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Determinants of contract farming in barley production – Regression tree approach

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ABSTRACT

Barley, a nutri-rich cereal is gaining momentum among stakeholders owing to multiple health benefits but the concern is its declining area, possibly attributed to lack of market and competitive pricing strategy. Amongst alternatives, contract farming is widely suggested for better price realisation and assured market. In the context, the present study was carried out during 2013–15 in four major barley growing states in India, viz. Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh for identifying the determinants of contract farming from a sample of 400 randomly selected farmers using regression tree approach. Findings indicated that the average yield of farmers enrolled in contract farming was 4791 kg/ha (n=90) against non-contractors with an estimated yield of 3549 kg/ha (n=310), implying a yield advantage of 35%. The practice of enrollment into contracts was popular in Rajasthan as corroborated by regression tree. The analysis also indicated that farm size, seed replacement behaviour, source of seed and area under barley were turned as deciding factors in contract enrollment. Overall, the study indicated that region plays a prominent role in enrollment into contracts despite multiple benefits availed. The study advocates barley growers to take advantage of contract farming, especially small-holders to enroll into contracts for mitigating price risk apart from self-empowerment in barley production.

Keywords: Barley, Contract farming, CART, Regression tree

Contract farming is widely advocated among small-holders for better price realization, access to quality input especially seeds, fair marketing and timely payment. It is regarded as a win-win situation to the buyers and sellers, with several successful cases reported across India (Kumaravel *et al.* 2007). Apart from mitigating price risk, contract farming provides multiple benefits, viz. access to modern technologies, improved skilling, assured market, technical advice and supply of inputs (Singh *et al*. 2012). In the realm of foodgrains, barley is the fourth important cereal in terms of global area and output (FAO 2019), but in India it is considered as a poor man's cereal and small-holders crop. The concern is the steep decline in the nutri-rich cereal area despite productivity witnessing an increasing trend in the recent past. Traditionally, the cereal has multiple usage like feed for cattle, food for human consumption and raw material for malting and brewing industries. The demand for malt barley has been increasing in the recent past, which led to the development of superior varieties catering the specifications of industries (Nagarajan and Verma 2000, Verma *et al.* 2007, Verma *et al.* 2008, Verma *et al.* 2011).

India stands 14th and 16th respectively in production and acreage with an estimated import of 2.5 lakh tonnes during 2019–20. The yield hovers between 2612 kg/ha (Himachal Pradesh) and 5251 kg/ha (Rajasthan) with significant yield gaps across regions (ICAR-IIWBR 2019) attributed to varietal lag, region-specific constraints and management practices apart from variations in site and inputs use (Sendhil *et al.* 2014) in addition to the major production challenges reported by Verma *et al*. (2010). To address the aforementioned issues, contract farming can be an option. In India, contract farming on malt barley was initiated by M/s United Breweries Ltd., Bengaluru since 2007–08 crop season. Likewise, M/s SAB Miller India and M/s Malt company India took up the contract farming, but did not lasted long, while M/s UB Ltd., still continuing (Verma *et al*. 2008, Verma *et al*. 2011). In the context, an attempt was made to analyse the possibilities of popularizing contract farming by identifying its determinants.

MATERIALS AND METHODS

The study was carried out during 2013–15 in four major barley growing states, viz. Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh, purposively. Post selection of states, two districts with significant area under barley were selected from each state and from each district 50

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sample households were selected randomly from a cluster of blocks and/or villages. Subsequently, the socio-economic and barley production data were collected from the total sample of 400 farmers.

Regression tree analysis: Morgan and Sonquist (1963) proposed an approach to analyse the survey data without imposing any restriction on interactive effects as well as independent of the order in which explanatory variables appear in the model. In the context of classifying the survey data, regression tree analysis – a non-parametric approach – was used to capture the association between socio-economic factors of barley growers and choice of farming *i.e.,* practice of contract farming or not. The approach employing a variance-minimizing algorithm facilitates to determine the underlying factors that are more associated with the choice of farming. The regression tree model progressively splits the data into subsets to find the increasing homogeneity based on the given partition criteria (Mahida *et al*. 2018, Zheng *et al*. 2009), i.e. the dependent variable. In our case, it is whether a farmer practicing contract farming or not. The dependent data are split into a series of descending left and right child nodes derived from the parent nodes by producing the best possible homogenous nodes (Larsen and Speckman 2004). The process stops when there is no additional information provided by the X_i variables. The nodes where the construction ends can be justified statistically and are known as terminal nodes (Riar *et al.* 2020, Cak *et al*. 2013). The functional framework is given as:

$$Y_i = f(X_1, X_2 \ldots X_n)$$

In the present study, Y_i refers to the choice of farming, *i.e.* practice of contract farming or not by the i^{th} farmer and X_i variables comprise continuous variables like farm size, experience, and area under barley as well as categorical variables such as education, source of seed, seed replacement frequency, sowing time and state. SPSS (ver. 21) has been employed to run the regression tree choosing classification and regression tree (CRT) option by fixing parent and child node, respectively at 50 and 25 observations (minimum level).

Table 1 Variables considered in the study

Variable	Description	Measurement
A. Dependent		
Contract farming experience	Whether farmer has enrolled in contract or not?	1 = Yes 0 = No
B. Independent		
Farm size	Operational area owned by farmer	Measured as hectares (ha)
Area under barley	Total area used for barley	Hectares (ha)
Farming experience	Experience of farmer specifically in agriculture	Number of years
Education	Level of education	Literate Illiterate
Source of seed	Where the farmer purchases the seed?	Farmers (own seed) Other sources
Seed replacement	Frequency in replacement of barley seed	Every year Not every year (others)
Sowing time	Time of sowing of barley seed in his/her farm	Timely sowing Early or late sowing
Location	Effect of farmer's location on contract decision	Haryana Madhya Pradesh Rajasthan Uttar Pradesh

RESULTS AND DISCUSSION

Socio-economic variables: Regression tree is a more successful approach to classify the explanatory variables based on the intention criteria. Our interest is to capture the determinants of enrollment into contract farming with respect to barley producers. Data indicates that the dependent variables takes categorical form, whereas, independent variables has both continuous and categorical variables as indicated in the material and methods section (Table 1).

Farm size largely influences the decision of farmer whether to get enrolled into barley contract farming. It is hypothesized that allotment of more area under barley will positively influence the decision of famer since contract farming in barley is popular in the study region. Similarly, farming experience and education facilitates the farmer to adopt contract farming, positively. Source of seed is another criterion largely influences the decision making on contract farming enrollment. If a farmer is likely to use own seed then there is a less chance for getting into contract, and *vice-versa.* Similar explanation shall be given to seed replacement frequency. Higher is the frequency of change, i.e. every year or so, farmers tend to look for seed selling center to purchase, preferably a contract agency or local contractor who mediates the process. Sowing time was considered as it has a direct linkage with the access to seed and seed source. If contract agency provides the barley seeds, then there is a great likelihood of the farmer to join the contract. Apart from these variables, regional dummy was included to know if respondents from a particular state are interested in contract farming. There might be other variables that influence the farmers decision to enroll himself/herself in barley contract like local leader's persuasion, political drive *etc*. which are difficult to capture in real time and beyond the scope of our study. Hence, the explanatory variables were restricted only to socio-economic profile of the respondents which are observable.

Socio-economic characteristics (Table 2) indicated that only 22.50% (90 respondents) were engaged in contract farming relative to the non-contract respondents (310: 77.50%). The average size of the farm holdings was high in the case of non-contractors (4.02 ha per household) against 2.86 ha per contract farmer. Accordingly, the area allocated

for barley differs. It was high in the case of contract farmers (1.16 ha) in comparison to non-contract farmers (0.80). On an average, a contract farmer allots around 41% of total farm area to barley cultivation. In the case of non-contractors, it was only 20%. Farming experience (in years) was not significant among the two groups as the gap between contract and non-contract farmer was marginal. Education is another variable which influences the decision-making of farmers. For the present study, literacy level was more within the groups. Among them, it was higher for the non-contractors. In the study region, a majority of the farmers used seeds from other sources like private seed dealers, contract agency *etc*. Among the two groups, it was more prominent within contract farmers. A less share of farmers within the two groups replaced the seeds every year. Though it is customary in contract that the agency will provide the barley seeds which obviously results in seed replacement every year, but in some pockets of the study region, middlemen or aggregators do exist who gets the farmers into contract informally only with the harvested produce without any formal agreement of supplying seeds and/or other inputs. In absolute terms, farmers opted timely sowing was higher in non-contract group (n=238) and more so in Uttar Pradesh (Sendhil *et al.* 2018). In terms of yield, 35% increase was noticed for contract farmers over their counterparts.

Contract farming profile: Location has been identified as a major factor in deciding the enrollment in contract farming (Table 2) (Sendhil *et al.* 2018). It is clear from the table that Rajasthan has the highest level of awareness regarding contract farming and so as its enrollment. The figures were abysmal in the rest of the study region. For instance, Uttar Pradesh recorded 100% no knowledge as well as no experience on contract farming. In the case of Haryana, almost 50% reduction noticed from past experience to present engagement. Undoubtedly, contract farming is touted against price uncertainty especially during harvest season where produce gluts the market. Despite the multiple advantages including the yield enhancement under barley contracts, the risk management strategy – contract farming – is prevailing only in the borders of Haryana and Rajasthan, wherein around 95% of the malt industries exist (Sendhil *et al.* 2018). Further, Rajasthan promotes contract farming (under APMC Act) as well as operation and bulk procurement of brewing companies like Carlsberg, SAB Miller and Soufflet via contract. In other states, the rules and regulations are relatively complex and many global players avoid such regions.

Determinants of contact farming: The regression tree analysis was done to get a visual representation of relationship between the dependent and explanatory variables so that it provides sufficient information on determinants of contract farming. The regression tree (Fig

Table 2 Socio-economic profile and contract particulars of barley producers (n = 400)

Particular	Contract (n=90)	Non-contract (n=310)
Farm size in ha	2.86	4.02
Area under barley in ha	1.16	0.80
Experience in years	26.41	27.81
Education in frequency		
Literate	68	251
Illiterate	22	59
Seed source		
Farmer	03	73
Others	87	237
Seed replacement frequency		
Every year	25	46
Others	65	264
Sowing time		
Timely sowing	68	238
Others (late or early sowing)	22	72
Yield level in kg/ha	4791	3549

Location	Contract farming particulars (n = 400)					
	Knowledge		Past experience		Present engagement	
	Yes	No	Yes	No	Yes	No
Haryana	24	76	13	87	6	94
Madhya Pradesh	3	97	--	100	3	97
Rajasthan	97	3	95	5	81	19
Uttar Pradesh	--	100	--	100	--	100
All States	124	276	108	292	90	310

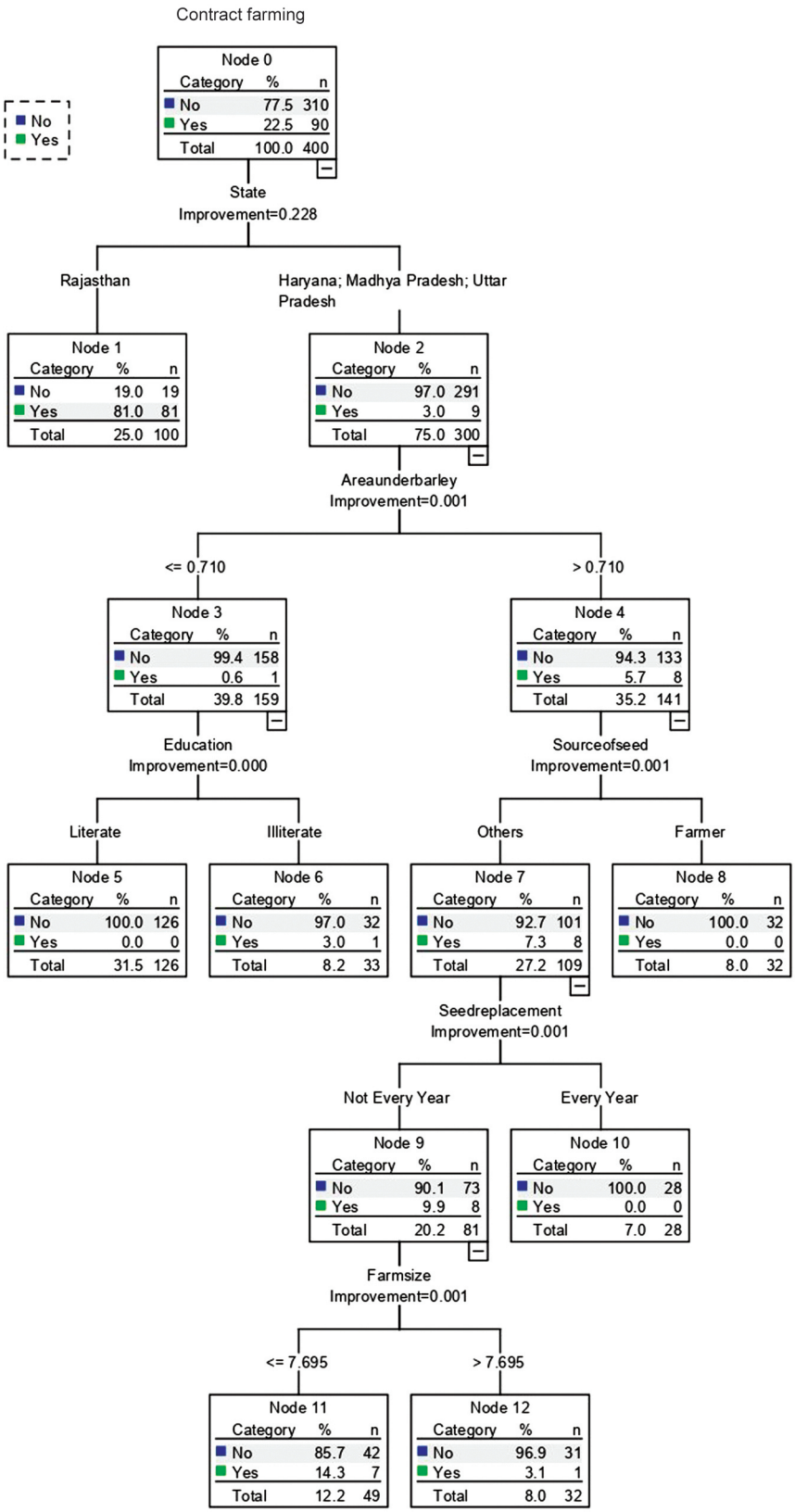

Fig 1 Determinants of contract farming.

1) shows the order of importance of variables influencing the enrollment in contract farming. The root node has been divided into node 1 and node 2, based on the state, which indicated that location is the foremost important factor among others that determined the enrollment, corroborating the information in Table 2. Surprisingly, the rest of the nodes were predicted for the factors that let not to join the contract. The variable in order of importance for not favouring contract farming was found to be area under barley, followed by education, source of seed, seed replacement frequency and farm size. Alternatively, respondents who doesn't have atleast 7.69 ha falling under 'No' in not replacing seed every year with 'No' under other category in source of seed followed by 'No' under atleast 0.71 ha of area under barley who're not from states like Haryana, Uttar Pradesh and Madhya Pradesh are likely to be away from contract engagement. The classification and regression tree showed the branches (nodes) based on the homogeneity prevailed among the respondents for a particular criterion. Ultimately, the process of branch formation gets terminated if there is no explanatory variable providing any additional information. In our case, sowing time and experience of farmers didn't turn significant in determining the decision of the farmer to get enrolled in contract farming. Hence, those variables failed to appear in the regression tree. The estimates of the predictive power of regression tree indicate that the model has predicted 93.90% correctly for observed 'No' responses and 90% for the observed 'Yes' responses. Overall, the model prediction percentage stood at 93 indicating the reliability of the regression tree results. Despite the marketing strategy having positive role on crop productivity (Sendhil *et al.* 2018, Singh *et al.* 2011), its percolation in the study region is very limited, barring Rajasthan. Several reasons shall be attributed to the adoption lag in contract farming. To cite a few; education, experience in agriculture, farm size, source of information, extension services, continuity of contract farming policy by company and seed availability with the contract company influence largely the decision making of the farmer (Singh *et al.* 2011). Ratneshwar (2013) found that the crop yield and price uncertainties were high among non-contract farmers. In terms of monetary benefit,

contract farmers received 7.31% higher price than their counterparts. Apart from price difference, raising barley has its own limitation. Low yield (Sendhil *et al.* 2018), high input cost, occurrence of disease and crop lodging were identified as major production constraints (Ratneshwar 2013). In marketing; low price realization (Singh *et al.* 2012), delay in procurement and payment were reported as major problems. Contract farming is one of the viable options to counter such production as well as marketing risks.

Issues in contract farming: Contract farming has some embedded disadvantages as well and because of the following reasons, the rate of adoption is too low in barley. A majority of the corporate-led companies operates as a monopoly (Singh *et al*. 2013) and tries to neglect the inclusion of small-holders owing to their limited marketed surplus. Literature reports that contracting agencies generally require farmers in a larger number to fulfil their utilisation capacity or demand and hence look for specific regions wherein assured supply exist meeting their standards or quality. Singh *et al*. (2013) finds that farmers had to store malt barley grain owing to delay in procurement by the contracting agencies, which let them to discontinue their contract in the subsequent season (Table 2). A lot of default activities (backing out of pre-agreed price) and less transparency in trading have been reported in the recent past especially under informal contract and as of now there is no clear-cut mechanism to manage them. Further, there is no proper legal mechanism if contracting parties involving an international company, especially in large scale, disobey their committed agreements. Yet, contract farming is a viable and potential strategy owing to its multiple benefits, by and large for price risk management and enriching the farmers' skill in crop production.

Contract farming fosters and strengthens the livelihood of small-holders and serves as a prominent price risk management strategy. It provides resilience to farmers in addressing their economic and financial crises under crashing market price. The present study on determinants of contract farming revealed about 35% yield advantage over non-contract farmers. Location also played a prominent role in contract enrollment. Regression tree analysis indicated respondent's region as a major determinant for getting into contract, followed by farm size, seed replacement frequency, source of seed and area under barley. Contract farming does have multiple benefits but at the same time have some embedded constraints, especially administrative. Further, issues like complex state-specific laws; monopoly operation by the corporate-led companies and delay in procurement post-harvest of malt barley poses a major concern for the farmers in continuing contract farming. So, policy interventions like easing the contract farming agreements especially in legal perspective and implementation of formal contracts with the farmers supported by the government has been suggested. Despite low adoption in the study region with the exception of Rajasthan, barley growers are recommended to take advantage of the risk management strategy and enhance their farming skills as well as profit.

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