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Impact of Contract Farming on Profits of Smallholders

Evidence from Cultivation of Onion, Okra, and Pomegranate in India

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ABSTRACT

This paper attempts to quantify the benefits of contract farming (CF) on farmers' income and investigates the determinants of participation in CF. This is based on a survey of 1,331 farmers from Maharashtra State in India engaged in onion, okra and pomegranate cultivation. The study, using 2-Stage Least Squares method and propensity score matching approach, reveals that CF ensures higher returns for smallholders to the tune of Rs 14.5 per kilogram over independent farmers. Access to institutional credit, extension services, farm size, personal ownership of transport and migration significantly affected farmers' participation in CF. The empirical evidence of the benefits of CF for high-value export commodities should encourage government policies to promote and scale up the use of CF in India.

Keywords: Contract farming, Onion, Okra, Pomegranate, Income, India

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ABBREVIATIONS

2SLS	Two-Stage Least Squares
ATE	Average Treatment Effect
ATT	Average Treatment Effect on Treated
CF	Contract Farming
CIA	Conditional Independence Assumption
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FYM	Farm Yard Manure
GoI	Government of India
ha	Hectare
HH	Household
IFPRI	International Food Policy Research Institute
MSE	Mean Squared Error
MTID	Markets, Trade and Institutions Division
OBC	Other Backward Caste
OLS	Ordinary Least Squares
PSM	Propensity Score Matching
q	Quintal
SATT	Sample Average Treatment effect for the Treated
SC	Scheduled Cast
SE	Standard Error
ST	Scheduled Tribes
USAID	United States Agency for International Development

1. INTRODUCTION

Contract farming (CF) has played a key role in promoting the modernization and commercialization of agriculture worldwide. It is well established in developed countries and in recent years has received considerable attention in developing countries (Wong, Darachanthara, and Soukkhamthat 2014).

CF has come up as a key component in the process of agricultural transformation that facilitates direct firm-to-farm linkages. CF may help farmers overcome the high transaction costs of marketing their produce. It provides farmers with opportunity for nonspot transactions, which are useful when transaction costs are high or markets fail. Markets fail because of factors such as imperfections in credit markets, poor economies of scale in transportation and marketing, asymmetric information about market prices and lack of capacity for smallholders to absorb risk. Further, spot markets are less able to efficiently solve quality and food safety issues, mainly owing to the asymmetric information in these markets. A number of studies have shown that CF can increase agricultural productivity, profitability and farmers' income, and reduce food insecurity; see, for instance, Maertens and Swinnen (2009), Bellemare (2012), Wang et al. (2014), Bellemare and Novak (2016) and Kumar et al. (2016). Even though CF has significant potential benefits for both the contractors and the contracted, particularly for critical quality and safety issues, its role and possible impacts in developing countries are still controversial. One contentious issue is the threat that smallholders may be excluded from CF arrangements, particularly if higher transaction costs (along with more stringent quality and safety demands) prevent small and marginal farmers from participating in CF (Pingali 2006).

India has gone through significant rural transformations and institutional changes that have shaped today's agricultural sector and agricultural policies. According to Chand (2005), CF's benefits to smallholders, who represent about 80 per cent of the rural population, include access to credit, inputs and extension services. Another benefit is the links that CF can create

between input markets and providers and the international markets by organizing the production of high-value food crops. The evidence of CF's impact in the Indian context has been mixed. For instance, Dev and Rao (2005); Nagaraj et al. (2008); Kumar and Kumar (2008); Ramaswami, Birthal and Joshi (2006); Tripathi, Singh and Singh (2005); Birthal, Joshi and Gulati (2005); Kalamkar (2012); Kumar (2006); and Dileep, Grover and Rai (2002) all found that contract producers earned profits almost three times higher than those of independent producers, owing to the former's higher yields and assured output prices. However, Singh (2002) and Opondo (2000) found negative impact of CF on the environment, farmer welfare and the power structure between contractors and farmers.

This study is aimed at identifying the factors that motivate farmers' participation in CF in an overwhelmingly smallholder-dominated context. It also assesses the impact on farmers' economic welfare. In doing so, it contributes to the ongoing debate on CF in India. This is especially important as the Government of India has developed a new model law to promote CF domestically.

The paper is organized as follows. Section 2 describes the production of onion, okra and pomegranate in India and presents the details of the survey data. Section 3 deals with the methodological approach. Section 4 presents and discusses the estimation results, and Section 5 concludes and provides some policy implications.

2. THE COMMODITIES AND THEIR CONTEXTS

Owing to its diverse agro-climatic conditions that favour cultivation of a variety of crops, India is a leading global producer of fruits and vegetables. It is the world's largest okra producer (5.5 million tonnes) with a share of 62 per cent of global production (8.9 million tonnes) during 2016. India is also the second-largest producer of dry onion (19.4 million tonnes) with 21 per cent of global production (93.2 million tonnes) (FAO 2017). Further, India is the world's largest producer of pomegranate (2.3 million tonnes) (GoI 2017a, GoI 2017b). Among India's states, Maharashtra is the leading state in the production of onion (6.5 million tonnes) and pomegranate (1.5 million tonnes), as well as a major producer of okra (0.12 million tonnes) in 2016 (GoI 2017a). Maharashtra accounted for 31 per cent of onion, 64 per cent of pomegranate and 2 per cent of okra production in India in 2016.

The study is based on survey data from 1,131 farmers covering three commodities: onion, okra and pomegranate. The survey was conducted in Maharashtra during March–April 2016. The list of contracting farmers for the year of the survey was obtained from one contracting firm (hereafter, the sample firm) for each commodity. We collected data on various farm and farmer characteristics, including cropping patterns, cultivation economics, marketing channels, good agricultural practices, assets and social networks.

The survey for onion was conducted in Nashik and Jalgaon districts, located in the Khandesh and Northern Maharashtra regions of Maharashtra. Farmers in the Jalgaon district had formal contracts to produce and supply white onions for Jain Farm Fresh Foods Limited. Contract onion farmers were from the Shirsoli, Vadali, Pasardi, Dhanora, Panchak, Nashirabad and Mhaswad villages in Jalgaon district. The independent farmers were selected from the Nashik district, adjacent to the Jalgaon district. Nashik is the largest onion-producing district in Maharashtra, contributing more than 25 per cent of state onion production. Jalgaon and Nashik are located in the same agro-climatic zone (Western Maharashtra Scarcity Zone). We

surveyed 105 contract onion growers (a majority of the total contract farmers) and 478 independent onion growers. To select independent farmers, we randomly identified three blocks from the Nashik district: Nifad, Sinnur and Baglan. The sample size for Nifad, Sinnur and Baglan was 139, 163 and 176, respectively. Then, we selected five villages from each block. Finally, we chose sample households in proportion to the village population for detailed investigation. Jain Farm Fresh Foods Limited is a subsidiary of the parent company Jain Irrigation Systems Limited. The firm has been contracting onion growers for around 15 years in Maharashtra. The contracts are formal and annually renewable. On an average, the surveyed contract farmers have been in contract for last 6 years with the firm. The firm targets international market and exports processed white onion powder to the US.

We surveyed a sample of 141 okra farmers, which included 84 contract and 57 independent farmers. Kay Bee Exports, an exporting company of fresh fruits and vegetables, had contracts with okra farmers in Baramati block of Pune district and Faltan block of Satara district. The firm's purchase price for okra was dynamic, based on changes in its export market price on a weekly to fortnightly basis. The company supplies its own inputs such as pesticides, insecticides and bio-fertilizers to the farmers, without any additional cost, to ensure minimum residual levels in okra for its exports to Europe. We surveyed most of the contract okra farmers from eight villages in sample districts. The independent farmers were surveyed randomly from the Solapur, Pune and Satara districts in the Western Maharashtra region. As relatively fewer independent farmers grow okra, we could survey only 57 farmers from the Solapur, Pune and Satara districts, scattered over 21 villages in three districts. The contracting firm Kay Bee Exports, established in 1989, has annually renewable formal contracts with farmers. The surveyed farmers have been in contract with the firm for an average of around 4 years. The firm's purchase price for okra is dynamic and depending on changes in export market price.

The survey for pomegranate was conducted in Solapur, a leading pomegranate-producing district. A sample of 407 pomegranate farmers were surveyed, comprising 130 contract and 277 independent growers, from 18 villages in the Pandharpur, Malshiras and Sangola blocks of Solapur district. We surveyed contract farmers from the Pandharpur, Malshiras and Sangola blocks, as most contract pomegranate farmers are located in these blocks. Sangola Pomegranate Purchasing and Selling Union (Sangola Dalimb Kharedi Vikri Sangh), a cooperative established in 1992, purchases the produce from its members and sells it to various agencies, primarily traders in Pune and other markets in India. Independent farmers were chosen randomly from the same blocks and villages from where contract farmers were surveyed (Pandharpur, Malshiras and Sangola).

3. METHODOLOGY

We worked out descriptive statistics to understand the characteristics of sample households. We carried out a partial budget analysis to estimate the costs and returns for both contract and independent farmers for each commodity. A farmer's profit is calculated as the difference between revenue generated and cost incurred in onion, okra and pomegranate cultivation. We performed econometric analysis to identify the factors that motivate farmers' participation in CF and to assess the impacts of CF on farmers' profitability, a proxy for farmers' economic welfare.

These two aspects of CF have been examined extensively in the empirical literature. Various studies determine the probability of a farmer's decision to contract as the first step in a two-step econometric process to analyse the impact of CF on farmers' welfare (for example, Katchova and Miranda 2004; Simmons, Winters and Patrick 2005; Miyata, Minot and Hu 2009; Wang, Zhang and Wu 2011; Bellemare 2012; Gupta and Roy 2012; Ito, Bao and Sun 2012). Many other studies, by contrast, focus only on the decision to participate in CF (Birthal, Joshi, and Gulati 2005; Guo, Jolly, and Zhu 2005; Masakure and Henson 2005; Zhu and Wang 2007; Fischer and Qaim 2012; Kumar, Shinoj and Shivjee 2013).

We employed a 2-Stage Least Squares (2SLS) model with instrumental variables to examine the impact of factors associated with a farmer's willingness to opt for CF (in the first stage of regression) and to assess the impact of participation in CF on farmers' profitability (in the second stage of regression). The equation for the 2SLS regression is

$$\pi_i = \alpha + \delta d_i + \gamma X_i + \varepsilon_i \qquad (1)$$

where, π_i is the net profit per kilogram (kg) for a farm household that cultivates onion, okra or pomegranate, d_i is a dummy variable that equals 1 if a farmer is under contract and 0 if not under contract, X_i is a vector of farmer characteristics and ε_i is the error-term.

We chose various socio-demographic and economic characteristics that can influence farmers' decision to participate in CF. These characteristics included age, education, gender of household head, social caste group, family size, farm size, farming experience, migration, primary occupation and access to institutional credit. In the first stage of 2SLS regression, the dependent variable was a binary variable (farmer's participation in CF = 1, otherwise = 0), and the independent variables were a mix of qualitative and quantitative factors, representing various farmer characteristics. We prefer to use the Linear Probability Model in stage one of the 2SLS process than other approaches like Probit model. We follow Angrist 2000 who observes that 2SLS estimates using a linear probability model are consistent vis-à-vis other approaches, thereby underscoring the use of a linear first-stage to be safe. The use of instrumental variable in the 2SLS model takes care of unobserved factors and helps in getting more realistic impact of treatment variable (participation in contract) on profits.

An estimation of equation (1) using ordinary least squares (OLS) regression may give biased results, as a farmer's decision to participate in CF is not random. Farmers either are selected for a contract by the contractor or choose to participate in CF. Hence, different observed and unobserved factors could guide farmers' entry into CF. Thus, the variable representing a farmer's participation in CF (d_i) can be endogenous, and thus correlate with the error-term ε_i. The use of an OLS regression for determining the contribution of CF to farmers' welfare may produce biased estimates.

We used the 2SLS model with instrumental variables to address the unobserved factors and thereby minimise the bias in estimating the impact of CF on a farmer's profit. An ideal instrumental variable should not correlate with the dependent variable in equation (1). It should, however, correlate with d_i, the variable representing CF participation. It should not be a variable from the vector of a farmer's characteristics, X_i.

Accordingly, we attempted to find suitable instrumental variables for the profit equation of onion, okra and pomegranate. We identified a specification comprising several instrumental variables: (1) 'information about contracting facility received by farmer from an institutional source' (yes = 1, 0 otherwise), (2) 'distance of bank from farmer's home', (3) 'averse to financial risk in investment' (yes = 1, 0 otherwise), (4) 'risk of limited marketing channels' (yes = 1, 0 otherwise), and (5) 'risk of poor roads' (yes = 1, 0 otherwise). If a farmer receives information about a contract facility from an institutional source, then the farmer's decision to join a farming contract will be influenced. The distance between the farmer's home and institutional facilities such as banks also influences CF participation. Frequent visit to institutions like banks provides farmers with an opportunity to interact with farmers from various locations, including the farmers engaged in contract farming. The networking effect is likely to prompt such farmers for joining contract farming. Farmers residing near to the banks are expected to visit banks more frequently. Further, proximity to banks may help in facilitating contractual obligations of farmers. A farmer who is risk-averse or who perceives particular production, sale, or delivery risks is more likely to participate in CF. For instance, farmers who are concerned about the risks of limited marketing channels or poor roads are more likely to join CF in order to reduce these risks. Although these instrumental variables are strongly related with d_i, they are not systematically related with the dependent variable—profit—in equation (1). We conducted the OLS and 2SLS regressions with product-fixed effect.

We conducted a Hausman test for endogeneity for the profit equation of onion, okra and pomegranate (Table A.3). Because the Hausman test indicated endogeneity, the 2SLS result should be preferred over OLS.

We then assessed the validity of instruments (when more than one instrumental variable is used) using the Sargan test for over-identification (Table A.4). The two instruments are valid

if the Sargan test outcome is statistically insignificant, and invalid if the outcome is significant. The Sargan test was statistically insignificant, and so the instrumental variables are valid.

We also used propensity score matching (PSM) method to gauge the impact of CF on unit profit. The matching approach helps find a large group of control households that are similar to the treatment households in all relevant pre-treatment characteristics X. Then, the differences between the outcomes of the control group and of the treatment group can be attributed to the treatment. Since conditioning on all relevant covariates is limited in the case of a high-dimensional vector X, Rosenbaum and Rubin (1983) suggest the use of balancing scores b(X), that is, functions of the relevant observed covariants X such that the conditional distribution of X given b(X) is independent of assignment into treatment, also known as the conditional independence assumption (CIA). One possible balancing score is the propensity score; that is, the probability of participating in a treatment given observed characteristics X. The matching procedures based on this balancing score are known as PSM. PSM also will be helpful in checking the robustness of the results based on OLS and independent variables.

Besides CIA, a second assumption of matching requires that treatment observations have comparison observations "nearby" in the propensity score distribution. This common support or overlap condition ensures that persons with the same X values have a positive probability of being both control and treatment households (Heckman, LaLonde and Smith 1999). The common support thus represents the area where there are enough of both control and treatment observations. The common support region allows effective comparisons of outcomes between the treatment and control groups.

Assuming that the CIA holds and that there is overlap between both groups, the average treatment effect can then be estimated. Ideally, we wanted to estimate $\Delta = Y_t^1 - Y_t^0$, which is the difference of the outcome variable of interest at time *t* between two groups, denoted by the superscripts 1 and 0. However, we were unable to estimate Δ in this way because a household

cannot be in the treatment and the control groups simultaneously. Therefore, we measured the average treatment effect (ATE) given the observable data, and estimated the ATE on the treated households (ATT) given a vector household characteristic, X (Birol et al., 2011):

$$ATT = E(\Delta|X, T = 1) = E(Y_t^1 - Y_t^0|X, T = 1) = E(Y_t^1|X, T = 1) - E(Y_t^0|X, T = 0) \quad (2)$$

To estimate the potential effects of participating in a contract, propensity scores are used to match households with similar observable characteristics. PSM entails forming matched sets of treated and untreated subjects that share similar propensity score values (Rosenbaum and Rubin, 1983, 1985). PSM allows one to estimate the ATT (Imbens 2004). We used nearest-neighbour matching to select best control matches for each subject in treatment group. We matched one, three and five control subjects to each treated subject using nearest-neighbour matching, along with kernel-based matching with bootstrap standard errors.

4. RESULTS AND DISCUSSIONS

Characteristics of contract and independent onion, okra and pomegranate farmers

Table 4.1 presents the average values of key household characteristics for farmers of each of the three commodities i.e. onion, okra and pomegranate. The average age of farmers ranged from 44 years to 47 years. Ninety-seven per cent of the households surveyed were headed by males. The caste[1] structure of households differed across commodities. Around 47 per cent of onion growers belonged to the Other Backward Castes (OBCs), 38 per cent were from the general class and the remaining 15 per cent were Scheduled Castes (SCs) and Scheduled Tribes (STs). More than 75 per cent of okra growers were from the general class, while 18 per cent were OBCs and 6 per cent were SCs or STs. Fifty-six per cent of pomegranate farmers were from the general class, 33 per cent were OBCs and 12 per cent were SCs or STs. The farmers' average years of education ranged from 8.4 years (pomegranate growers) to 9.9 years (okra cultivators), while the average years of education of the highest-educated person in each farming family was around 12 years. Around 99 per cent of onion, okra and pomegranate farmers had farming as their main occupation. The average length of farming experience ranged from 19 years for pomegranate farmers to 21 years for onion farmers. The average family size for onion, okra and pomegranate farmers was around six persons. Average dependency ratio ranged between 0.5 and 0.6 for cultivators across crop types. The average farm size was 1.7 hectares (ha) for onion growers, 1.9 ha for okra growers and 2.2 ha for pomegranate growers. About half of onion (52 per cent) and okra (49 per cent) farmers and 68 per cent of pomegranate farmers had access to institutional credit. One-third of the sample

[1] In India, the socio-economically most unprivileged caste groups relate to schedule caste and schedule tribe. Then, besides the schedule caste and schedule tribe, other caste groups that are socio-economically less privileged have been identified by the Government of India as other backward castes (OBC). The schedule caste, schedule tribe and OBCs receive reservation quota in education and government employment. The open category is known as the general class comprising of socio-economically privileged castes.

farmers were members of a cooperative. The percentage of farmers with their own means of personal transport was 73 per cent of onion growers, 67 per cent of okra growers and 51 per cent of pomegranate cultivators.

Some characteristics were significantly different between contract and independent farmers. For example, contract and non-contract onion farmers differed in terms of social caste, education, operational holding size, access to institutional credit, cooperative membership, crop insurance purchase, number of annual visits by private extension officials and own means of personal transport. The contract and independent okra growers differed in terms of family size, access to institutional credit and own means of personal transport. The contract and noncontract pomegranate growers differed in terms of highest education in family, farming experience, operational holding size, access to institutional credit, number of annual visits by private extension officials and own means of personal transport. Among contract onion growers, 81 per cent belonged to OBCs and 17 per cent were from general castes, but only 2 per cent were from SCs or STs. By contrast, 40 per cent of independent onion farmers were from OBCs, 43 per cent belonged to general castes and more than 17 per cent farmers represented SCs and STs. The average years of education of contract onion farmers (11 years) was higher than that of independent farmers (9 years). Contract onion farmers had higher average highest education in family (12.6 years) than independent farmers (11.5 years). Operational holding size was much higher among contract onion farmers (3.1 ha) than noncontract onion farmers (1.3 ha). Access to institutional credit was significantly higher for contract onion growers (72 per cent) than independent onion growers (47 per cent). More than half of the surveyed contract onion farmers belonged to a cooperative or organisation, compared with about a quarter of the independent farmers. Twenty-four per cent of contract onion growers had crop insurance, whereas only 1.5 per cent of independent onion growers insured their crops. Contract onion farmers received an average of six yearly visits from private

extension officials; independent onion farmers received only one visit. Regarding personal ownership of transport, 64 per cent of contract onion growers had their own means of transport compared with to 75 per cent of independent onion farmers.

Other differences were observed in the different groups of okra and pomegranate producers. In the case of okra, the contract farmers had a smaller average family size (5.6) than independent growers (6.8). However, access to institutional credit was lower for contract okra farmers (37 per cent) than independent farmers (67 per cent). In the case of pomegranate, contract farmers had higher average highest education in family (12.1 years) than independent farmers (11.3 years). Contract pomegranate farmers also had a longer average farming experience (22 years) compared with independent farmers (18 years). The operational holding size for contract pomegranate farmers (2.7 ha) was higher than that for noncontract pomegranate farmers (2.0 ha). Access to institutional credit was significantly higher for contract pomegranate growers (87 per cent) than for independent growers (59 per cent). Private extension officials visited contract pomegranate farmers three times per year and independent farmers twice per year. Regarding personal ownership of transport, 65 per cent of contract pomegranate growers had their own means of transport compared with 44 per cent of independent farmers. Table A.6 provides the average figure for household characteristics of onion, okra and pomegranate taken together by appending observations of the three commodities.

Table 4.1 Household characteristics of farmers

Household characteristics	All	Contract	Independent	Difference	*t*-Test value
Onion					
Age of household (HH) head (years)	47.1	46.4	47.2	−0.9	0.6886
Gender of HH head (%) (male=1, otherwise=0)	99.8	100.0	99.8	0.2	0.4684
Social caste (%)					
Scheduled Caste	5.0	0.0	6.1	−6.1	
Scheduled Tribe	9.4	1.9	11.1	−9.2	***
OBC	47.3	81.0	40.0	41.0	(Pr = 0.000)
General	38.3	17.1	42.9	−25.7	
Education of HH head (years)	9.4	11.0	9.0	2.0***	5.7437
Education of highest educated person in HH (years)	11.7	12.6	11.5	1.1***	3.0150
% farmers with farming as main occupation	99.5	100.0	99.4	0.6	0.8129
Experience in farming (years)	21.0	21.7	20.9	0.9	0.7291
Household size	5.8	6.0	5.8	0.2	0.6771
Dependency ratio	0.62	0.56	0.64	0.07	0.7610
Operational land (ha)	1.7	3.1	1.3	1.8***	7.2397
Access to institutional credit (%)	51.6	72.4	47.1	25.3***	4.7826
Membership of cooperative or other organisation (%)	31.2	54.3	26.2	28.1***	5.7835
Crop insurance (%)	5.5	23.8	1.5	22.3***	9.8111
No. of yearly visits by private extension officials	1.8	5.9	0.9	5.0***	12.4177
Own means of personal transport (%)	73.2	63.8	75.3	11.5**	2.4191
Okra					
Age of HH head (years)	43.9	44.1	43.6	0.5	0.2522
Gender of HH head (%) (Male=1, otherwise=0)	97.9	97.6	98.2	−0.6	0.2513
Social caste (%)					
Scheduled Caste	5.7	2.4	10.5	−8.1	
OBC	18.4	19.0	17.5	1.5	Pr = 0.122
General	75.9	78.6	71.9	6.6	
Education of HH head (years)	9.9	10.2	9.5	0.7	1.1364
Education of highest educated person in HH (years)	12.6	12.6	12.4	0.2	0.4566
% farmers with farming as main occupation	99.3	100.0	98.2	1.8	1.2160
Experience in farming (years)	19.4	19.4	19.5	−0.1	0.0345
Household size	6.1	5.6	6.8	−1.2**	2.3505
Dependency ratio	0.53	0.48	0.59	−0.1	0.8809

Household characteristics	All	Contract	Independent	Difference	*t*-Test value
Operational land (ha)	1.9	1.8	2.0	−0.3	0.7887
Access to institutional credit (%)	48.9	36.9	66.7	−29.8***	3.6019
Membership of cooperative or other organisation (%)	27.0	29.8	22.8	7.0	0.9096
No. of yearly visits by private extension officials	1.2	1.0	1.5	−0.5	1.1348
Own means of personal transport (%)	67.4	78.6	50.9	27.7***	3.5710
Pomegranate					
Age of HH head (years)	43.9	45.0	43.5	1.5	1.1832
Gender of HH head (%) (Male=1, otherwise=0)	98.8	100.0	98.2	1.8	1.5421
Social caste (%)					
Scheduled Caste	9.8	6.9	11.2	−4.3	Pr = 0.393
Scheduled Tribe	1.7	0.8	2.2	−1.4	
OBC	32.9	33.9	32.5	1.4	
General	55.5	58.5	54.2	4.3	
Education of HH head (years)	8.4	8.7	8.2	0.5	0.9837
Education of highest educated person in HH (years)	11.5	12.1	11.3	0.9**	2.2239
% farmers with farming as main occupation	98.8	98.5	98.9	−0.4	0.3880
Experience in farming (years)	19.3	21.6	18.3	3.4***	2.9953
Household size	5.8	6.0	5.6	0.4	1.4244
Dependency ratio	0.52	0.53	0.52	0.01	0.0520
Operational land (ha)	2.2	2.7	2.0	0.8***	2.8985
Access to institutional credit (%)	67.6	86.9	58.5	28.4***	5.9438
Membership of cooperative or other organisation (%)	31.9	100.0	0.0	100.0	–
No. of yearly visits by private extension officials	2.3	3.1	1.9	1.2***	6.5214
Own means of personal transport (%)	50.6	65.4	43.7	21.7***	4.1591

Source: Field survey (2016).
Notes: ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively.

Table 4.2 presents data on yield, production cost, output prices and profits of both contract and independent onion, okra and pomegranate farming households. The average onion yield was higher for contract growers (239.3 quintals per hectare [q/ha]) than for noncontract producers (187.4 q/ha), and differed significantly at the 1 per cent level. Additionally, the average price realised by onion contract farmers (Rs 753/q) was significantly higher than that received by noncontract farmers (Rs 598/q). Moreover, the cost of onion cultivation was significantly lower for contract farmers (Rs 515/q) than for noncontract farmers (Rs 762/q). The higher yields, better prices and lower production costs achieved by contract farmers made onion cultivation more profitable. Further, the open-market prices for onions had crashed in 2016 owing to increased production, and so the independent onion growers incurred a loss of Rs 164/q. The contract farmers were protected from these price fluctuations because of their contract-fixed prices and earned a profit of Rs 238/q. In case of okra, contract farmers produced a significantly higher yield than that of independent farmers. However, okra prices and production costs for contract farmers were lower than that of independent farmers. The independent farmers received higher open-market prices for okra, compared with the fixed prices received by contract farmers. Nevertheless, contract okra farmers received subsidies for their input costs, particularly for plant protection material and bio-fertilizers, which contributed to their lower production costs (Rs 1,469/q). The contract okra farmers therefore earned significantly higher profits (Rs 1,231/q) because of their lower production costs and higher yields. In case of pomegranate, the contract and independent farmers did not differ significantly in yield, price, cost or profit. Table A.1 depicts various components of the cost of cultivation. Table A.2 gives percentage distribution of the components in total cost of cultivation. Several studies have reported substantial positive impact on gross margins, crop income or total household income of contract farmers in developing countries; these include studies on Kenya (Wainaina, Okello and Nzuma 2012), India (Singh 2002; Birthal, Joshi and Gulati 2005; Tripathi, Singh and Singh

2005; Ramaswami, Birthal and Joshi 2006; Kalamkar 2012), Senegal (Warning and Key 2002), Laos (Leung, Sethboonsarng and Stefan 2008), Madagascar (Bellemare 2012), Nicaragua (Michelson 2013), China (Zhu 2007; Miyata, Minot and Hu 2009; Xu and Wang 2009) and Indonesia (Simmons, Winters and Patrick 2005).

Table 4.2 Economics of onion, okra and pomegranate cultivation for contract and independent farmers in India

Economics of cultivation	All	Contract	Independent	Difference
Onion				
Yield (q/ha)	196.7	239.3	187.4	51.9***
	(76.7)	(74.8)	(73.9)	
Price (Rs/q)	625.9	752.6	598.0	154.6***
	(196.3)	(405.5)	(82.7)	
Production cost (Rs/q)	717.7	514.7	762.2	−247.6***
	(339.5)	(197.0)	(348.0)	
Profit (Rs/q)	−91.8	237.9	−164.2	402.2***
	(394.3)	(381.8)	(358.8)	
Okra				
Yield (q/ha)	180.8	200.6	151.5	49.1***
	(71.9)	(68.3)	(67.6)	
Price (Rs/q)	2,871.6	2,700.0	3,124.6	−424.6***
	(359.6)	(0.0)	(462.6)	
Production cost (Rs/q)	2,028.4	1,469.4	2,852.2	−1,382.9***
	(1,153.3)	(775.7)	(1,128.5)	
Profit (Rs/q)	843.2	1,230.6	272.3	958.3***
	(1,022.5)	(775.7)	(1,079.3)	
Pomegranate				
Yield (q/ha)	98.3	95.9	99.3	−3.4
	(35.9)	(41.9)	(32.8)	
Price (Rs/q)	5,137.3	5,225.4	5,096.0	129.4
	(965.2)	(926.4)	(981.8)	
Production cost (Rs/q)	3,908.6	3,840.1	3,940.7	−100.6
	(2,220.9)	(2,044.8)	(2,301.8)	
Profit (Rs/q)	1,228.8	1385.3	1,155.3	230.0
	(2,327.9)	(2,322.3)	(2,331.2)	

Source: Field survey (2016).
Notes: ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively.
Figures in brackets represent standard deviation.

Determinants for farmers' participation in CF

Table 4.3 presents the results of the first stage of 2SLS regression (equation 1) that exhibits the determinants of farmers' participation in CF for onion, okra and pomegranate. The variables farm size, access to institutional credit, number of visits by government extension officials, number of visits by private extension officials, and own personal transport, had significant positive relation with CF participation. By contrast, migration of household members had negative impact on CF participation, because migration may hamper activities related to the contractual arrangements. In addition, okra and pomegranate farmers were more likely than onion growers to participate in CF.

Table 4.3 Determinants for farmers' participation in CF for onion, okra and pomegranate cultivators

Dependent variable: Participation in contract farming (yes=1/no=0)		
Variable	**Coefficient**	**S.E.**
Socio-demographic variables		
ln(Age of HH head) (years)	−0.142	(0.919)
Square of ln(Age of HH head)	0.0233	(0.126)
Gender of HH head (Male=1, 0 otherwise)	0.0810	(0.0890)
Caste		
OBC (Yes=1, 0 otherwise)	0.0203	(0.0337)
General (Yes=1, 0 otherwise)	0.0291	(0.0258)
ln(Years of education of HH head)	−0.0394	(0.0663)
Square of ln(Years of education of the HH head)	0.0163	(0.0208)
ln(Number of economically active family members)	0.00652	(0.0175)
Migration (Yes=1, 0 otherwise)	−0.109***	(0.0401)
Ln(Operational land) (Ha)	0.0364**	(0.0168)
Own personal transport (Yes=1, 0 otherwise)	0.0847**	(0.0428)
Economic variables		
Main occupation (Farming=1, Other=0)	−0.00184	(0.125)
Access to institutional credit (Yes=1, 0 otherwise)	0.0742***	(0.0219)
ln(Number of visits by government extension officials)	0.0650**	(0.0304)
ln(Number of visits by private extension officials)	0.0338**	(0.0160)
ln(Number of visits by farmer for extension officials)	−0.00332	(0.0168)
Product Fixed Effect (Okra)	0.903***	(0.0421)
Product Fixed Effect (Pomegranate)	1.180***	(0.0741)
Instrumental variables		
Information about contract facility received from an institutional source (Yes=1, 0 otherwise)	0.0499	(0.0325)
Distance to bank from home (kilometre)	−0.00355*	(0.00190)
Averse to financial risk in investment (Yes=1, 0 otherwise)	0.0588***	(0.0175)
Risk of limited marketing channels (Yes=1, 0 otherwise)	0.0910**	(0.0437)
Risk of poor roads (Yes=1, 0 otherwise)	0.0709*	(0.0418)
Constant	−0.0340	(1.579)
No. of observations	1,131	
R-squared	0.628	
Root MSE	0.2777	
District Fixed Effect	Yes	

Source: Authors' analysis based on field survey (2016).
Notes: Standard errors in parentheses; ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively. Standard errors are clustered at the district level.

Impact of contract farming on farmers' profit

Table 4.4 exhibits the results of the impact of CF on profits made by onion, okra and pomegranate cultivators. It gives the outcomes of the second stage of 2SLS regression along with OLS regression. Unlike OLS regression, the 2SLS regression takes care of the unobserved factors in regression and gives the true impact of CF on farmers' profit. The instrumental variables used in the 2SLS model were (1) 'information about contracting facility received by farmer from an institutional source' (yes=1, 0 otherwise), (2) 'distance of bank from farmer's home', (3) 'averse to financial risk in investment' (yes=1, 0 otherwise), (4) 'risk of limited marketing channels' (yes=1, 0 otherwise), and (5) 'risk of poor roads' (yes=1, 0 otherwise). The instrumental variables were tested for their validity using the Sargan test (Table A.4) and found to be valid. The Hausman test for endogeneity shows endogeneity in the profit equation (Table A.3). This means that estimates of 2SLS regression should be preferred over that of OLS regression. The results in table 4 show that CF had a significant positive impact on the profits of onion, okra and pomegranate growers. Participation in CF enhanced farmers' profit by Rs 14.5/kg. Migration had a negative impact on the profits. However, the product fixed effect did not indicate significant difference in the unit profits of okra and pomegranate with respect to onion.

Table 4.4 Impact of CF on profits for onion, okra and pomegranate cultivators in India

Dependent variable: Unit profit in production of onion, okra and pomegranate (Rs/kg)				
Variable	**OLS**		**2SLS 2nd stage**	
	Coefficient	**S.E.**	**Coefficient**	**S.E.**
Contract Farming (Yes = 1, 0 otherwise)	1.938***	(0.360)	14.54**	(5.106)
Socio-demographic variables				
ln(Age of HH head) (years)	−49.42	(30.56)	−47.83	(26.90)
Square of ln(Age of HH head)	6.759	(4.128)	6.484	(3.600)
Gender of HH head (Male=1, 0 otherwise)	−2.692	(3.207)	−3.752	(4.470)
Caste				
OBC (Yes=1, 0 otherwise)	−1.829	(1.974)	−2.238	(2.277)
General (Yes=1, 0 otherwise)	−0.950	(1.433)	−1.436	(1.743)
ln(Years of education of HH head)	−0.211	(1.435)	0.174	(1.464)
Square of ln(Years of education of HH head)	0.863	(0.829)	0.692	(0.764)
ln(Number of economically active family members)	0.831	(1.202)	0.731	(1.178)
Migration (Yes=1, 0 otherwise)	−7.859*	(3.080)	−6.458*	(2.505)
Ln(Operational land) (Ha)	0.188	(0.494)	−0.292	(0.808)
Own personal transport (Yes=1, 0 otherwise)	−2.953*	(1.247)	−4.010	(1.984)
Economic variables				
Main occupation (Farming=1, Other=0)	6.268	(3.225)	6.393	(3.028)
Access to institutional credit (Yes=1, 0 otherwise)	0.130	(0.493)	−0.741	(0.763)
ln(No. of visits by government extension officials)	0.718	(1.131)	−0.187	(0.507)
ln(No. of visits by private extension officials)	1.503	(0.836)	1.139	(0.686)
ln(Number of visits by farmer for extension officials)	−2.118	(1.602)	−2.199	(1.574)
Product Fixed Effect (Okra)	13.77***	(0.428)	2.179	(4.879)
Product Fixed Effect (Pomegranate)	24.78***	(0.433)	9.563	(6.387)
Constant	83.97	(56.37)	84.81	(52.44)
No. of observations	1,131		1,131	
R-squared	0.212		0.164	
Root MSE	14.296		14.728	
District Fixed Effect	Yes		Yes	

Source: Authors' analysis based on field survey (2016).
Notes: Standard errors in parentheses; ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively. Standard errors are clustered at the district level.

Robustness for profitability

We use the PSM method to evaluate the impact of CF on unit profit for onion, okra and pomegranate cultivators in India (Table 4.5). Table A.5 gives the variables involved in satisfying the balancing property and common support of the propensity score. Table 5 gives the outcomes of the nearest-neighbour matching estimation with analytical standard errors, as in Abadie and Imbens (2006), and kernel-based matching with bootstrap standard errors. For both okra and onion farmers, the unit profit for contract farmers was significantly higher than that for independent farmers. However, CF did not appear to have had a profit impact on pomegranate growers. The profit for onion contract farmers was more than that for independent farmers in the range of Rs 3.7/kg (nearest-neighbour matching with number of matches = 5) to Rs 4.4/kg (nearest-neighbour matching with number of matches = 1). In the case of okra growers, the contract farmers earned higher profit than the independent farmers, ranging from Rs 8.3/kg (kernel-based matching) to Rs 10.0/kg (nearest-neighbour matching with number of matches = 5). Further, when observations pertaining to onion, okra and pomegranate are taken together, contract farmers received higher returns with regard to independent farmers in the range of Rs 4.0/kg (kernel-based matching) to Rs 6.7/kg (nearest neighbour-matching with number of matches = 1). Thus, the results validate the outcomes of the 2SLS regression that contract farmers earn significantly higher profit than independent farmers do.

Table 4.5 Impact of CF on profits for onion, okra and pomegranate cultivators in India: Outcomes of the nearest-neighbour matching and bootstrap standard errors (kernel-based matching)

Number of matches (m)	Variable	Unit profit in production (Rs/kg)			
		Onion	**Okra**	**Pomegranate**	**All three**
m=1	SATT	4.360***	9.292***	2.915	6.704***
		(0.864)	(2.152)	(4.511)	(1.911)
m=3	SATT	3.791***	9.710***	2.595	5.602***
		(0.617)	(2.032)	(3.521)	(1.414)
m=5	SATT	3.659***	9.992***	2.079	5.722***
		(0.553)	(1.891)	(3.031)	(1.307)
Observations		583	141	407	1,131
Bootstrap standard errors (kernel-based matching)		3.978***	8.259**	−2.304	4.020***
		(0.716)	(3.257)	(3.597)	(1.469)
Observations		579	135	402	1,131

Source: Authors' analysis based on field survey (2016).
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1, m=1, 3 and 5 indicating 1, 3 and 5 neighbours, respectively.

5. CONCLUSION

This study is based on 2016 survey data of farm households cultivating onion, okra and pomegranate in India. It assesses the drivers for participation in CF and estimates the impact of CF on profits for growers of these commodities. Our results show that access to institutional credit, extension facility official visits, personal ownership of transport and farm size have a positive effect on farmers' participation in CF, whereas migration has a negative impact. Conditional on participation, the contract farmers were able to earn significantly higher profits in their onion, okra and pomegranate cultivation. CF also played an important role in connecting smallholders to high-end international markets. However, our study shows heterogeneity in the impact of CF. The higher CF profits for onion and okra stemmed mainly from higher yields and lower production costs, whereas CF did not realize higher yield or profit for pomegranate growers. In the case of pomegranate farmers, the motivation for CF may come from a desire to share the risks of cultivation. These findings have several important policy implications. The benefits of CF are product- and contract-specific, and therefore policymakers should design appropriate strategies and mechanisms to promote CF in several agricultural commodities, especially in high-value crops, without considering it to be a one-size-fits-all solution for agricultural production.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 The economics of cultivation of onion by sample contract and independent farmers in India (Rs per ha)

Particulars of cost of cultivation	Onion			Okra			Pomegranate		
	Contract	Independent	Difference	Contract	Independent	Difference	Contract	Independent	Difference
Labour	25,076	20,970	4,106***	99,707	116,404	−16,697	53,543	58,961	−5,417
	(15,607)	(12,225)		(59,339)	(80,800)		(34,861)	(56,581)	
Inputs:									
Seed	12,552	22,580	−10,028***	24,926	22,167	2,579*	25,024	28,801	−3,776**
	(3,966)	(12,452)		(8,563)	(8,865)		(8,452)	(17,832)	
Fertilizers	15,058	13,166	1,892*	28,818	56,123	−27,304***	48,213	55,572	−7,358**
	(10,504)	(9,990)		(25,623)	(28,815)		(34,302)	(35,301)	
Irrigation	31,676	29,094	2,581	63,844	73,220	−9,376	101,872	130,370	−28,498*
	(25,038)	(21,549)		(44,699)	65,579		(100,507)	(173,275)	
Farm Yard Manure (FYM)	6,268	11,263	−4,994***	17,372	18,143	−1,941	19,862	21,485	−1,623
	(7,986)	(12,046)		(17,852)	(12,706)		(18,455)	(14,703)	
Pesticides	9,648	13,714	−4,065***	1,486	51,744	−50,258***	39,693	42,345	−2,651
	(11,568)	(11,104)		(7,825)	(52,581)		(33,545)	(37,085)	
Other costs	0	16	−16	6,195	4,413	1,781	0	45	−45
	(0)	(288)		(15,833)	(10,448)		(0)	(415)	

Particulars of cost of cultivation	Onion			Okra			Pomegranate		
	Contract	Independent	Difference	Contract	Independent	Difference	Contract	Independent	Difference
Rent for bullock pair / machinery	8,570	12,126	−3,555***	17,919	19,825	−1,906	19,289	11,843	7,446***
	(7,281)	(11,097)		(11,829)	(20,557)		(15,927)	(10,066)	
Marketing costs	9,053	9,543	−490	1,691	27,181	−25,489***	19,448	20,872	−1,423
	(5,252)	(7,771)		(9,674)	(26,511)		(12,422)	(12,924)	
Total cost of cultivation	117,901	132,472	−14,571**	261,959	389,220	−127,262***	333,066	375,020	−41,954*
	(49,808)	(61,689)		(116,246)	(171,796)		(164,060)	(236,247)	

Source: Field survey (2016).
Notes: ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively. Figures in brackets represent standard deviation.

Table A.2 Composition of cost of cultivation of onion in India (%)

Head of Costs	% share in total cost of cultivation					
	Onion		Okra		Pomegranate	
	Contract	Independent	Contract	Independent	Contract	Independent
Labour costs						
Land preparation	0.37	1.01	0.55	1.69	1.24	1.10
Sowing	2.18	1.93	1.12	2.67	2.10	2.10
Irrigation	1.01	0.93	0.87	5.05	2.42	2.72
Weeding	6.29	3.43	5.98	3.34	2.69	2.14
Spraying	1.39	2.38	1.94	9.90	3.76	4.42
Harvesting	10.70	6.57	27.11	6.06	2.37	1.82
Input costs						
Seed	11.30	18.34	9.91	6.01	7.86	9.22
Fertilizers	13.46	10.71	10.15	15.20	14.90	15.69
Irrigation	25.81	19.79	25.77	18.97	31.64	31.98
FYM	5.07	8.74	6.54	4.68	5.73	6.38
Pesticides	7.34	10.03	0.65	13.01	11.21	11.89
Costs for hiring bullocks and equipment	7.43	9.04	6.47	5.33	6.19	3.31
Other costs	0.00	0.01	2.39	1.10	2.03	1.33
Marketing costs						
Labour	0.74	0.79	0.35	3.72	1.11	1.26
Transport and others	6.92	6.29	0.19	3.28	4.74	4.62

Source: Field survey (2016).

Table A.3 Hausman test for endogeneity in the profit equation for onion, okra and pomegranate

Dependent variable: Unit profit in production of onion, okra and pomegranate (Rs/kg)		
Variable	**Independent Variables:** (1) Information on contract facility received from institutional source; (2) Distance of bank from home; (3) Averse to financial risk in investment; (4) Risk of limited marketing channels; (5) Risk of poor roads	
	Coefficient	**S.E.**
Contract Farming (Yes = 1, 0 otherwise)	5.075**	(1.421)
Socio-demographic variables		
ln(Age of HH head) (Years)	−49.25	(30.17)
Square of ln(Age of HH head)	6.737	(4.074)
Gender of HH head (Male=1, 0 otherwise)	−2.636	(3.073)
Caste		
OBC (Yes=1, 0 otherwise)	−1.922	(1.926)
General (Yes=1, 0 otherwise)	−0.994	(1.377)
ln(Years of education of HH head)	−0.323	(1.405)
Square of ln(Years of education of HH head)	0.893	(0.818)
ln(Number of economically active family members)	0.776	(1.142)
Migration (Yes=1, 0 otherwise)	−7.849*	(3.010)
ln(Operational land) (Ha)	0.159	(0.494)
Own personal transport (Yes=1, 0 otherwise)	−2.912*	(1.300)
Economic variables		
Main occupation (Farming=1, Other=0)	6.437	(3.350)
Access to institutional credit (Yes=1, 0 otherwise)	0.114	(0.462)
ln(Number of visits by government extension officials)	0.724	(1.128)
ln(Number of visits by private extension officials)	1.510	(0.821)
ln(Number of visits by farmer for extension officials)	−2.176	(1.553)
Product Fixed Effect (Okra)	13.73***	(0.420)
Product Fixed Effect (Pomegranate)	24.68***	(0.469)
Ehat	**−3.305***	(1.268)
Constant	82.68	(55.68)
No. of observations	1,131	
R-squared	0.213	
Root MSE	14.298	
District Fixed Effect	Yes	

Source: Authors' analysis based on field survey (2016).

Notes: Standard errors in parentheses; ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively. Standard errors are clustered at the district level.

Table A.4 Sargan test for over-identification of instrumental variables in the 2SLS regression

Dependent variable: Profit (Rs/kg)

Instrumental variables: (1) Information on contract facility received from institutional source; (2) Distance of bank from home; (3) Averse to financial risk in investment; (4) Risk of limited marketing channels; (5) Risk of poor roads

Tests of overidentifying restrictions:

Sargan (score) chi2(4) = 5.64388 (**p = 0.2274**)

Basmann chi2(4) = 5.53677 **(p = 0.2365**)

Source: Authors' analysis based on field survey (2016).

Table A.5 List of variables involved in satisfying the balancing property and common support of the propensity score

Contract Farming

Socio-demographic variables

ln(Age of the HH head) (Years)

Square Ln(Age of the HH head)

Gender of HH head (Male=1, 0 otherwise)

Social caste

ln(Years of education of the HH head)

Square Ln(Years of education of the HH head)

ln(Number of economically active family members)

Migration

ln(Operational land)

Own personal transport

Economic variables

Main occupation

Access to institutional credit

ln(Number of visits by government extension officials)

ln(Number of visits by private extension officials)

ln(Number of visits by farmer for extension official)

Source: Field survey (2016).

Table A.6 Household characteristics of surveyed farmers taking together the onion, okra and pomegranate cultivators

Household characteristics	All	Contract	Independent	Difference	*t*-Test value
Age of household (HH) head (years)	45.6	45.2	45.7	-0.5	0.6422
Gender of HH head (%) (male=1, otherwise=0)	99.2	99.4	99.2	0.2	0.4001
Social caste (%)					
Scheduled Caste	6.8	3.4	8.1	-4.7	***
Scheduled Tribe	5.5	0.9	7.3	-6.3	(Pr =
OBC	38.5	45.5	35.8	9.6	0.000)
General	49.2	50.2	48.8	1.4	
Education of HH head (years)	9.1	9.8	8.8	1.1***	4.2517
Education of highest educated person in HH (years)	11.7	12.6	11.6	1.0***	3.7881
% farmers with farming as main occupation	99.2	99.4	99.1	0.2	0.4001
Experience in farming (years)	20.2	20.7	20.1	0.6	0.6885
Household size	5.8	5.8	5.8	-0.0	0.0420
Dependency ratio	0.6	0.5	0.6	-0.6	0.8524
Operational land (ha)	1.9	2.5	1.8	0.8***	4.0526
Access to institutional credit (%)	57.0	69.0	52.3	16.6***	5.1371
% of farmers having cooperative membership	30.9	43.4	28.5	14.9***	4.0800
Annual visits by government extension officials (number)	1.7	2.1	1.6	0.6***	3.2765
Annual visits by private extension officials (number)	1.9	3.7	1.5	2.1***	8.3289
Annual visits by farmers to extension officials (number)	1.9	4.1	1.5	2.6***	8.2155
Own means of personal transport (%)	64.4	68.3	62.8	5.5*	1.7485
Number of economically active family members	1.7	1.7	1.7	-0.0	0.0018
% of households having migration (%)	4.9	3.5	5.4	-1.9	1.3863

Source: Field survey (2016).
Notes: ***, ** and * represent 1 per cent, 5 per cent and 10 per cent significance, respectively.

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