There is a growing interest in intercropping as a potentiality beneficial system of crop production as it increases productivity per unit area. Development in agriculture and allied sector are of interest to a wide spectrum of people across the country, since the agriculture has been way of life and continues to be single most important live hood of the masses. Recently the demand of the agricultural product is rising at higher rate, while resources base production is shrinking. This implies that more output need to be produced per unit of bundle of resources. Agricultural in the state is characterized by wide disparities in output and productivity performance is a crucial task. This is important for future agenda and for fixing development polices. Among all the oilseed crops groundnut is widely cultivated and is most predominant in the state of Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh and Rajasthan. In fact Gujarat plays a vital role in oilseed production in the country. Castor is also important oilseed crop in the semi-arid tropics of Saurashtra and North Gujarat. It perform well in poor soil and region where moisture availability is inadequate, and also cultivated either as sole crop or mixed crop and intercrop with groundnut as well as other crops.

Groundnut based inter cropping is common practices in Saurashtra region. Inter cropping is growing two or more crop in definite row pattern. Thus, both crops share same part of the season.

Groundnut with castor inter cropping is an important cropping system for dry land area as it can increase the economic returns from a unit area of land. Saurashtra region comprises of high and low rainfall conditions relating it to a low crop potential zone. The inherent instability in crop production in the region is further amplified in the region by high evaporative conditions, low soil water holding capacity and unavailability of irrigation water. Under such conditions, an alternate and more viable proposition would be to raise two short crops. By the intercropping system a farmer reduces the risk of crop failure in mono (sole) cropping system. In Saurashtra, since castor is grown as a semi-rabi crop it is most suitable to be
Summary and conclusion

cultivated as an inter-crop with groundnut. In inter-cropping (groundnut + castor), groundnut is harvested in the months of September–October, while castor is harvested during the months of December–January. In this manner, the inter cropping not only generates additional income to the farmers but also leads to the efficient usage of available resources. All the above benefits augur well for the practice of inter cropping system is in Saurashtra region of Gujarat.

Accordingly, groundnut +castor intercropping could be a cropping system fitting well within the SAI concept, besides being an option to smallholder farmers in Saurashtra region. It has to be seen how this works out in practice in Saurashtra region, since the region happens to the epicenter of both groundnut and castor production in India. It has to be also seen whether the intercropping system is already used and how it is considered by smallholder farmers in Saurashtra region. In addition, economic returns, resource-use efficiency and farmers’ perceptions need to be focused as they determine the success of intercropping system as a whole. This cropping system is practically more economical to small farmers as they can get increase their output in water stress conditions and utilize natural resource at optimum level. Keeping all these in view, the present study entitled: “An Economic Analysis of Inter-Cropping (Groundnut + Castor) in Saurashtra Region of Gujarat” was undertaken to analyze the economics, resource use pattern and constraints in groundnut + castor intercropping along with the determinants of intercropping system in Saurashtra region.

The overall objective of this study is to explore the economic efficiency of intercropping (groundnut + castor) in Saurashtra region of Gujarat state, viz. (i) sole groundnut, (ii) inter cropping (groundnut + castor) and (iii) Sole castor. The specific objectives are as given below:

1. To estimate the costs and returns of all the three different cropping systems under study
2. To compare the profitability of intercropping system with groundnut and castor as sole crops
3. To measure resource use efficiency of each cropping system along with system specific scale of production
4. To determine the factors influencing the adoption of intercropping in the study area
5. To examine the constraints faced by farmers in the adoption of inter-cropping

Multistage sampling technique was adopted for the selection of sample farmers. Two districts of Gujarat state viz. Junagadh and Gir-Somnath were selected purposively, where the farmers of these districts follow the practice of inter cropping system. One taluka from each selected district, adopting this system was also selected purposively as the first unit of sampling. In the selected talukas a pilot survey was carried out and the list of villages having large number of farmers adopting groundnut-castor intercropping has been prepared. Two villages were selected randomly from each taluka adopting intensive inter cropping system. From each village, 12 farmers practicing inter cropping system (Groundnut + Castor), 12 farmers growing sole groundnut and sole castor each, were selected randomly as the ultimate sampling unit. Thus, a sample size of 48 for inter cropping of groundnut + castor, 48 for sole groundnut and 48 for sole castor, was selected making the sample size total to 144. Among these 12 selected farmers constitutes, 3 marginal (up to 1.00 ha), 3 small (1.01–2.00 ha), 3 medium (2.01–4.00 ha) and 3 large (above 4.00 ha) farmers.

The primary data on inter cropping (Groundnut + Castor) and sole groundnut and sole castor including acreage, yield, harvest prices, input cost etc. were collected by visiting each of the selected farmers personally and interviewing them with a pre tested questionnaire. The information was collected by survey method for *kharif* season of the year 2016–17.

The collected data were analyzed for achieving specific objectives of the study by adopting various statistical tools, viz., tabular analysis, resource use efficiency analysis, logistic regression; Garret’s ranking technique Cobb-Douglas production function was used to work out the resource use efficiency. The major finding of the study have been summarized as below

The average age of the head of the farm family was about 45 years. Out of 144 farmers, 36 farmers (25.00 %) were under young age group, while 75 farmers (52.08 %) and 33 farmers (22.92 %) belonged to middle age group and old age group, respectively. The reason for middle age group farmers having a major share among sample farmers might be due to the fact that the parental occupation was taken up by the middle age group, whereas old ones were unable to continue farming and the young ones were not capable of taking the responsibility. The average size of family
Summary and conclusion

of the sample farmers was 5.20 per family. It was also found that (79.17 %) of the sample cultivators were literate and remaining (20.83 %) were illiterate.

The category wise education level indicated that the proportion of illiterate cultivators was comparatively lower in large farms as compared to small farms. Among the selected farmers, 36.11 per cent of farmers had education up to primary school, 30.56 per cent had education up to secondary school, while only 12.50 per cent of farmers had college education. It indicates that about 43 per cent farmers have good education level of secondary school to college.

Among the different organizations, the highest participation of selected respondents were observed in milk co-operative society (23.62 %) followed by co-operative credit society (20.14%), village panchayat (9.72%), seva sahkari mandli (9.02) and youth club (5.55). It also observed that considerable portion of sample farmers (31.95%) were not participated in any organization.

In case of sole groundnut farms the overall average size of holding was found 3.55 hectares, which varied from 0.83 hectare in case of marginal farms to 8.08 hectares in case of large farms. The average area under groundnut crop was 1.98 hectares (55.77%). Looking to the characteristics of sampled farms, proportion of land allocated under groundnut crop was reported the highest by marginal farm size group farmers, followed by medium, small and large category of farms.

The sample respondents of sole castor growers, showed that overall average size of holding was 3.29 hectares, which varied from 0.60 hectare in case of marginal farms to 7.99 hectares in case of large farms. The average area under castor crop was 1.39 hectare (42.24%). Looking to the characteristics of sampled farms, proportion of land allocation under castor crop was the highest by medium farm size group farmers, followed by marginal, large and small category of farms.

In case of groundnut + castor intercrop growers, showed that overall average size of holding was about 3.34 hectares, which varied from 0.90 hectare in case of marginal farms to 6.99 hectares in case of large farms. The average area under groundnut + castor intercropping was 0.95 hectare (28.44%). Looking to the characteristics of sampled farms, proportion of land allocation under (groundnut + castor intercropping system was the highest in case of medium farm size group farmers, followed by large, small and marginal category of farms.
Summary and conclusion

It can be seen that 33.33 per cent of marginal farmers, 33.33 per cent of small farmers, 27.78 per cent of medium farmers and 25.00 per cent of large category of growers adopted farming and animal husbandry as a main occupation. On overall, about 29.86 per cent of the growers have adopted farming and animal husbandry, while 19.44 per cent adopted sole farming, 29.17 per cent adopted farming, animal husbandry and business and 21.52 per cent adopted farming, animal husbandry and service.

The average total cost of cultivation per hectare of sole groundnut farms was Rs. 71451. The highest cost was observed in large farms Rs. 75394, followed by medium, small and marginal farms. The average total cost of cultivation per hectare of sole castor farms was reported Rs. 63869, the highest cost was observed in small farms Rs. 69009, followed by medium farms, large farms, and marginal farms. The average total cost of cultivation per hectare of groundnut + castor intercropping farms was reported Rs. 107944, the highest cost was observed in medium farms Rs. 108704, followed by marginal farms, small farms, and large farms.

In case of sole groundnut the overall per hectare Cost-A came to (Rs. 44685/ha). On an overall Cost-C2 came to (Rs.71451/ha). Study also showed that Cost-B and Cost-C1 accounted for about 81.30 and 90.91 per cent, respectively. In case of sole castor the overall per hectare Cost-A came to Rs. 34516/ha. On an overall Cost-C2 came to Rs. 61046/ha. Whereas Cost-B and Cost-C1 accounted for about 78.64 and 95.11 per cent respectively. In case of groundnut + castor intercropping the overall per hectare Cost-A came to Rs. 71420/ha. Besides Cost-C2 came to Rs. 107944/ha. Study also showed that Cost-B and Cost-C1 accounted for about 79.51 and 90.90 per cent, respectively.

The average yield of sole groundnut farms was 1927 kg/ha and on an average the farm harvest price reported about Rs. 4068 per quintal. The overall average gross returns per hectare of sole groundnut farms amounted to Rs. 84640/- . Whereas the average yield of sole castor farms was 2379 kg/ha and on an average the farm harvest price reported about Rs. 4245 per quintal. The overall average gross returns per hectare of sole castor farms amounted to Rs. 102328/-.

Whereas, the average equivalent yield of groundnut + castor intercropping farms was 3925 kg/ha and on an average the farm harvest price reported about Rs. 4081 per quintal. The overall average gross returns per hectare of groundnut +
castor intercropping farms amounted to Rs. 167349/-. For the groundnut the overall per hectare farm business income, family labour income, and farm investment income were Rs. 39955, 26574, 33092, respectively. The data indicate the net profit per hectare of sole groundnut crop over Cost-C2 was Rs. 13189/- for all farms. In the castor the overall per hectare farm business income, family labour income, farm investment income were Rs. 67812, 54320, 57757, respectively. The net profit per hectare of sole castor crop over Cost-C2 was Rs. 38459/ha for all farms. In intercropping overall per hectare farm business income, family labour income, farm investment income were Rs. 95929, 81517, 83630, respectively. Besides, the net profit per hectare of groundnut + castor intercropping over Cost-C2 was Rs. 59405/ha for all farms.

Thus, the groundnut + castor intercropping farmers obtained considerable higher net income as compared to sole groundnut and sole castor. The overall total cost of production Cost-C2 per quintal of groundnut was about Rs. 3383/- and for castor crop was Rs. 2627/-. The overall total cost of production of Cost-C2 per quintal of groundnut + castor intercropping was Rs. 2570. Thus, the intercropping of groundnut + castor was found more beneficial to the farmer than the sole groundnut and sole castor.

As result out of the total 144 observations used in the model, 33.33 per cent of the respondents (48) adopted intercropping, whereas 66.67 per cent (96) were not following the practice of intercropping at least during the last three years in the study area. The goodness of fit of the model reported by McFadden $R^2$ was 0.92 and the same reported by McFadden Adj. $R^2$ was 0.81. The prediction success with a 50-50 classification system revealed that about 97.22 per cent of the sample farmers were correctly classified on the basis of their preference to adopt intercropping in the last three years. It is also seen in that the log likelihood was maximized and the convergence of the model was established at -7.77. The Chi-squared value was also found to be good at 167.78 and the overall significance of the model was reported to be at 1 % level. Thereby, the model was found to be well fitted and all the explanatory variables used in the model were collectively able to infer the farmers’ preference to adopt groundnut + castor intercropping system in the study area.

It is concluded from the results of the production function analysis of sole groundnut farmers that the variables of cost of family labour and cost of hired labour found to have significant influence on the gross income with elasticities of 0.490 and
Summary and conclusion

0.682 per cent, respectively. The co-efficient of multiple determination ($R^2$) showed that 46.28 per cent of the variations in the gross income was accounted for by the independent variables included in the function. The sum of the value of regression coefficients of variables ($\Sigma b_i$’s) was 1.31, which indicating increasing returns to scale. It observed that the ratio of MVP to factor cost was the highest for cost of irrigation (9.99) followed by family labour (5.77), hired labour (5.07), manure (4.54), seed (1.96). The ratio of more than one indicating that still there exists a scope for higher utilization of these inputs which in turn would increase the gross income.

Results of the production function analysis of sole castor farms indicated that the variables of cost of plant protection chemical and cost of irrigation found to have significant influence on the gross income with elasticities of 0.057 and 0.313 per cent, respectively. The co-efficient of multiple determination ($R^2$) showed that 40.30 per cent of the variation in the gross income was accounted for by the independent variables included in the function. The sum of the value of regression coefficients of variables ($\Sigma b_i$’s) was 0.56, which indicating dimishing returns to scale. It revealed that the ratio of MVP to factor cost was the highest for cost of seed (7.38) followed by irrigation (5.82), plant protection chemical (4.06), fertilizer (3.55), machine power (0.16) and manure (1.14). The ratio of more than one indicating that still there was exists a scope for higher utilization of these inputs, which in turn would increase the gross income.

Besides, the production function analysis of intercropping groundnut+ castor farms indicated that the variables cost of hired labour found to have significant influence on the gross income with elasticity of 1.281 per cent. The co-efficient of multiple determinations ($R^2$) showed that 67 per cent of the variation in the gross income was accounted for by the independent variables included in the function. The sum of the value of regression coefficients of variables ($\Sigma b_i$’s) was -4.450, which is indicating decreasing returns to scale. It is observed that the ratio of MVP to factor cost was the highest for machine power (3.60), and hired labour (1.66). They were more than one indicating that still there was exists a scope for higher utilization of these inputs which in turn would increase the gross income. This would help to maximize their profit in production.
Summary and conclusion

The major production constraints faced by respondent were; labour is not timely available (60.25 %), production of groundnut as a intercrop is less than the production of groundnut as a sole crop (56.47 %) and castor as a sole crop (56.16 %), lack of proper knowledge of intercropping pattern (55.50 %), irrigation facility is not available (51.94 %) and also other constraints faced by intercrop growers. The marketing constraints faced by farmers were, timely non availability of payment of goods sold (62.74 %), market price is not enough (48.40 %), storage facility is not available (42.45 %), lack of cheap and sufficient transport facility (42.17 %), non availability of marketing facility in village area (37.30 %), fluctuation in market price (26.52 %). The economic constraints faced by the farmers to get more return were, costly insecticide and pesticide (50.09 %), more price good seeds (41.06 %), high rate of labour (38.00 %), crop loan is not timely available (35.83 %), etc.

Policy implication

1. Groundnut + castor is a economically viable intercropping system hence attempt should be made to popularise this system in Saurashtra region to increase farmer’s income.

2. Adoption of improved technologies along with proper utilization of resources like HYV seeds, manures and fertilizers, irrigation, and better management would improve the yield and returns.

3. The study revealed over utilization of some factors of production like human labour, family labour, plant protection chemical, manure, etc. Hence, the farmers need to utilize these resources optimally. To overcome this issue, focusing on optimum utilization of resources, on farm demonstration (OFD), need to be carried out on each cropping system.

4. Timely sowing and cultural operation are prerequisite needs to be carried out to overcome yield losses particularly in groundnut + castor intercropping system. Farmers should be trained to adopt low cost technology with farm automation strategy and technical suggestion may help in proper utilized the resources of each cropping system.

5. Besides, insufficient market price and non-timely available money for good sold has a greater effects on adoption and thereby, facilitating to give proper
Summary and conclusion

market price and timely available money for sells product by formulation of suitable policy.

6. The study also indicated that costly insecticide and pesticide, more prices of good quality seeds and non-availability of labour in time are foremost problems in groundnut + castor intercropping production. Besides, there is vital need to proper used of insecticide and pesticide, develop a new resistant variety and also need to reduce labour intensive cultivation.