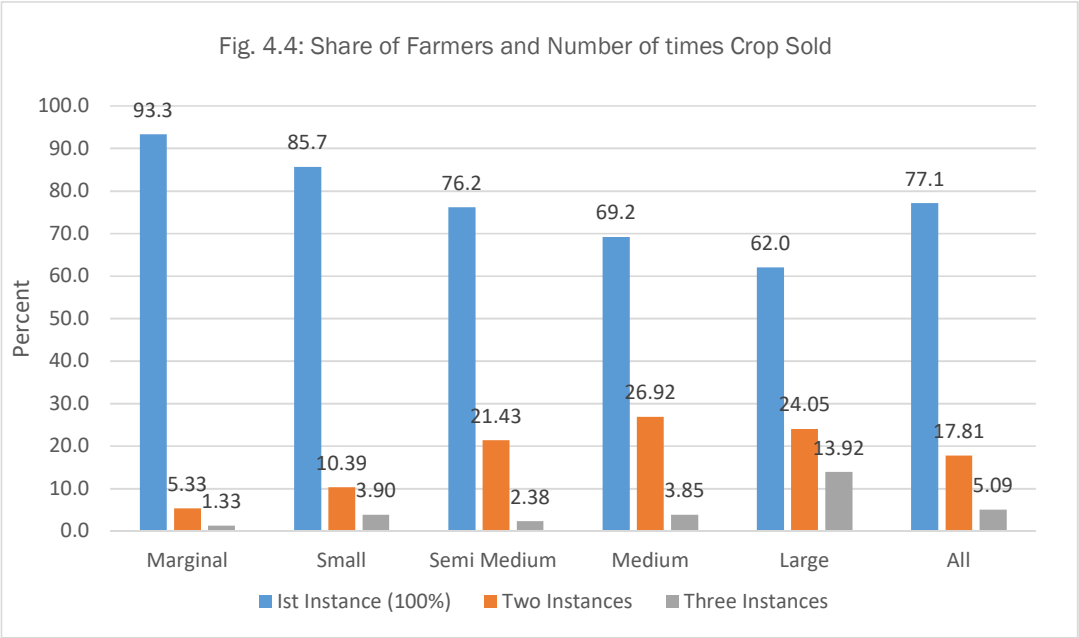


4.2.11 Sale of Output and Rate received:

The details on the price received and the crop output value are presented in Table 4.18. It can be seen from the table that on average, per quintal price for castor seed output realized by the sample households was Rs 4872/- per quintal. Across the land size group, the lowest rate was realized by the marginal farmers (Rs. 4621/- per quintal) and the highest rate was realized by the large size of land holders (Rs. 4977per quintal). Therefore, it is important to have idea about total quantity of sale of castor seed and number of times sale and agency to whom is sold. It can be seen from Fig 4.4 that 77 per cent of total households had sold 100 per cent out at first instance only. Across the groups, 93.3 per cent of marginal holders, 86 per cent of small holders and 76 per cent of marginal holders had sold all output at first instance only. Marginal farmers sold their output within 20 days of harvest.

Table 4.20: Details on Price received and Crop Output Value of Castor seed

Sr. No.	Particulars	Price received and Crop Output Value of Castor seed					
		Marginal	Small	Semi Medium	Medium	Large	Overall
1	Average Weighted Prices	4620.651	4809.127	4802.386	4782.508	4976.363	4872.22
2	Total Value of Output	5352331	7800885	14490720	18968382	45886048	92498366
3	Per hectare Output Value	119005.6	106563.9	117217.1	126670.3	144661.7	130510.3



It can be seen from the tables 4.18 to 4.21 that delayed sale of the output had advantageous in view of the upward shift in the rate of castor seed.

Table 4.21: Details on Sale of all Output in First instance

Sr. No.	Category	Details on Sale of all Output in First instance					
		No. of HH Crop loss	No. of HH Sold crop output	Quantity (Qtl)	Price (Rs/Qtl)	Transport and other Expenditure (Total) Rs.	Sale- No. of days after harvest of produce
1	Marginal	1	70	1038.35	4566.48	679.21	19.84
2	Small	2	66	1213.10	4680.63	957.31	22.15
3	Semi Medium	3	64	2360.35	4431.57	1101.54	29.51
4	Medium	0	54	2564.60	4690.28	1102.50	27.81
5	Large	1	49	4572.20	4731.55	1782.96	24.78
	All	7	303	11748.60	4610.55	1082.57	24.61

Table 4.22: Details on Sale of all Output in Two Instances

Sr. No	Category	Details on Sale of all Output in Two Instances							
		Number of House Hold	First Trade	Second Trade	Price Difference	% Change in Price	Transportation Cost Increase	% of Transportation Cost Incurred	Total Quantity
1	Marginal	4	38.46	61.54	218.75	4.487	262.5	31.82	91.00
2	Small	8	39.23	60.77	331.25	7.172	425.0	79.07	279.40
3	Semi Medium	18	43.68	56.32	357.5	7.389	180.6	26.64	609.05
4	Medium	21	49.41	50.59	371.90	7.519	5.2	0.50	1191.60
5	Large	19	61.39	38.61	557.10	11.683	68.4	6.24	2829.60

	All	70	54.73	45.27	405.07	8.389	130.1	14.53	5000.65

Table 4.23: Details on Sale of all Output in Three Instances

Sr. No.	Category	Details on Sale of all Output in Three Instances						
		Number of House Hold	Ist time	IInd Time	IIIrd Time	Quantity	Average Price	Average Transportation Cost
1	Marginal	1	34.48	34.48	31.03	29.00	4916.67	266.67
2	Small	3	30.86	30.86	38.27	129.6	4839.99	611.11
3	Semi Medium	2	31.25	31.25	37.50	48	4750.00	400.00
4	Medium	3	26.19	30.95	42.86	210	4886.11	877.78
5	Large	11	29.11	37.25	33.64	1819	5046.20	1062.12
	All	20	29.05	36.12	34.83	2235.6	4909.08	860.83

Table 4.24: Sale of Castor at First Instance

Sr. No.	Particulars	Sale of Castor at First Instance (100% sale)					
		Number of House Hold	Quantity (Qtl)	Price (Rs/Qtl)	Distance to the sale point	Transport and other Expenditure (Total) Rs.	Sale- No. of days after harvest of produce
A	Local Trader						
	Marginal	4	31.00	4750.00	0.00	0.00	7.75
	Small	7	99.60	4857.14	0.00	0.00	15.57
	Semi Medium	15	803.80	4550.00	0.00	0.00	16.13
	Medium	14	1190.40	4508.93	0.00	0.00	14.00
	Large	20	2484.20	4779.38	0.00	0.00	19.30
	Total	60	4609.00	4666.04	0.00	0.00	16.07
B	Commission Agent						
	Marginal	56	753.45	4661.96	16.11	831.16	22.77
	Small	55	994.60	4829.68	17.18	1166.18	24.47
	Semi Medium	47	1456.55	4662.55	20.87	1523.40	35.26
	Medium	38	1162.20	4759.87	18.95	1566.71	34.37
	Large	29	2088.00	4861.72	17.83	3012.59	28.55
	Total	225	6454.80	4745.37	18.07	1463.04	28.50
C	Private Company						
	Marginal	10	253.90	4415.00	1.60	100.00	8.30
	Small	4	118.90	4662.50	0.00	0.00	7.25
	Semi Medium	2	100.00	4762.50	0.00	0.00	9.50
	Medium	2	212.00	4637.50	0.00	0.00	0.00
	Large						
	Total	18	684.80	4533.33	0.89	55.56	7.28
D	Overall						
	Marginal	70	1038.35	4566.48	13.11	679.21	19.84
	Small	66	1213.10	4680.63	14.10	957.31	22.15
	Semi Medium	64	2360.35	4431.57	15.09	1101.54	29.51
	Medium	54	2564.60	4690.28	13.33	1102.50	27.81
	Large	49	4572.20	4731.55	10.55	1782.96	24.78
	Overall Total	303	11748.60	4610.55	13.38	1082.57	24.61

Source: Field survey data.

Most of the time castor seeds produce after harvesting is not properly cleaned and dried, packing material used are mostly gunny bags and also contains foreign materials like iron nails, dust, stone etc., such poor quality produce gets less prices for farm produce. The improved technology for drying cleaning, grading, and bulk packaging will help to improve the quality of raw material for industrial supply and increase the farmer's income. The main marketing channels identified in marketing of castor seed in selected study area were

1. Farmers- Village sale/Village Trader
2. Farmers- Village sale/Village Trader-Private Company
3. Farmers-Commission Agents-Processor-Exporter
4. Farmers-Commission Agents-Processor-Export

Table 4.25: Sale of Castor at Second Instance

Sr. No.	Particulars	Total Produce Sale in First Time (1 of 2)						Total Produce Sale in First Time (2 of 2)					
		No. of HH	Quantity (Qtl)	Price (Rs/Qtl)	Distance to sale point	Transport and other Expenditure (Total) Rs.	Sale- No. of days after harvest of produce	No. of HH	Quantity (Qtl)	Price (Rs/Qtl)	Distance to sale point	Transport and other Expenditure (Total) Rs.	Sale- No. of days after harvest of produce
A	Local Trader												
	Marginal												
	Small												
	Semi Medium												
	Medium												
	Large	2	1200.0	5000.0	0.0	0.0	40.0	2	520.0	5750.0	0.0	0.0	65.0
	Total	2	1200.0	5000.0	0.0	0.0	40.0	2	520.0	5750.0	0.0	0.0	65.0
B	Commission Agent												
	Marginal	4	35.0	4875.0	21.0	825.0	7.0	4	56.0	5093.8	21.0	1087.5	8.5
	Small	6	76.0	4741.7	16.3	716.7	10.7	6	118.8	5058.3	16.3	1283.3	18.2
	Semi Medium	14	196.1	4879.6	16.6	871.4	12.9	14	229.0	5228.6	16.6	1103.6	25.1
	Medium	17	488.8	5036.8	16.8	1296.5	25.7	17	490.0	5271.2	17.0	1267.7	40.9
	Large	15	417.2	4773.3	16.8	1390.0	16.7	14	436.0	5375.7	17.1	1582.1	42.0
	Total	56	1213.1	4883.8	17.0	1119.5	17.1	55	1329.8	5250.8	17.2	1294.6	32.4

C	Private Company												
	Marginal												
	Small	2	33.6	4250.0	0.0	0.0	8.5	2	51.0	4625.0	0.0	0.0	30.0
	Semi Medium	4	70.0	4693.8	0.0	0.0	21.8	4	114.0	5081.3	0.0	0.0	29.3
	Medium	4	100.0	4562.5	0.0	0.0	14.3	4	112.8	5518.8	2.5	150.0	50.0
	Large	2	120.0	4500.0	0.0	0.0	5.0	3	136.4	4808.3	0.0	0.0	23.3
	Total	12	323.6	4543.8	0.0	0.0	14.3	13	414.2	5082.7	0.8	46.2	34.4
D	Overall												
	Marginal	4	35.0	4875.0	21.0	825.0	7.0	4	56.0	5093.8	21.0	1087.5	8.5
	Small	8	109.6	4618.8	12.3	537.5	10.1	8	169.8	4950.0	12.3	962.5	21.1
	Semi Medium	18	266.1	4838.3	12.9	677.8	14.8	18	343.0	5195.8	12.9	858.3	26.1
	Medium	21	588.8	4946.4	13.6	1049.5	23.5	21	602.8	5318.3	14.2	1054.8	42.7
	Large	19	1737.2	4768.4	13.3	1097.4	18.0	19	1092.4	5325.5	12.6	1165.8	41.5
	Overall Total	70	2736.7	4828.8	13.6	895.6	17.3	70	2264.0	5233.9	13.6	1025.7	33.7

Source: Filed survey data.

Table 4.26: Sale of Castor at Three Instances

Sr. No.	Particulars	Total Produce Sale in First Time (1 of 3)						Total Produce Sale in First Time (2 of 3)					
		No. of HH	Quantity (Qtl)	Price (Rs/Qtl)	Distance to sale point	Transport and other Expenditure	Sale- No. of days after harvest of produce	No. of HH	Quantity (Qtl)	Price (Rs/Qtl)	Distance to sale point	Transport and other Expenditure	Sale- No. of days after harvest of produce
A	Commission Agent	4						4					
	Marginal	1	10.0	4750.0	10.0	250.0	30.0	1	10.0	5000.0	10.0	250.0	60.0
	Small	2	20.0	4880.0	9.0	550.0	17.5	2	20.0	5087.5	9.0	550.0	52.5
	Semi Medium	2	15.0	4375.0	9.0	400.0	10.0	2	15.0	4875.0	9.0	400.0	40.0
	Medium	2	35.0	4350.0	15.0	1125.0	27.5	2	45.0	5000.0	15.0	1375.0	75.0
	Large	8	397.5	4937.5	13.0	1150.0	15.8	8	517.5	5132.5	13.0	1443.8	36.3
	Total	15	477.5	4764.0	12.0	906.7	17.7	15	607.5	5065.7	12.0	1096.7	45.7
B	Private Company	5						5					
	Marginal												
	Small	1	20.0	4250.0	0.0	0.0	10.0	1	20.0	4500.0	0.0	0.0	10.0
	Semi Medium												
	Medium	1	20.0	4375.0	0.0	0.0	10.0	1	20.0	4625.0	0.0	0.0	10.0
	Large	3	132.0	3916.7	0.0	0.0	8.3	3	160.0	4666.7	0.0	0.0	21.7
	Total	5	172.0	4075.0	0.0	0.0	9.0	5	200.0	4625.0	0.0	0.0	17.0
C	Overall												
	Marginal	1	10.0	4750.0	10.0	250.0	30.0	1	10.0	5000.0	10.0	250.0	60.0
	Small	3	40.0	4670.0	6.0	366.7	15.0	3	40.0	4891.7	6.0	366.7	38.3
	Semi Medium	2	15.0	4375.0	9.0	400.0	10.0	2	15.0	4875.0	9.0	400.0	40.0
	Medium	3	55.0	4358.3	10.0	750.0	21.7	3	65.0	4875.0	10.0	916.7	53.3
	Large	11	529.5	4659.1	9.5	836.4	13.7	11	677.5	5005.5	9.5	1050.0	32.3
	Overall Total	20	649.5	4591.8	9.0	680.0	15.6	20	807.5	4955.5	9	822.5	38.5

Sr. No.	Particulars	Total Produce Sale in third Time (3 of 2)

		No. of HH	Quantity (Qtl)	Price (Rs/Qtl)	Distance to sale point	Transport and other Expenditure (Total) Rs.	Sale- No. of days after harvest of produce
A	Commission Agent	4					
	Marginal	1	9.0	5000.0	10.0	300.0	80.0
	Small	3	49.6	4958.3	10.7	1100.0	63.3
	Semi Medium	2	18.0	5000.0	9.0	400.0	80.0
	Medium	2	20.0	5850.0	15.0	1450.0	105.0
	Large	8	352.0	5523.1	13.0	1787.5	63.8
	Total	16	448.6	5360.0	12.1	1350.0	71.9
B	Private Company		5.0				
	Marginal						
	Small						
	Semi Medium						
	Medium	1	70.0	5000.0	0.0	0.0	25.0
	Large	3	260.0	5000.0	0.0	0.0	38.3
	Total	4	330.0	5000.0	0.0	0.0	35.0
C	Overall						
	Marginal	1	9.0	5000.0	10.0	300.0	80.0
	Small	3	49.6	4958.3	10.7	1100.0	63.3
	Semi Medium	2	18.0	5000.0	9.0	400.0	80.0
	Medium	3	90.0	5425.0	10.0	966.7	78.3
	Large	11	612.0	5474.1	9.5	1300.0	56.8
	Overall Total	20	778.6	5180.0	9.7	1080.0	64.5

4.2.12 Economics of Castor Seed Production:

The economics of castor seed cultivation per hectare is presented in Table 4.2 indicate that as per cost concepts, the paid out cost of cultivation was estimated to be Rs. 68,630/- per hectare while at Cost C2* basis, same is estimated to be Rs. 96,281/- per hectare.

Table 4.27: Cost of Cultivation per hectare of Castor seed on different cost concepts (Rs/ ha)

Cost	Cost of Cultivation per hectare of Castor seed					
	Marginal	Small	Semi Medium	Medium	Large	Overall Average
Cost A1	63562.89	65315.53	67411.46	69267.46	71246.2	68630.08
CostA2	63562.89	65315.53	67411.46	69267.46	71246.2	68630.08
Cost B1	76594.47	77964.91	79170.51	82060.09	83809.16	81169.08
CostB2	77256.35	78559.88	80808.91	82084.73	84670.93	82030.08
Cost C1	86811.07	86167.88	85281.37	87375.27	87961.03	86666.72
Cost C2	87472.95	86762.85	86919.77	87399.91	88822.8	87527.72
Cost C2*	96220.25	95439.14	95611.75	96139.9	97705.08	96280.49

While cost of production per quintal was estimated to Rs. 2562/- per quintal at Cost A1, while same was estimated to be Rs. 3594/- per quintal per hectare (Table 4.21).

Table 4.28: Cost of production of Castor seed on different farm size holdings (Rs/qt)

Cost	Cost of production of Castor seed on different farm size holdings					
	Marginal	Small	Semi Medium	Medium	Large	Overall Average
Cost A1	2468.46	2947.45	2761.63	2510.60	2450.85	2561.78
Cost A2	2468.46	2947.45	2761.63	2510.60	2450.85	2561.78
Cost B1	2974.54	3518.27	3243.36	2974.27	2883.01	3029.83
Cost B2	3000.25	3545.12	3310.48	2975.16	2912.66	3061.97
Cost C1	3371.30	3888.44	3493.71	3166.92	3025.84	3235.04
Cost C2	3397.01	3915.29	3560.83	3167.81	3055.48	3267.18
Cost C3	3736.71	4306.82	3916.91	3484.59	3361.03	3593.90

The returns from cost of cultivation of castor seed crop of sample households presented in Table 4.22 indicate that net income realised by the farmer was estimated to be Rs. 42983/- per hectare. While across the groups, the highest net return was realised by the large farm group (Rs. 55839 per ha) and the lowest was realised by the small farm size holder (Rs.19801 per ha). The lower level of productivity among the small land holder was on of the reasons for the lower returns per hectare. The per hectare net returns estimated as per cost concepts presented in Table 4.21 indicate that the net returns was highest for small farmers and the lowest for large size holders.

Table 4.29: Returns from cultivation of Castor crop on sample farms

(Rupees/ha)

Particulars	Returns from cultivation of Castor crop					
	Marginal	Small	Semi medium	Medium	Large	Weighted Average
Gross income	119005.64	106563.88	117217.10	126670.27	144661.68	130510.28
Farm Business Income	55442.75	41248.35	49805.64	57402.81	73415.48	61880.20
Family labour income	41749.29	28004.00	36408.19	44585.54	59990.75	48480.20
Net income	31532.69	19801.03	30297.33	39270.36	55838.88	42982.56

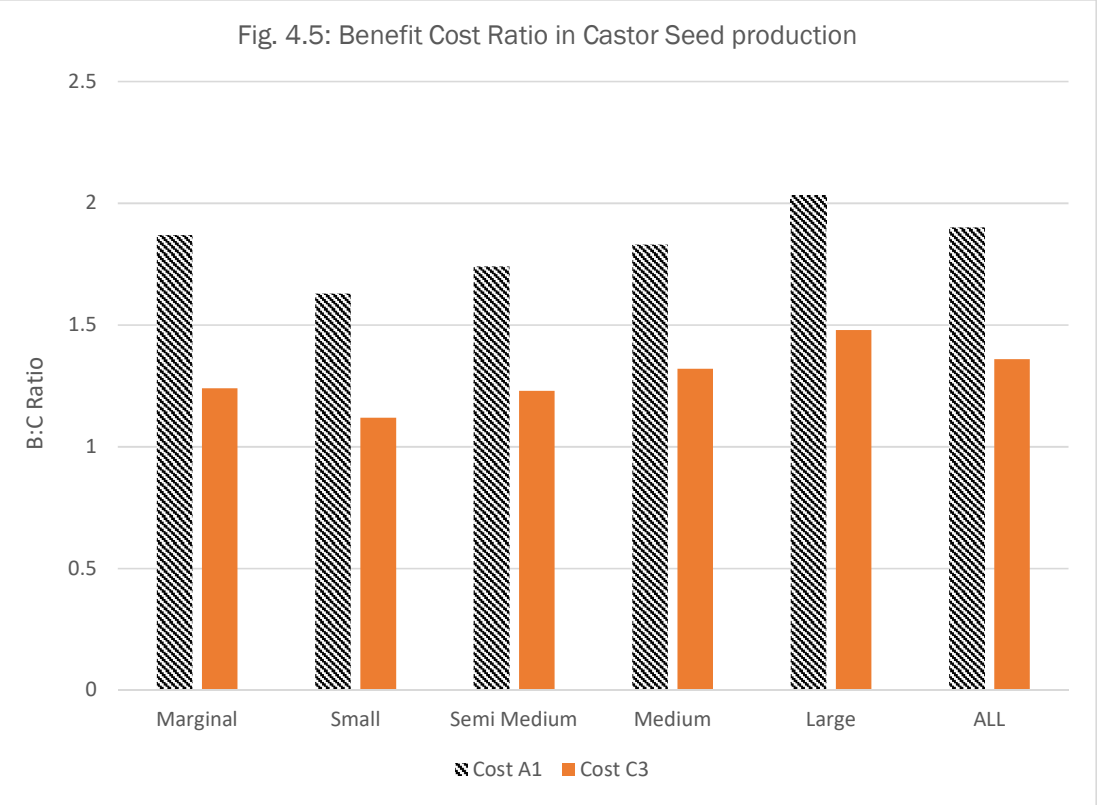
Table 4.30: Net returns per hectare of Castor seed on different cost concepts basis (Rs/ha)

Particulars	Net returns per hectare (Rs/ha)					Overall Average
	Marginal	Small	Semi Medium	Medium	Large	
Cost A_1	55442.75	53690.11	51594.18	49738.18	47759.44	50375.56
Cost A_2	55442.75	53690.11	51594.18	49738.18	47759.44	50375.56
Cost B_1	42411.17	41040.73	39835.13	36945.55	35196.48	37836.56
Cost B_2	41749.29	40445.76	38196.73	36920.91	34334.71	36975.56
Cost C_1	32194.57	32837.76	33724.27	31630.37	31044.61	32338.92
Cost C_2	31532.69	32242.79	32085.87	31605.73	30182.84	31477.92
Cost C_3	22785.39	23566.50	23393.89	22865.74	21300.56	22725.15

Castor growing is considered as a step forwards the diversification and commercialization of agriculture. The benefit-cost ratio of 1.36 was found to be economically efficient in castor cultivation in all groups. The highest benefit cost ratio was estimated for large land holder group and the lowest was in case of small land holder group.

Table 4.31: Returns per rupee of investment in Castor seed cultivation

Particulars	Returns per rupee of investment					Overall Average
	Marginal	Small	Semi Medium	Medium	Large	
Cost A1	1.87	1.63	1.74	1.83	2.03	1.90
Cost A2	1.87	1.63	1.74	1.83	2.03	1.90
Cost B1	1.55	1.37	1.48	1.54	1.73	1.61
Cost B2	1.54	1.36	1.45	1.54	1.71	1.59
Cost C1	1.37	1.24	1.37	1.45	1.64	1.51
Cost C2	1.36	1.23	1.35	1.45	1.63	1.49
Cost C3	1.24	1.12	1.23	1.32	1.48	1.36



4.2.13 Constraints faced by the Farmers:

The various constraints faced by the castor seed growers are presented in table 4.32. It can be seen from the table that the long duration of crop followed by lack of production technology and lack of resistant/tolerant varieties are major three technological constraints were cited by the sample farmers. The extreme variations in temperature followed by biotic stress and inadequate/excessive rainfall are three major agro-climatic factors were faced by the sample farmers.

Table 4.32: Constraints faced by the Castors Grower Farmers

Sr No.	*Constraints*	Constraints faced	
		Garrett's Score	Rank
A	**Technological**		
1	Longer duration of crop	181.57	1
2	Lack of Production Technology	170.96	2
3	Lack of resistant/ tolerant varieties/hybrids	170.82	3
4	Poor crop germination	161.45	4
5	Non-availability of HYV/Improved varieties	160.24	5

6	Lack of irrigation facilities	146.94	6
7	Weeds infestation	136.07	7
B	**Agro-climatic factors**		
1	Extreme variations in temperature	152.74	1
2	Biotic stress (pest attack)	144.81	2
3	Inadequate/ Excessive rains	138.05	3
4	Drought at critical stages of crop growth	133.27	4
C	**Economic and Institutional**		
1	Lack/poor extension services	178.45	1
2	Non-availability of other inputs	174.94	2
3	Problem of timely availability of seed	170.20	3
4	Low and fluctuating prices	142.48	4
5	Shortage of human labour	142.14	5
6	high-input cost on diesel, fertilizers,	129.03	6
D	**Post-harvest, marketing and value-addition**		
1.	Lack of Fodder Value	339.36	1
2.	Lack of Storage Facility	206.01	2
3.	Exploitation by market intermediaries	197.45	3
4.	Lack of farm gate procurement	171.98	4
5	Poor transportation facilities	164.48	5
6	High transportation costs	163.10	6
7	Non availability of marketing infrastructures	160.43	7
8	Small Quantity Produce	149.80	8

Whereas selected farmers did not receive the proper and accurate information on the crop grown due to lack/poor extension services in the study area followed by non-availability of inputs and timely availability of seed. The lack of fodder value, lack of storage facilities and exploitation by market intermediaries were the major constraints during post-harvest, marketing and value addition of castor seed crop.

4.3 Commission Agent:

The details on the trade of castor oilseed by the commission agents in selected markets of Gujarat indicate that the highest quantity was procured by the commission agents in the Mehsana district while the share of commission agents in total trade is very minuscule (table 4.33). Most of the purchase was done from farmers and average price per mt was estimated to be around Rs. 46150/- (table 4.34 and sale was mostly done to processor of castor seed (table 4.35).

Table 4.33: Details on the quantity of Castor traded during period 2020-21 as CA

Sr No	District	Quantity in Metric Tons (MT)	% to total
1	Banaskantha	63638	0.43
2	Katchh	2900	0.02
3	Mahsana	14788588	99.08
4	Patan	9615	0.06
5	Surendranagar	61682.42	0.41
	Grand Total	14926423	100.00

Table 4.34: The details on the quantity of Castor purchased by CA for storage

Sr. No.	Market	Average of Quantity in Metric Tons (MT)	Average of Price Rs./MT	Any exp or charges paid Rs./MT	Purchased from
1	Banaskantha	6363.8	52095	205700.00%	Farmers
2	Katchh	580	43085	1.5% of Rs 100 +5% (2.5 % CGST+ 2.5% SGST) GST of total value before tax	Farmers & Commission Agent
3	Mahsana	2509628.8	45210	630	Farmers
4	Patan	961.5	49091.5	1.5% of Rs 100 +5% (2.5 % CGST+ 2.5% SGST) GST of total value before tax	Farmers & Commission Agent
5	Surendranagar	6181.1276	41267.30	0.50%	Farmers

Table 4.35: The details on the quantity of Castor sold by CA

Sr. No.	District	Quantity in Metric Tons (MT)	Price Rs./MT	Any exp or charges paid Rs./MT	Sold to
1	Banaskantha	63638	53076.32	2100	Harij Mill, Gokul Agro, NK Proteins, Adani Proteins, NCDEX Gandhidham, Oswal Agri Impex Ltd., Junagadh, Vijapur Processing Mills,Girnar Ind. Junagadh,, MavjiHari Ind., Shivam Castor Processors, Vijapur, K N Enterprise, Ishedu Agro Processing, Jagana,Palanpur
2	Katchh	2900	43554.96	1.5% of Rs 100 +5% (2.5 % CGST+ 2.5% SGST) GST of total value before tax+T.Cost+Bardana cost	Gokul Agro Pvt. Ltd., Oswal Agri. Pvt. Ltd., Kandla Agro Pvt. Ltd.
3	Mahsana	25096288	45867.2	800	Adani & NK Processing Unit
4	Patan	9615	48601.5	1.5% of Rs 100 +5% (2.5 % CGST+ 2.5% SGST) GST of total value before tax+T.Cost+Bardana cost	Oil Mil & Trader
5	Surendranagar	30776.778	42365.934	600	ADANI & NK mill

The major problems faced during arranging for marketing, storage, and transport of produce and their suggestions to solve these problems are presented in table 4.36. It can be seen from the table that storage, TDS issues and payment problems were faced by the commission agents and therefore suggestion was made to make TDS filing process easy, e-way bills and quick transfer of payment by the purchaser. Same were the expectations of the respondents (Table 4.37).

Table 4.36: Major problems faced and Suggestions to solve these problems

Sl. No	District	Problems faced	Suggestions to solve	Problems faced	Suggestions to solve	Problems faced	Suggestions to solve
1	Surendranagar	Storage		fire safety			
2	Patan	TDS/TCS issue	Easy TDS/TCS rules by government	Transport issue	Related to Eway bill	Payment issue	They need cash for payment of farmers but they received payment atleast 15 days delay from traders especially oil mill company
3	Katchh	TDS/TCS issue	Easy TDS/TCS rules by government	Transport issue	Related to Eway bill	Payment issue	
4	Banaskantha	Lengthy process	Make it Easy rules by the government	Transport issue	Related to Eway bill	Payment issue	
5	Mahsana	Lengthy process	Make it Easy rules by government	Transport issue	Related to Eway bill	Payment issue	

Table 4.37: Role expected from the Government

Sl. No	District	What role do you expect from the Government?
1	Surendranagar	Strengthen of APMC
2	Patan	Easy TDS/TCS rules by government,easy process of Eway bill, they need cash fund from banks with lower interest rate,
3	Katchh	Easy TDS/TCS rules by government,easy process of Eway bill, they need cash fund from banks with lower interest rate,
4	Banaskantha	Easy rules by government
5	Mahsana	Government make any mediator group fro sale and purchse like that NCDEX platfrom.

4.4 Processor:

Castor oil can be extracted from castor seeds by solvent extraction, mechanical pressing or a combination of both. Mechanical pressing is disadvantageous as it can only extract about 45 % of the oil. This means that the rest of the oil in the cake must again be extracted by a solvent and therefore

causing double work, increase in extraction expenses and thus the process become environmentally unfriendly. On average, castor seeds contain between 45 and 55 % oil by weight depending on the varieties, geographical location and the method of extraction.

The two processors, one from the Kutch region and one from Banaskantha area were contacted and interviewed. The main source of castor seed for processor was directly purchase from village, village traderss and sometime from commission agents. On an average, rate paid for a quintal of castor seed was Rs. 5500-6000/- and Rs. 285 to 300/-cost was incurred on transportation (Table 4.38).

Table 4.38: Source of Raw Material (2020-21)

Sr. No.	Raw Material details Castor seed	From whom purchased	Method of purchase	Quantity purchased (Tonns)	Purchase Rate (Rs./Qtl)	Transportation Cost (Rs./Qtl)
1	Bhachau (Kutch)	Farmer, Village Trader and Commission Agents	by contact, by contract, and auction in APMC	6513	5500	300
2	Palanpur (Banskantha)	Farmer, Village Trader, Commission Agents, Wholesaler, and Import	by contact, by contract, and auction in APMC	90240	6000	285

The finished product such as castor oil, castor cake was sold in domestic as well as international agencies (Table 4.39). The processor had to invest a significant amount towards getting into the processing business of castor seed (table 4.40). The major constraints faced by the processor were lack of support from the government, competition from large processing units, high cost of processing and availability of credit (table 4.41). Processors have suggested that Government should remove mediator and give opportunities to farmer to get profit directly.

Table 4.39: Finished Product (2020-21)

Sr. No	Market	Name of the Finished product	Total Cost of production - (Rs./Kg.)	Quantity sold	Selling destination	Selling Price (Rs./Lit. /Kg.)	Buyers profile
1	Bhachau (Kutch)	Castor Oil	-	2800	Germany, France, UK, US	127	

		Castor Cake	-	1204	Local Fertlizer Company	11	Powder form- For Farmers & Solvant Plant- Oil extract
2	Palanpur (Banskantha)	Castor Doc	3.2		Local+Kandla	4.5	Oil Industries
		Castor Hi pro	8		Kandla	10	Derivatives
		Commercial Oil	120		Kandla	123	Derivatives
		FSG Oil	122		Kandla	123	Derivatives

Table 4.40: Details on Fixed cost at Processor level

Sr. No.	Particulars	Unit	Bhachau (Kutch)	Palanpur (Banskantha)
1	Plant	Cost at present (Crore)	50	45
2	Castor oil processing machinery	Cost at present lakh/machinery	25	22
3	Castor oil refinery machine	Cost at present lakh/machinery	20	15
4	Electricity cost (per Qtl)	Cost at present	45	40
5	Water Charges (per Qtl)	Cost at present	10	self bore well
6	Local taxes/etc.	Cost at present	as per procedure	as per procedure

Table 4.41: Constraints faced with regard to this business

on a scale of 1-5 (1-least affected, 5- most affected)

Sr. No.	Constraints faced by the Processor	Bhachau (Kutch)	Palanpur (Banskantha)
1	Lack of quality raw material, i.e. castor seed supply	1	3
2	Large number of small producers	1	2
3	Less supply of raw product i.e. castor seed supply	1	3
4	Labour constraint (less labour, high wages)	1	2
5	Lack of Credit	2	2
6	Less demand of domestic processed product in view of import	1	3
7	Less remunerative Price for finished product	1	4
8	Lack of updated technical information about processing	1	4
9	Competition from large processing units	2	3
10	No Supportive Policy from Govt.	3	3
11	High Cost of Processing	2	4

12	In adequate storage facility	1	4

4.5 Exporters Analysis

The exporter mentioned that Germany, France, UK, US and other European countries were the major countries for the export of Caster Seed Oil in 2020-21. The major source of procurement of the produce- Castor seed oil during 2020-21 was processor within the state and mostly from the wholesaler (tables 4.42 and 4.43)

Table 4.42: Major places from where exporter primarily procures the produce

Sr. No.	Place/s within Gujarat	Place/s outside Gujarat	Reasons for procuring from a particular source
1	Market	Within state	Nearest
2	Farmers	Within state	Nearest

Table 4.43: Exporters procure the produces for export supplies

Sr. No.	Source of procurement	Share of Procurement (%)	Rate of Purchase (Rs./qtl)	Other expenditure (transport, etc) (Rs./qtl)
1	Processor			
2	Wholesaler	50	5500	20
3	Farmers	50	5500	0

The export details presented in table 4.44 indicate that the quantity and value of castor seed oil has increased significantly during 2020-21 as compared to earlier years may be due to post covid opening of international markets. The total amount of exported castor oil was Rs. 49 Crore by the said exporter (Table 4.45). Castor seed oil need certification and cost incurred for export include freight charges, storage, transport, loading and unloading charges (Table 4.46).

Table 4.44: Export Details

Sr. No.	Year	Value of Exports (Crore Rs.)	Quantity of Export (Tonnes)	Rate Rs. Lakh/ton
1	2015-16	26	1650	1.576
2	2016-17	22	1226	1.794
3	2017-18	30	1250	2.400
4	2018-19	30	1200	2.500
5	2019-20	27	1300	2.077
6	2020-21	49	2800	1.750

Table 4.45: Cost involved in Export

Sr. No.	Storage Charges/ Expenditure (Rs./Qtls)	Transport charges to the port (Rs./Qtls)	Loading/unloading charges at the port (Rs./Qtls)	Dock charges/terminal handling charges (Rs./Qtls)	Freight charges to the destination port
1	50	5	5	0	15000 (16 Tonn)

Table 4.46: The problems faced by Exporter in procurement of the produce

Sr. No.	Level	Constraints	Rank
1	Domestic	Lack of regular supply	1
		Low quality of the produce	5
		High price compared to the quality	4
		Product standardization and inspection	6
		Lack of laboratories for checking	7
		Lack of Storage Facility	8
		Any other(Specify) GST refund issue in currently 90 days	3
2	International	Lack of knowledge about the standard quality norms in the international markets	1
		Lack of pre-shipment agency for inspection during export	2
		High Cost of Export (transport, shipment etc)	4
		Fluctuating Castor oil prices at International Market	5
		Lack of export subsidy or support from Govt.	3
		Lengthy/delay in export at Port	6
		Any other(Specify)	-

The exporter has reported the problems faced by him at domestic as well as international markets. The major three problems faced at domestic markets were lack of regular supply and GST refund issue and high price compared to the quality. While at the international level, lack of knowledge about the standard quality norms in the international markets, lack of pre-shipment agency for inspection during export and lack of export subsidy or support from the Government were major problems faced by the exporter.

4.6 Chapter Summary:

The field survey results indicate that almost all the farmers had irrigated castor cultivation having two-fifth of the gross cropped area was under castor crop cultivation. The average crop productivity of castor crop is estimated to be 26.5 qtls/ha. The total cost of cultivation of castor seed per hectare was estimated to

be Rs. 87528/-, On an average, per quintal price for castor seed output realized by the sample households was Rs 4872/- per quintal. Across the groups, 93.3 per cent of marginal holders, 86 per cent of small holders and 76 per cent of marginal holders had sold all output at first instance only. Marginal farmers sold their output within 20 days of harvest. The net income realised by the farmer was estimated to be Rs. 42983/- per hectare. Castor growing is a step forwards the diversification and commercialization of agriculture. The benefit-cost ratio of 1.36 was found to be economically efficient in castor cultivation in all groups. The highest benefit cost ratio was estimated for large land holder group and the lowest was in case of small land holder group. The major constraints faced by the castor seed growers were the long duration of crop followed by lack of production technology and lack of resistant/tolerant varieties are major three technological constraints were cited by the sample farmers. The extreme variations in temperature followed by biotic stress and inadequate/excessive rainfall are three major agro-climatic factors were faced by the sample farmers.

The major problems faced by the Commission agents were of storage, TDS issues and payment problems were faced by the commission agents. While major constraints faced by the processor were lack of support from the government, competition from large processing units, high cost of processing and availability of credit. The exporter mentioned that Germany, France, UK, US and other European countries were the major countries for the export of Caster Seed Oil in 2020-21. The major source of procurement of the produce- Castor seed oil during 2020-21 was processor within the state and mostly from the wholesaler. The major three problems faced at domestic markets were lack of regular supply and GST refund issue and high price compared to the quality. While at the international level, lack of knowledge about the standard quality norms in the international markets, lack of pre-shipment agency for inspection during export and lack of export subsidy or support from the Government.

Chapter V

Summary and Policy Implications

5.1 Backdrops

India is the world's largest producer of castor seed accounting for 89.8 percent share in total world caster seed production in 2020. India also dominates in the international castor oil trade with 92 per cent share of total world's castor oil production. The major castor-producing states in India are Andhra Pradesh, Gujarat, Karnataka, Odisha, Rajasthan, and Tamil Nadu. Gujarat has emerged as the largest castor-producing state in the country with 77.24 per cent share in area and 85.6 per cent share in production followed by Rajasthan and Andhra Pradesh (including Telangana) in 2020-21. Though the area and production of castor as well as its export are on increasing trend, the castor farmers are facing the problems in the cultivation of crop. The farmers have been reporting production as well as marketing constraints. The input costs also have been reported risen, mostly on fertilizers, pesticides and water. SDAU (2012) had noted that recommended technologies are being adopted partially or not adopted like application of a recommended dose of fertilizer, application of sulphur, irrigation schedule, spacing and harvesting, etc. The castor seed produce after harvesting is not properly cleaned and dried, packing material used are mostly gunny bags and also contains foreign materials like iron nails, dust, stone etc., such poor-quality produce gets less prices for farm produce. The improved technology for drying cleaning, grading and bulk packaging will improve the quality of raw material for industrial supply and increase the farmer's income. Thus, there was a need to have insights into the problems, prospects and export potential of castor crop cultivation in Gujarat. In view of the same, the present study was undertaken.

The present study is based on both secondary and primary data. The secondary data were compiled from published sources and primary data were collected from the selected 400 castor growers from selected five districts (Banaskantha, Kutch, Patan, Mehsana and Surendranagar) of Gujarat. The

multistage random sample method was used for selection of castor growers. The reference period for the primary data collection was the agriculture year 2020-21.

5.2 Summary

5.2.1 Findings from Secondary data

- Gujarat is India's largest producer of castor in India, accounting for about 85.60 percent of the total production of castor in the country (2020-21). The productivity of castor in the state is the highest not only in India but also in the world. Castor growing is considered as 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 around 20 per cent during last five-decade period, share of castor crop in total cropped area has increased from 0.61 per cent in TE 1972-73 to 5.62 per cent in TE 2020-21.
- Castor is heavily growth in the northern area of Gujarat. North Gujarat region alone accounted for half of the area and about 58 per cent of production of Castor in the state. During last five-decade period, only Saurashtra region has gained significant share in total area while Saurashtra and North Gujarat reported increase in production in TE 2020-21 as compared to TE 1972-73.
- The area-yield interaction effect followed by area effect is accounted for the output growth of Castor crop. Decomposition analysis results indicated that interaction between area- yield and cropping pattern accounted for the highest share of 48 per cent in the output growth during overall period. Due to the decline in area during period V, output growth of castor was negative.
- 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 given in GCH-2, GCH-4, GCH-5, GCH-6, GCH-7, GC3, GNCH-1(rabi), and GCH-8.
- At present, the 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 andhybrid seed production programs.

- India supplies almost 85 per cent to 90 per cent of the world's requirement of Castor Oil and its derivatives. The other castor producers in the rest of world are Brazil and China. As of 2019-20, three countries (India, China, and Brazil) produced 93 per cent of the world's supply of castor oil. As production is concentrated mainly in these three countries, total castor production varies widely from year to year due to fluctuations in rainfall and the size of the area utilized for planting. Consequently, this concentration has led to cyclic castor production.
- Global castor oil and derivatives key players include Jayant Agro, NK Proteins, Adani Wilmar, etc. Global main three manufacturers hold a share over 50 per cent. India is the largest market, with a share of over 90 per cent, followed by China, and North America, both have a share of over 5 percent. In terms of product, Hydrogenated Castor Oil is the largest segment, with a share of about 30 per cent,
- 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. The export of castor in terms of quantity as well as in terms of value has been significantly risen by 4.465 per cent and 8.288 per cent per annum, respectively. The export prices were also increased by 3.824 per cent per annum during this period. The variability was found higher in prices than quantity traded. Overall, the results indicate that the export of castor oil from India has bright prospects.
- India exports castor oil to many countries across the world. China ranked first with the export of Rs 3124 crore contributing 46.22 per cent in total value of export of castor oil from India followed by Netherland (12.97%), France (9.42%)and USA (9.97%). These four countries jointly accounted for about 80 per cent of total castor oil export from India. The 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 trading centers of castor and its derivatives in India are Rajkot (Gujarat), Ahmedabad (Gujarat), Gondal (Gujarat), Gadwal (Gujarat), Bhabar (Gujarat), Disa (Gujarat), Kadi (Gujarat), Jedcherla (Andhra Pradesh) and Yemignoor (Andhra Pradesh). Also castor and its derivatives like castor seed, castor oil and castor oil cake are traded in Indian commodity exchanges.
- 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. Higher indices of market arrivals of castor seed were noticed immediately after harvest.
- The season behavior of castor prices revealed the existence of seasonality in all the markets. Higher indices of market arrivals of castor seed were noticed immediately after harvest in the selected markets arrivals reached peak during April and relatively shoot up in September and October. The different markets of castor in the state of Gujarat were closely linked with each other for the movement of castor seed prices
- 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 consumers 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.
- There is a large scope for improving India's earnings from castor by converting castor oil to various derivatives. With the World becoming more environmentally conscious and with the increasing replacement of synthetic products with naturally derived products, castor oil-based derivatives could

find increasingly attractive markets worldwide. Besides, a 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. Experts suggest that this anomaly can be corrected if the industry expands the market by developing castor oil derivatives and invests in R&D. They unanimously believe, if the industry works as a more cohesive unit, India could soon be in a better situation.

- China currently imports about one-third of its total castor oil requirement, valued at $314.4 million from India. However, despite these glorious numbers, India continues to be a price taker and not a price setter in the global castor oil market[1]. One major reason is that India became the largest producer of the seed by default. Brazil, which in the 70s was the largest producer of castor seeds in the world, moved away from this seed to soybean which has a higher yield and greater export demand for both its beans and oil. So did other major countries, leaving India with a virtual monopoly. Ironically, with synthetic substitutes being available at cheaper prices, India has not been able to leverage this monopoly.

5.4 Findings from Primary data

- The field survey results indicate that almost all the farmers had irrigated land which was put under castor cultivation. About two-fifth of the gross cropped area was under castor crop cultivation, which comes to almost two-third cropped area during kharif season.
- The average crop productivity of castor crop is estimated to be 26.5 qtls/ha.
- The total cost of cultivation of castor seed per hectare was estimated to be Rs. 87528/-, of whoch around 78.4 per cent was estimated to be paid out cost and remaining was the fixed cost.
- If only total paid out cost is considered, 28.2 per cent of total cost was incurred on hired labour, followed by machine labour (22.5 per cent) and irrigation charges (19.7 per cent). Thus, 70.4 of total paid cost was incurred on these three items only.

[1] https://www.thedollarbusiness.com/magazine/castor-oil-it-promises-big-profits-patience-please/32744

- On an average, per quintal price for castor seed output realized by the sample households was Rs 4872/- per quintal. Across the groups, 93.3 per cent of marginal holders, 86 per cent of small holders and 76 per cent of marginal holders had sold all output at first instance only. Marginal farmers sold their output within 20 days of harvest.
- The net income realised by the farmer was estimated to be Rs. 42983/- per hectare. The benefit-cost ratio of 1.36 was found to be economically efficient in castor cultivation in all groups. The highest benefit cost ratio was estimated for large land holder group and the lowest was in case of small land holder group.
- The major constraints faced by the castor seed growers were the long duration of crop followed by lack of production technology and lack of resistant/tolerant varieties are major three technological constraints were cited by the sample farmers. The extreme variations in temperature followed by biotic stress and inadequate/excessive rainfall are three major agro-climatic factors were faced by the sample farmers.
- The major problems faced by Commission agent were of storage, TDS issues and payment problems were faced by the commission agents. While major constraints faced by the processor were lack of support from the government, competition from large processing units, high cost of processing and availability of cred it.
- The exporter mentioned that Germany, France, UK, US and other European countries were the major countries for the export of Caster Seed Oil in 2020-21.
- The major source of procurement of the produce- Castor seed oil during 2020-21 was processor within the state and mostly from the wholesaler. The major three problems faced at domestic markets were lack of regular supply and GST refund issue and high price compared to the quality.
- While at the international level, lack of knowledge about the standard quality norms in the international markets, lack of pre-shipment agency for inspection during export and lack of export subsidy or support from the Government.

5.5 Conclusions and Policy Implications

- 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 a package of practices, about scientific crop management through demonstrations and training. Low-input cost crop 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.
- In view of low SRR in Gujarat, there is a need to create awareness about the importance of improved hybrids/ varieties through demonstrations, training, *shibir*, literature, etc. There is a need of providing training to progressive farmers for seed production at the local level. Establishing well-organized seed multiplication systems, seed supply chain and commercial market are very important for faster adoption of castor in India. Quality of seed should be given utmost importance.
- To overcome deficit moisture conditions, especially in castor growing arid and semi-arid regions, there is a need to evolve high-yielding drought-tolerant short-duration cultivars. 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.
- In view of a large variation in productivity of castor seed crop across the districts, there is a need to narrow the yield gap across districts as well as in irrigated and rainfed conditions without mining natural resources.
- It was observed that castor seed produced after harvesting is not properly cleaned and dried, packing material used is mostly gunny bags and also contains foreign materials like iron nails, dust, stone, etc., such poor quality product gets less price for castor produce. Therefore, there is a need to propagate improved technology for drying cleaning, grading and bulk packaging to improve the quality of raw material for industrial supply and increase the farmer's income. There is a need for the popularization of the

use of seckters for harvesting. Manual harvesting is a labour-intensive operation. The high cost of the combined harvester is limiting castor growers to adopt mechanized harvesting.

- 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.
- 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.
- The international collaborations will increase both the efficiency and speed of research in developing castor as a bioenergy 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. With the World becoming more environmentally conscious and with the increasing replacement of synthetic products with naturally derived products, castor oil-based derivatives could find increasingly attractive markets worldwide.
- Besides, a 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. Experts suggest that this anomaly can be corrected if the industry expands the market by developing castor oil derivatives and invests in R&D. They unanimously believe, if the industry works as a more cohesive unit, India could soon be in a better situation.

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Castor Oiled Cake Export from India | Data, price & analysis of Castor Oiled Cake export (connect2india.com

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Comments on the Draft Report received from

Agro-Economic Research Centre,
Gokhale Institute of Politics and Economics
(Deemed University),
Pune, Maharashtra

Comments on draft report

1.	Title of report	Castor Crop Cultivation in Gujarat: Problems, Prospects and Export Potential
2.	Date of receipt of the Draft report	March 31, 2022
3.	Date of dispatch of the comments	March 31, 2022
4.	Comments on the Objectives of the study	The objectives have been addressed.
5.	Comments on the methodology	The methodology has been followed
6.	Comments on analysis, organization, presentation etc.	The overall presentation is good and all objectives have been satisfied.
7.	References:	References are made at the appropriate place.
8.	General remarks:	The study deals with an important crop-castor. The constraints in cultivating the crop are highlighted and serve as a road map for policy makers. The crop has potential in drought-prone areas and its cultivation must be promoted. The study has dealt with all aspects of the potential of the crop and is well presented.

9. Overall view on the acceptability of the report:

The report is acceptable. The authors may go through it once more before final submission, in view of minor editing mistakes.

AER Division Directorate of Economics & Statistics,
Department of Agriculture and Farmers Welfare,
Ministry of Agriculture and Farmers Welfare, Government of India

Minutes of online meeting on presentation on four studies with AERCs/Us held on 02nd June, 2022 (F. No. 5-1/2020-AER-ES dated 08.06.2022)

Comments on Draft Study report titled, 'Castor Crop Cultivation in Gujarat Problems, Prospects and Export Potential'

This study was proposed by AERC VV Nagar itself and conducted by Prof. S. S. Kalamkar and Dr. H. Sharma.

1. Adviser (AER) informed that the study report is comprehensive, well drafted as well as well structured.

2. It was informed that on Pg. 17, the Cuddy Della Valle index (CDVI) formula needs a re-checking
CDVI = CV*X
Where, X = 1 - 2, CV is coefficient of variation, and 2 is adjusted coefficient of determination.

The formula given above need rechecking and may be CV*(root of X) where $X=1-R_2$ and R_2 is the adjusted coefficient of determination

3. It was observed that the study period has been divided into 05 time periods, viz. Period I to Period V and overall. This needs to be incorporated in Table 1.3 and other table(s), if required.

4. It was suggested that the Tables like 3.5, 3.6 etc have data up to 2017/18 which may be updated.

5. It was mentioned that the policy recommendations arising out of Granger–Causality test of co- integration test be suitably placed in the report, since it has been found that various castor markets are related. Some policy recommendations on the interconnectedness of the markets may be made.

6. Overall, the objectives set out in the research proposal have been well studied.

Action taken by the authors based on the comments received

- All the suggestions and corrections are adopted at appropriate places in the report.

Project Team