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# Economics, water and nutrient productivity and profitability of castor as influenced by different castor (*Ricinus communis* L.) Based cropping systems in north Gujarat agro-climatic condition

**SJ Vaghela, JC Patel, DG Patel and JS Dabhi**

**Abstract**
A field experiment was conducted during the years 2011-12 and 2012-13 to study the effect of different cropping systems on economics, system productivity and profitability of castor in North Gujarat Agro-climatic condition on loamy sand soils of Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The experiment was laid out in randomised block design with four replications comprising ten treatments viz., $T_1$ : Castor sole, $T_2$ : Greengram + castor (2:1), $T_3$ : Cowpea + castor (2:1), $T_4$ : Groundnut + castor (2:1), $T_5$ : Sesamum + castor (2:1), $T_6$ : Greengram-rabi castor, $T_7$ : Castor-summer pearl millet, $T_8$ : Castor-summer greengram, $T_9$ : Castor-summer sesamum and $T_{10}$ : Castor-summer moth bean. Inter cropping system groundnut + castor (2:1) recorded significantly maximum CEY (5141 kg/ha), water productivity (10.3 kg/ha-mm) and nutrient productivity (16.0 kg/kg nutrient) while water profitability (` 244/ha-mm) and nutrient profitability (`383.6/kg-nutrient) were recorded maximum when castor was sown as sole crop during *kharif* season. The highest LUE (86.6 %) was registered with groundnut + castor (2:1), but an employment generation of 201 man day/ha was recorded with castor-summer pearl millet during both the years. Growing of groundnut + castor (2:1) as intercropping system produced higher castor equivalent yield and secured maximum net realization along with water productivity (10.3 kg/ha-mm) and nutrient productivity (16.0 kg/kg nutrient) under North Gujarat Agro-climatic condition.

**Keywords:** crop production, cropping systems, net return, nutrient productivity, nutrient profitability, water productivity, water profitability

## Introduction
Castor (*Ricinus communis* L.) is one of the most important oilseed crops of India as its oil has a diversified uses and great value in foreign trade. It is a non-edible oil seed crop (45 to 50 % oil) having high industrial importance due to presence of unique fatty acid and ricinoleic acid. It belongs to family *Euphorbiaceae* and originated from Ethiopia. Castor is extensively cultivated in India, China, Brazil, Ethiopia and Thailand. The contribution of India in the world is 56 per cent in area and 84 per cent in production of castor. Thus, India is a leading country in the world not only in area and production, but also in productivity of castor. Gujarat is the leading producer of castor in India with nearly 85 per cent of the output followed by Andhra Pradesh and Rajasthan. Further, Gujarat occupied 7.14 lakh ha area, 14.13 lakh tonnes production and 1979 kg/ha productivity of castor crop (Anonymous, 2016) [2]. The castor oil is differs from other vegetable oil due to its non-freezing nature up to temperature of -18˚C. It is therefore, considered to be the best lubricating agent particularly for both high speed engines and aeroplanes. Castor oil has many medicinal uses, *viz.*, curing in constipation (when taken internally), relief from pain, inflammation and stomach problems. It has also cosmetic uses and has been said to restore a youthful glow and maintain smooth and supple skin. It is also been used in the manufacturing of dyes, detergents, plaster of paris, soaps, polishes, greases, rubber, hydraulic brake fluids, polymers, wetting agents, surfactants, surface coatings *etc*. To reduce the duration and increase cropping intensity along with saving of irrigation water, cultivation of castor during *rabi* season is a suitable option. Castor is generally sown by maintaining plant to plant distance of 60 to 75 cm and at a row distance of 90 to 180 cm depending on the hybrid and soil type.

Intercropping is a common practice followed by farmers of semi-arid and arid tropics where primary concern is to secure their investment in order to sustain their living under the vagarie of nature. A significant feature of intercropping is that, it is s biologically more dynamic than a sole crop and is therefore, less likely to succumb to vagaries of weather *e.g.*, reduction in yield of one crop may be compensated by the other. Thus, intercropping is intrinsically more secure and dependable in providing some returns than sole cropping (Chetty and Rao, 1979) [4].

Shortage of pulse and oil seeds in our country have focused the attention on their inclusion in intercropping systems which have a capacity to get more return per unit area as well as to improve the physical, biological and chemical properties of soil. As the wide space is available between two rows of main crop in which profitable short duration crop can be grown during early growth stage of the crop as intercrop which gives an additional income also (Chetterjee and Mandal, 1992) [3]. Sequence crop is also used to control pests and diseases that can become established in the soil over time. Sequence cropping could also help in maintaining soil fertility provided suitable crops such as legumes may be included in the cropping system. An important aspect of sequence cropping is the utilisation of nutrients more efficiently as the crops growing on the same piece of land would have different nutritional requirements.

## Materials and Methods

A field experiment entitled to study Economics, water and nutrient productivity and profitability of castor as influenced by different castor (*Ricinus communis* L.) based cropping systems in North Gujarat Agro-Climatic condition was conducted during *kharif* seasons of 2011-12 and 2012-13. The detail of experimental procedure, techniques followed, material used and methodology adopted for evaluation of treatments during the course of investigation are presented in this chapter. The experiment was laid at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, and District: Banaskantha. It is situated in the North Gujarat Agro-climatic Zone of the Gujarat State. This zone is characterised by arid and semi-arid climate with extreme cold winter and hot and dry windy summer. The soil of the experimental plot was low in organic carbon (0.18 %) and available nitrogen (148 kg/ha), medium in phosphorus (47 kg/ha) and available potash (284 kg/ha). The experiment was laid out in randomised block design with four replications comprising ten treatments *viz.*, $T_1$ : Castor sole, $T_2$ : Greengram + castor (2:1), $T_3$ : Cowpea + castor (2:1), $T_4$ : Groundnut + castor (2:1), $T_5$ : Sesamum + castor (2:1), $T_6$ : Greengram-*rabi* castor, $T_7$ : Castor-summer pearl millet, $T_8$ : Castor-summer greengram, $T_9$ : Castor-summer sesamum and $T_{10}$ : Castor-summer mothbean. Castor: GCH 7, mungbean: GM 4, cowpea: GC 5, groundnut: GG2, sesamum: GT 2, pearl millet: GHB 558, mothbean: GMo 2 were taken for experiment. The RDF of castor, mungbean, cowpea, groundnut, sesamum, pearl millet and mothbean were180-37.5-00-20, 20-40-00-00,20-40-00-00 25-50-00-00, 50-25-00-20, 80-40-00-00 and 20-40-00-00 N-P-K-S kg/ha respectively. The total rainfall received during July-October, November-March and April- June was 916.1, 0 and 0 mm during 2011-12 and 590.6, 2.0 and 199.5 mm during 2012-13 respectively. The average monthly air temperature, relative humidity and sunshine hours were almost similar during both years.

Castor was sown in the first fortnight of August during both the years and harvested in the last week of January to first week of March (2012) while during 2013 castor was harvested in the first week of February to first week of March. *Rabi* castor was sown in the first fortnight of October and harvested in the third week of February to second week of March during both the years. Greengram, groundnut, cowpea and sesamum were sown on second fortnight of July during 2011 and 2012 as an intercrops. Greengram and cowpea were harvested in the last week of the September while sesamum was harvested in the first fortnight of October and groundnut was harvested in first fortnight of November. Sowing of summer greengram, pearl millet, sesamum and mothbean on last week of March during both the years as summer sequence crops. Greengram and mothbean were harvested in the first week of June while peal millet and sesamum were harvested on third and fourth week of June, respectively. The number of irrigations applied in the *kharif* castor was 7 and in intercrop greengram, groundnut, cowpea and sesamum were 3 and in *rabi* castor was 5 while in summer sequence crop 7 irrigations were applied in pearl millet and sesamum while 5 irrigations were applied in greengram and mothbean. Economic yields of the component crops were converted to castor equivalent yield (CEY), taking into account the prevailing minimum support price (MSP)/market prices of the crops. System productivity was calculated by adding the CEY of the component crops. System profitsbility was calculated by taking system net returns of the component crops. The statistical analysis of data of various characters was done using analysis of variance techniques as suggested by Panse and Sukhatme (1985) [9].

## Results and Discussion

### Castor equivalent yield (kg/ha)

Among the different intercropping systems under study groundnut + castor (2:1) found better (5141 kg/ha) than rest of the intercropping systems with respect to castor equivalent yield during both the years as well as in pooled results. Higher castor equivalent yield obtained in this system might be due higher yield potentiality of groundnut crop as compared to other crops alongwith higher market price of groundnut. This result is in accordance with the findings of Gupta and Rathore (1993), Srilatha *et al.* (2002), Mudalagiriyappa *et al.* (2011) and Neginhal *et al.* (2011) [6, 14, 7, 8].

On the other hand, all the cropping sequence under study was at par in term of producing castor equivalent yield. However, castor-summer greengram recorded maximum CEY. This might be only due to higher yield of castor because, it grown as sole during *kharif* season as compared to castor sown as intercrop and better yield of greengram. This result is in conformity with the findings of Singh (2009) [9] and Patel *et al*. (2009) [11].

## Economics

Among different intercropping systems groundnut + castor (2:1) proved better in respect of obtaining net realization. This might be due to higher yield of groundnut and castor which turned into maximum CEY. Results are in conformity with Patel *et al.* (1989) [10] and Prasad and Verma (1986) [12]. While castor-summer greengram recorded maximum net profit among the different cropping sequences under study. This might be due to higher CEY owing to more net realization.

Maximum value of benefit : cost ratio (2.87) recorded with sole castor might be due to lowest cost of cultivation while minimum value of benefit : cost ratio (1.60) obtained with sesamum + castor (2:1) might be due to the lowest CEY turned into lower net realization with high cost of cultivation. The results are inconformity with the findings of Singh (2009) [13]. With respect to net return, sole crop recorded higher net realization than all the treatments except $T_4$ [groundnut +

castor (2:1)] and $T_8$ (castor-summer greengram). This might be due to sowing of sole castor having lower cost of cultivation with higher castor seed production than other systems. More or less lower net realization recorded under the sequential cropping systems, eventhough higher CEY in these systems might be due to more cost of cultivation in these systems.

### Derived calculations

### Water and nutrient productivity based on CEY

Significantly the highest water and nutrient productivity during 2011-12, 2012-13 and in pooled data (Table 2 and 3) in terms of CEY was recorded in treatment $T_4$ [groundnut + castor (2:1)]. In sequential cropping systems two crops sown in sequence which produced higher total yield in terms of CEY as compared to intercropping systems except specific one, resulted into higher water and nutrient productivity. Results are similar as obtained by Dhimmar (2009) [5] and Negilhal *et al.* (2011).

### Water and nutrient profitability

Significantly higher water profitability was recorded under castor sole and groundnut + castor (2:1) during both the years and in pooled results than that of rest of the systems under study (Table 2). As castor grown during *kharif* season less amount of water (350 mm) applied during later stage and there was no any sequence crop in this treatment, so it registered higher water profitability.

The results indicated that maximum nutrient profitability (Table 3) was recorded when castor sown as sole crop during 2011-12, 2012-13 and in pooled results. Higher net return with less amount of nutrients applied to sole castor treatment resulted into recording maximum nutrient profitability.

### Sequence duration and land use efficiency

The data presented in Table 4 showed that castor when sown as sole crop required 200 days to complete its life period, which is minimum among all the systems under study during 2011-12 and 2012-13, respectively. Similarly, LUE was also noted minimum with castor sole during both the years.

### Employment generation

It seems that treatment castor–summer pearl millet utilised the highest human labours (Table 5) among different cropping systems during both the years. This might be due to this treatment having two crops in sequence and pearl millet crop require much labour for completion of all operations. While castor sole recorded the lowest human labours used among different cropping systems during both the years.

**Table 1:** Castor yield, component crop yield, castor-equivalent yield and economics (average 2 years) as influenced by different castor (*Ricinus communis* L.) Based cropping systems

| Treatment | Castor yield (kg/ha) | | Intercrop/Sequence crop yield (kg/ha) | | Gross income (`/ha) | Net income (`/ha) | Benefit cost ratio (`/ha) |
|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | 2011-12 | 2012-13 | | | |
| Castor sole | $3665^{a}$ | $3772^{a}$ | - | - | 1,39,760 | 91,102 | 2.87 |
| Greengram + castor (2:1) | $2645^{bc}$ | $2946^{ab}$ | 696 | 756 | 1,39,437 | 66,877 | 1.92 |
| Cowpea + castor (2:1) | $2316^{c}$ | $2463^{b}$ | 664 | 711 | 1,22,459 | 49,899 | 1.69 |
| Groundnut + castor (2:1) | $3307^{ab}$ | $3684^{a}$ | 1034 | 965 | 1,90,215 | 1,13,595 | 2.48 |
| Sesamum + castor (2:1) | $2253^{c}$ | $2227^{b}$ | 360 | 335 | 1,10,523 | 41,301 | 1.60 |
| Greengram-*rabi* castor | $1975^{c}$` | $2048^{b}$ | 728 | 789 | 1,11,098 | 48,771 | 1.78 |
| Castor-summer pearl millet | $3711^{a}$ | $3747^{a}$ | 1336 | 1202 | 1,69,036 | 90,005 | 2.14 |
| Castor–summer greengram | $3785^{a}$ | $3806^{a}$ | 671 | 633 | 1,73,201 | 97,421 | 2.29 |
| Castor–summer sesamum | $3622^{a}$ | $3718^{a}$ | 341 | 377 | 1,65,044 | 85,578 | 2.08 |
| Castor–summer mothbean | $3733^{a}$ | $3770^{a}$ | 323 | 349 | 1,59,305 | 83,003 | 2.09 |
| S. Em.± | 255.4 | 290.1 | - | - | - | - | - |
| C.D.at 5 % | 16.5 | 18.0 | - | - | - | - | - |

**Note:** Treatment means with the letter/letters in common are not significant by DNMRT at 5 % level of significance
Castor: 37/kg greengram: 40/kg groundnut: 48/kg sesamum: 75/kg
Pearl millet: 14/kg mothbean: 45/kg

**Table 2:** Water productivity and profitability as influenced by different caasor based cropping systems

| Treatment | Castor equivalent yield (kg/ha) | | | Water productivity (kg/ha mm) | | | Water profitability (`/ha mm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled |
| Castor sole | $3723^{bcd}$ | $3832^{bcde}$ | $3777^{bc}$ | 9.3 | 11.0 | 10.1 | 223 | 266 | 244 |
| Greengram + castor (2:1) | $3583^{cd}$ | $3954^{bcd}$ | $3769^{bc}$ | 7.2 | 7.9 | 7.5 | 120 | 148 | 134 |
| Cowpea + castor (2:1) | $3209^{d}$ | $3411^{cde}$ | $3310^{c}$ | 6.4 | 6.8 | 6.6 | 92 | 107 | 100 |
| Groundnut + castor (2:1) | $4955^{a}$ | $5327^{a}$ | $5141^{a}$ | 9.9 | 10.7 | 10.3 | 213 | 241 | 227 |
| Sesamum + castor (2:1) | $3026^{d}$ | $2948^{e}$ | $2987^{c}$ | 6.1 | 5.9 | 6.0 | 85 | 80 | 88 |
| * Greengram-*rabi* castor | $2928^{d}$ | $3078^{de}$ | $3003^{c}$ | 7.3 | 8.8 | 8.1 | 115 | 147 | 131 |
| Castor-summer pearl millet | $4573^{ab}$ | $4564^{ab}$ | $4569^{ab}$ | 6.1 | 6.5 | 6.3 | 120 | 128 | 124 |
| Castor–summer greengram | $4691^{a}$ | $4672^{ab}$ | $4681^{ab}$ | 7.2 | 7.8 | 7.5 | 150 | 162 | 156 |
| Castor–summer sesamum | $4375^{abc}$ | $4547^{ab}$ | $4461^{ab}$ | 5.8 | 6.5 | 6.2 | 110 | 127 | 118 |
| Castor–summer mothbean | $4271^{abc}$ | $4340^{abc}$ | $4306^{ab}$ | 6.6 | 7.2 | 6.9 | 126 | 140 | 133 |
| S.Em.± | 263.5 | 300.3 | 281.9 | 0.6 | 0.7 | 0.6 | 20.7 | 24.0 | 22.3 |
| C.D.at 5 % | 13.4 | 14.8 | 14.1 | 1.6 | 1.9 | 1.8 | 60.0 | 69.6 | 64.8 |
| C.V % | - | - | - | 15.6 | 16.4 | 16.0 | 30.5 | 31.0 | 30.8 |

* *Kharif* castor was sown on $18^{th}$ and $13^{th}$ August while *rabi* castor was sown on $15^{th}$ and $12^{th}$ October, 2011 and 2012, respectivel

**Table 3:** Nutrient productivity and profitability as influenced by different caasor based cropping systems

| Treatment | Nutrient productivity (kg/kg nutrients) | | | Nutrient profitability (`/kg nutrients) | | |
|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled |
| Castor sole | 15.7 | 16.1 | 15.9 | 375.1 | 392.1 | 383.6 |
| Greengram + castor (2:1) | 12.0 | 13.3 | 12.7 | 201.7 | 247.9 | 224.8 |
| Cowpea + castor (2:1) | 10.8 | 11.5 | 11.1 | 155.2 | 180.3 | 167.7 |
| Groundnut + castor (2:1) | 15.4 | 16.6 | 16.0 | 332.0 | 374.7 | 353.3 |
| Sesamum + castor (2:1) | 9.7 | 9.4 | 9.6 | 136.8 | 127.6 | 132.2 |
| * Greengram-*rabi* castor | 15.4 | 16.6 | 16.0 | 248.6 | 278.6 | 263.2 |
| Castor-summer pearl millet | 12.8 | 12.8 | 12.8 | 252.3 | 251.3 | 251.8 |
| Castor–summer greengram | 15.8 | 15.7 | 15.7 | 328.7 | 326.3 | 327.5 |
| Castor–summer sesamum | 14.0 | 14.6 | 14.3 | 263.7 | 284.0 | 273.9 |
| Castor–summer mothbean | 14.4 | 14.6 | 14.5 | 274.7 | 283.3 | 279.0 |
| S.Em.± | 0.9 | 1.1 | 1.0 | - | - | - |
| C.D.at 5 % | 2.7 | 3.1 | 2.9 | - | - | - |
| C.V % | 13.5 | 14.9 | 14.2 | - | - | - |

* Kharif castor was sown on 18th and 13th August while rabi castor was sown on 15th and 12th October, 2011 and 2012, respectively.

**Table 4:** Sequence duration and land use efficiency as influenced by differen cropping systems

| Treatments | Sequence duration (days) and land use efficiency (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2011-12 | | | | 2012-13 | | | |
| | Sequence duration | | | LUE (%) | Sequence duration | | | LUE (%) |
| | Castor | Inter/sequence crop | Total | | Castor | Inter/sequence crop | Total | |
| Castor sole | 200 | - | 200 | 54.8 | 197 | - | 197 | 54.0 |
| Greengram + castor (2:1) | 200 | 71 | 271 | 74.3 | 197 | 68 | 265 | 72.6 |
| Cowpea + castor (2:1) | 200 | 71 | 271 | 74.3 | 197 | 72 | 269 | 73.7 |
| Groundnut + castor (2:1) | 200 | 116 | 316 | 86.6 | 197 | 119 | 316 | 86.6 |
| Sesamum + castor (2:1) | 200 | 85 | 285 | 78.1 | 197 | 85 | 282 | 77.3 |
| Greengram-*rabi* castor | 152 | 71 | 223 | 61.1 | 152 | 68 | 220 | 60.3 |
| Castor-summer pearl millet | 200 | 86 | 286 | 78.4 | 197 | 83 | 280 | 76.7 |
| Castor–summergreengram | 200 | 69 | 269 | 73.7 | 197 | 75 | 272 | 74.5 |
| Castor–summer sesamum | 200 | 92 | 292 | 80.0 | 197 | 84 | 281 | 77.0 |
| Castor–summer mothbean | 200 | 74 | 274 | 75.1 | 197 | 70 | 267 | 73.2 |

**Table 5:** Employment generation as influenced by different cropping systems

| Treatments | Employment generation (man days/ha) | |
|---|---|---|
| | 2011-12 | 2012-13 |
| Castor sole | 131 | 131 |
| Greengram + castor (2:1) | 196 | 196 |
| Cowpea + castor (2:1) | 196 | 196 |
| Groundnut + castor (2:1) | 189 | 189 |
| Sesamum + castor (2:1) | 191 | 191 |
| Greengram-*rabi* castor | 160 | 160 |
| Castor-summer pearl millet | 201 | 201 |
| Castor–summer greengram | 190 | 190 |
| Castor–summer sesamum | 196 | 196 |
| Castor–summer mothbean | 194 | 194 |

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