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PROSPECTS OF CASTOR BEAN CULTIVATION IN RAINFED TRACT OF PAKISTAN

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Abstract

Non-edible oilseeds carry special importance along with edible oilseeds in the world oilseeds economy as well as Pakistan. Castor bean is an important non-edible oilseed. The agro-ecological conditions of rain-fed Pothwar region of Pakistan provide good potential for increasing cultivation of castor bean. The experimental plots of castor bean planted at three locations of Pothwar selected on the basis of rainfall shows that castor bean is a moisture sensitive crop and productivity is directly associated with rainfall levels. Similarly, earlier planted fields out-yielded than late planted ones. Among varieties, DS-30 and PR-101 performed relatively better than PR-7/1 and local. The combined effect of variety and planting time revealed that higher yielding varieties planted earlier has resulted in higher yield ha^{-1} as compared with the yields by the same varieties planted late. The competitiveness analysis of returns from castor bean production vis-à-vis returns from sorghum and millet production at three locations showed that castor bean cultivation gave much higher returns. It is concluded that castor bean cultivation was found much profitable for the farmers of Pothwar region of Pakistan. Secondly, selection of better variety and optimum plantation times are also important, but farmers in Chakwal region should struggle for early plantation besides selecting high yielding varieties (HYVs).

Introduction

The total area of Pakistan is 79.6 million hectares, out of which 70% is arid to semi-arid. The ecologies of Khyber Pukhtun khawa and Northern Areas range from semi-arid to humid. The Sindh province is primarily arid while Punjab and Balochistan have arid-semi arid ratios as 58:29 and 43:57, respectively. This diversified climate is suitable for cultivation of wide range of food, cash, horticultural and medicinal crops. Among non-edible oilseeds, castor bean and linseed are mainly cultivated for medicinal use. The oilseed economy of Pakistan is mainly edible oilseeds based and the area under non-edible oilseeds is negligibly small in spite of good environment and area availability for these crops.

Castor bean (*Ricinus communis* L.) belongs to *Euphorbiaceae* family, locally called '*Arind*' or '*Arindi*' is a non-edible oilseed crop with diversified uses of its products ranging from farm yard manure and fuel to its multiple uses like leaves for feeding silkworms, oil traditionally used as purgative and in the preparation of various cosmetic products, plastic industry, lubricants and manufacturing of biofuel. Castor bean is cultivated all over the world and India, China, Brazil, Ethiopia, Paraguay, Vietnam and Thailand are its major grower by contributing about 97 percent of the world castor bean production (Anon., 2008). Castor can be grown in both irrigated and rainfed ecologies, varied climatic conditions and on almost all soils provided they are well drained and not much alkaline.

The underlying purpose of this study was to revive the castor bean cultivation in the marginal areas of the above delineated regions and districts by taking Pothwar as case study. The Pothwar region of Pakistan comprises of Attock, Rawalpindi, Jhelum and Chakwal districts. Pothwar tract represents 10.8% of the total geographic and 30.6% of rainfed geography of the Punjab province of Pakistan (Anon., 2000). Majority of the farmers in this tract own less than two hectares of land. Food and fodder securities are the main concerns of the agriculture of this tract where crop production entirely depends upon the intensity and distribution of rainfall during the production season. The climate of Pothwar can be classified as true semiarid in the southwest to sub-humid, sub-tropical continental lowland in the east and northeast. The general features are high temperatures in June and July (average 40^oC with maximum to 50^oC) with occasional hot, dry winds and dust storms; cold nights in winter (average about 4^oC); and two rainy seasons. Rainfall varies across the region from 350 mm in the drier southwest to 1000 mm in the more humid northeast region. The rainfall is erratic with much of it occurring during the months of July and August and gentle showers are received from December to March. This variation in rainfall is reflected in the cropping intensity of the area. The area can be sub-divided on the basis of rainfall into the arid south-west (<400mm), semi-arid central portion (400-650 mm) and the sub-humid northeast (650-1000 mm) (Anon., 2009).

Prospects of growing castor are very promising in Pothwar for its aridity tolerance nature, deep root system to stop erosion and growing with low fertility. The Pothwar soils having low rain fall and pH ranges from 7.5 to 8.5 is also tolerable for castor bean (Muhammed *et.al.*, 2009; Ahmed, 1988). From infrastructural support perspective, besides the presence of the provincial Department of Agricultural Extension, one agricultural research institute namely Barani Agricultural Research Institute (BARI) is situated in the region. The region is also well integrated with major cities of Pakistan (like Rawalpinid-Islamabad, Lahore and Peshawar) through GT-Road and newly constructed Motorway. In rural households, the contribution of non-farm income and remittances is significant in livelihood composition of the household. This indicates that farm households in the area can invest in agriculture from their own sources in favor of more profitable and sustainable options.

This study not only aimed at investigating the relative success of castor cultivation in different parts of this region but it also aimed at comparing the returns from

castor crop with other competing summer season (kharif) crops of the region. The specific objectives of this paper were: i) to determine the optimum time of castor bean cultivation in Pothwar region; ii) to identify the most suitable castor bean cultivar for recommendation to the farmers of this region; iii) to compare the returns from castor bean cultivation with sorghum and millet; and iv) to suggest guidelines for the researchers and extension staff for promoting the cultivation of castor bean in marginal areas of the country in general and Pothwar region in particular.

Materials and Methods

The planting material comprised of varieties viz., DS-30, PR-7/1, PR-101 and local as control. The source and description of plant material is presented in the following table.

Cultivar name	Salient features	Source
DS-30	Short growing variety attaining height of about 155 cms, stem, red, capsules spiny, early maturity, takes about 120 days for short picking. Shelling percentage 61% seed index 25 gm. Tolerant to Jassids, suitable for irrigated as well as non-irrigated areas	Selection from local variety
PR- 7/1	, Medium growing (height 145cm) takes 115 days to first picking, Tolerant to sucking insects, suitable for sowing in irrigated as well as un-irrigated areas, Average yield 2.2 mt /ha as irrigated and 0.9 mt/ha under un-irrigated conditions, Oil content 51%	Selection from local variety
PR-101	Medium growing (height 150cms) takes 115-118 days to first picking, Tolerant to sucking insects, suitable for sowing in irrigated as well as un-irrigated areas, Average yield 2.2 Mt /ha as irrigated and 0.9 mt/ha under un-irrigated conditions, Oil content 50%	Selection from local variety
Local (Check)	Long growing height, and low yielding but hardy to resist bio-tic and a-bio-tic stresses	

The experiments were carried out at National Agricultural Research Center (NARC), Islamabad; Groundnut Research Station (GRS), Attock; and Barani Agricultural Research Institute (BARI) Chakwal. These sites represented three rainfall regions (high, medium and low, respectively). The average annual rainfall at NARC Islamabad ranged between 1000-1200 mm, 650-850 mm at GRS Attock and 450-550 mm at BARI Chakwal. Minimum and maximum mean temperatures in Rawalpindi (at an elevation of 510 meters) are 14.8°C and 28.9°C, respectively (Nyrop and Richard, 1975). However, temperatures vary in the study area relative to elevation.

For planting the crop, the first planting was carried out on July 15th, 2004 and then sowing was carried out with 15 days interval upto 30th August. Plot size consisted 5 rows each 9 meter long with row to row and plant to plant distance of one meter. The experiment was laid out in randomized complete block design. The fertilizer was applied @ 31:62 NP kg ha^{-1} to fulfill the nutrition requirements of crop. The crop was hoed twice to eradicate weeds. Recommended agronomic practices were carried out in order to provide optimum crop growth conditions. The agronomic parameters recorded for evaluating crop performance were emergence percentage, plant height, number of branches per plant, days to first flowering, maturity date, the number of capsules per plant, weight of 100 seeds, and yields per hectare. However, for economic analysis, data on production practices adopted and yield per hectare were utilized.

Analytical procedures: Since the nature of the analysis is to examine the potentials of cultivating castor seed in the Pothwar region, which implies investing the competitiveness of the enterprise under consideration with existing crops. A new crop can win area in an existing cropping pattern, if it is either significantly more profitable or it minimizes the production risks. In present study, the returns from castor seed cultivation were compared with sorghum and millet. The criterion used for examining competitiveness were cost of production per hectare, ratio of variable cost to total cost, and returns (i.e. benefit-cost ratio) against variable and total costs.

The standard procedures were adopted for estimating the cost of production of castor seed and other competing crops (Ahmad *et al*., 1993 & 1994 and Chakrabarti & Ahmad. 2008). For estimating the cost of production, the cost items were divided into two broader groups, i.e. variable and fixed costs. Variable costs included expenses incurred on land leveling, ploughing, planking, seed, seed sowing, fertilizer, pesticides, irrigation, harvesting, threshing and manual labour. Whereas fixed costs included expenses such as interest on capital (variable costs) for the crop period, land revenue and opportunity value of land rent. Both types of costs were pooled under total costs. On the revenue side, the gross value of output was estimated by simply multiplying the output quantity with the market price. The difference between gross value of output and the costs incurred was net income.

Although positive net income shows returns above the costs incurred, however, it does not explain returns per rupee invested. Therefore, the benefit-cost ratios were calculated against total costs and variable costs to estimate the returns per rupee invested. The idea behind these estimations was that whether all costs (variable & fixed) were recovered with some additional income or at least variable costs (which are mostly cash costs from the farmers' perspectives) were recovered. In economic analysis, non-recovery of variable costs implies break-even point of the investment in an enterprise in the short-run perspective. Such analysis is discussed in detail by Ahmad *et al*. (1993 & 1994); Cheema *et al*. (1994); Farooq *et al*. (1999); Tanveer *et al*., (2003).

Results and Discussion

Yield performance analysis: Sowing of crop at optimum time along with other agronomic factors is the key to maximum production of any crop. Four castor varieties were tested at three locations in the region. The mean yield of the experiments planted at NARC, Islamabad was higher followed by Attock and Chakwal locations (Table 1). It was observed that as we move from areas of high rainfall to medium rainfall and further down to low rainfall zones, the incidence of frosty nights increases and so is the decline in castor productivity indicating strong dependence of productivity on rainfall and frost free nights during maturity stage of crop. At Islamabad and Attock locations, relatively higher yields were obtained from 30th July plantation whereas in Chakwal ecology, the 15th of July plantation gave the highest yield (Table 1). One day delay in castor bean plantation between 30th of July to 15th of August caused an average yield loss of 8.73 kg ha^{-1} day^{-1} in Attock, 3.79 kg ha^{-1} day^{-1} in Islamabad and 24.87 kg ha^{-1} day^{-1} in Chakwal region. Among cultivars, DS-30 out-yielded at all three locations whereas PR-7/1 followed by PR-101 performed better compared to local check at NARC and GRS Attock. Slightly different yield performance was observed between PR-7/1 and PR-101 at BARI Chakwal. Considering the plantation of different varieties at different times, overall DS-30 outstandingly performed at all locations with all planted times experimented followed by PR-7/1 at NARC and GRS Attock and PR-101 stood second at Chakwal while local variety's yield was lowest at all sites (Table 1).

Table 1. Mean Yield (kg ha^{-1}) of different castor bean varieties planted at various locations and different sowing dates in Pothwar region.

Sites/planting dates	Varieties planted				Overall
	DS-30	PR-7/1	PR-101	Local	
Islamabad	**883.00**	**838.45**	**776.41**	**605.71**	**775.89**
15th July	969.33	881.66	787.00	618.83	814.21
30th July	960.33	902.16	837.66	640.66	835.20
15th August	837.66	842.33	813.16	622.50	778.91
30th August	764.66	727.66	667.83	540.83	675.25
Attock	**781.33**	**732.58**	**680.42**	**490.92**	**671.31**
15th July	899.50	825.50	724.83	528.83	744.67
30th July	*902.50*	*849.00*	*781.33*	*533.00*	*766.46*
15th August	691.66	680.50	672.00	495.33	634.87
30th August	631.66	575.33	543.50	406.50	539.25
Chakwal	**354.75**	**295.42**	**309.83**	**239.04**	**299.76**
15th July	667.16	571.83	578.00	418.00	558.75
30th July	531.83	494.50	498.50	415.16	485.00
15th August	151.50	84.83	121.00	90.83	112.04
30th August	68.50	30.50	41.83	32.16	43.25

Based on the yield performance of four varieties and four planting times (Table 1), DS-30 and PR-7/1 were grouped as higher yielding varieties (HYVs) and PR-101 and Local as lower yielding varieties (LYVs). Similarly, July 15th and 30 plantations were placed under optimum planting (OT) wile plantation in August was termed as delayed planting (LP). This grouping yielded four combinations *viz*., HYV+OT, HYV+DP, LYV+OT, and LYV+DP. Cross tabulating combinations against experimental locations (Table 2), it was revealed that HYVs outstandingly performed at all locations when planted till 30th of July. Any delay in sowing of these varieties beyond 30th of July caused yield loss of 9.06 kg ha^{-1} day^{-1} in Islamabad, 14.99 kg ha^{-1} day^{-1} in Attock and 32.12 kg ha^{-1} day^{-1} in Chakwal. This suggested that timely plantation of better yielding varieties is relatively more important at Chakwal than other two locations. Comparing planting date combinations of LYVs at different locations, it was found that these varieties also performed better at all locations when planted till 30th of July. A delay in sowing of these varieties beyond 30th of July caused yield loss of 3.95 kg ha^{-1} day^{-1} in Islamabad, more than 7.58 kg ha^{-1} day^{-1} in Attock and 27.02 kg ha^{-1} day^{-1} in Chakwal. This finding further reinforced the earlier conclusion that timely plantation is also more important even for LYVs, particularly at Chakwal. It was established that irrespective of location, the selection of better variety and optimum plantation times are important, but farmers in Chakwal district should struggle for early plantation besides opting for HYVs.

Table 2. Mean Yield (kg ha^{-1}) of different castor bean varietal groups planted at optimum and delayed at different sowing dates in Pothwar region.

Sites & planting dates	Variety type and planting date combinations				Overall
	HYV + OT	HYV + DP	LYV + OT	LYV + DP	
NARC	929.10	793.19	721.53	662.23	775.89
GRS Attock	869.79	644.93	642.46	528.79	671.31
Chakwal	565.86	84.01	476.90	71.66	299.76

HYV = High yielding varieties (DS-30+PR-7/1), OT = Optimum time planting, LYV= Low yielding varieties (PR-101+ Local), DP = Delayed planting

Research work conducted in India on the impact of sowing date on castor bean yield shows that in India, most of the sowing date experiments were carried out by planting this crop from July to November. This may be attributed to diversified climatic conditions of various locations of this gigantic country. However, early plantation yielded better than late planting. For instance, Goverdhan & Pooran (2002) found that castor bean crop sown in July gave better yield compared to August month plantation. Patel *et al*., (2005) are of the opinion that highest yield with excellent performance of yield contributing attributes could be obtained in early sowing (July-August) rather than late sowing (September-October). Similarly, Reddy *et al*., (2007) found that July plantation gave higher yield than the August sown plots. Sreedhar & Yakadri (2004) found that in Hyderabad, 1st September sown castor been out-yielded 1st October sown crop. Nagabhuhanam & Raghavaiah (2005) found that in southern India, the 15th of October plantation performed better both in terms of growth, yield and oil contents when compared with plantation in November. It showed that early plantation provide more returns than late planting.

Economic analysis: With input levels kept constant at all sites, the average cost of castor bean cultivation was Pak. Rupees 20200 ha^{-1} (US$ = 86 Pak. Rupees) with a 81:19 ratio of variable to fixed costs (Annex-1). The net income ha^{-1} was highest at Islamabad location followed by Attock and Chakwal. This is because the net returns ha^{-1} are directly associated with the yield ha^{-1} (Table 3).

Table 3. Overall economic analysis of castor bean cultivation at different locations in Pothwar region of Pakistani Punjab.

	Economic analysis parameters	NARC Islamabad	GRS Attock	BARI Chakwal
A.	Yield per hectare (kg)	775.89	671.31	299.76
B.	Gross Returns@Rs.1500/40 kg	29095.88	25174.13	11241.00
C.	Marketing Cost (@ 5%)	1454.79	1258.71	562.05
D.	Transportation to Market	193.97	167.83	74.94
E.	**Total cost**	**20200.43**	**20200.43**	**20200.43**
F.	**Gross return**	**29096.03**	**25174.13**	**11241.00**
G.	**Net income against TC**	**7246.83**	**3547.17**	**-9596.42**
H.	**Net income against TVC**	**12725.65**	**8803.75**	**-5129.38**
I.	**CB-ratio against TC**	**1 : 1.44**	**1 : 1.25**	**1 : 0.56**
J.	**CB-ratio against TVC**	**1 : 1.78**	**1 : 1.54**	**1 : 0.69**

Measuring the economic viability of castor bean cultivation at different planting dates in terms of cost-benefit ratios, this ratio ranges from 1:1.25 to 1:1.55 in Islamabad, 1:1.00 to 1:1.42 in Attock, and 1:0.08 to 1:1.04 in Chakwal. The cost-benefit ratio estimates against variable costs shows that it ranges from 1:1.55 to 1:1.91 in Islamabad, 1:1.23 to 1:1.75 in Attock, and 1:0.10 to 1:1.28 in Chakwal (Table 4). This implies that it is more profitable to cultivate castor bean in Attock and Islamabad whereas in Chakwal, it just recovers the costs incurred, provided it is planted at optimum time (3rd week of July). Any delay beyond this date shall result in loss which is mainly attributed to incidence of frost at crop maturity stage causing serious damages to the yield. On the other hand, the returns against variable costs are further improved at all ecologies, particularly in Chakwal region by improving its viability of cultivation till 30th of July.

A perusal of results across different combinations of varieties with planting times, it is evident that cost-benefit ratios ranged from 1:1.23 to 1:1.72 in Islamabad, 1:0.98 to 1:1.61 in Attock, and 1:0.13 to 1:1.05 in Chakwal. The cost benefit ratio (CBR) of better yielding varieties has further improved at all locations when planted till 30th July. The CBR against variable costs was ranged from 1:1.52 to 1:2.13 in Islamabad, 1:1.21 to 1:1.99 in Attock and 1:0.16 to 1:1.30 in Chakwal (Table 5). These findings lead to reiterate that planting of better yielding varieties before 30th July is the best option for achieving high returns from castor bean cultivation at all locations. The consideration of timely plantation is even more important in case of relatively low yielding varieties. Planting castor bean beyond 30th July seriously deteriorates the returns ha^{-1} along with quite sharper decline in cost benefit ratios.

In conclusion, the cultivation of castor bean is a profitable option for the farmers in Pothwar region in Kharif season. Maximum returns could be achieved from this enterprise if planted between 15th and 30th July in Attock and Islamabad regions and by 15th July in Chakwal region. Selection of better yielding varieties like DS-30 and PR-7/1 is also important for further improving the returns from castor bean cultivation. Delaying further beyond these dates affects the returns ha^{-1}, negatively. This analysis clearly showed that plantation should be completed by 30th July and farmers should prefer planting varieties like DS-30 and PR-7/1, in order to achieve high returns from castor bean cultivation.

Competitiveness of castor bean cultivation in pothwar region: In this section, castor bean cultivation was compared with the kharif crops already being cultivated in the region on different economic grounds. The measures considered were net income against variable and fixed costs, share of variable costs in total cost, and CBR against variable and total costs. The information in (Table 6) clearly showed that castor bean cultivation at optimum planting dates result in higher income per ha^{-1} as well as CBR-ratios at all sites whereas the share of variable cost in total cost in castor bean was almost same as other crops like millet and sorghum. This implies that castor bean bears strong capability of winning area on farmers' land in Pothwar region on competitive basis.

Table 4. Economic analysis of castor bean cultivation at different planting dates in Pothwar region of Pakistani Punjab.

Sites and planting date	Net income/hectare against		Variable costs share in total cost (%)	Cost-benefit ratio against	
	Variable costs (Rs./hectare)	Total costs (Rs./hectare)		Variable costs	Total costs
Islamabad	**12725.65**	**7246.83**	**81.04**	**1 : 1.78**	**1 : 1.44**
15th July	14208.25	8645.41	81.04	1 : 1.87	1 : 1.51
30th July	14949.55	9344.70	81.04	1 : 1.91	1 : 1.55
15th August	12818.31	7334.25	81.04	1 : 1.78	1 : 1.44
30th August	8926.49	3662.96	81.04	1 : 1.55	1 : 1.25
Attock	**8810.97**	**3554.39**	**81.04**	**1 : 1.54**	**1 : 1.25**
15th July	11613.70	6197.89	81.04	1 : 1.71	1 : 1.39
30th July	12355.00	6897.18	81.04	1 : 1.75	1 : 1.42
15th August	7445.12	2265.61	81.04	1 : 1.45	1 : 1.18
30th August	3830.05	-1144.69	81.04	1 : 1.23	1 : 1.00
Chakwal	**-5129.38**	**-9596.43**	**81.04**	**1 : 0.69**	**1 : 0.56**
15th July	4571.35	-445.40	81.04	1 : 1.28	1 : 1.04
30th July	1791.48	-3067.75	81.04	1 : 1.11	1 : 0.90
15th August	-12199.33	-16265.68	81.04	1 : 0.25	1 : 0.21
30th August	-14702.45	-18627.02	81.04	1 : 0.10	1 : 0.08

Source: Appendix-2 Cheema N.M. 2011 Yield and chemical composition of castor bean (*Ricinus communis* L.) as influenced by environment. Ph.D. thesis UAAR, Rawalpindi

Table 5. Economic analysis of interaction between planting dates and variety type in castor bean cultivation in Pothwar region.

Sites and variety-sowing date interaction	Net income/hectare against		Variable costs share in total cost (%)	Cost-benefit ratio against	
	Variable costs (Rs./hectare)	Total costs (Rs./hectare)		Variable costs	Total costs
Islamabad	**12748.83**	**7270.00**	**81.04**	**1 : 1.78**	**1 : 1.44**
HY + OT	18470.73	12666.35	81.04	1 : 2.13	1 : 1.72
HY + DP	13374.29	7858.72	81.04	1 : 1.82	1 : 1.47
LY + OT	10687.08	5323.77	81.04	1 : 1.65	1 : 1.34
LY + DP	8463.18	3225.89	81.04	1 : 1.52	1 : 1.23
Attock	**8810.67**	**3554.06**	**81.04**	**1 : 1.54**	**1 : 1.25**
HY + OT	16246.83	10568.47	81.04	1 : 1.99	1 : 1.61
HY + DP	7814.54	2614.02	81.04	1 : 1.48	1 : 1.20
LY + OT	7721.88	2526.60	81.04	1 : 1.47	1 : 1.19
LY + DP	3459.40	-1494.34	81.04	1 : 1.21	1 : 0.98
Chakwal	**-5135.06**	**-9602.08**	**81.04**	**1 : 0.69**	**1 : 0.56**
HY + OT	4849.34	-183.18	81.04	1 : 1.30	1 : 1.05
HY + DP	-13219.85	-17228.43	81.04	1 : 0.19	1 : 0.16
LY + OT	1513.49	-3329.99	81.04	1 : 1.09	1 : 0.89
LY + DP	-13683.16	-17665.50	81.04	1 : 0.16	1 : 0.13

Source: Appendix-3 Cheema N.M. 2011 Yield and chemical composition of castor bean (*Ricinus communis* L.) as influenced by environment. Ph.D. thesis UAAR, Rawalpindi

Table 6. Competitiveness of castor bean cultivation in Pothwar region.

Site and crop types	Net income/acre against		Variable costs share in total cost (%)	Cost-benefit ratio against	
	Variable costs	Total costs		Variable costs	Total costs
Islamabad					
Millet	5360.17	492.72	79.59	1 : 1.08	1 : 1.36
Sorghum	5444.60	982.91	78.16	1 : 1.09	1 : 1.40
Castor bean	14949.55	9344.70	81.04	1 : 1.55	1 : 1.91
Attock					
Millet	1417.81	-3164.91	79.59	1 : 0.87	1 : 1.09
Sorghum	1469.38	-2721.24	78.16	1 : 0.87	1 : 1.11
Castor bean	12355.00	6897.18	81.04	1 : 1.42	1 : 1.75
Chakwal					
Millet	2463.17	-2195.06	79.59	1 : 0.93	1 : 1.16
Sorghum	4165.24	-209.19	78.16	1 : 1.02	1 : 1.30
Castor bean	4571.35	-445.40	81.04	1 : 1.04	1 : 1.28

Source: Appendix 4 to 9. Cheema N.M. 2011 Yield and chemical composition of castor bean (*Ricinus communis* L.) as influenced by environment. Ph.D. thesis UAAR, Rawalpindi

Conclusion

Castor bean is a moisture sensitive crop and productivity is directly associated with the rainfall levels. However, in low rainfall ecologies, relatively earlier plantation than medium and high rainfall ecologies can notably compensate the rainfall deficiencies. The castor bean cultivar DS-30 is best suited for medium and high rainfall ecologies while DS-30 and PR-101 performed better under low rainfall conditions. Secondly, earlier planted fields gave higher production compared to late sown fields. The combined effect of variety and planting time revealed that higher yielding varieties planted earlier resulted in higher yield ha^{-1} as compared to the same varieties planted late. The competitiveness analysis of returns showed that castor bean cultivation gave much higher returns than other competing kharif crops. Irrespective of locations, the selection of the best variety and optimum plantation times are important, but farmers in Chakwal region should struggle for early plantation besides opting for HYVs.

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